EXPLORING THE FACTORS RELATED TO ACADEMIC PUBLICATION PRODUCTIVITY AMONG SELECTED MALAYSIAN ACADEMIC ENGINEERS AND SCIENTISTS

by

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TABLE OF CONTENTS

CHAPTER 4: ANALYSIS OF RESPONSES FROM THE ACADEMIC ENGINEERS

CHAPTER 5: ANALYSIS OF RESPONSES FROM THE ACADEMIC SCIENTISTS

CHAPTER 6: EXLORING THE SURVEY FINDINGS

LIST OF FIGURES

LIST OF TABLES

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Abstract

EXPLORING THE FACTORS RELATED TO ACADEMIC PUBLICATION PRODUCTIVITY AMONG SELECTED MALAYSIAN ACADEMIC ENGINEERS AND SCIENTISTS

This is an exploratory study, which aims to examine the factors affecting the research publication productivity of academic engineers and scientists from the National University of Malaysia (UKM) and University of Malaya (UM). This study aims to identify problems, as well as increase the understanding of factors conducive for a productive academic research environment. The study identifies (a) the total number and types of research publications published by the sample groups; (b) examines the endogenous factors such as personal, home, academic background, attitude, views and problems faced and how these are related to publication productivity; (c) examines the exogenous factors such as departmental and institutional variables which are environmentally generated and their relation to publication productivity ; (d) examines academic staff's information use and disseminating behaviour ; (e) examines the problem associated with publishing articles or in obtaining library materials and services and how these factors are related to publication productivity. The sample population comprises 125 academic engineers and 311 academic scientists from the National University of Malaysia and University of Malaya. The engineers are from the civil, chemical, electrical and mechanical departments, while the scientists are from the departments of botany, chemistry, genetics, geology, mathematics, physics, and zoology. The data collection and information about academic staff are obtained from three sources: (a) a self-administered questionnaire, (b) the university calendar and (c) academic research activity report from both universities. Following the analysis of the data from the questionnaire, interviews were conducted with a selection of 56 academics to further explore and explain findings of the survey. The results are reported in descriptive statistics and tested for significance and correlation using the chi-square test for nominal type variables and the Spearman rank test. The results generally show that in more cases, the correlates are significantly related to publication productivity of academic scientists than engineers. The significant correlates (<0.01) are respondents' age, number of professional memberships, affiliation, discipline, qualification, academic rank, working experience, per cent of time spent on research, research collaborative behaviour (with colleagues within the departments, universities or outside the country), total amount of funding received, laboratory support, active use of the computer for research, positive views on research, and using formal resources (journals, library's accession lists, special bibliographies) to keep abreast with research information.

Keywords: Publication Productivity; Academic engineers; Academic scientists; Correlates of academic productivity; Channels of information; Publication output; Research publications; Method of keeping abreast; Collaboration; Computer use for research.

Chapter 1

INTRODUCTION

1.1. BACKGROUND

University academic staff engage in research, teaching and administration, and many consider research the most important of their activities (Herbstein, 1993). The standing of a university, to a certain extent depends upon its academic staffs' research achievements. Appointments and promotions within the university system are strongly linked to research output (Abu Hassan, 1977) and its impact on the society.

A member of academic staff within this context is seen as an individual attempting to fulfill varied professional roles, one of which is to undertake research. She or he is seen as the centre of the university research system and around him/her, individually or as part of a group, the university's research process revolves to achieve the university's institutional and departmental research goals and objectives. To understand the research publication output attained by academic staff members, it is appropriate to examine the factors, which might be related to this activity. Creswell (1985) opined that the value of research is clearly understood by those working in the university system but it is less clear how academic staff perform research. There have been numerous studies assessing research performance reported in the literature which date from as early as the 1940s (Wilson, 1942; Lazarfelds and Thielens, 1958; Pelz and Andrews, 1966; Braun, Glanzel and Schubert, 1990; Budd, 1995; Babu and Singh, 1998). These studies reveal the wide variation in the publication behaviour among disciplines, and the largely unexplained "situation" of why some academic staff publishes year after year while others does not.

Within the Malaysian context, the emphasis on research for development began in the last ten years. This is the result of the country's vision to be an industrialised nation by the year 2020

(Mahathir, 1991). Allocations and incentives for research were provided for in the country's five-year development plans. In addition, certain thrust or priority areas of research have been identified for the disbursement of research funds to ensure that research proposals are streamlined in accordance with these areas. In Malaysia, the Ministry of Science, Technology and Environment is responsible for the allocation and monitoring of research and development (R & D) allocations and spending. The allocation to the institutions of higher learning amounts to only 11.8% of total R & D expenditure (National survey, 1998), spread over the twelve universities in Malaysia. Besides the financial resources from the central government, each university disburses smaller amount of its own funds for research. Currently, the Ministry of Science, Technology and Environment reports on the expenditure and fund allocations in three reports published in 1994, 1996, 1999 (National survey, 1992, 1994, 1998). The report highlights the level of research activities conducted in terms of fund allocation and expenditure but provides no information on the output of research (total number and types of published works) or its outcome (citations, awards, recognition received). As a result, it is difficult to ascertain the actual achievements of research activities undertaken. At the university level, the only evidence of 'output' is the annual report of academic research activities published by each university. Research 'output' in the form of published works is the focus of this study. A published work is defined as a written contribution in a refereed source, either at the national or international level. The total number of research output in this context, refers to the total number of published work (raw count). The types of research output include; single or joint authored works, journal articles, conference papers, books, chapters in books, edited and translated works, research or consultation reports and standards or patents obtained. An attempt is also made to identify possible factors related to research publication productivity. Since research plays an important role in academia, it is considered appropriate to conduct an exploratory study to examine the relationship of identified factors on the total publication output. It is assumed that faculty members are affected by a variety of internal and external factors when performing their research, and an understanding of these factors would help university management understand the conditions that give rise to a vibrant and healthy research environment.

The main analysis of this study compares the total number of publication output with identified external and internal factors. The factors included are those used by previous studies on publication productivity located through published literature as well as factors identified by the researcher herself.

1.2. PURPOSE

The purpose of this study is to explore the factors, which may be related to high academic research publications amongst selected Malaysian engineering and science faculty members. This study will also identify problems that researchers encounter, as well as probe into academic's perception of the environment conducive for academic research.

The study aims to:

(a) identify the types and frequency of research publications by academic engineers and scientists in Malaysia;

(b) examine whether endogenous factors are related to academic staff's publication productivity. Endogenous factors are situations that originate from within the individual, and are usually within his/her control. These include his/her personal background, home situation, academic background, attitudes, views and problems;

(c) examine whether exogenous factors are related to academic staff's publication productivity. Exogenous factors are situations that originate from outside the individual's environment and are beyond his/her control. The situations are environmentally generated and these include the departmental and institutional variables;

(d) examine whether academic staff's information use and disseminating behaviour influence his/her research publication productivity;

(e) examine whether problems in publishing works and in obtaining related library materials and services, influence a faculty member's publication productivity.

1.3. RESEARCH QUESTIONS

The study proposes to answer the following questions regarding the publication output of academic engineers and scientists and the factors, which may be related to it.

(1) What are the number and types of research publications published by academic staff between 1990 to 1995?

(2) Is publication productivity related to the length of time that elapses after the respondent wrote his/her first research report?

(3) Which are the journals chosen by academic staff to publish their research results and their geographical distribution?

(4) Are the respondents' demographic, academic, institutional and professional factors related to publication productivity?

(5) Is publication productivity related to the respondents' views on their role in research and the support provided by their department and institution?

(6) Is publication productivity related to the degree of collaboration undertaken?

(7) Is publication productivity related to the use of formal and informal channels to locate, communicate and disseminate their research findings?

(8) Is publication productivity related to the methods the respondents' used to keep abreast of current research information?

(9) Is publication productivity affected by the confidence that respondents have of their research communication skills and the problems they encountered when locating or obtaining information provided by their libraries?

1.4. HYPOTHESES

The variables that make up the endogenous and exogenous factors will be compared to the total number of publication productivity achieved. The literature on research assessment and correlates of publication productivity covered in chapter 2, indicate results which are inconclusive. Determinants that indicate significant relationship to publication productivity in some studies, have failed to find similar results in other studies. It is also difficult to ascertain that the findings obtained from studies carried out in the United States or European countries equally apply to the Malaysian academic context. As such, this study adopts the null hypotheses. The following null hypotheses will be tested.

1.4.1. Influence of Endogenous Variables

(a) Personal Factors

Personal variables comprise demographic attributes which are either inherent within the person under study or are closely related to his/her personal environmental makeup. Previous studies have included personal and individual characteristics when investigating publication productivity (Lawrence and Blackburn, 1988; Jungnickel and Creswell, 1994).

Hypothesis 1 - The total number of publications achieved by academic engineers and scientists are independent of their personal background such as gender, race, age and the number of children they have.

(b) Academic Factor

This factor comprises seven variables related to the academic make-up of the researcher, which puts him/her in an advantageous position as a lecturer and a researcher. A number of studies have included academic variables such as, academic discipline, qualifications, professional experience, and academic rank when studying publication productivity (Blackburn; Behymer and Hall, 1978; Lawrence and Blackburn, 1988).

Hypothesis 2 - The respondents' institution, the department they are attached to, the highest academic qualification obtained, the number of years since their highest degree was obtained, the country from which they had obtained their highest qualification, the length in years of working experience and their academic rank are not related to the total number of publications achieved.

(c) Professional Factors

Prpic (1996a) has included active membership in international associations when investigating the publication productivity among eminent scientists. In this study, professional factors include the total number of professional affiliation, total consultation undertaken, and total number of editorial involvement in scholarly publications.

Hypothesis 3 - The total number of publications achieved are not related to the number of professional associations that respondents are involved in, the number of consultation work undertaken and the number of journals edited.

(d) Attitudinal Variables

Blackburn, et al. (1991) used academic staff self-evaluation and perception of their role in research and their environment when studying research performance. In this study, academic staffs' views were sought on research role, their perception of departmental and institutional support in research.

Hypothesis 4 - The respondents' ratings on research outcome statements, departmental and institutional view statements are independent of the total number of publications achieved .

(e) Channels of Information Used and Research Dissemination Behaviour

Previous studies have investigated the researchers' use of formal and informal sources of information (Hagstrom, 1965; Dill, 1986). However very few have related this to academic's research performance. Formal channels are written sources and informal channels are usually oral in nature (Meadows, 1974). In this study, respondents were asked to rate their use of 13 formal channels and 8 informal channels for research information.

Hypothesis 5 – The respondents' rating on formal and informal channels that they use to obtain and disseminate research information are not related to the total number of publications achieved.

(f) Methods Used to Keep Abreast with Research Literature

Subramanian (1981) observed the relationship between letter journal for current information and the value of correspondence and conference proceedings in the early stages of research. In this study, the respondents were asked to rate eleven channels for keeping abreast of current literature

Hypothesis 6 - The respondent's ratings on methods of keeping abreast with the literature are not related to the total number of publications achieved.

(g) Problems in Publishing, Using or Obtaining Information Needed for Research

Two types of problems are considered here. Firstly, respondents were asked to rate on eight possible problems that they faced when publishing their research results. Secondly, the respondents were asked to indicate their ratings on fifteen problem situations related to using or obtaining related library materials or services needed for research.

Hypothesis 7 – The respondents' ratings of their research writing and library related problems are not related to the total number of publications achieved.

1.4.2. Influence of Exogenous variables

(a) Departmental Factors

Departmental variables such as teaching and administration load and time allocated to research have been included in a number of studies investigating publication productivity (Garland and Rike, 1987; Wood, 1990). These variables will be included in this study.

Hypothesis 8 -The per cent of time allocated to research, teaching and administration, the minimum publication requirements set by departments, the number of faculty members employed and research students enrolled within each department have no effect on the total number of publication productivity.

(b) Organisational Factors

Organizational factors considered in this study are variables such as funding awards, grants, library facilities, laboratory and electronic support. The inclusion of factors such as the library facilities and electronic support have rarely been considered in previous researches of publication productivity but is considered essential due to the changing role of libraries and the facilities offered through the Internet.

Hypothesis 9 – The total as well as the amount of funding received, the ratings on the library facilities, laboratory services provided and the ratings on the type of computer used are independent of the respondents' total number of publication productivity.

(c) Collaboration factors

Recent studies have included research collaboration when investigating publication productivity (Avkiran, 1997; Babu and Singh, 1998). This variable is considered important and included in the present study.

Hypothesis 10 - Respondents' total number of publications productivity are independent of their ratings on the five types of collaborative situations frequently undertaken.

1.5. ORGANISATION OF THE STUDY

This thesis is organised into seven chapters. Chapter one presents the background to the study, the objectives, the research questions and the ten hypotheses to be tested. Chapter two presents a review of pertinent research drawn from literature on the publication productivity of university faculty members and the correlates associated with it. It also presents the research and development scenario in the Malaysian context. Chapter three presents the research design and methods of the study. The research systems model is also included in this chapter. Chapters four and five report the results of the survey of the academic engineering and science samples and the discusses of the results of the ten hypotheses tested. Chapter six describes the results of the interviews with a selected sample of the highly productive academic engineers and scientists in order to verify the findings of the survey. Chapter seven concludes this study by giving a summary of the results of the research questions posed in chapter one, highlighting the contributions of this study and giving recommendations for future studies.

Chapter 2

COUNTRY SETTING AND REVIEW OF LITERATURE

This chapter is divided into three parts. The first part describes the research setting in Malaysia, the second presents general methods used to measure publication productivity and the third relates previous studies on the determinants of publication productivity.

2.1. PART ONE: THE RESEARCH SETTING IN MALAYSIA

2.1.1. Government Commitment

The Malaysian government has recognised Science and Technology (S & T) activity as a necessary constituent of her socio-economic development plans only in the last 10 years. The Fifth Malaysia Plan covering 1985 to 1989 (Malaysia, 1986), embodied this commitment with a whole section (chapter 8) on "Science and Technology", in which the government unveiled its vision to achieve industrialised status by the year 2020. Subsequent 5-year plans have included science and technology, research and development policy and management strategy.

Under the Sixth Malaysia Plan (1990 to 1995), the public research sector and universities were encouraged to promote 'contract research systems' where research units within organisations could be contracted directly. This policy helped to alleviate the burden on the government in bearing the total cost of R & D activities and contribute to the achievement of a 65% self sufficiency target by the year 2000. Research institutions and university consulting units were also encouraged to move towards commercializing their research activities. Priority was given to R & D activities that are multi-disciplinary and multi-institutional in nature. The six core priority areas of research were:

(a) information and communication (high performance computing, networking, communications, digital imaging, multimedia, high definition display, high density storage, software and simulation and modeling);

(b) microelectronics (sensor technology, semiconductor materials and microelectronic circuits, optoelectronics, avionics, advanced semi-conducter devices);

(c) biotechnology and life sciences (biotechnology materials and process, medical devices and diagnostics, medical technology);

(d) advanced manufacturing and technology (flexible computer integrated manufacturing, machine intelligence and robotics, micro fabrication, systems management technology);

(e) advanced materials (composites, ceramics, semiconductor materials, photonic materials, materials synthesis and processing, superconductors, high performance metals and alloy); and

(f) environment and energy related activities (green materials, agro-based waste, renewable energy, portable energy, pollution minimisation, remediation and waste management).

The Seventh Malaysia Plan (1995 to 2000) concentrated on the commercialisation of R & D in both public research institutions and universities. Commercial and investment units of research institutes and universities were restructured, gradually corporatised and made responsible for commercialising as well as marketing the intellectual property of their inventors and researchers. Added incentives were provided to ensure that R & D personnel, especially those who contributed to successful commercial ventures was appropriately rewarded. This included offering share options in the subsidiaries of corporatised research institutions and the company they serve in (Malaysia, 1996).

2.1.2. Research Active Institutions

Scientific research is undertaken by three main sectors in Malaysia, comprising: the government agencies and public research institutes; institutions of higher learning; and non-profit organizations. The universities and other institutions of higher learning are responsible for undertaking research to advance knowledge, support teaching needs and provide consulting services.

Research activities are defined as " Creative work undertaken on a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications" (National survey, 1994, p.2). The activities included in research are (a) design, construction and operation of prototypes where the main objective is technical testing or to make further improvements; (b) construction and operation of pilot plants not operated or intended to be operated as commercial units; (c) research into and original development of computer software such as new programming languages and new operating systems; (d) feedback R & D directed at solving problems occurring beyond the R & D phase, such as technical problems arising during initial production runs; (e) research work in the biological, physical, social sciences and the humanities.

2.1.3. R & D at the Universities

Table 2.1 reveals the total expenditure on R & D allocated to institutions of higher learning.

Table 2.1: R&DExpenditure (RM) in 1992 to 1998 by Type of Activity for Institutions of Higher Learning (IHL)

Sector	Basic research	Applied research	Experimental development	Total R&D expenditure	% total expenditure for sectors
IHLs					
1992	21,210,234.00	6,840,962.00	6,840,962.00	34,892,158.00	9%
1994	9,995,956.00	135,,329,600.00	5,553,948.00	150,879,504.00	24.6%
1996	14,437,753.00	18,395,110.98	7,506,908.79	40,339,772.77	7%
1998	91,323,309.00	32,067,043.11	10,247,848.40	133,638,200.51	11.8%
Total R&D expenditure					
1992	68,858,422.00	229,367,628.00	210,192,191.00	550,699,237	100
1994	44,212,432.00	383,543,949.00	183,470,084.00	611,226,465	100
1996	49,234,294.67	228,543,084.60	272,449,004.19	550,226,383.46	100
1998	138,804,168.05	568,638,757.56	419,589,663.74	1,127,032,589.35	100

Source: *National Science and Technology Data Book 1998*. Kuala Lumpur : Malaysian Science and Technology Information Centre, 1999

The table also indicates that allocations to institutions of higher learning were reduced from 24% in 1994 to 11.8% in 1998. Institutions of higher learning spent about 68.3% of total expenditure allocated on basic research, and 24% on applied research.

The federal government is not the sole source of R & D funds. About 30.9% of the R & D funds was obtained from state/local government, 27.3% was from the institution's own fund, 22.7% came from IRPA (Intensified Research in Priority Areas) and 17.4% was from the Federal Government. Table 2.2 indicates sources of funds received by the institutions of higher learning in 1998. In 1998, UM led with RM51.2 million spent on R & D, followed by UKM with RM 36.8 million, USM with RM30.3 million and UPM with RM6.4 million.

Table 2.2: Source of R & D Fund Obtained by Universities - 1998

Univer-sity	Own Fund	IRPA	Fed.Govt.	Cess	State/local Govt	Other Funds	Total (RM)
UIAM	937,103.77	191,296.00	169,000.00	n.a.	n.a.	1,500.00	1,298,899.77
UiTM	595,059.16	410,863.55	165,000.00	n.a.	n.a.	17,287.55	1,188,210.26
UKM	7,434,404.98	4,886,805.37	22,223,709.00	20,000.00	643,750.00	1,140,884.25	36,349,553.60
UM	3,923,014.92	6,699,184.23	209,234.73	n.a.	40,350,000.00	59,300.00	51,240,733.88
UMS	43,034.18	n.a.	n.a.	n.a.	n.a.	n.a.	43,034.18
UNIMAS	464,991.43	1,341,018.80	n.a.	n.a.	n.a.	5,163.00	1,811,173.23
UPM	2,149,643.00	3,899,228.55	31,200.00	n.a.	n.a.	284,600.00	6,364,671.55
USM	19,652,564.14	9,619,069.35	221,415.14	n.a.	273,520.00	469,111.57	30,235,680.20
UTM	789,581.20	3,222,569.88	239,469.55	n.a	n.a	69,130.00	4,320,750.63
UTN	39,798.00	n.a.	n.a.	n.a.	n.a.	n.a.	39,789.00
UTP	25,600.00	n.a.	n.a.	n.a.	n.a.	191,700.00	217,300.00
UUM	481,822.27	46,573.61	n.a	n.a	n.a	n.a	528,395.88
TOTAL	36,536,617.05	30,316,609.34	23,259,028.42	20,000.00	41,267,270.00	2,238,676.37	133,638,201.18

Source: *National Survey of Research and Development 1998*. 1999 ; Table 8.2

UIAM=International Islamic University Malaysia ; UiTM=MARA University of Technology ; UKM=National University of Malaysia ; UM= University of Malaya ; UMS=University of Sabah, Malaysia ; UNIMAS=University of Sarawak, Malaysia; UPM= Putra University of Malaysia ; USM=Science University of Malaysia ; UTM=University of Technology, Malaysia; UTN=University of Tenaga Nasional ; UTP=University of Technology, Petronas ; UUM=Northern University of Malaysia

Malaysian universities spent the most amount of R & D monies in basic research and University of Malaya (UM) tops the list followed by National University of Malaysia (UKM) and Science University of Malaysia (USM) (Table 2.3). In applied research, USM tops the list, followed by UKM and UM. USM also lead in experimental and developmental research. Table 2.3 indicates the entrance new universities such as University of Sabah, Malaysia, University of Sarawak, Malaysia and private universities, University of Technology Petronas and University of Tenaga Nasional.

Table 2.3: R & D Expenditure by Type of Research - 1998

Univer-sity	Basic Research	Applied Research	Experimental Development.	Total	% from total
UIAM	295,600.00	688,893.95	314,405.82	1,298,899.77	0.97
UiTM	276,486.71	575,060.00	336,663.55	1,188,210.26	0.89
UKM	26,955,395.24	7,885,240.63	1,508,917.73	36,349,553.60	27.20
UM	43,904,435.65	5,402,777.20	1,933,521.03	51,240,733.88	38.34
UMS	43,034.18	n.a.	n.a.	43,034.18	0.03
UNIMAS	591,237.90	899,272.33	320,663.00	1,811,173.23	1.36
UPM	1,817,355.25	3,784,166.99	763,149.31	6,364,671.55	4.76
USM	15,126,676.88	11,331,744.01	3,777,259.31	30,235,680.20	22.63
UTM	1,789,691.98	1,237,790.00	1,293,268.65	4,320,750.63	3.23
UTN	n.a.	39,798.00	n.a.	39,789.00	0.03
UTP	n.a.	217,300.00	n.a.	217,300.00	0.16
UUM	523,395.88	5,000.00	n.a.	528,395.88	0.40
TOTAL	91,323,309.67	32,067,043.11	10,247,848.40	133,638,201.18	100.00

Source: *National Survey of Research and Development 1998*. 1999; Table 8.5a

Table 2.4 indicates the R & D expenditure by fields of research for UM and UKM. UM lead in the expenditure on chemical science, followed by medical and biological sciences. UKM also indicated similar expenditure trend and is seen to increase its activity in agricultural sciences. Both universities appear to be active in similar areas of research with new venture in the fields of environmental sciences. This "likeness" in research orientation and departments make both universities suitable subjects for study in order to understanding the possible determinants of publication productivity in the fields of engineering and sciences.

Table 2.4: UKM & UM R & D Expenditure by Field of Research 1992,1994 and 1998

Field of Research	UM			UKM		
	1992	1994	1998	1992	1994	1998
Mathematical science	31,900	13,220	--.	--	17,280	--
Physical Science	328,572	660,927	36,975	311,400	39,100	903,269
Chemical Science	980,250	171,105	40,642,466	1,187,939	957,738	25,023,662
Earth Science	129,300	49,968	--.	215,000	162,400	248,275
Information, Computer & Comm. Sciences	24,804	97,228	767,539	318,700	853,520	--
Applied Science & Technology	390,826	296,898	273,078	1,443,400	332,237	--
Engineering	208,378	191,200	489,732	76,850	811,114	n.a.
Biological Sciences	1,111,590	684,281	1,432,747	1,649,271	1,482,924	1,886,942
Agricultural Sciences	286,306	255,112	180,930	727,598	437,650	1,274,909
Medical Sciences	2,026,367	2,288,208	7,116,263	683,042	958,367	4,461,854
Environmental Sciences	--	100,736	--.	--	208,362	1,920,840
Material Sciences	--	28,419	296,000	--	1,787,839	170,000
Marine Sciences	--	--	--.	--	--	--
Social Sciences	62,931	445,120	5,000	--	112,857	67,674
Humanities	89,000	34,398	--.	--	2,664	392,127
TOTAL	5,670,224	5,308,821	51,240,733	6,613,200	8,164,053	36,349,553

Source: *National Surveys of Research and Development 1992, 1994, 1998*, published in 1994 and 1996, 1999

Malaysia's gross expenditure on R & D as a ratio of gross domestic product stood at 0.39% in 1998 compared to other Asian countries such as Japan (3.0%, 1996), Korea (2.10%, 1994), Singapore (1.76%, 1998), Taiwan (1.82%, 1994), India (0.79%, 1994), China (0.72%, 1994), Thailand (0.2%, 1994), and Indonesia (0.16%, 1991). This is still considered low as at least 1% of GNP is usually the accepted level at which R & D can begin to effectively support socio-economic development in a country (Malaysia, 1996)

2.1.4. Research Performance

The monitoring and assessing R & D activities is undertaken by the Ministry of Science, Technology and the Environment (MASTIC) in Malaysia. To date, its information centre have published three reports on R & D statistics (*National Survey*, 1992, 1994, 1998).There has been no assessment on the output of research at the national level. MASTIC monitored resource allocations and provided ranking only in terms of the amount of research activities conducted (amount of allocations and expenditure). The 1994 report indicated that the top three ranking institutions of higher learning in terms of R & D expenditure were UPM, UKM and UM. The 1998 report however, shifted the top ranking institution to UM, UKM and USM. The reports did caution the validity of the ranking provided, indicating that the universities differ in terms of academic orientation, age and discipline emphasis. The results of the 1998 survey conducted by MASTIC identifed some factors limiting R & D activities. The top five limiting internal factors indicated are: (a) limited financial resources, (b) lack of skilled R & D personnel, (c) delays in making decisions by management, (d) lack of emphasis on the importance of R & D for long term benefit and (e) weak current organisation structure. The top external factors identified are: (a) increasing capital costs; (b) shortage of R & D personnel with requisite expertise, (c) poor physical infrastructure support, (d) too many government regulations, and (e) lack of government incentives. In this context, the focus was on the 'inputs' of research not the 'output' or 'outcome'.

Very few bibliometric studies have considered Asia or Asean countries as a whole in research assessment studies. The performance of Malaysia was included as one of the countries under study by Arunachalam and Garg (1986). The study indicated Malaysia's performance in terms of world scientific literature, as part of their analysis of science in the Asean countries. This study identified works published over a two-year period (1979-1980) from five Asean countries (Indonesia [182], Malaysia [452], the Philippines [241], Singapore [258] and Thailand [447]) covered by the *SCI* and citations of them from 1979-1983. Despite the relative economic affluence, science in Asean countries is still on the periphery. The total number of papers from Malaysia between 1979-80 is 452 and the subject distribution is indicated in Table 2.5.

Table: 2.5: Malaysia's Scientific Performance (1979-1983)

Subject distribution	No. of papers
Medical sciences	174
Physical sciences	43
Agricultural sciences	51
Biological sciences	47
Chemical sciences	83
Engineering/earth sciences	10
Mathematical sciences	19
Food science & Technology	8
Environmental sciences	6
Veterinary sciences	-
Others	11
Institutional distribution	**No. of papers**
University of Malaya	178
University Science Malaysia	91
Institute of Medical Research	23
University Putra Malaysia	17
Malaysian Agricultural Research & Development Centre	12
Others	131
Publication in journals according to impact factor	**No of papers**
0.0-1.0	275
1.0-2.0	103
2.0-3.0	46
3.0-4.0	6
4.0-5.0	2
>5.0	4
Others	16

Source: Arunachalam and Garg, 1986

Among the universities, only University of Malaya, Science University of Malaysia and University Putra of Malaysia were represented as active publishers. Compared to the other Asean countries, Malaysia produced the largest number of papers and more of her authors contributed more than one paper in the two-year period. The study indicated that the total number of papers published by Malaysian scientists was low and most papers were published in low impact journals, which were rarely cited. Arunachalam and Garg's study is outdated and the situations in the 1990s might be vastly different, considering that real expenditure on R & D began in the 1990s. An exploratory study on the publication output of Malaysian scientists and engineers from two of Malaysia's oldest universities is considered appropriate and timely. The focus will be on identifying the total and types of publication output and factors related to publication productivity.

2.2. PART TWO: MEASURING RESEACH PRODUCTIVITY

2.2.1. Academic Research Assessment

A number of review articles highlighted the evaluation process of research performance (King, 1987; Creswell, 1985; Martin and Irvin, 1983; Daniel and Fisch, 1990). Creswell (1985) reported that early studies examining faculty research performance began in the 1940s and 1960s as exemplified by Wilson (1942), Westbrook (1960) and Pelz and Andrews (1966). Martin and Irvin (1983) described and discussed performance indicators of research used in Great Britain, the United States and other countries. The review also discussed in some length the various measures of research productivity, quality, impact and outcome.

Some studies viewed the academic activity as a sociological "role" (Fenker, 1975; Startup, 1979). The role here referred to the behaviour expected of people belonging to an identifiable category (by virtue of their membership). The university lecturer's behaviour was not considered random but directed towards defined objectives. The major categories of faculty behaviour identified were: teaching, research, participation in university activities or campus organizations, administrative responsibilities and professional activities (consultation, reviewer and public speaking). The responsibility of the university lecturer was closely linked to the responsibility of the university in that he or she helped to produce the various "outputs" notably "educated students" or "research papers" which advanced frontiers of knowledge in the various disciplines.

This section focuses on literature investigating indicators used in higher education to evaluate research performance. Research is an important academic activity and is expected of every faculty member. The assessment of research may take the form of an input-output process. The inputs constitute manpower (qualified lecturers and professors, percentage of time spent on research, number of research students, number of support staff); institutional resources (supportive administration, adequate laboratories, library and electronic facilities); and financial resources. The outputs of research are more complex comprising intangible outcomes such as new scientific knowledge, awareness of new methodologies, discovering new theories and new empirical findings. The tangible output of research are either published in the form of research reports, journal articles, and theses or communicated in the form of conference papers or produced as a finished product in the form of patented inventions and trained / qualified researchers. The outcome of research comes in varying forms of recognition conferred to the researcher on the basis of his contribution to his field of research which, include positive ratings or rankings by peers, and award of honours and prizes (Moracsik,1985; Cuenin, 1986; Frackmann, 1987; Cave, Hanney and Kogan, 1991).

The pressure to evaluate research grew out of reduced funds available for research. Universities were asked to indicate their research plans as well as priority areas through budget proposals. This is happening in most universities throughout the world. As a result a number of techniques were tried out. In the UK the University Grants Committee (UGC, 1988) requested universities to provide details on staff, publications, students, research grants, contracts and statements of plans. The universities were rated on a five-point scale and this information was used to make research-funding allocations. Chan (1978) proposed knowledge-recognition output indicators that considered assessment at three main stages of research. The first were output indicators at the preliminary stage of the research that included research proposals submitted and research proposals, which successfully obtained funding. The second output indicator exemplified those generated at the communication stage of the research activity such as, research reports, dissertations, papers, invited papers, patents/copyrights, commercial publications, research seminar. These are called knowledge-related output indicators. The third output indicators are those obtained at the evaluation stage of the research that includes peer judgments of research reports, citations, invited papers, awards and prizes, honorary elections, and department quality rating. These are called the recognition-related output indicators. Based on this model Chan distributed questionnaires to academics and administrative staff in the civil, electrical and industrial engineering departments. The results revealed consensus of opinion among the respondents with regard to indicators they considered important. Articles published in prestigious journals were recognised as the most important knowledge indicator and 93% of faculty gave this indicator a rank of 1 or 2. Both the faculty and administrative staff judged published articles, dissertations and invited papers as highly important criteria of effectiveness. Chan's study confirmed the types of research output academics felt to be important and provided a picture of possible output indicators that could be considered at the various stages of research.

Phillimore (1989) proposed these four indicators of research performance: (a) output (publications); (b) impact (citations); (c) quality (research grants, research studentships; awards, prizes, honours, journal editorship, peer judgment, reputation; (d) utility (external income, patents, licences, contracts). The study indicated more agreement on the validity of most research performance indicators than that for teaching. Published research findings are the most common variable used to measure the output of research. It is often regarded as the main source of esteem for individuals and institutions as well as a requirement for promotion. It is recognised as a scholarly activity that needs to take a physical form as published paper, communicated or exchanged. The university culture equates academic distinction with publications (Ramsden, 1994). Hodges et al (1994) proposed the following measures of performance indicators: total number of publications, number of articles published in academic journals, refereed conference papers, authored books, edited books, short works, book reviews, research grants and contracts awarded, and the number of research students enrolled.

Other studies saw the potential of using bibliometric data as a tool to assess the productivity of individual scientists, departments or institutions (Wade, 1975; Martin and Irvin, 1983, 1985; Moed, et al., 1983 and Debruin, et al., 1993). Bibliometric analysis is the term used when applying quantitative methods to published bibliographic data. The bibliographic data of published research were extracted from indexes, abstracts, bibliographies, annual reports and databases such as the *Science Citation Index* (*SCI*) produced by the American Institute for Scientific Information. Katz and Hicks (1997) used measurements of size, recognition, impact of publications and collaboration to assess research productivity. Size was measured by counting refereed scientific publications. Impact and recognition were measured using citations to these papers. Collaboration was measured using information derived from institutional addresses listed on co-authored publications. Recognition and impact were compared to size across scientific communities within a nation and across nations within scientific fields. Invariably, national and international scientific activity comprised: (a) the size or number of published papers; (b) the recognition received as measured by citation of papers; (c) impact measured by citations/paper; (d) collaboration, measured by the number of co-authored papers (Katz, 2000). The total number of papers published by a group, institutions or nations is a partial indicator of the strength of research undertaken. The number of citations is a partial indicator of impact of the research activity. The impact of the research is a partial measure of research quality. Traditionally the impact indicator is considered to be robust as the number of citations received is independent of the publishing (Katz, 1999a, 1999b). Most researches on the evaluation of research productivity combined publication count with citation count in order to effectively explore the complex relationship between scientists and research productivity.

2.2.2. Measuring Productivity: Publication Counts

A measure frequently used to assess publication productivity is the quantity of publication produced by an individual or group of scientists, departments or institutions. The quantity of publication considered includes the total number of articles published over a specific number of years or total career publications and total books published. Blackburn, Behymer and Hall (1978) solicited total articles and books published (over 2 years and total career output) from

1,216 academic staff in four-year colleges and 7,484 academics from universities in the United States. The instrument used was a questionnaire. The use of a survey questionnaire to gather self-reported publication data was indicated to be reliable. Allison and Stewart (1974) found that self-reported response from chemists correlated with publication counts obtained from *Chemical Abstracts*. Braun, Glanzel and Schubert (1990) used the *Corporate index files* of the *SCI* to obtain information about the publication productivity of authors from 10 OECD countries between the years 1981 to 1985.

Publication counts are often used to study the trend of research output. As early as 1926, Lotka examined the pattern of scientific productivity in the field of chemistry. He noticed that there was a regularity in the rate of publications and indicated that the number of scientists producing n articles was proportional to $1/n^2$, that is, 100 scientists publishing 1 article, 25 published 2 articles, 10 published 3 articles and so on. Price (1963) remarked that this pattern is not new and should be indicated in most scientific discipline. The studies above have led to the growth of several formal, analytical and predictive models which described and analysed the phenomena of scientific productivity (Bookstein, 1977; Coile, 1977; Schorr, 1974; Murphy, 1973; Rao, 1980).

Publication counts therefore refer to individual, group or institutional output and include conference papers, journal articles, monographs, book chapters, books and patents. Publication counts of a department is a formal indication of its research activity. This is shown in the list of publications that figure in many universities' annual reports. In assessment, consideration is given to the type of publications to be included, the weights to be given to each type, the sources of information about publications to be used, the scope of publications to be included (whole department or publications of each academic staff) and the percentage of staff who had not published during three preceding years.

There are two broad approaches to the type of publications to be included. Some recommended limiting it to journal articles (Frame, 1983; Drew and Karpf, 1981, Johnes, 1986; Ward and Grant, 1996) and some used a range of publications such as books, journal articles, conference papers, reviews, books edited and translated (Cave, Hanney and Kogan, 1990). The techniques used to analyse total journal articles were varied; some used contributions from a range of journals (Crewe, 1987 covered 2,00l journals in which British political scientists had published); some limited it to leading journals only (Knudsen and Vaughn, 1969; Cox and Catt, 1977,Graves , Marchand and Thompson, 1982); some used a quality weighting system for the journals academic staff published in; and others considered the number of pages published (Bell and Seater, 1978). Graves, Marchand and Thompson only considered articles in the top 24 academic journals in the field of economics. Meltzer (1949) used a weighting scheme that equated 18 articles to one book.

Weights for the different types of publication was a method used to assigned quality to quantity counts (Harris, 1989). Manis (1951) gave 1 point for articles as well as edited books, and 18 points for single-authored books. Glenn and Villemez (1970) assigned 30 points to research or theoretical monographs, 15 points to textbooks, 10 points for edited books, and 4 to 10 points for articles in journals depending on the quality of the journal. Glenn and Villemez stressed that the weights given must be different across disciplines, such as giving more weights to journal articles in the sciences and to books for the social sciences. Lightfield (1971) gave 1 point for an article, 1 point for an edited book, and 1 point per 100 pages. Finkensteadt and Fries (1978) gave weights to the following types of publications; monographs 50, co-authored monographs 40, journal articles 10, co-authored of journal articles 8, editorship 10, co-editorship 8, school text 5, translations of a book 5, book review 1, and dissertation 20. Waworunto (1986) used a modified weighting system for Indonesian academics; research report 2, printed book 7, edited book 2, chapter of a book 2, article in an international professional journal 5, article in Indonesian professional journal 3, publication in mass media ½, and unpublished scholarly writing, conference papers 2½. Creswell (1985) cautioned the accuracy of weight counts because equal credit may be given to poorly written paper in high-quality journals and high quality paper in an unranked journal. The above studies indicated that there are no one standard formulated for assigning weights to publications.

The period over which publications were counted was variantly applied ranging from 13 years (Laband, 1985) to one year (Gillett, 1989). A number of studies found correlation between total departmental publications and reputation ranking (such as those by Cartter, 1966 and Jones, 1982) or peer review ratings (Crewe, 1987; Zhu, Meadows and Mason, 1991; Martin and Skea, 1992). Frame (1983) suggested that publications count enabled management to adjust allocations for research. To obtain a more realistic picture of the collective strength of a department, Crewe (1987) suggested that 20% of the most productive should be eliminated from the count and that the department with the strongest collective strength should be given priority.

In general, the studies revealed that the average number of publications produced was quite small. Halsey (1980) reported that 23 percent of his UK university academic staff sampled and 68 percent from polytechnics had not published. Blume and Sinclair (1973) reported mean numbers of papers by academics ranged from 13 to 26 in different fields of chemistry in British universities. Fox (1992) estimated a mean of 2.4 among social scientists in three years. In Australian universities, Harris (1990) found 24 percent of academics produced no output between 1984 to 1988 and the average is one publication per year.

There are however, a number of problems related with publication counts. Firstly, there need to be a common consensus about the types of publications that should be included. Questions need to be asked whether it is realistic to just consider total journal article contributions or contributions in journals which are ranked when assessing publication productivity across disciplines and countries. Secondly, the number that gets listed in international databases might represent only a small percentage of total scientists' publication and this is especially true for developing or third world countries. Schrum (1997) compared the results of a search of international databases on agriculture and natural resource management in Ghana, Kenya and Kerala with results from interviews with researchers. The results indicated that the data provided by international databases provided only a "view from afar" that did not accurately reflect the total output of the population of researchers in less developed countries. It is on this basis that the current study has included only publications published between 1990 and 1995, listed in the annual research reports of two Malaysian Universities published between 1990 and 1996.

Other problems included: co-authors were given the same amount of credit as a solo author; a short paper was counted the same as a long one; no distinction was made between a poor and an excellent paper and between an original or repetitive work (Knorr, 1979a and 1979b). Martin and Irvin (1983) suggested that the relationship between total publication and scientific progress was not straightforward. Some 'mass producer' of publications made very little scientific progress, while other 'perfectionists' achieved few publications which were significant scientific contributions. A simple count could provide a measure of scientific production but not scientific progress. Martin and Irvin further suggested that publication counts can be used to compare individual or small group performances provided the subjects are carefully matched.

Nevertheless, publication counts was highly used in studies because such data can be readily obtained from international, local databases or published annual reports. Surveys could also provide publication counts obtained from self-reports by scientists. Gathering data from individuals through self reported questionnaire was also found to be reliable (Allison and Stewart, 1974, Creswell, 1985). Also, previous studies have indicated a correlation between the quantity, citation counts and peer ratings (Pelz and Andrews, 1966; Cole and Cole, 1967). Lawani (1986) analysed 279 papers from the 1975/76 volumes of the *Yearbook of Cancer*, published in serials covered by the SCI and found positive correlation between quantity and quality counts of research productivity. Lawani suggested that scientists who undertake more research, become better researchers and becomes more familiar with the demands of the literature in their field. This led to the situation where the producer of quality also becomes a producer of quantity. Cole and Cole (1967) suggested that where citation counts are not readily available, especially for countries that are not adequately presented in the SCI, publication counts can be considered an indicator of the significance of a scientist's work.

Research performance of selected Malaysian academic engineers and scientists is the main concern of this study. The indicator of research productivity considered are total number of publications which, includes journal articles, conference papers, book chapters, books edited, translated, authored and patent as well standards obtained.

2.2.3. Measuring Quality: Citation Counts

Citation counts refer to the number of times a particular work was cited as reported in citation databases such as the *Science Citation Index*. Citation counts imply a measure of impact, use or quality of published works (Martin and Irvin, 1983).

A measure used to assess quality is the number of citations obtained by a department or individuals over a period of time (Moed, et al., 1985 and Laband, 1985). Quality in this context depends on the extent to which the result were used. Citation and publication counts were extensively used at the University of Leiden during the period 1981-1984, particularly in the fields of natural and life sciences. Citation analysis could also be used to analyse institutional and national research efforts and to monitor effects of changing policies (Schwarz, Schwarz and Tijssen, 1998). There were proposals that citation counts can replace the costly research assessment exercise (RAE) in the United Kingdom in assessing the research output of university departments (Oppenheim, 1995, 1996). Using the Institute of Scientific Information citation databases, total citations received by academics in the discipline of library and information science, genetics, anatomy and archaeology for articles published in the period 1988 and 1992 were compared to scores assigned by the 1992 RAE. In the case of 217 academics, who taught library and information science, a significant correlation was found between the total number of citations received by a department, the average number of citations and the RAE rating. The results were similar for the fields of genetics, anatomy and archeology (Oppenheim, 1997). These results elaborated the possible use of citation counts to ascertain university department's productivity.

Zhu, Meadows and Mason (1991) studied the performance of chemists and found that the more productive academics not only publish more but their work was also highly cited. The study proposed that the research excellence of a department might be limited to the publication activity of a limited number of staff. This showed that unless a person obtain citation after a few years in the department, he/she would unlikely obtained citations later in his career. However, information about citation of one's work does not seem to have an effect on individual's publishing activities.

The main problem connected to citations is the "halo effect" (Cole and Cole, 1972) that describes the tendency for eminent researchers to be cited more frequently. Authors cited eminent researchers to add authenticity to their bibliography (Kroc, 1984; Lindsay, 1978). Sher and Garfield (1966) studied the citations to works by Nobel prize winners in physics, chemistry and medicine between 1962 and 1963. They found that 30 Nobel prize winners were cited 30 times more frequently (average of 169 citations) than the average scientists in their fields (average of 5.51 citations). Garfield (1977) extended this study to cover the period 1961 to 1975 for all sciences and a similar pattern of citation rate were indicated. The average prize winners received an average of 2,877 citations, while the average authors would expect to receive less than 50 citations. There was also evidence that citation counts was correlated to peer judgements on the quality of the awarding institutions (Bayer and Folger, 1966; Clark, 1954). The most used citation counts are those compiled by the Institute of Scientific Information (ISI) which are available in various versions (printed, CD-ROM and online). Moed et al (1985) used the *SCI* to compile citation data for the faculties of medicine and mathematics/natural sciences of the University of Leiden in Holland for the period 1970 and 1980. The group analysed 5,7000 publications and 42,000 citations. The method used was to compile a list of publications and search the *SCI* for citations to the publications. The group did find problems in compiling the data, such as missing data that affected the performance evaluation of departments and the small number of publications / citations received by small research units. Other studies chose selected journals to count citations (Johnes, 1986)

Citations have not been included in the present study for two reasons. Firstly, the number of citations of Malaysian publications listed in the ISI indexes is too small to make effective analysis possible (Arunachalam and Garg, 1986). Secondly, there are no Malaysian citation database that can provide citation data needed for the study.

2.2.4. Measuring Impact: Peer ratings

Peer review is a process of assessing scientific quality and progress. Ratings or rankings were given to individuals, groups or institutions based on perceived contributions to the discipline. Ratings imply an assessment of reputation and visibility and were often gathered from questionnaires or interviews. The disadvantage of peer review is its subjectivity. Studies have indicated that peer ratings closely corresponded to the results obtained from citations and publication counts (Anderson, Narin and McAllister, 1978; Wallmark and Sedig, 1986). Cole (1979) reported a correlation between the quantity of research output and perceived quality and between citations and perceived quality. The results of a survey of peer opinion of psychology departments were correlated to Gillett's (1987) counts of the research performance of psychology departments in the same period. Gillett used two indices of research performance, the number of publications and average citations received. This indicated that impressionistic peer review seems to be related to the department's actual research output. This may be due to the fact that raters tended to consider publication totals when making judgements. Sonnert (1995) explored the criteria by which biologists in the United States evaluated their peers' scientific performances. Six distinguished biology professors rated forty-two former postdoctoral fellows on the basis of their curriculum vitae, six best articles and author's bibliographies. Most professors based their rating on the annual publication productivity rate. The other criteria used was total solo-authored publications and graduate school prestige. These results indicated that publication productivity was paramount in the raters' minds when they rendered quality judgments. Also, crude rankings of departments by publication productivity did not take into account other factors such as departmental size, staff-student ratio, the quality of computing facilities, the size of the library, and the availability of support staff that may influence research activity.

The peer review method has not been adopted for the present study, because the number of academic scientists within the same discipline are too small to provide a pool of impartial raters. The other universities in Malaysia offer academic degrees in engineering and science in diverse disciplines. The numbers who are in exactly the same discipline as those from the universities under study was too small to establish an effective peer rating group of experts.

2.2.5. Other Measures

Assessment of research productivity in the form of publication, citation counts and peer ratings could be considered with other types of measure. One measure is an estimation of how active the researchers are in particular a department, institution or country. Schubert and Glanzel (1991) studied the frequency distribution of publications between the period 1981 and 1985. Data were collected from the *Corporate Index* files of the *Science Citation Index* database. The frequency of publication distribution of authors were collected (a) for each single year separately; (b) forward cumulated periods (1981, 1981-82, 1981-83, 1981-84, 1981-85); and (c) backward cumulative period (1981-85; 1982-85, 1983-85, 1984-85, 1985). A total of 24 countries were selected. Scholars were divided into two groups: transcients and continuants (Price and Gursey, 1976). Transcients were characterised by authors who published one single paper in their lives (usually the material from their Ph.D) and then disappeared from scientific research and information exchange. Continuants were authors whose names appeared year after year in every index, listings or databases. Publication activity must include transcient authors. However an extreme number of transcient authors was considered to be unhealthy because it did not encourage exchange of information and hence scientific progress. Among the 24 countries, Malaysia was indicated to have a high renewal indicator (qr = 1.13). The renewal indicator is the ratio of new to leaving authors in a discipline. The renewing world average qr is slightly above 1 (1.02). This indicated that in Malaysia, the number of new authors entering into the publishing population was fairly high indicating a growing author population. Malaysia was categorised in the middle range countries (with Hong Kong, Korea, Saudi Arabia and Kuwait) where the renewal rate is above 1.1.

An increasing number of studies used a combination of indicators. Hagstrom (1971) used several indicators to assess the outputs of 125 science departments of mathematics, physics, chemistry and biology. These included department size, number of research articles, citations to articles, ease of obtaining information, quality of Ph.D, mean time on research, mean number of research students and number of post doctoral fellows. Arunachalam and Garg (1985) used both productivity and citation counts to assess Singapore's performance in world's scientific research. The study indicated that Singapore's contribution was mainly in medical research and most works were seldom cited. Zachos (1991) applied both publication and citation counts to evaluate the performance of mathematics departments in two Greek universities. Zhang (1995, 1996) also used publication and citation data to analyse the research performance of medical universities in China. This increased use of combined indicators in the assessment of basic research was summarised by Martin (1996). Martin surveyed the methods used by articles submitted to 12 issues of *Scientometrics* (volumes 31-34 published between 1994-1995). Comparison was made with 12 issues published in 1988-1989 (volumes 14-15). The survey indicated that in the earlier study, 38 out of 54 (70%) papers used one or two indicators and only 2 papers used five indicators. In the later years 43 out of 67 (64%) papers used one to two indicators and only 1 paper used 8 distinct indicators. The proportion of papers using three or more indicators was not significantly greater in the later years. The most common indicator used were publication counts (72 out of 121 paper, 70%) and citation counts (38 papers, 32%). Academics who were interviewed favoured the peer review process (86%), followed by publication counts (64%) and weighting publications according to the status of the journals in which papers were published. Overall the majority favoured a combined approach.

One problem in using International databases is the selectivity of the journals they cover. Royle and Over (1994) examined the appropriateness of using the Institute for Scientific Information databases to measure the research productivity of Australian academics. The results indicated that only 27 percent of periodical articles authored by academics in the social science disciplines were captured by the ISI databases. For the science disciplines, the coverage was slightly better at 74 percent. This indicated that using data obtained only from the ISI source indexes would give a distorted picture of academic staff's productivity especially for those in the social science disciplines. Another problem brought up was the need to arrive at a valid definition of what can be considered in the publication count.

In summary, the studies indicated that a variety of measures were used to assess research productivity. However, the two most used indicators are publication and citation counts. The counting comprised raw total counts, average counts, and weighting schemes to enhance total counts. Since publication is the standard way of communicating research findings, it is widely considered an appropriate measurable instrument of a scientist's performance (Sonnert, 1995).

The research productivity in the present study is measured in terms of total number and types of publication achieved by a selected number of academic scientists and engineers from two universities in Malaysia. The reasons for considering only these outputs are: (a) publication counts can be easily obtained within the Malaysian context from the annual research reports published by universities in Malaysia; (b) total and types of publications achieved are the criteria considered in promotion exercises in Malaysian universities; (c) data on citation counts are not easily available; (d) the inclusion of Malaysian scientists' works in sources covered by the *SCI* were too small to facilitate meaningful citation evaluation; and (e) data on citations in locally published journals, conference proceedings and theses are not available.

2.3. PART THREE: DETERMINANTS OF RESEARCH PRODUCTIVITY

This section is divided into three main parts. The first part describes published review literature on the determinants of research productivity. The second part deals with published studies, which considered a combination of determinants, and the third part focuses on studies of single determinants of research productivity.

2.3.1. Review Literature on the Determinants of Research Productivity

Reviews on research productivity studies are few and sporadic. Cole and Zuckerman (1984) cited 40 studies published since 1975. Wanner, Lewis and Gregario (1981) compared studies on research productivity among academics in the sciences, social sciences and humanities and provided a precise and detailed summary of previous research published up to 1981 that have attempted to develop models of productivity. Wanner, Lewis and Gregario commented that the differences in methodology and measures used in previous research have resulted in no one model that can be applied across all disciplines. This opinion was echoed by Wood (1990) who highlighted that methodological problems, limited empirical testing and disagreements about the effects of different variables have prevented the development of a unified theory to explain the varying productivity of researchers.

Fox (1983) summarised the findings of ninety studies published on various aspects of research productivity. The studies were divided into three categories: (a) productivity and individual level variables (included personal variables such as psychological traits, attitudes, motivation, interests, creativity, work habits and demographic characteristics such as age and experience); (b) environmental variables (included institutional prestige, departmental affiliation, collegial, departmental and institutional support); and (c) reward or feedback variables (comprised citations, awards, increment in salary, rank and positive peer review). There were studies that indicated certain variables do correlate strongly with productivity. However, no one study could explain the vast variations in scientific productivity and "the challenge for productivity studies lies in the capacity to combine perspective and untangle effects"(p.298). The following year Finkelstein (1984) reviewed a large set of studies on the correlates of faculty research and Creswell (1985) updated this. The main contribution by Creswell is the groupings of research productivity studies by the type of disciplines covered (whether single or multiple disciplines). The scope of Finkelstein's review covered studies published up to 1983.

Johnes (1988) discussed the problems and drawbacks of the various measures of research productivity used in academic assessment studies. The problems highlighted was: (a) the use of variant types of publication output for assessment, (b) the variant weighting system used for the publications, (c) the short comings of citations as a factor, and (d) the subjectivity of peer review ratings. In general, the review described studies that mainly used publications and citation analysis. The strength of this review is in highlighting the drawbacks of the various factors as plausible measures so that conclusion can only be drawn with caution. Biggs (1991) discussed a number of studies investigating possible factors affecting the amount of scholarly activity among academics. Studies were grouped under sub-headings of gender, doctoral program attended, affiliation of academic staff, collegial relationship, tenure and promotion, time spent on research and monetary reward. The review also focused on scholarship among academics in library schools. This review article provided 149 references.

Cave, Hanney and Kogan (1991) broadly grouped performance indicators on research as follows: the number of research students, output of research, quality or impact indices, research incomes, peer review and reputation ranking. Some of the indicators mentioned above can be considered as an input rather than output variable. For example, the number of research student is actually the inputs into the research process that may result in "qualified" output. The use of student number as an indicator, can be problematic since it can discipline-dependent. Research income can also be considered as an input factor in the research process. Publication output basically measure the quantity of research output obtained. Citations and impact factor of journals academics used to publish are often considered as a measure of quality. Peer review and reputation ranking are also considered as quality measures even though they contained a certain degree of subjectivity.

Blackburn et al., (1991) indicated that the principle weakness of previous studies was the limited type of predictor variables employed. Astin (1984) noted that most researchers usually used these independent variables: gender, marital status, age, field of specialization, educational experience, characteristics of the graduate institution and characteristics of the employing institutions. Most of these variables seldom indicate strength in relationship to productivity. Most researchers did not indicate why the variables were chosen. The review article by Joshi and Maheswarappa (1996) also indicated the inconclusiveness of previous studies. The authors indicated that the various studies were non-comparable and inconclusive owing to substantial differences in the analytical methods applied. They stressed on the need for a standardized methodology and coordination of research efforts so that models developed can be generalised.

2.3.2. Combined Determinants of Research Productivity

The following section covers studies that used a combination of variables in order to understand why certain groups of researchers or academics are productive.

One of the earliest study which investigated factors that stimulate research and development among scientists was carried out by Pelz and Andrews (1966). Pelz and Andrews gathered data from 1,311 scientists and engineers located in 11 different laboratories. The objective of the study was to identify the conditions, which prevailed in the scientists' laboratories and compared these conditions with their performance based on peer judgments of an individual's work as well as the number of scientific product, papers and reports published within a 5-year period. Most of the variables considered were personal factors because it involved obtaining scientists' perceived believes about the amount of freedom they exercise in their research, their dedication, motivation, satisfaction, creativity, and age. Organizational factors considered were the research team, coordination of individuals within the team, the value of colleagues and the communication behaviour of researchers. The study indicated that high performance were accompanied by scientists who felt they exerted more influence on decisions affecting them or where decisions were exerted by the scientists himself jointly with his chief or with his colleagues. Performance was low in groups where the chief alone decided. Pelz and Andrew suggested that individuals could exert more influence in a flatly structured organization with fewer levels. The productive scientists were thoroughly involved in their work, and worked 9-10 hours on average. However longer hours did not necessarily produce the highest performance. The productive scientists were motivated by their self-directed ideas and have diverse research interests. The effective scientists were more satisfied with their work environment and perceived their organisation as providing opportunities for professional growth. The scientists whose personal interests were in congruent with those of their organization wrote more reports, but the best scientists moderately disagree with the interests of their organization. This implied that an organization remains vigorous if there exists a certain amount of tension between the wants of its members and the organizations. A certain amount of dissatisfaction is healthy in a research environment. The organizational variables indicated that the effective scientists would both sought and receive more contacts with colleagues, work on a several projects at the same time and work in groups that were cohesive and intellectually competitive. The main contribution of Pelz and Andrews was in highlighting the personal characteristics of the productive scientists as well as the conducive organisational environment which contributes to their productivity.

A comprehensive study was conducted by Blackburn, Behymer and Hall in 1978. A 12-paged questionnaire was sent out to 7,484 academic staff. The academic staff selected were lecturers, appointed as full-time teaching staff, with at least a masters degree and from major departments in the arts and sciences. Three dependent variables included were faculty self report of the rate of article production (over 2 years), total career article publication and total book publication. A total of 21 independent variables were considered. The variables comprised environmental and personal variables, school type, institutional prestige, preference for research, method of communication, journal subscription, importance of research to self, perceived importance of research to institutions, tenure, activity in the department, activity in the institution, influences in departments, influences in institutions, autonomy/democracy within the department, rank, age, tenure, mobility, teaching responsibility, academic division, department size and gender. Generally the results indicated strong relationships between productivity and school type as well as institutional prestige. Those who published more were those from research-oriented universities (compared to 4-year colleges); with strong emphasis on graduate education; and employed at prestigious institutions (as assigned by a prestige rating by the American Council on Education). The high producers were more likely to be interested in research (also found by Clement, 1973), communicated more frequently with other scholars at other institutions, and subscribed to more academic journals (also found by Wowuruntu, 1986). The high producers were more likely to come from universities where their role expectations and the reward system were consistent with their career goals. Productivity however, was found to decrease with advancing age (also indicated by Fulton and Trow, 1974). The high producers were also more active and influential within their own department and institutions. The best predictor of productivity was rank. However, age and tenure were eliminated as predictors because they strongly correlated with rank. Full professors published five or more articles over a two-year period compared to associate professors and lecturers. Blackburn et al. cautioned against accepting these findings in total because professors have more opportunities to do research and publish their findings. Departmental variables and gender were poor predictors of productivity. However, the level of teaching was correlated to productivity as those who taught graduate programmes were more likely to be productive than those teaching undergraduates. The importance of this study lies in its extensive use of independent variables which was compared to productivity measures in an academic environment.

Wanner, Lewis and Gregario (1981) tested a model incorporating both academic and non-academic factors as determinants of productivity with samples from physical, biological scientists, social scientists and humanities, taken from the 1972-73 American Council on Education survey of faculty at US institutions of higher learning. Demographic variables included were gender, race, marital status and socio-economic status of scholars. The academic variables considered were years of experience estimated by the arithmetic difference between the year of the survey and the year respondents obtained their doctorate degree, academic rank, tenure status, time took to obtain the doctorate degree, number of grants obtained, time allocated to research, number of journal subscriptions, expressed commitment to research, respondent's perception of departmental norm concerning productivity and promotion, and the Roose-Andersen (1970) ranking of institutional prestige. The study found variations in the process determining productivity both across the broad disciplinary categories as well as within categories. The physical and biological scientists indicators that yield convergent results should be considered. If the results of measures concur (or converge) then inferences can be made about the performance of research units. The use of the converging partial indicators indicated positive results when applied to the study of four radio astronomy observatories.

Creswell (1985) categorised productivity predictors into four main groups: individual/ psychological characteristics (intelligence scores, motivation, stress, gender and age); cumulative advantage (superior education and training); reinforcement (feedback processes such as early productivity, preference for research, promotion in academic rank, tenure, networking with colleagues) and discipline differences (different pattern of collaboration and acceptable forms of communication).

One of the main contributors to the study of research productivity from Southeast Asia was Waworuntu (1986). Waworuntu studied the predictors of research productivity among Indonesian academics and surveyed 11,269 academics from nine fields of studies. The dependent variables were weighted and unweighted research publications. The types of publication output considered were research reports, books, books edited, book chapters, journal articles both national and abroad, publications in the mass media, unpublished report, and conference papers. The independent personal variables were gender, respondent's age, spouse's occupation, spouse's level of education, number of children (family size), marital status, and religious belief. The academic predictors included were academic rank, research attitudes and interests, and institutional prestige. A linear regression model of productivity function was used. Male academics were found to have larger productivity means than their female colleagues. The high producers were more likely to be below the average age (younger), have started publishing at an early age, single and if married have below average dependents. The high producers owned more books, subscribed to foreign or Indonesian journals and had taken the research methodology and statistics course in their graduate training. The productive academics tended to collaborate with peers from other universities and have a positive view about the quality of their research. Waworuntu did concede that productivity is a difficult concept to measure and mere counts ignore the question of impact.

Another detailed study was attempted by Blackburn et al (1991) which surveyed 4,4000 academic staff from eight disciplines (history, English, biology, chemistry, mathematics, political science, psychology and sociology). Academics were asked about their perception of their work environment, their own competency and efficacy as academic staff, their attitudes about teaching, research and services. Extensive interviews were conducted with academics on campuses representing a diverse set of environments. The study grouped the variables into several theoretical frameworks: need theory, life-stage theory, socialization theory, and reinforcement theory. These theories were used to describe possible relationships among correlates. The study proposed that the manner in which people differently assessed their personal abilities and interests interacts with their perceptions of the organization's priorities and causes them to engage extensively in some activities and less frequently in others. The academic institution and departments were looked upon as an achievement oriented environments in which faculty, students and administrator's performance were continuously evaluated. The behaviour of the academic staffs was viewed within a social environment. Academic staff used assessments of themselves and their social context to make logical decisions about their actions. Experiences over time led individuals to modify their understanding of their work environment as well as their self-image and these changes affected their work activities and their level of involvement in different activities. Some perceptions of work environment have greater impact on the individuals. The way individuals perceive themselves, their self-efficacy and competence were dependent on how they perceive their environments. Personal variables such as gender, race, chronological age were included because of their influence on individual's access to career opportunities, personal values and goals. Professional variables such as the university individuals obtained their Ph.D., their discipline, prior publication record, career age, current rank, tenure status, the employing university and the administrative position occupied were considered because they provide the environment for possible early recognition, further opportunities and resources. The environment instituted by the universities, the reward systems, performance evaluations and incentives received for certain behaviours, also affects the academic's behaviour. The individual behaviour is the result of a complex interaction between personal and work environment variables. The outcome that the study was primarily interested in was scholarly publications. The results from the interview indicated that financial support was a strong predictor of publication productivity. There were graduates from non-research I (R-1) universities who were high publishers indicating that active publishers would remain to be so even though they did not graduate from an R-I university. Gender was not a predictor of productivity. Interests in research did not predict actual output and academic staffs who perceived that what they do genuinely makes a difference performed better. This study helped to explain an academic's research behaviour within a social and environmental framework.

Bland and Ruffin (1992) focused on institutional and departmental variables and proposed 12 factors considered important in ensuring research success. These include clear research goals, a positive group climate, assertive and participatory governance, decentralised organizational structure, frequent communication, accessible resources (especially human resources), sufficient number of researchers, age of researchers, diverse and appropriate rewards, recruiting and selecting good scholars, leaders who are expert as researchers and who practised participatory management style.

Ramsden and Moses (1992) and Ramsden (1994) also considered several correlates of productivity. These include the level of research activity, subject area, institutional type, gender, age, early interest in research and satisfaction with the promotion system. The study reported the rate of productivity measured by scholarly publications of Australian academics from 18 higher educational institutions between the years 1985 and 1989. The study presumed that differences in research output could be explained by personal and structural factors. Two indicators of individual research performance were used. The first indicator was an index of research productivity (IP) defined as total number of authored books, journal articles, books edited, book chapters published over a period of five years. The second was the index of research activity (IA) calculated from answers to a series of questions about academic activities during the past two years. Each affirmative reply to an item was given a score of one point. The total score represented the staff's score on the index. Academic staff was asked to give rating on statements indicating their commitment to teaching, their intrinsic academic motivation, and cooperative departmental environment. The results indicated that a minority of staff produced most publications and the average publication rate of Australian academics was low. About 12 percent reported not publishing within the 5 years under study. The results indicated that structural factors such as how academic departments are managed and led, combined with personal variables such as interest in the subject matter influenced the level of productivity achieved. The strongest personal correlates were early interest in research, early involvement in research activity and seniority in academic rank. The very productive published on average more than five times than members in the low publishing group. Other personal factors such as age and gender were not significantly associated with research productivity. The results also indicated that the more cooperatively managed units were associated with higher levels of productivity. Certain kinds of departmental context may lead to higher productivity, such as a cooperatively managed unit, and a high sense of job satisfaction. This is in congruent with the results obtained by Bland and Ruffin (1992). The results highlighted the importance of a conducive departmental environment in the promotion of research productivity.

Another comprehensive study reported in 1994 was undertaken by Jungnickel and Creswell (1994), who applied several workplace correlates to scholarly performance of 296 clinical academic staff in 67 clinical pharmacy faculty. Scholarly performance was defined by using multiple indicators: refereed research, grants/books research, non-research scholarship and contracts. Five sets of correlates were explored: individual, cumulative advantage, reinforcement, department and colleagues. The individual variables included were gender, age, year of Pharmacy doctorate degree and experience as an academic staff. The cumulative advantage variables were professional education and training such as the type of pharmacy degree, requirement of a research project as part of the pharmacy doctorate program, years of residency and/or fellowship training and the percentage of residency training devoted to research activities. Reinforcement was measured in terms of the number of off-campus conversations with colleagues during the previous week, tenure status and primary orientation (teaching or research). The departmental variables included were the percentage of time spent in research, departmental respect as well as support for research, and chairperson support for research. The respect and support for research was measured by a series of five Likert scale items that measured the research orientation of the department, the pressure to publish, work experience, encouragement given by colleagues, respect for scholarly works of departmental colleagues and the amount of friction among departmental colleagues. Chairperson's support was measured by academic staff's ratings of their chairperson on 21 Likert scale items. The college variables included were those related to research expectations, adequacy of resources to support research, salary sources and college location. The study used the survey method. The findings revealed that about one-quarter of the academic staff had not published any refereed research articles and the average was one half articles in the three-year period studied. However if research reports and non-refereed articles were considered the average totaled to about 2.5. This is similar to the findings by Bentley and Blackburn (1990) who found that academic staff's two-year publication rates varied from 2.6 (in 1969) to 3.1 (in 1988). The variables that explained variations in scholarly work was the amount of time that academic staff spent in research, collaboration in the form of communication with other scholars and researchers off-campus. In contrast the cumulative advantage and individual variables did not influence performance. Within the variable sets, departmental chair support, college resource support, prior research experience and training exercise have less influence on scholarly work, which differed from earlier studies in health sciences (Harrington and

Levine, 1986; Ostmoe, 1986). In general, the results indicated that productive academics spent more time on research, maintained contacts with colleagues both within and outside the university, received personal support, were experienced and supported by their chairperson.

Babu and Singh (1998) obtained 200 variables that influenced research from published literature, biographies of great scientists and discussions with eminent scientists. A total of 80 variables were selected and subjected to a Q-sort technique and distributed to selected 912 Indian scientists out of whom, 325 responded. The top 26 variables obtained from the Q sort technique were factor analysed and the results indicated eleven factors affecting research productivity. The factors were grouped into two categories; those personal and organisational. The personal factors include; persistence, initiative, intelligence, creativity, high learning capability, deep concern with advancement and professional commitment. The organisational factors were; adequate funding, access to literature, stimulating leadership and external orientation (collaboration). The uniqueness of this study is the methods used to collect data and the Q-sorting technique that helped highlight the significant variables. The four personal factors found to be related to productivity were, persistence (characterized by the scientists who are observant, and have the capability to work under constraints); initiative (characterized by self-reliance) intelligence (characterized by sharp memory and creativity that led to work satisfaction since scientists have the freedom to plan and organize their work) and learning capability (characterized by the ability to exploit new scientific developments, and the ability to self-examine one's own performance).

Studies above used a number of variables (mainly personal and departmental) in order to explain variations in research or publication productivity. Various disciplines were covered and a number of productivity measures were used. The studies have enlightened us with the possible traits of the productive researchers and the organisational environment that promote, support and sustain such productivity.

2.3.3. Specific Correlates of Research Productivity

The following sections present selected research productivity studies under various categories of variables. The variables are: (a) personal correlates (gender, age, and family size); (b) personality correlates (interests, attitude, motivation, work habits, cognitive and emotional traits, ability, creativity, freedom and autonomy); (c) academic correlates (rank, qualifications, training, experience and tenure); (d) departmental correlates (time spent on research, discipline differences, department/group size and age, graduate student supervision, departmental/research leadership, departmental prestige, cumulative advantage, early productivity and tenure); (e) collaboration correlates (interaction with colleagues, relationship between research teams, institutional, national and international collaboration); (f) communication correlates (channels used to obtain information, channels used to communicate research results); and (g) institutional correlates (financial support, library resources and services; electronic support).

(a) Personal Correlates

(i) Gender

Three issues are recurrently indicated in studies investigating the relationship between gender and research productivity and these are: (a) men publish more than women; (b) there are differences in publication productivity between married and unmarried women, and (c) the gap in the publication performance between genders is narrowing.

Men publish more than women. Early studies generally reported that men did not only publish more than women academics but were cited more. Creswell (1985) related studies by Babchuk and Bates (1962) and Astin (1969), that reported women publishing less than their male colleagues. Fulton and Trow (1974a, 1974b) found that academic men in general published 2.5 times more than women academics. Blackburn, Behymer and Hall (1978) also found male academics were three times more likely than women to have published 11 or more articles during their careers and 5 or more articles in a two-year period, irrespective of academic discipline. In a study of 526 scientists Cole and Zuckerman (1984) found that on average, male academics published 40% to 50% more papers than their female counterparts. An Indonesian study (Waworuntu, 1986) found that male academics were more productive and gender was correlated to total raw count and weighted publication scores. Franklin (1988) reported that in the European community, women scientists published on average, five articles in a three-year period, compared with eight papers by male scientists. Kyvik (1990a, 1990b) compared the productivity of a sample of European assistant professors and professors and found that on average men published 5.0 article equivalents in the three-year period (1979-1981) while women published 3.5 (30%) fewer articles. Even though some studies found men to publish more then women, other studies had indicated that some women are more productive.

Publication productivity between married and unmarried women. Previous studies indicated that married women are more likely to be more productive than unmarried women. Simon, Clark and Galway (1967) reported that married women with Ph.D. and holding full-time occupations published more on average than either single women or men. Cole and Zuckerman (1987) carried out a longitudinal study of American natural and social scientists, which showed that married female researchers with children published more per year during the course of their career than their married female colleagues. Luukkonen-Gronow and Stole-Heiskanen (1983) also found that married Finnish female academics were more productive than their single colleagues. In Norway, Kyvik (1990a, 1990b) observed that:(a) married and divorced persons were more productive than single persons (applies to both men and women); (b) women with children were more productive than those without children; (c) women with more than two children were less productive than those with only one child and (d) women with children under 10 years old produced fewer publications than their male colleagues in the same position or those with older children. The study proposed the following explanations as to why the situation above has arisen. These are: (a) married women have more energy and stamina than women without children; (b) they get support from their husbands; (c) they experienced a more stable social life; (d) their family life increases their self-respect; and (e) being married neutralized the effect of sex since married women cooperate more with their male colleagues than those unmarried. The studies above indicated that married women performed better in research if these conditions were satisfied: they held full-time jobs, their marriage provided emotional and social stability, they have not more than two children, and they would perform better still if the ages of the children are above ten. In the late 1990s, more studies were conducted on the academic performance among academics partners who were married. Creamer (1996) conducted a national survey of senior and prolific academic staff and found common formal and informal collaboration among married academic couples. Collaboration comprised giving and receiving feedback about drafts of publication and co-authorship works (in articles, books or monographs). The effectiveness of married academic partnership is dependent on the amount of overlap in research areas and skills. The findings of this study were also observed by other studies. Astin and Milem (1997) found that the academic staff whose spouse were also academicians was more productive. This may be due to the fact that women with an academic spouse benefited from access to information and to collegial networks. Academic couples also benefited in terms of obtaining "invisible labour" which included typing, editing, conducting experiments and collecting data. Bellas (1997) indicated that having a partner with a Ph.D. in the same field was significantly associated with publication productivity. Academic partners seemed to provide the reinforcement (feedback about ideas) needed to sustain productivity. In a more recent study, Creamer (1999) interviewed 21 academic couples who were tenured, at the rank of associate professors or full professors and have published 21 or more journal articles and authored 3 or more books. The 21 academic couples were employed at 14 different colleges and universities. The study found that productivity was related to couples who had long-term research partnership.

The gap in the publication performance between genders is narrowing. There are evidences, which indicated that the gap in scholarly productivity between the genders is narrowing. Cole and Zuckerman (1984) compared the 1957-1958 cohort studied by Cole (1979) to a matched sample who received their doctorates in the natural and physical sciences in 1969-1970. They found an increased proportion of women among the most prolific scientists. Astin (1978, 1984) compared data from the surveys of 1969, 1972 and 1980 and found greater growth in productivity among the women than among the men, supporting the "narrowing of the gap" argument in publication productivity between the genders. Long (1992) studied the publication productivity of male and female biochemists and found that the differences in publication was slight during the first three years (26% difference) in employment and widened between the 3^{rd} and 4^{th} year (66% difference). The percent difference increased by the 9^{th} year (91% difference) after which, the productivity of the males leveled off, while the females continued to increase in productivity, narrowing the gap to 56% by the 17^{th} year. The study also found that the average paper of a female scientist was cited more frequently than the average paper of the more prolific male scientists. The females who managed to "stay in the game" long enough would continue to perform, thus narrowing the differences in performance between the gender.

There were evidences that indicate contrasting results from those described above. Guyer and Fidell (1973) surveyed 122 female and 122 male psychologists with Ph.D. from the 1968 *Directory of the American Psychological Association,* and found that although the men published a higher number of papers per year than the women, such differences in publication rates diminished when other variables were controlled such as subject matter, training, length of time in career and academic position. Clemente (1973) studied the publication records of 2,205 Ph.D. holders in sociology and found gender a weak predictor of publication productivity. Hamovitch and Morgenstern (1977) found that married American female academics with children were not significantly more productive than those unmarried and the productivity differences were least in the natural sciences. Other studies similarly found gender to correlate weakly with publication productivity, especially when the effects of other relevant variables were controlled (Blackburn, Behymer and Hall, 1978; Blackburn, et al., 1991). Faver and Fox (1984) and Garland (1990) found that the educators (in social work and library and information science) published slightly more articles then their women colleagues, but the data was not statistically significant. Gender was not a significant predictor to the number of articles published. Furthermore, there may be other factors that influenced female academic productivity, such as their sensitivity to job security and the amount of encouragement and citations received (Reskin, 1978, Creswell, 1985). Hence, gender was not a significant predictor of scholarly publication when other variables such as rank, education and type of institution was controlled (Garland and Rike, 1987; Garland, 1990).

The findings from previous studies were inconclusive. It is uncertain whether Malaysian female academics would exhibit similar publication behaviour. The present study will include gender as a variable to be compared to publication productivity of selected Malaysian engineers and scientists.

(ii) Age

Various types of age correlates have been used. Some used chronological age (Clemente, 1973; Cole, 1979; Pelz and Andrew, 1966), while others used years of professional experience (Creswell, Patterson and Barnes, 1984a, 1984b) and some used years since receipt of the doctorate degree (Allison and Stewart, 1974; Bayer and Dutton, 1977). The general findings indicated that age would affect research performance, though performance improved with experience. Lehman, H.C. (1953, 1958, 1960) indicated that scientific discoveries would most likely occur when the scientists are in their late 30s and early 40s and, thereafter would continuously decline. He found that the productivity peak would appear earlier in abstract disciplines (mathematics and theoretical physics) and later in more empirically based disciplines (geology, biology). However the causal mechanism for this finding have not been tested.

There were several reasons put forward to explain Lehman's findings. One of the reasons was the decline in the intellectual functioning of scientists as they age. A favourite reason was that the more able scientists were often drawn off into teaching, administration and committee work. However, Knorr et al. (1979) contradicted this proposal and found that administrative work fostered rather than inhibit scientists' performance. Higher administrative positions provided the resource that increased the possibilities for publication. Another explanation put forward is the relaxed and diminished strength in motivation after young scientists have struggled and built their reputation. Another hypothesis put forward is that as scientists become specialists they lose the fresh viewpoint needed for breakthroughs. This implied that if scientists resisted specializing or changing their field periodically, they would not continue to perform. Another hypothesis is that scientists lost touch with recent advances and that time off-periods for study or intensive seminars should sustain their achievements.

Pelz and Andrews (1966) investigated technical performance, working relationship and motivation among 1,300 scientists and engineers. The study found a saddle-shaped curve of scientific performance between the age of 45-49 and between 55 and older in four of the five groups studied. Pelz also indicated this saddle-shaped curve in an earlier study (1957). Several suggestions were offered for the saddle-shape curve. Firstly, the downturn occurred when the scientists were less active in research as they were asked to teach and the second peak occurred when scientists began publishing jointly with subordinates or students. The two peaks represented different kinds of contributions; the earlier one constituted creative discoveries and the later were syntheses of a lifetime's progress. Another explanation given was the financial pressures in the early forties for those with college going children or the physiological mid-life crisis of the 40s. Pelz proposed that the older scientists did better in development research where their cumulative experience became an asset. The results suggested that performance declined because individuals relaxed their zeal or motivation. The study also found that performance was sustained with periodic change in project, self-reliance and interest both in breadth and depth. Productivity increased with age among the productive academics employed in prestigious institutions (Clemente, 1973; Allison and Steward, 1974). This means that high producers remain relatively high publishers over time. Bayer and Dutton (1977) observed a similar two-peak curve for five out of the seven disciplines studied. The first peak occurred at about the 10^{th} year of a scientist's career age, followed by a second peak as the scientist near his/her retirement age.

Cole (1979) studied the research output of scientists working in Ph.D. granting institutions in the fields of chemistry, geology, mathematics, physics, psychology and sociology. The output were papers published between 1965 and 1969 and citations received for those publications. The study reported a slight curvilinear relationship between age and publication productivity. Publication peaked during late 30s and early 40s and then declined. Hammel (1980) conducted a longitudinal study of chemists in the University of California and found that productivity increased with age with an evidence of a flattening and not necessarily a decline with age. Sodofsky (1984) indicated that academic's rate of publications peaked for the 36-40 years old and declined for those 55 or older. The decline in publication rate was attributed to several factors such as the relaxation of pressures to publish after the desired promotion was achieved, and the allocation of more time for consultation. A Norwegian study by Kyvik (1990a) observed that the age factor that affected productivity varies between disciplines. In the social sciences, productivity remained the same at all ages. In the humanities, publication productivity declined in the 55-59 years age group but reached a new peak for those 60 or over. In the natural sciences, productivity continued to decrease with increasing age.

Changes in interests might mediate the influence of environmental factors on role performance. Lawrence and Blackburn (1988) attributed the decline in productivity to psychological reasons such as (a) professors productivity in mid-life would began to decline when they began to realise that they could not achieve the height of their scholarship; or when (b) professors in their mid to late thirties experienced a sense of overload when given multiple role demands. Bayer and Dutton (1977) proposed that the decline occurred because of changing market conditions, where the productive scientists were taken away from academic work, but might return to it during the second half of their career. Kyvik (1990a) observed that in fields where the production of new knowledge is fast and the use of scientific methods and equipment are continuously introduced, productivity may be slower because researchers would find it difficult to cope with new developments. In fields where the production of new knowledge occurs at a slower pace, the faculty may be productive throughout their careers. Thus, in the natural sciences, the older academic staff member in physics is less productive than older researchers in mathematics. Also those who have achieved rank and tenure were less motivated to maintain a high rate of publication. Kyvik (1990b) therefore proposed the maximising theory, where researchers choose to reduce their research effort over time because it would not really improve the high professional reputation they have already achieved. Other studies attributed the decline to economic reasons especially among older scientists who realised that the financial reward declines as they get older.

The relationship between age and productivity is still vague. Previous studies have given inconclusive results (Folger and Gordon, 1962). Blackburn, Behymer and Hall (1978) found that age was a weak predictor of publication productivity. Cole (1979) in his study of the research activity of a sample of 497 mathematicians with Ph.Ds in American universities between 1947 and 1950, found that their productivity did not differ significantly with age. Creswell (1985) proposed that age itself has little predictive influence on performance but the variables highly related to age may help explain variations in productivity. Over (1982) found that the British psychologists over the age of 45 published less than those under the 45 and there was considerable individual variations in productivity between both the older and younger psychologists. Scientists' previous research productivity was a far better predictor of subsequent performance than their age. Also, age became an insignificant correlate when productivity was regressed against gender, academic rank, prior publication and research standing of the university. Other studies such that of Waworuntu (1986) and Levin and Stephan (1989) also found that age was not significantly related to productivity

In summary, there are basically three models presented by studies when comparing age and productivity. Firstly, the relationship is curvilinear and productivity peaked in the late thirties and early forties and declined thereafter (Lehman, 1953; Cole, 1979; Over, 1982). The second model suggested a bimodal or saddle shaped curve (Pelz and Andrews, 1966; Bayer and Dutton, 1977; Reskin, 1980). In this case, productivity peaked during the ages of 35 to 44 and again at 50 to 54. The second peak was attributed to the return to academic positions later in life after stints in administrative positions. A third model is a gradual decelerating increase, that productivity increases with age and did not decline after the mid-career peaks but flattened gently (Hammel, 1980; Creswell, Petterson and Barnes, 1984). All the above studies cautioned against putting too much emphasis on age as a predictor of productivity since it may be the other variables that is related to age that provided the right environment for productivity. It is not clear whether age has a bearing on Malaysian academic's research performance since entry age into an academic career is considerable early and the retiring age in Malaysia is also earlier (50 years). The present study will therefore include age as a variable to be compared to publication productivity of selected Malaysian engineers and scientists.

(iii) Family Size

Previous studies have indicated that marital fertility has an effect on job performance. Hargens, McCann and Reskin (1978) found that researchers with children publish fewer articles and the articles were of below average quality compared to the childless group. The effect of children on publication productivity may vary according to the children's ages and indicated by studies described under the personal variable "gender". Kylik (1990a, 1990b) found that women with children under 10 years of age published less than their male colleagues (with similar aged children) and other female academics with older children. The present study would include the number of children as a variable to be compared to publication productivity.

(b) Personality Traits

This section will present studies on personal characteristics of scientists that have been compared with research productivity. The personal characteristics include interests, attitude and motivation towards research, work habits, cognitive, emotional traits, ability, creativity, freedom and autonomy.

(i) Interests, Attitude and Motivation

Among the psychological traits that were frequently mentioned in relation with productivity were interests and motivation, which sustained the scientists with the energy to continue in the absence of external reward (Pelz and Andrews, 1966, 1976). Pelz and Andrews asked 1,300 scientists to indicate their feelings of involvement with their work, how challenging, important and interesting they perceived their work to be. They found that these factors showed significant positive relationships to both ratings of performance and actual output of the scientists. The low publishers often depended on their supervisors for their motivation. Cole and Cole (1973) accorded the "sacred spark" to explain high productivity. Eminent scientists were highly motivated, intellectually self reliant and confident (Merton, 1973a, 1973b, Pelz and Andrew, 1966). Andrews (1979) contended that, where the sense of dedication was high, many kinds of research performance also tended to be high. The main contribution of Andrew's work was the consideration of motivation and performance as characteristics of the research unit as a whole. Because of these traits, the productive scientists were often indicated to be hardworking, could tolerate and handle stress and have positive attitudes towards their work (Horowitz, Blackburn and Edington, 1984). Andrews (1979) also found that the productive scientists have a diversity of interests. Diversity of interests led to the acquisition of new knowledge that is either directly or indirectly useful in solving research problems.

Creswell (1985) included in his review article psychological-individual explanations to explain characteristics that were present in highly productive researchers. The psychological characteristics included ability, inner compulsion and high motivation (also found by Cole and Cole, 1973; Pelz and Andrews, 1976). The productive scientists were often recognized as personalities with high ego strength, have personal dominance, preference for precision, exactness, and were often preoccupied with ideas (Cattell and Drevdahl, 1955, Knapp, 1963; Roe, 1964).

Eastman (1989) also found the effect of breadth of interests on productivity. Subramaniam's (1984) study indicated a positive correlation between the number of papers published and the number of sub-areas represented especially in the field of computer science. In a discipline such as mathematics where the routine was less predictable, work habits was found to have little impact on productivity.

Other personal characteristics identified in productive scientists by Wood (1990) were ability, energy, creativity, motivation, ambition and self-discipline. The productive academics tended to be a senior academic, who could cope with a heavy workload, intellectually curious, liked writing and always puts away time for research. Some saw the productive academic as one who is competent at academic gamesmanship, hard-nosed about the time allocated for research even though other responsibilities may suffer. For some academics however, the productive academics were strategists who published short articles quickly interspersed with a number of quality papers and have the ability to focus on research. The less productive academics were identified as those (a) disillusioned with the reward system; (b) lacked the confidence in being judged by peers, (c) adhered to such high standards that their work never gets published; (d) older in age; and (e) lacked experience. Wood (1990) also found that the productive scientists have certain attitude and approach towards research such as, they put greater stress on their research function, worked evenings as well as weekends on their research and undertook short term research projects that can produce quicker results. In the present study, Malaysian academic staff will be asked to indicate their interests and motivation in research by rating on a number of Likert-scaled statements. Ratings will be compared to their publication performance to ascertain relationship.

(ii) Work Habits

An individual variable that is often used in studies on productivity is scientists' work habits. The productive scientists were found to be intellectually cunning, and very well organized (Mills, 1959; Hargens, 1975). Pelz and Andrews (1966, 1976) found that their effective scientists have the capacity to work hard, "persist in the pursuit of long-range goals" and were strongly involved in their work (also found by Roe, 1953, Eiduson, 1962, Zuckerman, 1970, Fox, 1983). They often work more than the normal eight hours, are highly absorbed, involved and strongly identified with their work. The productive scientists are highly organized with their time, space and materials, is a supportive team member, and worked closely with their mentors (Krebs, 1967). They worked hard to pursue at long range goals (Zuckerman, 1970). Hargens (1975, 1978) analysed the association between scholarly output and work habits in three disciplines, chemistry, mathematics and political science. He found that in predictable disciplines such as chemistry work habits did affect productivity. In discipline with less routine practices, the impact on output was not indicated. Simon (1974) found that eminent scientists tended to spend a great deal of time on their research and they work on several problems at the same time. Wood (1990) described the productive scientists as those who can cope with extraordinary workload, are intellectually curious, enjoy writing and always put time away for research.

Fox (1983) cautioned that the causal relationship between work habits and productivity is uncertain and needed to be explored further, perhaps more effectively through a qualitative approach. There are studies, however, that indicated otherwise. Lawler and Hall (1970) studied 291 American scientists and found that job involvement was not correlated to self-rated measure of scientific performance.

(iii) Cognitive and Emotional Traits

Knapp (1963) reported that the productive scientists show high ego strength, personal dominance, preference for precision and exactness, preoccupied with ideas and things rather than people. They have the acute ability to play with ideas, tolerate ambiguity and abstraction (Gordon and Morse, 1970). As to how cognitive differences influences productivity or performance cannot be directly ascertained by existing studies. Wilkes (1980) indicated that differences in cognitive styles may affect the orientation of the research but do not affect rates of publication.

Some studies have indicated that the productive scientists often came from families that gave them a high degree of autonomy, independence and self-sufficiency. Chambers (1964), Roe (1952), Taylor and Ellison (1967) reported on biographical studies of eminent scientists. Most eminent scientists showed marked autonomy, independence and self–sufficiency as a child, have a distinctive attitude about religion, tended to be detached from their immediate families and were more attached to objects or abstract ideas of their work. They were less concerned with attaining approval for the work they were doing.

Fonseca et al (1997) highlighted the importance of human factors in explaining the success of 50 eminent Brazilian scientists in the field of biochemistry and cell biology. The scientists attributed a number of personal factors in explaining their success. This include finding pleasure in their work, facing challenges effectively, relating effectively with members of their research team, and dedicating time to work. Besides having enough support in relation to facilities, equipment and materials, the scientists singled out human relationships as the most important factor for scientific productivity. The majority indicated that problems in their personal lives have interfered with their productivity. In the present study, besides asking Malaysian academics about their interests in research, academics would be asked to indicate problems they faced in disseminating and publishing their research results.

(iv) Ability

The relation of ability to productivity was investigated in earlier studies but has been ignored recently. Bayer and Folger (1966) found that IQ correlated very weakly with productivity and achievement in science. Ability here may perhaps appropriately refer to the ability to find and persist in finding solutions to problems (Shockley, 1957). Taylor and Ellison (1967) studied 2,000 scientists of the National Aeronautics and Space Administration and found the productive scientists to be independent, intellectually research oriented and was highly confident of their ability. This observation was also indicated by Cole and Cole (1973) who indicated that the productive scientist have an innate scientific ability, talent, and intelligence In the present study, academic ability is equated with those who are academically qualified. It is assumed that those with at least a Masters degree have the ability to undertake research.

(v) Creativity

A number of previous studies found that eminent scientists were more creative, exact, precise, reliable, intelligent and introverts (Cattell and Drevhahl, 1955; Knapp, 1963; Roe, 1953, 1964; and Collins, 1971). Stein (1962) discussed creativity and regarded it as synonymous with research competence. Seyle (1964) argued that creativity manifested in terms of independence of thought, initiative, imagination, intuitiveness and genius and these characteristics makes a scientist competent. Cropley and Field (1969) equated creativity with an intellectual style, which effectively process and utilize information obtained from environments. Ideas, objects and concepts were viewed in a creative way. Data were gathered from two complex organizations and consisted of 64 scientists in the natural and life sciences. Each scientist completed the Remote Associates Test (RAT), an instrument to differentiate scientists on the basis of their creative ability. The study indicated that those scoring high on the test were also more productive.

Connor (1974) described creative ability as being independent of thought, having initiative, imagination, and concluded that these factors contributed to research competence and helped explain variations in research productivity. The sample studied were scientists in several disciplines employed in a highly research-oriented unit of a large state university and an independent laboratory. The Remote Associates Test (RAT) devised by Mednick (1962) was used as an instrument to measure creativity. Connor, however, found no direct relationship between measured creativity and research performance. He pointed out that creativity would result in an improvement to work productivity only if the social and organizational variables in which the scientists works in support the manifestation of such creativity. It may be erroneous to assume scientific creativity as an individual ability rather than a social phenomenon as it is possible for competent scientists to receive their creative inputs from their colleagues. Connor therefore suggested further investigation into the social and intellectual interaction of scientists to completely understand how creativity contributes to scientific productivity. Babu and Singh (1998) also attributed high productivity to sharpness in memory and creativity. The studies above indicate that creativity, though not the only contributor, is nevertheless an important ingredient for productivity. The creative scientists have the knack "to relate unrelated concepts in a new and novel fashion: to form new gestalts" (p.3)

However, not all studies have found similar findings. Wilkes (1980) and Connor (1974) did not find any relationship between scientists' psychological traits and their productivity. Bayer and Folger, 1966 found that IQ correlates only weakly with productivity. Also, certain traits could not exist in isolation. Creativity does not exist in a vacuum and is affected by social and organizational factors that interact and affect it. Andrews (1976) remarked that creativity would result in productivity in the presence of strong motivation and autonomy.

(vi) Freedom and Autonomy

A number of previous studies have related individual and organizational autonomy to research productivity. Shilling, Bernard and Tyson (1964) studied 64 biological laboratories and the use of information with policies governing funds and freedom. The study found that a policy of unrestricted long distance telephoning correlated highly with success in obtaining information but not with productivity. On the other hand, a policy of unrestricted travel correlated highly with both productivity and success in obtaining opinion. Pelz and Andrews (1966) indicated that organizational freedom was an important factor supporting productivity among scientists. They proposed that a combination of organizational freedom and coordination was effective for high performance.

Box and Cotgrove (1968) investigated eight industrial research laboratories. They found a higher level of publication productivity among scientists who were free to select, initiate and terminate their own research project. Box and Cotgrove stressed that autonomy brought with it more commitment and the conscious effort to transform research findings into publishable papers. Vollmer (1970) evaluated industrial scientists and reported positive relationship between productivity and organizational freedom. The productive scientists were more likely to be located in institutions where they have freedom to select their research projects and be involved in projects outside the engineering development activities. Stahl and Stevens (1977) studied physical scientists and engineers in the US Air Forces research and development laboratories and reported that the production of paper was closely associated with opportunities provided by the universities, the ability to participate in decisions about projects and to undertake independent research.

Again in this respect the causal relationship between autonomy and productivity was not certain. It was not clear whether the more productive scientists were more attracted to settings that provided freedom to select, initiate and engage in research or whether the settings promote productivity.

In the present study, the information about academic staff's attitude and interest towards research was gathered from the structured questionnaire. Other motivations and feelings that academic staff has concerning research would be solicited through the interview following the analyses of response from the questionnaire.

(c) Academic Correlates

(i) Rank

Promotion in academia is often taken as evidence of high research activity and is closely related to publication productivity. Previous studies have indicated that academics higher in academic rank published more than those in the lower ranks (Blackburn, Behymer and Hall, 1978; Dickson, 1983; Creswell, Patterson and Barnes, 1984; Bentley and Blackburn, 1990). Over 28% of full professors in Blackburn, Behymer and Hall's sample, published 5 or more articles over a two year period compared to associate professors and lecturers. The study proposed that full professors have more opportunities to do research and publish their findings because of lesser teaching load, better professional contacts and access to research funds. Kyvik (1990a) and Prpic (1996b) also indicated similar findings.

Wanner, Lewis and Gregario (1981) found that rank was strongly related to article count among natural scientists and social scientists but not among the humanities. For those in the humanities, rank was related to a higher book count. The early studies also indicated that academic staffs' salaries and rank were related to a higher number of published articles (Brown, 1967; Skeels and Fairbank, 1968; Siegfried and White, 1973; Katz, 1973; Tuckman and Leahey, 1975). Cole and Cole (1967, 1968) found that the quantity of publications were used as a promotion criterion especially in less prestigious departments. Lightfield (1971) surveyed 200 sociologists and observed that the quantity of publications was strongly related to ratings by peers as a criterion required for promotion to various levels but it was not the sole requirement for promotion.

Englebrecht, Iyer and Patterson (1994) studied the effect of promotional exercises on the publication behaviour of faculty members. The study monitored the publication history of 584 accounting faculty members promoted to the rank of associate and full professor during the 1987-1989 academic years in US and foreign institutions. The publication history of individuals was collected from the *Accountant's Index*. Publications comprised single and joint-authored works, books, monographs and conference proceedings. The results indicated that on the average, associate professors and full professors in accredited universities published more than those in non-accredited institutions. The number of publications produced by associate professors increased at a greater rate in the years immediately approaching their promotion years. The study also found that the number of publication was subject dependent. Academic staff who concentrated on tax and audit areas published more papers. The study also found that 74% of promoted faculty members in doctoral granting institutions had published at least one article in one of the top ten journals which followed the ranking developed by Hull and Wright (1990).

Bayer and Smart (1991) and Tien and Blackburn (1996) recognised that there is a hierarchical structure that academic staff passed through during their career. Each step represented a promotion and an upgrade of status and salary. The major criteria for promotion in universities are high publication productivity (Gaston, Lantz and Synder, 1975; Tuckman, 1976; Salthouse, McKeachie and Lin, 1978; Kasten, 1984). Tien and Blackburn therefore proposed the behaviourism theory that indicated that promotion has a motivating effect on productivity. They measured research productivity of 2,586 full-time academic staff in the rank of assistant, associate and full professors by the number of publications during the two years prior to the survey. Various statistical techniques were used to determine variability and associations between the ranks. They found that for the entire population, full professors published significantly more than academics in the other ranks but there were no publication differences between assistant professors and associate professors. The results supported the prediction that the higher the rank of faculty members, the more research they publish but rejects the prediction of more variability in research performance for those lower in rank. Assistant and associate professors who stayed in rank longer than the average six years were less productive than their colleagues in the same rank. Full professors continued to be productive because of the effect of intrinsic motives on productivity, such as higher peer recognition, and continued dedication to research.

The behaviourism theory indicated that academic productivity was controlled by the intervals between the various rank intervals. The expected publication rate would remain low in the early period of the interval in rank level because no promotion reward was conferred. The publication rate rose towards the end of the rank interval due to the closeness to promotion. After the promotion, the publication rate would decline again and a post-reinforcement pause would occur. The productivity rate would rise again near the next possible promotion interval. Extending or creating more rank levels would change and prolong the publication life of academics. They estimated the timing interval between each rank level to be six years.

Findings regarding the relationships between rank, research interests and research productivity are often conflicting and inconclusive. Guyer and Fidell (1973), Wanner, Lewis and Gregario (1981) and Over (1982) found that rank has no influence on academic staff's research productivity when other relevant variables were taken into consideration. Tien and Blackburn (1996) attributed this inconsistency to the variations in study samples, differences in statistical techniques used, and variations in the measures of faculty research performance. Gunne and Stout (1980) found no relationship between rank and total output among academics. Creswell (1985) suggested that because of the unclear causal relationship, there may be a need to hold academic rank constant in studies or used it as a controlled variable. In the current study, it could be ascertained that rank contributes to academic publication productivity among selected Malaysian academic scientists and engineers. As such rank is included as an independent variable to be compared to scores on publication productivity.

(ii) Qualification, Training and Experience

Studies have indicated that those who held Ph.D. tended to be more productive (Meltzer, 1949; Folger and Gordon, 1962). Raymond (1967) found a positive relationship between the length of time to attainment of the doctorate and productivity.

A number of studies indicated that the department, which trained the scientists significantly influenced their standard of performance and style of work (Crane, 1965; Zuckerman, 1977). Crane interviewed 150 scientists (biologists, political scientists and psychologists) located at three universities of varying prestige levels. Crane indicated that the setting in which scientists obtained their postgraduate training had more effect on later publication than the place where they work after graduation. She also reported that scientists from major universities are more likely to be productive regardless of their current work environment, while scientists at less prestigious universities were unlikely to be productive. The greatest influential effect was the motivation and judgements in selecting research topics. Zuckerman (1977) interviewed Nobel Laureates who indicated that the socialization during postgraduate research was important in transmitting the standard of achievement, selection of research problems and confidence in work abilities.

Reskin (1979) studied chemists who received doctoral degrees from US universities between 1955 and 1961. Reskin analysed the effect of both pre- and post-doctoral publication and citation and found that training with a productive university faculty and collaboration with the sponsor was associated with higher productivity. Reskin suggested that although sponsorship was important in the launching of scientists' early publication, the quality of their graduate programmes influenced continued productivity. Other studies like that of Long, Allison and McGinnis (1979), reported that the effect of doctoral department is small. Long's study did find a strong and direct effect of pre-doctoral productivity on future productivity.

Chubin, Porter and Boeckman (1981) monitored Ph.D. recipients in the field of electrical engineering, physics, psychology, sociology, zoology and biochemistry and found that early publication was a good predictor of later publication. Astin (1984) regarded the earning of a Ph.D. would affect an individual's socialization orientation. Those with Ph.D. would be trained to conduct research and as such those trained in research institutions (Carnegie, 1987) would be less interested in teaching but would engage more in research activities. Anderson (1989) proposed that the monitoring of the output of research training programmes (Ph.D. system, advance laboratory courses) help to estimate the subsequent research impact of trainee schemes. Nederhof and Van Raan (1989) found that Ph.D. students being awarded with cum laude doctorate were cited more frequency than students who did not obtain this predicate. A study of eminent Croatian scientists indicated that among the most relevant productivity factor was an early acquisition of a Ph.D. (Prpic, 1996b).

Rushton, Murray and Paunonen (1987) indicated that publication output varies with age and experience. The average publication of researchers increased with the number of years of professional experience that would subsequently flattened off. Their vast research experience and an acquaintance with varied research practice characterized the productive Indian academics (Babu and Singh, 1998). It is uncertain that Malaysian academics at the different ranks, having variant qualifications and working experience would differ in publication productivity. As such, these academic variables would be compared with academic performance on publication productivity to ascertain any relationships.

(iii) Tenure

Another factor that might be related to the scope and type of research that academics could undertake is tenure. Kasten (1984) studied a sample of 135 tenured full professors or associate professors from the discipline of social studies. Interviews with the academic staff revealed that research was the most important consideration in tenured decision and acceptable research must be supported by teaching and service. This creates problem for the academics who were being paid to teach but were evaluated on their research for tenure and promotion.

However the actual amount of publications needed for tenure is not large promotion (Caplow and McGee, 1965).

Wood (1990) likened tenure as a "hidden factor" which acted as an incentive for research. The relationship between tenure and higher productivity is however not clear. Holley (1977) found a decrease in productivity among sociologists after tenure regardless of institutional affiliation. Neumann (1979) found no difference in the productivity between tenured and untenured academics from four departments (physics, chemistry, sociology and political science). These findings indicated that tenure is not a very strong predictor of high productivity. In the present study, tenure will be used as a basis to ascertain sample groups to be studied. Only tenured academic staff would be included in the present study.

(d) Departmental Correlates

(i) Time Spent on Research and Teaching

At a glance, the academic job is relatively unstructured, since only the teaching hours are time tabled. Several surveys indicated that academics spent more time on average to teaching and the rest of their time were devoted to research, administration, student supervision, consultation, etc (Robbin's report, see under Great Britain, 1963; Startup, 1979). However, the time put into research is voluntary and arbitrary, even though academics expressed greater interest in research. The study by Halsey and Trow (1971) indicated that 10% of university academics had greater interest in research, and 54% were interested in both teaching and research with leanings towards research and the remaining 36% were more interested in teaching. Startup (1979) reported interviewing academic staff from four universities in Wales about their research and teaching activities. The academics gave the following reasons for undertaking research: (a) they enjoyed doing it; they wanted (b) to advance human knowledge;(c) to increase chances for promotion, (d) to obtain prestige; (e) to do one's duty as an intellectual; and lastly (f) for financial reward. Priority was given to intrinsic reasons. About 86% of academics felt under some pressure to publish and 26% felt they were under great pressure. Generally, none of the academics expressed dissatisfaction with the quantity or quality of their research but were dissatisfied with the time available for research. Satisfaction was also discipline dependent. The pure scientists (who were active publishers) expressed more satisfaction than academics in the social sciences and the arts. The pressure to published was also reported by Morton and Price (1986) where 53% of academic staff of a research university rated the pressure to publish as strong or more or less, while those working in second tier institution rated the pressure as extremely strong or strong.

Very few studies have found any relationship worth noting between research and teaching (Voeks, 1962; Dent and Lewis, 1976, Harry and Goldner, 1972). Bresler (1968), however, did find a small but statistically significant relationship between research and teaching. Webster (1985) looked at nine studies, all of which concluded that there was little or no positive correlation between research productivity and teaching effectiveness. Michalak and Friedrich (1981) cautioned about coming to any firm conclusions about the relationship between research and teaching because of a number of problems. Firstly, most of the studies were carried out at large public institutions making it difficult to generalise to smaller institutions. Secondly, the measures used were varied (such as asking academic staff to estimate the time spend on research or the number and types of contracts obtained, the total number of published works, number of citations received), which are highly vulnerable to distorted reporting (Bresler, 1968; Harry and Goldner, 1972; Linsky and Straus, 1975; Dent and Lewis, 1976). Thirdly, the studies used limited time span to examine the relationship between teaching and research such as a single semester or a year, which would not reveal meaningful results. Finally, the complexities of the relationship, which may be affected by other variables such as intelligence, self-discipline, time management skills, fields of study and the complexity of research undertaken were often ignored. Future studies should focus on finding out how high research productivity affect teaching. Michalak and Friedrich (1981) studied the relationship between research and teaching among academic staff at Franklin and Marshall College in Lancaster, Pennsylvania over a five-year span. The study found that the faculty members who were active researchers tended to be better teachers, even though the relationship is not a strong one. The relationship was strongest among academics in the lowest academic rank and weakest in the highest rank. The relationship was also strongly indicated in the social sciences and the humanities than the natural sciences. No firm conclusion can be drawn from this study since the motivation for research may be different across disciplines and results might be affected by academic staff's years of experience.

The weak relationship between the effectiveness of teaching and research continued to be indicated in studies in the later half of 1980's. Feldman (1987) found no significant relationship between instructional effectiveness and research accomplishments. Webster (1985) covered nine studies that indicated little or no positive correlation between research productivity and teaching effectiveness. Ramsden and Moses (1992) also found negative or near zero correlation both at the individual and departmental level among Australian academics. Research might increase teaching effectiveness by increasing awareness and currency, but good teachers need not necessarily be good at research (Centra, 1983, Barnett, 1992; Neumann, 1992). The direct relationship becomes difficult to study because both variables are difficult to measure. If at all a correlation exist, it may be that research performance would not enhance pedagogical skills but increase academic's knowledge, interest and enthusiasm for the subject he is teaching and this is discussed in some length by Brew and Boud (1995).

Early studies in the United States have indicated that academic staff rated teaching and research equally important, regardless of whether they were from the medium sized or top quality universities (Brown, 1965; Kelly and Hart, 1967, 1971; Klapper, 1969). However, those at better institutions did allocate longer hours for research (Parson and Platt, 1967). Halsey and Trow found that the tendency to stress on teaching increased for the older academic staff and this is especially so for those who saw themselves as teachers since the research oriented academics tended to publish at any age even when 40 years of age.

Austin and Gamson (1983) in their study of the academic workplace indicated that extrinsic factors such as teaching loads, administrative practices, rewards and opportunity structures could influence faculty productivity and morale. Clark and Corcoran (1985), Clark, Corcoran and Lewis (1986) distinguished that the faculty who indicated vitality were those who were highly active, allocated a smaller percentage of their time to teaching, had stronger research orientations and viewed their departmental and institutional service as a strain on their research time. Clark and Corcoran employed the interview method to gather data. Academic staffs were asked about their interests, activities, satisfaction, goals, working conditions, development opportunities, professional achievements and collegial relationships. The productive professors were those who expressed enthusiasm in supervisory work; allocated sufficient time to explore ideas; tended to work longer hours than the average professors; were professionally more active (often a representative at professional meetings or paid consultants); wrote more books; collaborated with their colleagues; made room for professional growth by developing new subject interests; allowed possible career change; and regarded administrators as helpful in purchasing equipment or in reducing course loads. Edem and Lawal (1999) found that academics who were satisfied with their achievements or responsibility and who were accorded recognition were likely to be more productive.

Startup (1979) conceded that the amount of time allotted to each activity (research, teaching, etc.) varies in accordance to the academic rank and discipline. The 77 respondents sampled, indicated devoting 40% of their time to teaching, 15% to research, 10% to administration, 10% to counseling and the rest to programme design. Abu Hassan (1978) interviewed 80 Malaysian academics, out of whom, 88% stated that research was important to them but most considered insufficient time as the main stumbling block that hindered their research plans. About 85% of the Malaysian academics indicated that they used a quarter of their time to research and most of their time was devoted to teaching or non-research activities.

Previous studies indicated that spending more time on research was related to publication productivity and this seems to the case across a number of disciplines. Manis (1951) found an association between time spent on research with productivity and reputation among social scientists. In the UK, Halsey and Trow (1971) found that a larger percentage of the academic staff sampled were more oriented towards research, but the results were inconclusive because the questions asked seemed to lead to a biased response in the direction of research (Lofthouse, 1974). In the health sciences, Calligro et al (1991), Harrington and Levine (1986) indicated that their more productive academic staff member spent greater amount of their time on research than the less productive faculty. Similarly, Allison and Stewart (1974) found that the highly productive biologists, mathematicians, physicists and chemists spent more time on research and this is correlated to their research productivity. The amount of time spent on research increased for the productive scholars and declined for the less productive. Baldridge, et al, (1978) surveyed academics from private institutions and found that the productive scientists allocate 25% of their time to research compared to 22% from the public universities. Blackburn, Behymer and Hall (1978) indicated that when academic discipline and rank were controlled, the preference for research emerged as the strongest predictor of total journal article productivity over a career. The highly productive tended to have a high preference for research over teaching, were more likely to be employed in institutions that both encouraged and rewarded research, and provided high-quality doctoral programme with access to adequate resources (Reskin, 1979; Creswell, Barnes and Wendel, 1982). Some studies proposed that academic staff should assigned ideally about 40 percent of their academic time to rersearch (Allison and Stewart, 1974; Knorr, et al., 1979a, 1979b).

Fox (1992) surveyed a total of 3,968 academic staff between 1986 and 1987 on work attitudes and practices. The dependent variables were the number of articles published or accepted for publications in refereed journals within three years. The independent variables included aspects of academic roles and work (time allocated to teaching and research); teaching load (number of courses taught and the number of undergraduates taught) and time investments (in course preparation, undergraduate supervision, research and writing, reviewing journals, service on editorial boards and correspondence with colleagues). The multiple regression method of statistical analysis was used. The findings revealed academic staff's strong interest and commitment to research, and their perception that their departments reward research activities supported higher total publication productivity. Publication productivity was not related to factors relating to teaching, supervision and course preparation, Fox suggested that research and teaching do not represent aspects of a single dimension of academic investments, but are different conflicting dimensions. Those academics whose publication productivity was high have strongly invested in research but not in teaching. As a result there exist a strain between academic staff's role in research and teaching and this is contrary to the notion that the two activities were complementary. There are also studies that indicated that an interest in research need not necessarily predict high publication productivity (Stein, 1962; Blackburn et al, 1991). In the present study, it cannot be ascertained that allocating a higher percentage of time to research would result in higher publication productivity for the Malaysian academic staffs. As such, the survey instrument would ask academics to indicate the percentage of their time allocated to research and the rating will be compared to scores on publication productivity to ascertain relationships.

(ii) Discipline Difference

Faculty research productivity differs between disciplines. Biglan (1973) indicated that scholars in the hard sciences such as chemistry produced more journal articles compared to those in the softer science disciplines, such as accounting. Those academics in the latter discipline produced more books. A number of studies found that the publication rate was higher in chemistry than in physics (Hagstrom, 1965; Cole, 1979; Thagaard, 1986). Hargens (1975) pointed out that the research processes and cognitive structures of disciplines influenced research performance. In a discipline such as chemistry, the scientists tended to collaborate more either with colleagues or research students. Blackburn, Behymer and Hall (1978) supported this finding and indicated that faculties in the natural sciences published more articles than their humanities colleagues. Wanner, Lewis and Gregario (1981) also observed differences in publication productivity among the natural sciences, social sciences and the humanities. The natural scientists wrote more journal articles, while books were mainly written by the social scientists, followed by the humanities. Thus the norm of putting too much emphasis on journal publications may put researchers in the other disciplines in a disadvantaged position. A British study by Rushton, Murray and Paunonen (1987) compared university departments and individual researchers in the field of psychology, and found that 2 of the 51 departments accounted for the majority of total journal publications and one-third of total citations. The study indicated that in the field of psychology, a few key researchers or "superstars" account for most of the scientific impact in their field.

Wood (1990) investigated academic staff in Australian universities about the factors influencing their research performance and proposed that discipline influences the degree of productivity since research processes and techniques within and between disciplines differ. Research outcome would be influenced by the type of research undertaken (pure or applied, of high or low risk, fieldwork, desk or laboratory based, established or developing, local or international, short or long term, and experimental or ecological). The length of time needed to complete the research would also influence research outcome. Pelz and Andrews (1976) indicated that the stage of entering into the research area would influence productivity of the research. Academics would have a better chance of making a significant contribution if they enter the field of research at an early stage.

Palmer (1991) compared publication rate achieved by biochemists, entomologists and statisticians with discipline and gender. Publication rate refers to the number of papers published per year, calculated for each individual by dividing the total number of papers by the number of years since the first paper was published. The results indicated that biologists published one or more journal articles a year. In taxonomy and other descriptive subjects, the annual production rate might be as high as ten to fifteen short papers. Fast moving fields such as molecular biology and biochemistry was characterised by shorter, more frequent publications, which were often multiple authored. In disciplines such as mathematics and statistics the papers are longer and co-authors are not common (Becher, 1989). Prpic (1996) studied 385 Croatian scientists in four different fields. The study found that the total career publication and average five-year productivity was significantly different across the examined fields. Firstly, the ratio of solo-authored and co-authored publication differs between disciplines. Co-authored works were common in the natural sciences, biosciences and technical sciences, while so-authored publications were predominant in the social sciences and humanities. Secondly, the share of works published abroad by eminent academics also differs between disciplines.

The performance of scientists in a discipline has also been compared between countries. Bottle, et al (1994) compared professors and associate professors in the United States with professors and readers and senior lecturers in the United Kingdom in the field of chemistry for the period 1980 and 1991. The sample included 230 professors, 224 readers and 275 senior lecturers. The *Chemical Abstracts* published between 1980 and 1991 were used to obtain information about publication counts. The study found no significant difference between the overall samples but the British readers and senior lecturers published significantly more than the American associate professors. The British chemists also published in a wider range of journals while about 72 percent of the American chemists published in American journals. This is a reflection of the advantaged position that American scientists have over their world counterparts with the availability of mainstream communication channels at their disposal. Wanner, Lewis and Gregario (1981) found that the number of journals available in different disciplines influenced the number of publications produced.

The above studies indicate that differences and similarities of publication productivity may be explained by discipline difference. As such, the present study will include discipline as a variable to be compared with publication productivity scores among Malaysian academics. The study will also investigate the journals the Malaysian academics used to disseminate their research findings.

(iii) Department / Group Size and Age

The studies which investigated the relationship between research productivity with department or research group size indicated contradictory results. Department size in the context of this section refers to the number of academic staff in a department or number of group members in a research team.

Wallmark and Sellerberg (1966) and Wallmark et al. (1973) collected data from 60 research teams in three specialised areas of applied physics and concluded in general that size is not important in research. The study found no positive effect of increasing group size on performance, no evidence of either an optimum or minimum size effect on performance, and the effect of other contributing factors such as material resources, selection of group members, the effectiveness of group leadership needed to be taken into account. Cohen (1991) also found no reliable evidence that indicated that size or range of size of groups increases output. Hemlin and Gustafsson (1996) studied research production in the arts and humanities and found that the size of the department has no effect on individual productivity.

Blume and Sinclair (1973) reported only a modest positive association between individual productivity and research group size for a large sample of British University chemists. Blackburn, Behymer and Hall (1978) found that department size was a poor predictor of scientific productivity when investigating a sample of academics in American colleges and universities. The study did find a critical minimum group size of between 11-15 departmental members. Beyond this size, productivity remained relatively stable. Gallant and Prothero (1972) also observed that department size was a poor predictor of productivity but proposed that a minimum size was necessary to facilitate productivity. A department needed an average of 11 to 15 members to facilitate communication between colleagues. Beyond this size the productivity per professor remained relatively stable.

One European study (Stankiiewics, 1979) did find a significant relationship between group size and output of published papers. Stankiiewics studied 173 Swedish academic groups and observed that the relationship was curvilinear especially when group age was controlled. The bigger the group the larger the output, till a certain size was reached after which output began to decline. The optimum group size in this case was between 5 to 7 scientists. Another European study, Fitschi, et al. (1980) also found a relationship between productivity and department size, but observed that for chemistry, physics and mathematics, a significant productivity peak was indicated when the department size was between 9 to 22 researchers and assistants.

Jordan, Meador and Walter (1988, 1989) used ranked economic departments by their output of published research to assess whether department size was related to the average research productivity. The study found that research productivity was positively affected by department size. However, this effect diminished as department size increased. Maclean and Janagap (1993) studied the publications of 22 international agricultural centres in 1990 and found no correlation between scientific productivity and number of scientists in a centre but did find correlation between scientific productivity and budget. Qurashi (1993) compared per-capita research output of an interacting group of research workers with the size of the group. The results showed an initial linear rise, followed by one or more maximum, the first being at group size of 6 to 8 persons and the second at the group of 8 to 9.

Kyvik (1995) examined whether large university departments provided better opportunities for research than small ones. The sample comprised assistant professors or higher at four universities in Norway. The study found no significant relationship between department size and productivity in scientific publishing. However, the academic staff in the smaller departments was more contented with their research environment than their colleagues in larger departments. This finding was consistent with an earlier study by Kyvik (1991), that found departmental size has variant effects on disciplines. In the humanities, the smaller departments perform better, while the opposite was indicated in the medical sciences. This may be due to the nature of study in each discipline. There was more teamwork in the medical sciences then in the social science department.

Johnston (1994) summarised the suggestions by the various studies on the effective optimum size of a research group as follows: (a) about six fully qualified scientists working in the same problem area with a dozen support staff, graduate students and post-doctoral fellows (suggested by Ziman, 1989); (b) as few as three persons, up to more than twenty; (c) a middle range of four at the lower level and six or eight at the upper limit (suggested by Etzkowitz, 1992); and (d) a group size of five (suggested by Franklin, 1988). The studies above indicated no optimum standard group size for the various disciplines.

A number of studies have investigated the effect of the age of the research group on productivity. Group age is defined as the average number of years the members belonged to a group. A group with high researcher turnover is regarded as young, even though it has existed for a long time. Shepard (1956) found that the productivity of research teams in industrial laboratories was highest during the first 16 months of its existence and declined thereafter. Wells (1962) and Wells and Pelz (1966) found that the general scientific contribution of their groups tended to decline with increasing age and the group's overall usefulness was pertinent during the first four to five years after which it declined. The study used 83 research groups (49 in industry and34 in government sectors). Wells and Pelz attributed this situation to the decreasing cohesion and competitiveness in the aging groups. Stankiewicz (1979a) proposed that the nature of the group themselves and the institutional/organizational setting they operate within would be affected by the size of research groups. The study consisted of 172 randomly selected Swedish academic research group in the fields of natural science and technology. Research output was found to be significantly related to group age. Group age was found to be significantly related to research output. Output per scientist increased during the first 10 years of a group's existence, after which it stabilises or declines. Output also declined when group size was 11 or more years old.

The studies above indicated two things. Firstly, the size of a research group of department would have some effect on the performance of the group but most probably the effect would be small. Increasing the size of the group would not necessarily result in higher productivity. There are evidence that there might be an optimum group size that helps to stimulate performance in a group but further research need to investigate whether the optimum is discipline or type of research dependent. Secondly, there are evidences, which shows that group age might influence group research performance. Again, the findings are inconclusive and further investigation is needed to observe the effect of group age on the dynamics of group performance in various context and situations. In the present study, information about the number of academic staff and the number of postgraduate students enrolled in a department would be obtained from the questionnaire and this information would be compared to the department's publication output.

(iv) Graduate Students Supervision

Creswell (1985) discussed the possible departmental variables that might help promote research productivity and proposed correlates such as the quality of graduate programmes that train and socialise graduates to perform research. Studies have indicated that student supervision helped to increase academic's publication productivity. Berelson (1960) found that the productive scientists were more likely to supervise three or more students compared to their less productive colleagues. Hagstrom (1965) also reported a significant correlation between the number of graduate students and a professor's productivity. The likelihood of student supervision was indicated to be discipline dependent. In the fields of mathematics, less supervision was indicated compared to fields such as political science or chemistry (Hargens, 1975). This situation was also found by Lodahl and Gordon (1972) for physics and chemistry who indicated that physicists and chemists are more willing to work with graduate students compared to sociologists and political scientists.

Wood (1990) explored the availability of postgraduate students, the teaching responsibilities allocated, and the individual autonomy in research. All academics accepted the importance of postgraduate training but felt that this effect was not lasting unless conducive work environment existed in the academics current work place. The importance of research students was also accepted by most academics, as these students would enrich the research environment through their enthusiasm and new ideas. This environment would not work if the ability of the students who undertook research were poor. Academics from smaller departments also indicated inhibitions in terms of teaching limited topics, the amount of time needed to reorganize and rewrite courses and the limited time allocated to undertake quality research. The individual autonomy in selecting research topics was also considered important. However choices would have to be in tune with funding and national priorities.

Kyvik and Smeby (1994) studied academic staff within the ranks of assistant professors or higher at four Norway universities. Academic staff's views were sought about Ph.D. supervision, how Ph.D. students influence research in their departments and how these students influence staff's own research activity. The productivity indicator used was total publications in the three-year period 1989 and 1991. The results indicated that on average, academic staff spent 13 per cent of their working time on supervising graduate students (about 6.3 hours per week). The academic staff also supervised on average 1.9 Ph.D. students and 4.0 major subject students. Also, about 30% of major subject students and 46% of Ph.D.

students worked on dissertation in connection with their supervisor's own research projects. The study found a positive correlation between the number of graduate students academics supervised and productivity (Pearson r=.22). There was also a correlation between the number of major subject students supervised and productivity (r=.15). The full professors supervised more graduate students than the associate and assistant professors. The higher the rank, the more productive the academic staffs were. Regression analysis were used and the results revealed that the supervision of Ph.D. students had an independent effect on faculty member's research performance in the natural, medical sciences and technology but not in the humanities and social sciences. The results also revealed that correlation was higher between students involvement with academic's own research project and productivity. The academics who supervised Ph.D. students gave favourable assessment to the importance of supervising for their own research and this is higher in the natural and medical sciences where collaboration is necessary, compared to the humanities and social sciences where students worked more independently. Fonseca, et al. (1997) interviewed 51 scientists who indicated that students are important to their productivity.

Despite evidences of a relationship between productivity and the number of students supervised, there were also studies that did not support such findings. Clemente and Sturgis (1974) observed a weak relationship between the quality of the departmental programme and research productivity. Fox (1983) pointed out in her review that a clear causal relationship was not indicated by the studies. In the present study, Malaysian academics would be asked to indicate their satisfaction with the research students enrolled for postgraduate programmes in their department. The quality of research students is regarded as an input factor in the research process and is expected to be a contributory factor to research productivity.

(v) Departmental Prestige

Social order in academia is expected to have some influence on research performance. The graduate and postgraduate programmes offered at universities, helped to socialise students to the norms of a profession, helped develop knowledge, skills, competence, cultivate values, attitudes and standard of performance. Ben-David (1962) indicated that scientists at major universities were more likely to be highly productive and more likely to receive recognition. Crane (1965) contended that the best graduate schools would attract the best students, who would be in turn, selected for training by the top scientists who are themselves productive. Crane interviewed 150 productive scientists at three universities of varying prestige. Her findings revealed that a scientist trained at a major university was more likely to be productive than the one who had been trained at a minor institution. Scientists trained at minor universities were unlikely to be unproductive unless they were located at a major university. This indicated that differences in research environments influenced research productivity. In the major universities, leading academics stayed in the same area of research, which resulted in the continuity of research undertaken.

Brown (1967) distinguished between the non-publishers (no publications), the publishers (those having published more than 10 articles) and the big publishers (10 or more articles or at least one book). He found that a higher percent of the big publishers were located in the top ten percent schools. Prestigious universities did not only attract talented graduate students but also shaped their academic staff's research performance. Prestigious institutions stimulated individual research productivity.

There seems to be an agreement among academics in general that the productive scientists were generally trained at prestigious universities (Mulky, 1976). Zuckerman (1967) studied Nobel Laureates from America and found that about half of them received their degrees from four universities, namely Harvard, Columbia, Berkeley and Princeton, which during the period under study produced only about 14% of science doctorates awarded by American universities. In another study, Zuckerman (1970) found that membership of the National Academy of Sciences was mainly drawn from scientists at a few universities. In the UK, Eisner (1973) observed that the Fellows of the Royal Society in 1971 who received their first degree from British universities mainly came from Oxford or Cambridge. Eminent scientists tended to concentrate in highly regarded universities or centres because of several factors, such as, self-selection, selective recruitment, better research facilities, a more structured postgraduate programme, prestigious or well respected academic staff, and the availability of a fair share of research funds (Knapp and Greenbaum, 1953; Holland, 1957; Halsey and Trow, 1971). Those less eminent, would also benefit for being affiliated to prestigious universities because it provided the opportunity to be in contact with elite academics and their numerous informal communication networks. The chances of a young scientist's work being recognised was better when affiliated to prestigious institutions.

Instead of focusing on productivity, Hagstrom (1971) focused on departmental prestige and the variables related to it. Departmental prestige used Cartter's (1966) scores and categorized departments into distinguished, strong, good, adequate and less adequate. Most of the variables characterizing quality departments were produced by aggregating data for individual member's mean number of research papers published between 1961-1966, citations to works in 1966, quality of graduate faculty, awards obtained, percentage holding offices in societies, positions in government advisory committee, undergraduate selectivity, number of review articles, the number of books in careers, and the number of textbooks in careers. The sample was taken from 125 departments of mathematics, physics, chemistry and biology. The study found a correlation between departmental prestige and department size, research production (research articles and average citation accounts) research opportunities (the availability of grants), faculty background (faculty received their doctorate and bachelor's degree from high quality departments and they obtained their doctorates in a shorter period of time), number of postdoctoral fellows, faculty awards and offices (number of awards indicated in the *American Men of Science* biographies for scientists), average amount of informal scientific communication and departmental morale. The situation that gave rise to prestigious universities was the competition for prominent researchers, grants and cooperation.

Competition among the universities is related to innovations and an academic standard that helped to nurture greater scientific productivity. There were signs of change where consortia of universities were formed to share expensive research facilities, or share information of prospective personnel. However, Hagstrom cautioned against taking the relationship too seriously.

Employment in a prestigious university shaped and stimulated research performance. Once employed in a prestigious institution, the correlation between the prestige of the university and productivity grew over time. Long (1978) carried out a longitudinal investigation of publication histories of scientists and reported that the effect of location upon productivity was strong, especially for scientists moving into their first academic position. The scientists' publication levels were affected by their pre-doctoral publications and not immediately by their new institution. Their new institution would affect influence only after three years within employment in the institution. As a result, those who gained entrance into prestigious institutions would be productive after about three years compared to those in less prestigious departments who would begin to publish less. Long and McGinnis (1981) extended this line of inquiry, to investigate whether employment in a research university or non-research university affected publication productivity. Long and McGinnis studied biochemists, who obtained their doctorates in the years, 1957, 1958, 1962 and 1963. The variables compared were the biochemist's educational and occupational experiences, prestige of the doctoral department (prestige rating given by Cartter, 1966), the prestige of postdoctoral appointments (based on the ratings of Roose and Andersen, 1970) with the number of citations received to papers published. The results indicated that gaining employment in a particular organization was not related to productivity (number of papers and citations received). There were evidences however, that scientists level of productivity conforms to the characteristics of the organisation that employs them within three to six years of occupying a position independent of previous productivity. As a result, scientists who were employed in industrial research, or teach in four-year colleges were less productive than those who worked in research universities. The findings indicated that the major universities provided the right environment that encouraged and sustained productivity. Chubin, Porter and Boekman (1981) supported Long's finding that the prestige of the doctoral programme was an important predictor of productivity.

Reskin (1979) studied chemists who had received doctoral degrees from American universities between 1955 and 1961. The study found that training with a productive sponsor were associated with high productivity during the pre-doctoral period, while the calibre of the doctoral programme was important to productivity at the middle and end of the first post-doctoral period. The results indicated that the quality of graduate programmes was important for continued productivity. This finding was supported by Allison and Long (1990) who studied 179 job changes by academic chemists, biologists, physicists, and mathematicians. The study found that publication and citation rates increased after academic staffs were relocated to more prestigious departments. The results showed that prestigious departments enhanced scholarly activities.

The above studies however failed to explain how prestigious departments foster productivity and how minor institutions discourage publications. The studies also failed to specify whether productivity was influenced by the existence of the research assistantship, or by a favourable reward system or through the exchanges and communication among colleagues and associates. A number of studies indicated that the effect of the graduate school was only temporary, at most the first five years of an academic career. Beyond 5 years, graduate school prestige was no longer significant. Debackere and Rappa (1995) who studied 373 selected scientists working on the development neural networks supported this finding. The study rank-ordered the universities according to an index of institutional prestige that comprised citations and publication information from data compiled by the Institute for Scientific Information. However the study cautioned that the measure pertains to the university as a whole and not to the prestige of individual departments that can vary widely in a given university. Respondents were classified as early entrants (those begin research in the field before it obtains widespread legitimacy within the scientific community) or late entrants. The year 1984 was used as the base year that marked the growth of neural network research. The study found no significant difference between scientists who entered the field early or late. The study did find that early entrants as students in neural network research were more likely to continue doing their graduate work at universities of higher prestige and these students exhibited pioneering behaviour in their approach to research.

The prestige of departments cannot be ascertained in the present study since no national ratings have been carried out by the Malaysian givernment. However, the present study hopes to find out whether departments affected academic's publication productivity.

(vi) Cumulative Advantage

Cumulative advantage refers to resources that scientists accumulate because of their earlier productivity. Scientists who published extensively, would have been advantaged by the resources such as location in prestigious institutions and recognition gained from accomplishments obtained early in their career. The idea is based on Merton's (1973b) *Mathew effect* in science, where, once scientists receive recognition from their colleagues, they accrue additional advantage as they progressed through their career. The advantages began with doctoral training in a prestigious department that leads to a position in a major research university. Reinforcement refers to the feedback one receives from successful published work, which is also highly cited (formal or informal). Faculty tended to publish more when they are reinforced or recognised by their colleagues. The recognition they received stimulated further publication (Gaston, 1978). Cole and Cole (1973) indicated that more citations to earlier works would result in continued high productivity among physicists. Creamer and McGuire (1998) revealed a number of studies, which applied the cumulative advantage perspective to measure publication output (Fox, 1983, 1985; Clark and Corcoran, 1993; Bentley and Blackburn, 1990). Some researchers developed mathematical models to test the evidence for cumulative advantage on cross-sectional survey data for chemists, physicists, mathematicians (Allison and Stewart, 1974) and biochemists and chemists (Allison, Long and Krauze, 1982). The mathematical models did indicate that productivity and output were related to situations where the scientists were advantaged in terms of resources, being trained at prestigious institutions, having published early in their careers. Other situations included having developed an interest in research early in their career, being mentored by a prominent, senior scholar, published early with these mentors, accepted initial faculty appointments in research institutions, and developed an extensive collegial networks (Creswell, 1985; Blackburn, Behymer and Hall, 1978; Bentley and Blackburn, 1990; Fox, 1992). Ramsden (1994) summarised the key elements of cumulative advantage situation as: (a) having opportunities gained through training (at prestigious institutions, mentored by productive scholars, supported by adequate resources); and (b) the recognition received (formally through awards and citations and informally through collegial feedback and collaboration).

The cumulative advantage perspective indicated how success breeds success. However, it did not show how people managed to be productive without the advantage of early recognition, institutional prestige and resources. Reskin (1977) carried out a longitudinal study of doctoral chemists who obtained their Ph.D. from US universities between 1955 and 1961. Data on the professional history of the scientists were collected which included the length of doctoral study, employment setting at the beginning and the end of the first postdoctoral decade. The longitudinal data were subjected to regression analyses. The findings provided some support for the cumulative advantage theory since prestige of the doctoral training programme, early productivity, collegial recognition, organizational context, pre-doctoral collaboration with sponsors were related to productivity at the end of the first postdoctoral period. Reskin proposed that immediate, informal recognition from research oriented colleagues may help maintain or sustain productivity in the longer run.

Creamer and McGuire (1998) stressed the influence of disciplines. Creamer and McGuire interviewed 31 senior-level faculty in the field of education with a substantial publication record. The cumulative advantage perspective looked at were (1) the doctoral training (whether the doctorate was earned from a research I institution); (2) early interest in faculty career; (3) the type of mentoring received in terms of co-authorship in joint publications; (4) early publication success in refereed journals during or within two years of completing the doctorate; (5) the initial faculty appointment; and (6) collegial networks. Participants were asked how these factors contributed to or inhibited their ability to be productive writers. The study found that: (a) the majority of productive scholars earned their doctorate from a research I university but the completion of a doctoral degree did not ensure the development of the skills required to be successful in publishing; (b) being productive did not necessarily meant developing an early interest in a faculty career; (c) most productive scholars reported the important effect of their mentors and three-quarters of the men but only one-third of the women had published with their mentor; (d) early publishing is strongly related with productivity with the majority publishing at least one refereed publication during the doctorate or within two years of completing it (the average age at first publication was calculated to be 31); (e) initial faculty appointment was found to be weakly related to productivity; and (f) collegial networks was found to be moderately related to productivity, where most productive scientists reported the importance of collegial feedback in terms of reading draft of papers, conference presentations, informal interactions, and exchanging ideas. A number of the participants indicated that the initial motivation to publish was shaped by their institutional reward system and this was sustained by the norms set by the scholarly community outside of their institutions. The results supported strongly only one of the six elements included in the cumulative advantage perspective. The academics did not set out early in their careers to become prolific writers. Most were involved in a scholarship environment that shared interests, exchange ideas and commitment to research and writing. It is this rather than departmental reward structure or formal recognition that set the norm of productivity and provided the motivation. Variations may be explained by discipline differences. In the case of Creamer and McGuire, their sample consisted of scholars in the field of education where, experience as practitioners rather than an early start in an academic career is considered more important and necessary for admission to a doctoral programme. As a result scholars in this field have achieved high levels of productivity without the advantage of an early start on a faculty career or without access to resources afforded by affiliation with a research institution. The results of this study therefore, cannot be generalised to other disciplines.

(vii) Early Productivity and Reinforcements

A number of studies have indicated that early productivity was related to higher later publication output (Meltzer, 1949, Davis, 1954, Dennis, 1954). The younger the age of first publication, the higher the number of articles and books authored (Clemente, 1973; Meltzer, 1949). Lightfield (1971) indicated that those sociologists who published and were cited highly following obtaining their doctorate, continued to publish during the next five years. This was also indicated among chemists (Reskin, 1979). Blackburn, Behymer and Hall (1978) found that the initial two-year performance studied was an excellent predictor of total career productivity. These studies also indicated that high producers continue to publish throughout their careers.

Publishing early accompanied by reinforcements would ensure continued productivity. This situation is based on the behaviourist theory that stipulates an activity which is rewarded continues to be enacted, while an activity not rewarded would be discontinued (Skinner, 1953). This concept is closely related to cumulative advantage but they are basically different. Fox (1983) pointed out that positive reinforcement can exist without cumulative advantage but reinforcement will not account for much productivity unless accompanied by the accumulation of resources for research. On the other hand, cumulative advantage does not exist prior positive reinforcement. Hence, the process of reinforcement almost certainly accompanies enabling advantages. Lightfield (1971) pointed out that sociologists who received their doctorates between 1954-1958 and received citations to their work in the 5 years immediately after receiving the doctorate continued to be active. The reverse was indicated for those who published but did not receive citations during the first five years. Hence, only a small number of those who published early would continue to receive citations during their second 5 year after their Ph.D. The study concluded that unless scientists achieve a quality piece of work during their first 5 years as a researcher, it would seem unlikely that they will do so during the next 5 years of their career. This situation was supported by Cole and Cole (1973) who indicated that those who received heavy citation early would continue to be highly productive, while those whose work were not cited would decline in productivity. Early success brought with it rewards and once these rewards were received, they have an independent effect on the acquisition of further resources (cumulative) (Gaston, 1978; Long, Allison and McGinnis, 1979).

Reinforcement also comes in the form of collegial support. Reskin (1977) suggested that in research oriented universities, the immediate and informal collegial recognition that follows publication is important in maintaining productivity. Cole (1979) also supported the view that reinforcement in the form of recognition helped to stimulate further publications and shape academic research performance. The association between research productivity and institutionally dispensed rewards such as salary as well promotion were indicated in previous studies (Katz, 1994; Fulton and Trow, 1970; Hoyt, 1974; Kasten, 1984) and some were previously described under academic correlates such as rank and tenure. In the present study, rewards in the form of academic rank and the number of consultation received would be compared to publication productivity. Citation data have not been included because such data is not available nationally and those covered by the citation indexes are too small to ensure a fair assessment of productivity.

(viii) Research Leadership and the Departmental Head's Role

The role of the departmental leaders in enhancing research performance is a fairly recent variable being considered. Heads of departments or research group leaders can help create a healthy climate for scholarship by setting realistic goals, identifying areas where the department could excel in and adopting a more individualised approach when dealing with members (Friedrich, 1985). Creswell (1985) and McKeachie (1983) touched on the function of the departmental leaders in encouraging research. Departmental leaders who respected research performance of academic staff provided an environment that was stimulating especially in cases where the departmental leaders were role models for high research performance. The effective leader established clear departmental goals and objectives in terms of research, encouraged academic staff to share outstanding research achievements, collated and updated annually academic staff's list of publications (Creswell, 1985). Boice (1988) indicated the importance of the departmental head in encouraging writing through forming discussion groups, highlighting good writing habits, fostering communication and holding writing workshops. Creswell and Brown (1992) carried out a qualitative study (thirty-three interviews) of chairperson's support in research. The study proposed the importance of administrative roles in providing resources needed for research, providing sufficient time for scholarly work, promoting and publicising academic staff who has improved their scholarship, and adopting an interpersonal role of mentoring, collaborating, encouraging and challenging team members.

Snyder, Mclaughlin and Montgomery (1991) attributed research excellence to the presence of a conducive management environment and culture. The study used telephone survey of 37 outstanding research universities, ranked as the top 100 universities by the 1987 National Science Foundation. The study examined the management practices at these universities and observed that the successful department heads provided institutional support to academic staff by locating and communicating funding opportunities, helped in proposal preparation, allocated seed money for new faculty member, provided statistical data on research activity, adopted the "cheer leading" role for research and made available incentives in order to attract outstanding academic staff and graduate students. The research division of such universities acted as a clearinghouse rather than a controlling function. Research productivity also increased when specific goals were set and resources were mobilised to support such goals.

Barnhill and Linton (1992) provided some insights on how Heads can promote research. This included: promoting a balance between teaching and teaching; identifying the best undergraduate students for the staff recruitment programme; encouraging under-represented groups such as females and minorities to perform; establishing clear departmental research plans; encouraging team research groups; identifying what is needed further by the successful team; and paying attention to current as well as future needs for expertise. The head is also responsible for creating the right research climate; informing staff of available grants; sharing copies of successful proposals and setting up periodic research seminars. The head's role in mentoring also includes learning about the interests of faculty members; setting occasions to talk to them about their work; and reading drafts of their articles. Barnhill and Linton's advice for research leadership are as follows; (a) lead by example; (b) lead pro-actively; (c) lead nationally; (d) search for local resources; (e) encourage inter-disciplinary research; (f) encourage industrial collaboration; and (g) advertise departmental research. Jungnickel and Creswell (1994) also highlighted the importance of including departmental head's support in research. Fonseca et al., (1997) observed the influence of the relationship between team members and leaders on publication productivity.

In the present study, questions about academic staff's opinion about the role of their heads in research was dropped from the questionnaire after consultation with the supervisor of this research for fear that it would be a sensitive issue and the heads would not cooperate in disseminating the survey instrument to their staff. However, opinion on this issue would be put forward to academics in the interview session, which follows the analysis of the survey instrument. Academic staffs interviewed would be asked their opinion about the right research environment and the role of their department heads in research.

(e) Collaboration Correlates

Collaboration in this section refers broadly to the interaction or communication scientists maintained within and between their departments or research groups and the collaboration formulated between institutions at national or international level. The research process includes active interactions among scientists, in terms of talking to each other, sharing ideas or equipment, writing and reading papers, communicating, co-producing and co-reporting research results (Melin and Persson, 1996, 1998). Studies that relate these situations to productivity will be described.

(i) Interactions with Colleagues

Previous studies suggested that scientists' own behaviour, attitudes and the relationship they maintained with their colleagues influenced their productivity. Colleagues were often an important source of preprints and unpublished papers for the productive scientist (Hargen and Hagstrom, 1967; Parker, Lingwood and Paisley, 1968). Pelz and Andrews (1976) defined colleagues as other professionals with whom a man worked with within a laboratory. In the context of this study, this would apply to departments in universities. Pelz and Andrews studied scientists in organizations and observed that the output of papers were highest when the scientist contacted their colleagues weekly. Those who saw their colleagues as important and met frequently tended to perform at a higher level than those who maintained less contact. Colleagues helped to enhance performance, provided new ideas, provided needed information, helped point out errors, and helped to keep current. The study also found that scientists perform better if they work on 2-3 projects rather than one or none. In most groups the scientists performed less well if they worked a standard 8 hours or less. Generally a 9-10 hours day gave better results than 11 or more hours. "All work and no diversity was making Jack a dull scientist". Pelz and Andrew also found that old groups that behaved like young groups continued to achieve. This meant continuing communication, maintaining competition, upholding a certain amount of secrecy, resisting being so specialized, and maintaining zest for broad pioneering areas. The communication line should be actively maintained not only among colleagues but also with heads or leaders. The effective group leader was not necessarily technically better but remained a neutral sounding board, drawing out ideas from members and inviting challenges. The effective leader were those who could build a cohesive group, did not claim credit for his subordinate's achievements but gave credit to the group.

Anderson and Murray (1971) stressed on the importance of collegial support in research activities especially in nurturing, shaping and refining ideas. Parsons and Platt (1968) and Blau (1973) indicated that a prestigious department was often characterised by active collegial discussion and exchange about research discoveries and problems. Reskin (1978) pointed that productive colleagues are especially important for scientists who faced conflicting demands for other than research performance (such as women academics who faced conflicting demands for their domestic, teaching and research roles). Collegial support within departments provided social and intellectual support which in turn facilitated scientific performance. Some studies have highlighted the importance of human relationships in enhancing scientific productivity. Bursts of productivity was found to be related to close relationships between team members and to a lesser extend on material conditions such as the availability of equipment, grants, time for research (indicated by the study of 50 Brazilian scientists undertaken by Fonseca et al., 1997).

The productive researchers are those who not only maintain regular contacts with colleagues within their institutions but also with those outside their institutions (Behymer, 1974; Pelz and Andrews, 1966; Finkelstein, 1982). Productive colleagues seemed to improve the productivity of their colleagues especially those who are usually low publishers (Braxton, 1983). Colleagues helped to provide information through the circulation and distribution of preprints, unpublished papers, telephone conversations, and correspondences (Parker, Lingwood and Paisley, 1968). Finkelstein (1982) cautioned about the total acceptance of such findings since the results cannot clearly show that colleague caused increase productivity. It may be that high productivity creates a situation, which allows collegial interaction.

(ii) Relationships Between Research Teams

Research groups are, in many fields of science, the most important 'unit of action'. The relationships and situations between groups helped to create a conducive environment for productivity (Van Raan, 1989). A number of studies indicated that the work team is the most significant information source for the technologists and scientists. Higher team performance was related to a high level of communication with colleagues (Allen,1977; Pelz and Andrews, 1966; Rosenbloom and Wolek, 1967).

A highly active group is characterised by high coherence of research subjects and collaboration. The way the research teams are organised might have an effect on research performance. Higher productivity was indicated in organizations that are flatter with less layers of hierarchy, which empowered staff. Pelz and Andrews (1966, 1976) proposed that high degree of motivation and dedication among team members of a group is related to their research productivity. Motivation is characterised by giving voluntary overtime and showing high interest to their work. The study also found that scientists with Ph.D contacted colleagues weekly and the output of papers by these scientists were the highest. Pelz and Andrews also found that research diversity is significantly related to research productivity. Diversity is characterised by involvement in diverse research and development activities, projects and specialties, the use and acquisition of several skills, the interdisciplinary nature of the projects, the diverse specialisation among members, the available of funds from several sources, using diverse methods in the research work, and having team leaders with diverse characteristics. This study indicated the possible predictive powers of team motivation and diversity of interest to account for research performance differences.

Visart (1979) focused on the effect of communication behaviour of scientists between as well as within their research units, and the communication channels used to transmit information on productivity. Visart studied 1,222 research units from 6 European countries, totaling 10,000 individuals. The study examined three measures. The first measure was the scientists' general contributions, recognition received, social effectiveness, research and development effectiveness and application effectiveness. The countable performance measures used were the number of published written product of a unit, the number of patents and prototypes, and the number of reports produced. The second measure used was the communication channels used by scientists to transmit information, the frequency of contacts between units as perceived by unit heads, as perceived by staff scientists, contact with users, contacts within units as perceived by unit heads and as perceived by staff scientists. The countable measures used were the number of visits, number of publications sent, number of meetings attended, the number of weeks delay in receiving communication, and the number of unit members providing useful information. The third measures used comprised structural, environmental, climatic and managerial features. These include morale in the unit as rated by unit heads and staff scientists; staff scientists' ratings of their satisfaction with their professional ability and knowledge of their immediate supervisors; and the head of unit's rating on the autonomy of the unit. The countable measures includes staff composition of the unit, number of units in same field within easy access outside the organization, scientific staff turnover, number of research projects shared with other units, the diversity of scientific fields borrowed by the head in his research work, and the diversity of products resulting from the unit's work. Visart found relationships between the number of visits, meetings attended with the number of publications sent; the number of unit members providing useful information and the number of meetings attended; contacts with users and the number of publications sent. This indicated the possible important influence of oral contacts over written ones. The productive units tended to assign higher ratings to contacts between units and with users. Different channels of communication were preferred in different settings. The academic units tended to report a higher number of S & T visits and publications sent, while units from cooperative research institutes report a higher number of meetings. In productive enterprises, researchers reported a higher number of unit members providing useful information. The morale indices showed positive relationships between and within unit contacts, professional competence of immediate supervisors and these were related to high innovative spirit, dedication to work, and high sense of cooperation. Communications between and within units were found to be the best predictors of general contribution (number of published written products) and recognition, applications and R & D effectiveness. Visart proposed that R & D managers might try to provide research units with those conditions that enhanced communication between and within units which proved to have a strong relationship with the recognition obtained by the units, their R & D effectiveness, the number of published written work and their applications effectiveness. The study however cautioned that the results do not necessarily represent a model or ideal pattern of group communication in organisations.

Kowalewska (1979) investigated scientists' perception of the amount of influence certain groups of individual exercise over nine types of decisions. The groups comprised unit heads, other scientists within the unit, organizational leaders outside the research unit and authorities or customers outside the organisation. The ratings were compared with performance measures such as outputs of publications and recognition. The results indicated that units could perform well when unit heads and scientists themselves exercise roughly equal amounts of influence. This is especially true for academic oriented performance (training effectiveness, recognition, output of publications). The organizational leaders seemed to be influential for more applied aspects of performance (application effectiveness, output of patents and prototypes). Most studies did not however consider the influence of communicational systems and network, the organisation conducive for experimental research and the informal social order.

Sakakura (1991) conducted a survey of 108 companies belonging to the Japan Society of Science Policy and Research Management and 158 other enterprises and national laboratories in 1987. Companies were asked about questions concerning R & D projects, both successful and unsuccessful. The survey revealed several situations, which seemed to characterised the successful research team. A higher degree of success is indicated if the following conditions apply: (a) when both leaders of research groups and individual researchers take part in deciding on the R & D subjects from the first phase of planning; (b) when leaders of research groups were given the autonomy to decide upon the members of the R & D teams; (c) when research team includes members who are skillful at collecting information, in the marketing and production functions; (d) when the top management of an organisation show interest in R & D projects and the overall results of the project; (e) when the team exhibit a very active participatory atmosphere; and (f) when researchers conduct in parallel both basic and applied research.

Bibliometric analysis indicated that scientific collaboration paid off in higher quality work due to the collective experience and pre-submission refereeing process that normally took place in joint works (Crase and Rosato, 1992). Co-authored works tended to be of higher quality based on citation counts in physics (Crow, Levine and Nager, 1992). Gowda and Chand (1993) explored the impact of programmer's productivity and individual characteristics of the team members, and the cohesiveness of the team. Programmers in an information systems division of a large corporation in an American Metropolitan city participated in the research. Leader behaviour, software development environment and organizational structure and management practices were monitored. The measure of productivity is the actual lines of code achieved by programmers. The results indicated only leaders behaviour and year of educational background affect programmers' productivity. It appears that leaders who apply more output pressure would affect productivity adversely. The study proposed that the age of groups might have an effect on programmer's productivity. The age of a group can be measured by the degree of mobility of its team members (the higher the mobility, the more immature the group). Most of the groups in the corporations under study were in a transition state and may not have been cohesive or mature enough to maintain and sustain productivity.

Not all studies on collaborative work indicated positive relationship. Oromaner (1975) found no significant difference between citation rates for single authored with multiple authored works in the field of sociology. The study concluded that collaborative work did not necessarily mean better quality work. Avkiran (1997) found no significant difference between the quality of collaborative and individual work. The measure of quality used were citations received over four years following the year of publication. The study cautioned decision makers about interpreting collaborative work as a criterion of quality.

Previous researches, therefore, highlighted the importance of active communication between groups members, the size and "maturity" of the group in influencing the productivity of the group. In the present study, the group refers to the various departments the academic staff belongs to. The environmental factors considered were the size of academic staff members in each department, the number of postgraduate students enrolled, the perceived publication requirements by members from each department, and members perception of their departments prominence in the research activity and the support given by their colleagues.

(iii) Institutional, National and International Collaboration

Faculty collaboration is a cooperative endeavor that involves common goals, coordinated effort, and outcomes or products for which the collaborators share responsibility and credit (Austin and Baldwin, 1992). Subramaniam (1983), identified six types of collaboration: (a) teacher-pupil collaboration where the professor guides several students in different research projects at the same time; (b) collaboration between colleagues, where a number of colleagues worked on one or more projects, each contributing expertise in different aspects of the project; (c) supervisor-assistant collaboration, where the principal investigator is assisted by a number of laboratory assistants; (d) Researcher-consultant collaboration, where individual researcher in the research team can obtain assistance from consultant(s); (e) collaboration between organisations, where scientists in different organisations collaborated on research projects of mutual interests; and (f) international collaboration, where scientists collaborated with colleagues in other countries. Smart and Bayer (1986) proposed two categories of collaboration in research: "supplementary", where researchers divide tasks and make separate contributions to a shared projects, or it can be: "complementary", The degree of collaboration is also indicated to be discipline dependent. Collaboration is common in data disciplines (like physics or chemistry) and less in "word disciplines" (sociology or political science) and rare in fields like philosophy and literature (Bayer and Smart, 1988; Berelson, 1960, Fox and Faver, 1984).

Beaver and Rosen (1978, 1979a, 1979b) undertook a thorough review study on scientific collaboration, the origin of co-authorship, its effect on research productivity, visibility and the history of modern scientific co-authorship. The review revealed that cooperative activities first began in France during the Napoleonic years of the 17th and 18th centuries and grew exponentially after the Second World War. The review also indicated that collaboration generally leads to greater productivity in research, enhanced the mobility and visibility of scientists.

Olaisen (1985) indicated that the more productive academic staff was involved in greater amount of off campus contacts. All academic staff maintained contacts on campus but off campus, national or international contacts were only limited to the productive academics. Collaboration has also been indicated to result in an increase in productivity, sustain motivation, stimulate creativity and risk taking, maximises limited resources and enhances the quality of research and teaching (Austin and Baldwin, 1992).

The honours and awards received by scientists tended to attract collaborators, which in turn increased their productivity. This pattern was found for 422 works published between 1956 and 1995 by Nobel laureate Pierre-Gilles de Gennes, a French physicist. De Gennes published in a diverse range of different fields and the spread of his publications published in various journals more or less follow Bradford's Law of scatter (Kalyane and Sen, 1996).

Collaboration is increasingly indicated in joint-authored publications (Harsanyi, 1994). As early as 1964 Clarke found an increasing average trend of multiple authorship of 2.3 for the period 1934 and 1969. Price (1963, 1966) also indicated this trend in authorship. Price predicted that the trend in single authorship would slowly decline and the change in the size of authorship has been associated with a transition from little to big science. Active collaboration was related to overall scientific productivity, especially in terms of improved communication (Long, 1978; Blume and Sinclair, 1973) and this seems to be the case for several disciplines. Pao (1982) indicated that in musicology the most collaborative musicologist were also the most productive (especially in new area such as computational musicology). Subramaniam (1983) studied research collaboration in biochemistry and chemical engineering and found that collaboration affected the visibility and productivity of scientists and collaborative research papers were more supported by grants compared with single-authored works. Rousseau (1992) proposed that multi-authored papers tended to be more highly cited than single-authored papers (Rousseau, 1992). Gupta (1993) studied 3,417 publications in *Geophysics* and 1,318 publications in *Geophysical prospecting* and found that 56.2% of all publications were single-authored. Joint authorship in geophysics increased from 1.17 per item during 1936-1950 to 1.9 during 1981-1985. Like most disciplines in the sciences, collaboration in geophysics research has increased. Over and Smallman (1973) pointed out that in the field of psychology, the authorship placement in multi-authored works was alphabetical sequenced at an above chance rate and this maintained the individual visibility of collaborative publications. The continued existence of collaborative works in a discipline may indicate that the discipline is still developing and dynamic. Gupta and Karisiddappa (1998) compared the growth of funds and collaboration on publications in the field of theoretical population genetics from 1956-1960 and 1976 and 1980 and observed a strong correlation between the growth of research publications generally and collaborative publications.

Studies have indicated links between international collaboration and higher visibility of documents (Bordons et al.,1996). Bordons used the cluster analysis of the most productive authors as well as centres and indicated the highly active collaborative habits in the field of neurosciences, gastroenterology and cardiovascular system among Spanish authors. A positive correlation was found between productivity and international and domestic collaboration at the author level. This study used the bibliometric indicators comprising total publications obtained from the *Science Citation Index* database. Luukkonen, Persson and Sivertsen (1992) studied the international pattern of scientific collaboration and the results indicated that collaboration between research institutions increased in most research fields and internationally co-authored articles doubled during the previous 10 to 15 years. Melin (1996) studied staff's publications (1,572 papers) from the Umea University in Sweden, between 1991 and 1993 and found that a total of 1,446 papers were co-authored of which 40% were local, and 26% national and 34% international collaboration. Most of the collaboration was in the field of medical sciences.

The investigations on international collaboration were more active in the second half of the 1990s. Meneghini (1996) analysed 48,335 bibliographic records of Brazilian published papers retrieved from the ISI databases for the years 1981 and 1993. The study indicated that solo works remained steady but the growth of collaborative publication increased (especially international collaboration). Sen (1997) introduced the term mega authored works, which comprised papers authored by 10 or more authors. He studied 1,294 papers published in the Proceedings of the National Academy of Sciences of the United States of America and observed that about 5% papers were mega-authored (articles authored by 10 or more authors). Collaborative works was investigated by Persson et al in 1997, who analysed 2,000 articles by Nordic scientists from 22 universities. The results indicated varying degree of collaboration across fields. The highest degree of collaboration was in the fields of physics and medicine. Melin and Persson (1998) further investigated collaborative works by academics from European universities. The study indicated that there were no major differences between universities of various sizes in terms of their output of national or international co-authored works. The study did find a negative correlation between country size and proportion of international collaboration. Scientists from smaller country tended to establish a higher degree of international collaboration. Katz (2000) also observed an increased in collaborative works in the United Kingdom in 1995 where, 50% of all scientific papers involved 2 or more authors and 30% involved 2 or more institutions from different countries (National Science Board, 1998). The study observed that smaller educational institutions have a greater propensity than larger institutions to collaborate domestically (local industrial partners and other educational institutions) (<1.0). Larger institutions have a greater propensity to collaborate internally and internationally (>1.0). Plaza, Martin and Rey (1996) also observed this situation when analysing Spanish publications and found that the percentage of bi-laterally co-authored papers was 43.8% while the number of multilateral co-authored papers was 56.2%. Poland and Russia were the countries with highest number of collaborated papers with Spain. However, the flow from Spain to other countries was small. The study pointed out that international as well as domestic collaboration were correlated to productivity and publishing with a foreign partner increased the scientist's visibility by achieving publication in high impact journals.

Academic institutions are beginning to accept the value of co-authored works and it is therefore acceptable in the present study, to consider both single and co-authored works as a measure of publication productivity. Academics in the present study are required to indicate their position in their collaborative team and the types of collaboration undertaken. Data from these variables will be compared with academics publication output achievements.

(f) Communication Correlates

Communication correlates in this section refer to the use and dissemination of information for research purposes. This includes academic staff's use of formal and informal channels to obtain information, to keep current as well as their behaviour in communicating research results and how information use and disseminating behaviour helps in academic research especially in terms of improving research performance.

(i) Channels Used to Obtain Information for Research

Academic staff sought information for various reasons and situations that are related to their role of teaching, research, supervision, consultation and administration. As a process, information use is dynamic and varies in accordance to discipline and situations (Rouse and Rouse, 1984).

Hagstrom (1970) identified eight formal channels, which chemists, biologists, physicist and mathematicians used for research. This includes research reports, technical reports, articles in journals, papers presented at symposiums, review articles, chapters of a book, monographs and textbooks. Chaudhry and Rehman (1993) indicated that engineers at the Saudi Consolidated Electric Company (SCECO) preferred to obtain information from technical books, standards, internal technical reports, reference sources, vendor's catalogues, journal articles, abstracts, legal sources, and government documents. These formal channels however, disseminate information at a slower pace, and that gave rise to a situation where scientists supplement their information needs with informal sources such as preprints, reprints from fellow researchers, contacting colleagues, and attending conferences (Pelz and Andrews, 1966). This is especially so in rapidly developing fields. Lin, Garvey and Nelson (1970) reported that pre-prints were useful for allowing data to be reinterpreted, incorporating new techniques, supporting or confirming one's own work, providing background information, revising of procedure used, stimulating work in a new area and providing a better feel for the relevance of one's own work to the general discipline. This provided evidence that informal sources helped in improving the quality of research even though direct relation was not indicated by the studies above.

Gupta (1993) identified three categories of information need situations: (a) everyday, where quick answers were needed and may occur several times a day; (b) exhaustive, which comprised queries which needed exhaustive search, selection and preparation; and (c) catching up, where scientists needed an overall picture of current topics to keep up with trends in research. In research, information sources were used in the following situations: (a) the initial stage, where thorough literature search was needed; (b) the collation of retrieved literature; (c) the identification of sources needed to satisfy current needs; (d) the discussion with colleagues and team members; (e) the formulation of hypotheses and pilot studies; and (f) the testing of hypotheses and making public of the results obtained.

The type of channels used by academic staff might be discipline dependent. Garvey, Tomita and Woolf (1979) pointed out that scientists prefer to use journals, to publicly establish their priority rights to the results of their research, to add their findings to other scientific information and to formally archive their scientific work. The technologists indicated higher dependence on unpublished technical report, vendors and manufacturer's catalogues (Ladendorf, 1973). The non-academic scientists also indicated high preference for sources such as trade magazines, books, manuals, government document, company reports, newspapers and trade literature (Kremer, 1980). Even among the engineers there were differences in channels used between engineers who worked in the research departments in large companies and those in universities (Smet, 1992), with the former more oriented towards production, measurements, and quality control of products.

Pinelli et. al (1993) reviewed literature on the information seeking behaviour of engineers which laid out the nature of engineering work, their information use behaviour in comparison to scientists, the influence of their information seeking behaviour on their work, and the types of information preferred. A total of 77 references were provided and described. The review stressed that engineers performed activities that are diverse and multi-faceted. The engineer's work encompassed "both intellectual and physical tasks, i.e., both knowing and doing" (p.176). However, the different functions engineers perform, influenced the flow of information in technology. Engineers used information to produce a product and as such they tended to work in teams, make greater use of informal sources, depended greatly on their personal collections of information, their colleagues, and in-house technical reports or trade publications. When they used the library they tended to use it in a self-help mode. They also made greater use of information technologies, electronic networks, and e-mails.

Holland and Powell (1995) compared the information sources used by engineers who have attended the information skills programme during their undergraduate days with those who had not attended such courses. The results indicated that both groups preferred their own personal libraries and oral communication. However, those who had attended the technical communications skills course significantly rated channels such as colleagues and public libraries much higher than those who have not attended the course. Both groups of engineers ranked highly personal knowledge, members of their immediate working group and outside contacts. This preference for informal channels was also reported in studies of other professions such as psychologists (Garvey and Griffith, 1966), economists (White, 1975), security analysts (Baldwin and Rice, 1997), biochemists, entomologists, and statisticians (Palmer, 1991).

Various reasons were put forward as to why certain information channels were preferred. High on the list of reasons were authoritative, reliable and relevant (Summers, Matheson and Conry, 1983; Kaufman, 1963), accessibility, ease of use (Allen and Gerstberger, 1967;

Rosenberg, 1967; Hodges and Angalet, 1968; Kremer, 1980; Hardy, 1982; Holland and Powell, 1995), technical quality, successes with past experience (Kremer, 1980), speed and accurateness (Smet, 1992). Low on the reasons list includes information sources that are free or inexpensive. The main stumbling block to information use was lack of time to look for the needed information and getting the information at the right time. The above ratings however, could not be generalized as different groups of scientists show preference for different types of information sources. For example, Kaufman (1963) reported that engineers used different types of information sources in problem solving and depended more often on their personal experience than any single specific information source. Libraries were used to find leads to information sources, online computer searches were used to define their problem and technical literature was used to obtain information about new techniques to current problems. Other studies that indicated similar findings are Anthony, East and Slater (1969), Rosenbloom and Wolek (1970) and Allen (1977). However, the studies did not clearly relate information preference or use to research performance. The relationship was merely implied.

Together the formal and informal sources in science served distinctive functions that complemented each other (Garvey and Griffith, 1967; Menzel, 1973). The advantages of informal channel clearly lies in its characteristics (Menzel, 1973). Menzel highlighted the important characteristics of informal communication in science as: (a) promptness, (b) relevance where interpersonal network directed scientists to relevant contacts, (c) screening and evaluation of a source was sometimes pointed out by colleagues who have gone through a large number of documents (d) transfer of know-how from prominent members, and (e) instantaneous feedback. Garvey and Griffith (1967) highlighted the contributions from formal channels. Formal channels (a) are more public and disseminate information at a comparatively lower cost; (b) disseminate information which are permanently stored and retrievable, although the information carried might be comparatively older; and (c) carried information which are monitored and complete.

Recent studies have revealed another channel that has grown in importance in terms of providing information needed for research. This is the Internet, electronic databases and electronic publications. Academic staffs are increasingly indicating a strong preference for online databases compared to their printed equivalent (Crawford, Halbrook and Igielnik, 1986; Clark and Gomez, 1990; Hurd, Weller and Curtis, 1992). Academic's acceptance of e-journals as a publishing channel is slowly gaining strength. O'Connor (2000) is of the opinion that electronic publishing has changed the communication behaviour of scholars. The advantages the Internet offers include; reducing the lag time from submission to publication and reducing the cost and process of printing and mailing. The review process has become more effective as articles posted on the Web may obtain quicker expert review and feedbacks from scholars who have read the article. Already users are showing less preference for the printed serials. O'Connor (2000) reported low use of printed serials at the University of Technology Sydney library and rapid use of electronic resources. Also, academics in fast growing areas such as computer science, science, engineering and business published their work in electronic form on the Internet. Because of this change, criteria for promotion and tenure are expected to change as well. This includes the acceptance and certification for electronic publications. This situation however, would place scholars in developing countries at a disadvantage because a number would still not have access to the Internet.

Very few studies have investigated the relationship between the use of information sources and research productivity or work performance. Smith (1966) studied the factors that affected scientific performance in an industrial laboratory involved in developmental research. A total of 418 scientists and engineers were judged in terms of their production of papers, patents and research reports. These performances were compared to their use of information sources and media. The results indicated that for most scientific and technical tasks performed within the organization, formal internal meetings with colleagues were found not to stimulate high performance. There was negative correlation between contacts with outside consultants and lecturers and level of performance. However, attendance at professional society meetings was strongly correlated to creative activities and has less effect on developmental activities. The findings indicated the possible effects of information sources on certain types or level of work performance since the needs of creative work might be different from those developmental, applied or basic in nature.

Allen (1977) investigated the impact that various information-gathering practices have on the quality of research. A detailed study of 27 pairs of research groups working on government-sponsored projects, indicated that the use of internal information methods or media (informal conversations, internal reports, etc) predominated among the more highly rated project teams. External methods and media (journals, meetings, etc) featured among the less highly rated groups.

Informal communication was found to be predominant among the productive scientists (Griffith and Miller, 1970; Meadows, 1974; Styvendale, 1977; Mick, 1979; Garvey and Griffith, 1979). A higher degree of informal communications was indicated in situations where institutions have limited research facilities or the organizations have a limited number of researchers in the field or the area of research interests was highly technical or specialised. Hagstrom (1971) who studied 125 science departments also indicated that scientists in high prestige departments engaged significantly in informal scientific communication compared to other scientists. They published more and were actively engaged in the informal circulation of manuscripts. They often obtained information indirectly through service on advisory committees and through direct contacts with fellow researchers.

Garvey, Tomita and Woolf (1979) revealed that the productive scientists used a variety of information sources, but the two main sources were colleagues within the organizations and journals. The scientists who worked on a number of projects at the same time and successfully obtained different information at the various stages of information needs tended to publish 2-3 papers per year. However the kind of information needed at the various stages of research differ among researchers of different disciplines as well as between those experienced and the inexperienced. Blackburn, Behymer and Hall (1978) found that academic staffs' use of journals, professional associations and exchange networks correlated with productivity. Wowuruntu (1986) found that the highly productive Indonesian academics tended to subscribe to foreign journals. Al-Salem (1989) also observed that the productive academics exhibited heavier use of scholarly journals, books, theses, dissertations and conference papers. They also needed more current information.

Baldwin and Rice (1997) administered a random telephone survey of 100 security analysts from 40 investment banks in the United States and the United Kingdom. The study found that greater use of informal channels, external contacts and computer usage leads to greater productivity, job satisfaction and higher ranking. Even though the information obtained through these channels was not substantial, it was often most important. Most analysts made little use of their internal libraries. However, those who worked in information rich environments have greater visibility and are better ranked.

Previous studies therefore indicated that: (a) the academic researchers used a wide variety of information sources, (b) information was needed at different stages of the research phase, (c) the research role of academics require more information than perhaps their teaching role, (d) the less experienced and younger academic staff were more dependent on formal information sources and the more experienced rely heavily on informal information channels, and (e) the productive researchers indicated higher consultation with colleagues and use of journals. It is difficult to identify a clear relationship between information use and research performance because the methods used in the studies were varied and case dependent. The present study will attempt to investigate whether the productive academic staff significantly exhibit identifiable preference for certain type of information sources that will be categorized into formal and informal sources and whether the preference is related to publication productivity. It is hoped that findings in this context would help explain the usefulness of library related resources for research.

(ii) Channels Used to Communicate Research Results

A number of methods have been used to communicate or disseminate scientific communication. Allen (1991) grouped them into: (a) oral (telephone conversation, face to face conversation, conferences, seminars), (b) written (refereed articles, preprints, monographs, popular journals, conference proceedings, technical reports, dissertations, newsletters and abstracting journals) and (c) electronic communication (video conferencing, facsimiles, electronic mail, electronic journals, electronic newsletters, bulletin boards, electronic discussion groups).

Garvey, Lin, Nelson and Tomita (1972) described the communication behaviour of 12,000 scientists and engineers in research. The studies monitored scientist's dissemination behaviour from the commencement of their research to journal publications and highlighted the role of seminars and journals in the communication process. Generally, scientists from most disciplines exhibited similar communication behaviour with some variations in the time taken to publish in journals. Presentation of findings at seminars began after two years embarking on the research and this began as close door colloquiums, which progressed to national, regional and international seminars or conferences. The seminars represented a major communication medium and about two-third of such materials were eventually published in journals. Of all the channels used within the system, the seminars offered the greatest range both in degree and number of opportunities for scientific communication. It is a widely accessible means of disseminating and obtaining feedbacks on current research results prior to formal publications in journals (Garvey and Griffith, 1967). Although conference proceedings were the most used channel for disseminating results, they were often regarded as an intermediary stage before the construction of a journal article. Also, whether a conference paper eventually ended in a journal may be discipline dependent. Drott (1995) found that only 13% of papers presented at the 1987 Annual Meeting of the American Society of Information Science ended up as journal articles, compared to 50% in Garvey's (1979) study. The author attributed this low rate to (a) the small size of the sample and (b) the fact that information science as a field may be less publication-oriented and the conference paper functions as the final product. Drott therefore, proposed a remodeling of the knowledge communication process to include conference proceedings and "group monographs" as the final product alongside the journal articles.

The most preferred form of dissemination among scientists is the journal article (Fussler, 1949; Subramanyam, 1981; Luukkonen, 1992). The journal articles served four main functions: (a) they provided quality control through the review process; (b) they assigned priority to an idea or concept; (c) they disseminated information universally; (d) and they archived the article in a permanent, unchangeable format (Walker and Hurt, 1990; Poland, 1993). Fussler (1949) indicated a high proportion of serial use among chemists and physicists. Wanner, Lewis and Gregario (1981) found that the number of journals available in different disciplines influenced the number of publications and contributions. This preference for journal articles is not confined to those scientists in the developed countries only. Altbach (1982) pointed out that journals "remained the most important means of disseminating knowledge" among academics in developing countries and the majority of prestigious journals preferred were published in developed countries (especially the United States, Great Britain, France and Germany). Most of these journals were internationally circulated and paid little attention to issues faced by the Third World. As a result, Third World scholars preferred to publish in international journals rather than local publications, even when the latter existed. Scientists from the less developed countries orientated their writings to the interests of the international journals, even though these may not be particularly relevant to their own countries. "Third World academic institutions frequently foster this sense of inferiority by giving international journals more weight in decisions concerning promotions. The frequently inadequate infrastructures of the Third World journals also make scholars hesitant to contribute to them, since there are often delays in publications" (Altbach, 1982, p.134). Asian scientists also preferred to publish in a wide variety of foreign journals especially those published in the United States and the United Kingdom (Ashhor and Chaudhry, 1993). The preference for foreign journals as a channel to publish research results was also indicated by Nederhof et al. (1993) who studied the dissemination behaviour of academics in an agricultural university in the Netherlands. The study found that the productive academics published more in foreign English language journals than those published in the Dutch language. The study also found that those articles published in ISI journals received more citations than the non-ISI publications, Contributions to conferences received low citations and research reports were hardly cited at all. The preference for foreign journals however, was not indicated by American chemists (Luukkonen, 1992) among whom over 70% chose to publish in journals published in the United States. Luukkonen suggested that scientists prefer to publish in their national journals as a means to inform their colleagues of the results of their research and establish field expertise. As such in countries where the journal system is established, scientists prefer to publish in their national journals, which in a number of cases (in the United States and Great Britain) have attained international status. An established journal system would ensure better visibility of a scientist's work and would ensure easy access to his works by other scientists. Bottle et al (1994) found that British chemists published in a wider range of journals, while their Americans colleagues published the majority of their publications in American journals.

Most of the studies on the communication behaviour of scientists and technologists have focussed on the type of publications preferred, the sequences or stages of the communication process and the reasons for preferring to publish in a particular format. Only one study was found to relate publication productivity with a preference to communicate in certain type of publications. Prpic(1996) has focused on eminent Croatian scientists and indicated that these scientists were not only more productive than the average population but also published four times more in journals published abroad (more than the average population). The present study of Malaysian academic scientists and technologists aim to find out their research communication behaviour. The study also hopes to ascertain whether the productive academics are more predisposed to publish in certain form of publications. This would help to highlight which local channel needed to be nurtured or developed in order to stimulate or improve Malaysian publication contributions.

(g) Institutional Correlates

Institutional correlates refer to the support provided by university management. These include financial support, supportive library resources and services and electronic support.

(i) Financial support

Funding is considered an important determinant of research productivity. Implicit in the research fund allocation process is the assumption that bigger is better. Folger and Gordon (1962) and Salisbury (1980) found a positive relationship between adequate financial support for research and research productivity. Institutions used various guidelines for fund allocations and they basically fall into three criteria (Wakefield, 1978): (a) that the research findings would have an impact nationally and form the basis for further research; (b) that the research would fill knowledge gaps that have arisen because of little work in the area or because previous findings have been inconclusive; (c) that the research has potential in terms of quality of the proposal, qualification of the researchers, and the soundness of the design.

Studies indicated that funding did not ensure similar productivity among scientists in the various disciplines. Warner, Lewis and Gregario (1981) compared the mean number and amount of grants received by social scientists and natural scientists. The study found that the amount of grants have resulted in greater productivity of articles for the natural scientists and higher book output for the humanities. The study found a positive relationship between expenditures in R & D and the number of papers published in journals for the scientists. In the same year, Meltzer (1949) compared the publication counts of academics from 169 universities in Britain, Canada and the United States with institutional correlates such as revenue of the university, age of the university, the number of journal subscriptions, the number of bound volumes in the library and the number of graduate and postgraduate students. The US sample showed a correlation between number of publications and university's income. In an earlier study Meltzer (1956) proposed that funds must accompany freedom of its use in research organizations. Freedom would help boost academic staff to be more productive. For the scientists, adequate and continued funding is a very important factor in ensuring success in research (Wood, 1990). Many academics expressed the problems of justifying the need for support staff, which funding bodies assumed to be available. A number mentioned the difficulty of retraining trained technical and research assistants when there was no continuity in funding. The availability of adequate funding influenced the scope of the projects undertaken. Johnston (1994) surveyed research productivity studies and found strong evidence from existing literature that the scale and continuity of funding helped higher-level research activity, especially in areas more strategically targeted with a higher risk but promised greater achievements. Johnston concluded that large, well-funded, well-led research groups produced more publications of higher impact and received higher international recognition. In a study of 50 highly productive scientists, Fonseca, et al. (1997) observed that material conditions, such as adequate facilities and sufficient funds to purchase chemicals helped improve publication productivity.

Although funding is an important criteria for research, it could not clearly indicate influence on the quality of research. Previous studies have not considered whether the management of research funds influenced research performance. In the present study of Malaysian academic staff, the questionnaire devised would solicit from academic staff the number and amount of research funding they had received within the 5 years under study and their opinion on the disbursement of research funds. The present study will also compare publication performance with feedback about research funding and disbursement.

(ii) Library Resources and Use

Academic research activity placed a great deal of pressure on libraries to supply the resources used in the research process and to provide the services related to the resources. There is an assumed inter-dependence between information collections and the services of the university and the faculty, who are both the producers and consumers of that information. The output of research such as the publishing activity of academics or the number of doctorates produced have been compared with certain key library-related variables such as, total number of volumes held by the university libraries, the libraries' total expenditures, materials expenditure and the number of professional staff employed (Budd, 1995). These variables would benefit the academic staff and can be considered as inputs in the research process. Budd compared the above library variables with the total number of doctorates produced by the universities in 1992. Data were collected from the 1991-1992 ARL statistics. The rank order correlation was employed to make comparisons. The results indicated that the total raw publication counts of the universities were related to the number of volumes held in libraries (.678); total library expenditure (.803); total material expenditure (.717); total number of professional staff employed (.746). Budd however, cautioned about taking the results too seriously, since there is no evidence that any causal relationship existed between the variables.

When an academic institution boosts of its ability to provide academic excellence, the quality and extensiveness of its library service and resources to support teaching, learning and research are often highlighted. It is however difficult to indicate how the library actually help to further student, courses and academic progress. The exact nature of the relationship between usage of libraries and academic performance is not clear. Startup (1979) interviewed academics from four universities in Wales and observed that academics in the arts discipline complained that the university library was insufficient for their research needs and indicated that inter-library loan facility must be good to make-up for these deficiencies. Engineers indicated limited use of bibliographic databases but used it mainly to define or redefine research problems (Shuchman, 1981; Kaufman, 1983; Pinelli, Kennedy and Barclay, 1990). In an Australian study, Hiscock (1986) found that previous experience of library bibliographic tools and use of the catalogue helped undergraduates to obtain relevant text that have not been recommended by their lecturers and these factors are significantly related to the students' academic performance. It is unclear however, whether this relationship exist for academics who are adept at using the library services and sources for their research information needs. A library use study, carried out at Purdue University (Types and needs, 1970) indicated that the main interests of faculty for using the library was to research for a publishable paper, read for self-improvement and read materials required for a course. Reading materials needed for a course was also given as the main reason for using the library by graduate students. Both academic staff and graduate students use scholarly journals and periodicals as their primary material indicating the importance of this resource in the academic institutions. Lonnqvist (1990), who studied information seeking behaviour of scholars in the humanities, observed that journals were used to supply research news, present new literature, read book reviews and obtain related articles needed in the chaining process. Lorenz (1973) found that users of University of Nebraska library perceived a high need for photocopying services in the periodical library. Academics generally perceived the library services as essential but often admitted to infrequent use. This low use might be the result of ignorance as academics might be aware of only half of the services actually available.

The use of libraries is foreseen to change in future from depositories to central services, which provide access to online databases both bibliographic and full-text at academicians' on desks. There is evidence that indicated that academics are readily using online databases made available by their libraries. Curtis, Weller and Hurd (1997) found that academic staff preferred to access electronic databases from their offices to doing so from the library. Zhang (1998) surveyed the use of electronic resources by academic staff at Rollins College in the United States and observed 69% of academics sampled used the online catalogue, 53% used UMI's *ProQuest* direct online databases, 35% used the OCLC *First Search* package and 35% used the *ProQuest* CD-ROM databases made available through the campus network. Bonzi (1992) indicated that access to databases and computer support facilitated academic staff's research productivity. Babu and Singh (1998) observed that eminent Indian scientists regarded access to literature and adequate library resources as important in order to keep abreast with current literature in their research areas.

Published literature in library and information science revealed numerous studies on academic's use of library resources and services. However, very few studies have investigated how library use have improved academic performance and specifically how it has contributed to faculty publication productivity. Most scholars who are involved in studying the assessment of academic research performance have not considered resource use as a possible variable. The present study will attempt to find out whether resource use preference of academics is related to their publication productivity. The survey instrument will also require academics to indicate the problems they face in using or obtaining library-related resources for research and how libraries can further improve their service to the academic research community.

(iii) Electronic Support

A growing number of studies explored the impact of electronic support on academic's communication behaviour for research and teaching. Academic's connectivity, especially the nature and level of Internet use is expected to change the traditional research productivity model. It is in academia that the study of computer use is most active. The current concern is whether academic staff are fully utilising the electronic networks available to them and whether it is contributing to their productivity. As early as 1985 Irvin and Martin concluded that scientific output in the Eastern bloc in the field of high energy accelerators have been small in comparison with the West because of inferior facilities in terms of scientific instrument and computers. In 1988, Schefermeyer and Sewell found that an increase in the use of e-mail by academic staff to communicate and seek others with similar research interests regardless of their geographical locations have opened opportunities. for improvement in scholarly productivity, increased technology transfer and widened information access. Zhang (1998) indicated that over 72% of faculty from Rollins College, Florida consulted the Internet for their information needs. Academics have been reported using electronic networks for e-mailing, electronic discussion groups, accessing databases, running programs and transferring files (Abel, Liebscher and Denman, 1996; Liebscher, Abel and Denman, 1997; Applebee, Clayton and Pasco, 1997). Lazinger, Barllan and Peritz (1997) found that 362 out of 371 academics used the Internet for e-mail and most e-mail correspondences were research related. Over 80% of respondents allocated between 1 to 5 hours to e-mail per week and 75% respondents considered e-mail indispensible. Kaminer and Braunstein (1998) indicated that academics at Berkeley used the electronic network for e-mail, telnet services, listservers, FTP services and electronic journals. Chu (1994) and Cohen (1996) observed that younger academic staff used the Internet more than those older but Applebee, Clayton and Pascoe (1997) indicated that the older academics have caught on in using computers in their work. A number of studies have indicated higher usage of computer among scientists than those in the humanities (Chu, 1994; Cohen, 1996; Lazinger, Barllan and Peritz, 1997).

There are very few studies that investigated the relationship between the use of electronic networks and research performance. It is expected that the Internet would have a socio-economic impact on the academic research process. Almquist (1992) indicated that scientists used IT for different phases of their research especially at the subject identification and proposal stage to be familiar with the literature outside their own specialities. A Chilean study by Ruth and Gouet (1993) surveyed scientists' use of computer networks and found that those who used the network published a higher number of publications. Hesse, Sproull, Kielser and Walsh (1993) observed that oceanographers who frequently used the network published more articles in refereed journals and received higher peer recognition. Bruce (1994) reported that over 80% of Australian academics believed that network access benefited them in conducting research and 63% believed that it helped increase their publication.

Massy and Zemsky (1995) proposed that the availability of IT support and computer mediated communication provided greater access to resources, would result in greater involvement in research and therefore affect productivity. Computers and advance communication technologies have improved productivity of research teams at the University of Ulster, Northern Ireland that used the Internet to develop strategic academic and industrial alliances. In other words Internet technology revolutionized the way collaborative team worked together (Grant and Scott, 1996). Cohen (1996) investigated the relationship between 888 academics' use of computers and scholarly productivity and found that those who frequently use computer-mediated communication performed significantly in publication rates. Overall, academic staff believed that e-mail and network access benefited their research in terms of access to information, enhanced contact with faculties from other institutions and facilitated collaboration with colleagues at other institutions. Abel, Liebscher and Denman (1996) observed that academics accessed electronic services for teaching and predominantly for research. Lazinger, Barllan and Peritz (1997) observed that the scientists are more likely to use the Internet to conduct research with distant colleagues. Studies have indicated that research centres and research universities in the United Kingdom and North America have improved research productivity and work patterns as a result of using the appropriate technologies (Lubanski and Mathew, 1998). Kaminer and Braunstein (1998) compared bibliometric data of scholarly productivity to frequency of Internet use and indicated that an increased in using Internet login was related to publication productivity. Hughes (1999) explored the telecommunication environment that supports faculty productivity and found that a networked environment helped to promote information about faculty publishing productivity and foster a more creative research and work environments.

Johannessen, Olaisen and Olsen (1999) cautioned that investing in IT does not ensure its proper implementation and there is a need to investigate its consequences on innovation and improvement of performance. There is a need for studies that investigate the use of IT and successful innovations and how this affects performance. In Malaysia, all universities have access to the Internet through Jaring (Net in the Malay language). Jaring links Malaysia to other world networks through a dedicated lease line. With this facility Malaysian academics have access to sources and services offered by the Internet and could utilise it for teaching and research. The present study will explore Malaysian academic's frequency and type of use made of the electronic networks and whether this use is related to their publication productivity.

2.3.4. Conclusion

The diversity of factors influencing research productivity is well documented in published literature. However, differences in findings about the relative relationship of research productivity and various variables remained. There are disagreements in the continued effect of graduate training on research productivity. Similar incongruities were indicated in the effect of personal and academic variables with research productivity. The models utilised and developed are diverse and no single model could explain variations in academic productivity between disciplines and within members of a discipline. It is indicated that a single model of scientific productivity cannot assume to be operable in all academic disciplines. Administrators and academics tended to agree on the definition of a productive researcher. A productive researcher is one who is self-directed, who answers important questions, communicates results in an appropriate way and is recognised by the scientific community he/she serves (Ross and Donnellan, 1994). Even so, there are disagreements on how research productivity should be measured. Ross and Donnellan found that university administrators emphasised national reputation and publication in refereed journals, while academics tended to support a variety of output measures. Perhaps the best solution is to study in detail the predictors that worked in the various disciplines and a multi-model for all disciplines can be formulated.

The inconclusive results have triggered studies that focused on the productive scientists in the hope to unravel the correlates which contributed to their productivity. Baldwin (1990) focussed on professors at the University of Minnesota and observed that professors shared similar interests and experiences. Teaching was their primary concern followed by research, scholarship, outside professional activities and administrative services. A large number had designed and taught new courses in the five years under study. Many enjoyed working with young people and the common source of satisfaction was the provision of sufficient time to explore ideas. The productive professors worked longer hours than their colleagues, made frequent presentations at professional meetings, often served as paid consultants, published more number of books, collaborated more with colleagues and often took professional risk by engaging in innovative and nontraditional research activities. A number of the productive professors pointed out the change in their work roles, moving from administrative position to a teaching one. The findings suggested that many professors experienced a desire to revise their career, moving into new areas. The productive professors were observed to be more dynamic, multifaceted and preferred administrative staff who are supportive, who give financial and morale support and who gave recognition for achievements attained. Baldwin's study is exploratory in nature and revealed factors that maintained academic vitality. These include (a) fostering diversified academic careers, encouraging professors to expand their interests in order to maintain a sense of progression in their lives; (b) encouraging career planning through individual assessment of careers periodically to prevent professors from falling into the plateauing trap (Bardwick, 1986); (c) encouraging collaboration, risk taking and role change that would help them experience new teaching and research strategies; (d) employing academic personnel policies which are flexible that enabled talented professors to achieve their full potential, empowering them to use their range of talents fully; and (e) providing due recognition and reward for achievements in the form of awards and citations. Professors needed to feel that their contributions are needed and valued. The study of faculty vitality should be an important future agenda together with the study of academic cultures (institutional as well as disciplinary).

Prpic (1996a, 1996b) has also focused only on the eminent Croatian scientists. The eminent scientists were predominantly male, 45 to 59 years of age and came from a middle or higher economic strata parental background. Most of them did well at university, published early (often during their undergraduate studies) and the average number of publications achieved were higher (3.1 compared to the average 2.6 publications). The eminent scientist came into the field at an average age of 35 years, possessed doctorates at a younger age (average of 36 years of age compared to the average age of 39), appointed to the highest scientific rank at a younger age, and spoke two or more foreign languages. They were editors and reviewers of a higher number of professional foreign and domestic journals. They reviewed a higher number of colleague's papers than the average research population. They supervised a higher number of Masters and Doctorate students and stood out in the average number of memberships in committees of postgraduate studies. They were also members of a higher number of national and international scientific societies and were recipients of scientific awards. During a five-year period, the eminent scientists published almost four times more in foreign publications and three times more professional papers than the average research population. On the average they published more co-authored than single-authored works and collaborated with a higher number of domestic researchers. Although some insights were given about the conducive environment productive scholars work well in, it would not ensure that providing such an environment would increase research productivity. Further studies need to be undertaken to identify the right catalyst that not only promote but sustain academic productivity.

It is evident from the amount of literature reported that there are still unanswered issues that had led to a continuing investigation in this area. Previous studies have not conclusively explained the complex situation of why some academics are publishing more than others given similar situations and conditions, and why some departments are so successful in nurturing their academic members to publish. Publication output is just one measure of productivity and is affected by numerous determinants that are interwoven. As such, no single determinant can be used in isolation to explain the situation. In a developing country such as Malaysia, research productivity studies are extremely lacking. The Ministry of Science, Technology and Environment has been focusing on monitoring and reporting only on the inputs of research while the output and outcome is not easily known. This study is a small attempt to fill in this gap. This is an exploratory study that will identify the publication output of selected sample of academic engineers and scientists and the determinants related to publication productivity. Only total and types of publication output will be considered since there are constraints in obtaining citation data and the number of academics in similar departments in Malaysian universities are too few to facilitate an effective peer review-based study. The description of the methods used to carry out this study will be described in Chapter 3.

Chapter 3

RESEARCH DESIGN AND METHODOLOGY

This is an exploratory study, which aims to examine the factors affecting the research publication productivity of academic engineers and scientists from the National University of Malaysia (UKM) and University of Malaya (UM). This chapter discusses the research design and methodology used in the study. The research design presents the model of academic research system indicating the objectives and roles as well as determinants of publication productivity identified from published literature. The discussion on the procedures of the study will follow. The procedures encompass a description of the selected population sampled, the design of the research instruments, an explanation of the data collection procedures and data analysis.

3.1. THE UNIVERSITY RESEARCH SYSTEM

The university is seen as a productive system that involves the purposive organisation of resources (inputs) for the attainment of a number of outputs and outcomes. The design and allocation of inputs are generally dependent on the objectives laid out by each university's objectives and mission plans. The objectives, therefore, shape each faculty and the departments within it with regard to achieving the set goals and objectives. As an example, the University of Malaya states its corporate mission as:

> To be a premier University, seeking excellence in the achievement and dissemination of knowledge to meet the aspirations of the nation [University of Malaya, 1998]

In order to achieve these aspirations six broad objectives were identified:

a) To be in the forefront of knowledge

b) To produce graduates of high quality

c) To develop a permanent pool of excellent scholars

d) To contribute to nation-building and the well-being of the population

e) To promote universal human values

f) To develop an efficient, innovative and committed management team.

The above objectives have direct and indirect implications for research. It is only through research that the frontiers of knowledge expanded. High quality research will not only attract quality graduates but will also help to produce high quality graduate researchers needed by the nation's public and research institutions. Excellent scholars are those who are actively researching in the priority areas (IRPA, 1996) identified by the nation. Subsequently, the product of excellent research should inevitably help contribute to the nation's development yet remain sensitive to the need to explore and expand basic knowledge. Finally, excellent research ventures can only be effectively realised with proper management and disbursement of research inputs needed for the research process. The emphasis on research, quality and excellence apart from other objectives is therefore apparent in the mission statement. The importance of research to most university communities is exemplified by a statement made by the University of Edinburgh (Whittemore and Echol, 1995) which defines a research university as "a university with an excellent research reputation" where;

- Research is an activity, of equal importance to teaching;
- Excellence in research is being regarded as being of similar importance to the quality of its teaching;
- Its entire academic staff will have an active, funded research programme;
- Research should be in relation to its teaching and teaching is effectively informed by current research; and
- Teaching takes place in an active and high quality research environment.

This does not imply either research or teaching should enjoy priority status, but rather that every member of the staff, at all times, should be pursuing or be excellent at both. These university aspirations are filtered downwards to the various faculties and departments. For the

University of Edinburgh, the Faculty of Science and Engineering laid out these objectives that are common goals amongst most universities:

a) All teaching staff must have demonstrated their quality as researchers, through appropriate post-graduate education, post doctoral experience and publications;
b) All teaching staff should expect to support a credible category entry into the Research Assessment Exercise ((RAE) i.e. they can be listed as active workers and are able to forward four quality publications within the RAE definitions;
c) Every department must be carrying out active research, involving the majority of its staff, at all times; and
d) Every department should aspire for excellence in research (Whittemore and Echol, 1995).

The understanding of the term 'research' follows the United Kingdom's Research Assessment Exercise's definition (NISS, 1966) as "original investigation undertaken in order to gain knowledge and understanding. It includes work of direct relevance to the needs of commerce and industry, as well as to the public and voluntary sectors; scholarship; the invention and generation of ideas, images, performances and artifacts including design, where these lead to new or substantially improved insights; and the use of existing knowledge in experimental development to produce new or substantially improved materials, devices and processes, including design and construction". In the Malaysian context, the legitimate form of academic research would include both laboratory or empirically based, as well as theoretical and library-based research.

3.1.1. The Academic Research System

The model for this study was adapted from that of Jungnickel and Creswell (1994) who used it on pharmaceutical academics. The model categorised correlates of scholarly performance into exogenous and endogenous variables. The endogenous variables used were environmental aspects of the teaching staff's workplace that might be related to scholarly performance. Academic staff's departmental and institutional variables were grouped in this category. The exogenous variables refer to situations outside the departmental and institutional scope. Individual, academic and reinforcement variables were included in this category. The present study uses similar categorisation of terms (endogenous and exogenous), but components of correlates within each category are different. The correlates chosen were based on those reported in the literature. Useful studies by Creswell (1985) and Fox (1983) distinguish between individual level variables (motivation, inner compulsion, attitudes, interests, cognitive style, ability, work habits, age); environmental variables (departmental and institutional variables) and feedback processes (reinforcement and cumulative advantage). Studies, which connect computer use and publication productivity, are very recent (Hess, Sproull, Kiesler and Walsh, 1993; Cohen, 1996; Prpic, 1996a, 1996b) and helped point out the possible connection between types or extent of use of electronic support system with research productivity. In addition, White (1975) studied the communication behaviour of academic economists and found slight differences between the publication productivity of those who frequently use formal and informal channels. The variables identified from the literature are then grouped under exogenous and endogenous categories. Description of the variables under each category is presented under section 3.1.3.

The conceptual model of this study is presented as an academic research system (Figures 3.1and 3.2), that requires input into the system to obtain the desired output. The difference between the two yields a measure of the productivity of the research system (i.e. whether the set research objectives have been achieved). The product of the research system would inevitably generate output, reporting on research results and deriving impact when other researchers found its applicability to their own research endeavours.

Universities account for a large proportion of new knowledge in science and technology. The system, therefore, aims to show possible factors, which may help to contribute to the generation of this knowledge, and if they do, reveals the characteristics of these factors. As a production system, the model aims to describe the circular inter-connective relationships between the systems' objectives, inputs, outputs and outcomes. The system illustrates the way in which various elements that constitute inputs in the system are used in the research process, transforming inputs into desired outputs, thereby meeting the objectives for which the system is designed. These objectives are set out and agreed upon by those who proposed to join the system and accepted by those who are already within it. All academic staff who are employed by the university know automatically that besides teaching, research is expected of them and those already within the system continue to undertake research and accept this as an important aspect of their academic life. The research activity simultaneously helps to fulfil the objectives which are: to train future researchers in priority areas which concurrently advances the frontiers of knowledge in those areas; and to increase the academic staff's reputation through reputable research publications and increase the utility of the research results. The university is, as it were, licensed by the wider society to undertake research and train future researchers. The end product thus comes in the form of trained, skilled researchers as well as an advancement of ideas and knowledge through published works.

The factors that influence research performance at a university are inevitably complex and are interwoven in its relationships. This relationship is described well by Whittmore and Echol (1995) who observed that ;

> "The university's eminence in research is based upon a complex range of factors. Foremost amongst these are; the high quality of the university's staff; the opportunities available to pursue interdisciplinary research in an academic environment characterised by breadth and excellence; the close proximity and interdependence of research and teaching; the provision of access to a major research library within the university, and to an exceptional computing and communications infrastructure".

3.1.2. Academic Research Objectives and Academic Staff's Roles

At the apex of the academic research system is the university's central government whose activities are governed by a number of mission statements and objectives, one of which encompasses research activity (Figure 3.1). These research objectives govern the interplay of factors within the systems as a whole. Generally, Malaysian university research objectives can be summed as;

(1) To promote excellence in research and be in the forefront of knowledge
(2) To produce graduate researchers of high quality which are needed by both the public and private sector
(3) To develop a permanent pool of excellent scholars who would undertake research and thereby increase the university's prestige through the utilisation of such research.

The general university research objectives, in turn, influence the research objectives of each science and technology faculty and department since the objectives at this level are formulated to support central institutional objectives. These are:

(1) To train excellent researchers as required by the university
(2) To undertake and strive for excellence in research endeavours
(3) To disseminate research results in the most effective way so as to improve the faculty's/ department's/university's prestige.

These faculty and departmental objectives would inevitably influence the academic staff's role within the system. Figure 3.1 portrays the academic staff as the "player" with several roles. These roles include: teaching; supervision of graduate researches; undertaking research projects; conducting academic workshops and seminars; providing public services through disseminating knowledge to the general public; undertaking consultation work; being involved in professional-cum-academic activities such as writing editorials for academic publications; undertaking administrative activities allocated by the heads of departments/deans of faculties; publishing research results in reputable periodicals; and presenting research findings at international /national seminars. The variety of roles indicate the near invisible relationships between research process, output and outcome. Undertaking and supervision of research and teaching based on research, clearly constitute the research process, whilst publications, seminar presentations, consultation work, etc., comprise the output of research which in turn affects the process.

3.1.3. Research Inputs

The sum of the objectives of the university's central management is expected to influence the inflow of inputs into the faculties and consequently departments that carry out the research process (Figure 3.2). The inputs consist of variables that go into making the activity of research possible and are expected to be related to research performance. Basically, material, labour and energy constitute the sum of inputs in a production system. Figure 3.2 focuses on the research activity of academic staff, which are influenced by a variety of factors. The factors are categorised into endogenous and exogenous factors. The endogenous factors are inputs originating from within the academic staff, whilst exogenous factors are inputs emanating from the staff's environment. In this context, the content of this model differs from the one proposed by Jungnickel and Creswell (1994) because the focus is on the individual. Variables that directly affect the individual or can be controlled by the individual are categorised as endogenous, while factors that are determined by an academic staff's department and institution are categorised as exogenous. Academic staff in the Malaysian context refers to tenured lecturers and exclude lecturers employed on a contractual basis. Academic staff is envisaged as a resource embodied in the form of knowledge and skills, which they possess for which they apply directly to carry out teaching and research roles.

The endogenous variables comprise a combination of personal related constructs that may be considered as belonging to the input categories of "labour" and "energy". The "labour" element refers to the individual academic staff member, his/her personal makeup as an academic (his/her personal variables, qualifications, achieved rank, years of experience, his/her discipline) and the "energy" element may refer to academic's attitude, perceptions and information use habits that are expected to influence the amount of zest an academic staff puts into his/her research activity. This, in turn, is expected to affect his/her research output.

The exogenous variables encompass factors that are "environmentally" generated, emanating from outside of the academic staff member's control (departmental and institutional support). Both endogenous and exogenous variables are independent variables and are expected to have some relationship on the dependent variables of publication productivity.

FIGURE 3.1: ACADEMIC RESEARCH OBJECTIVES AND ACADEMIC STAFF ROLES

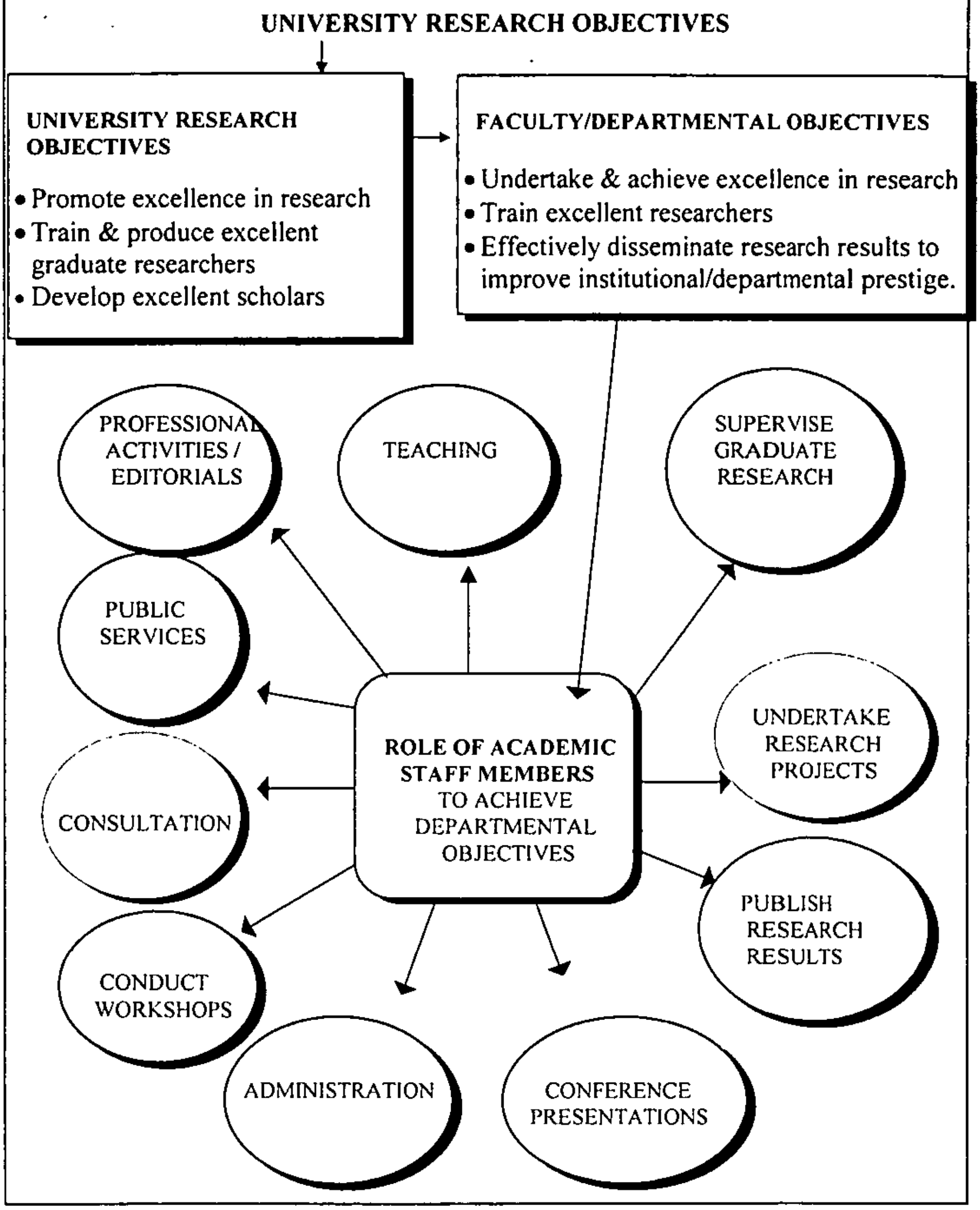
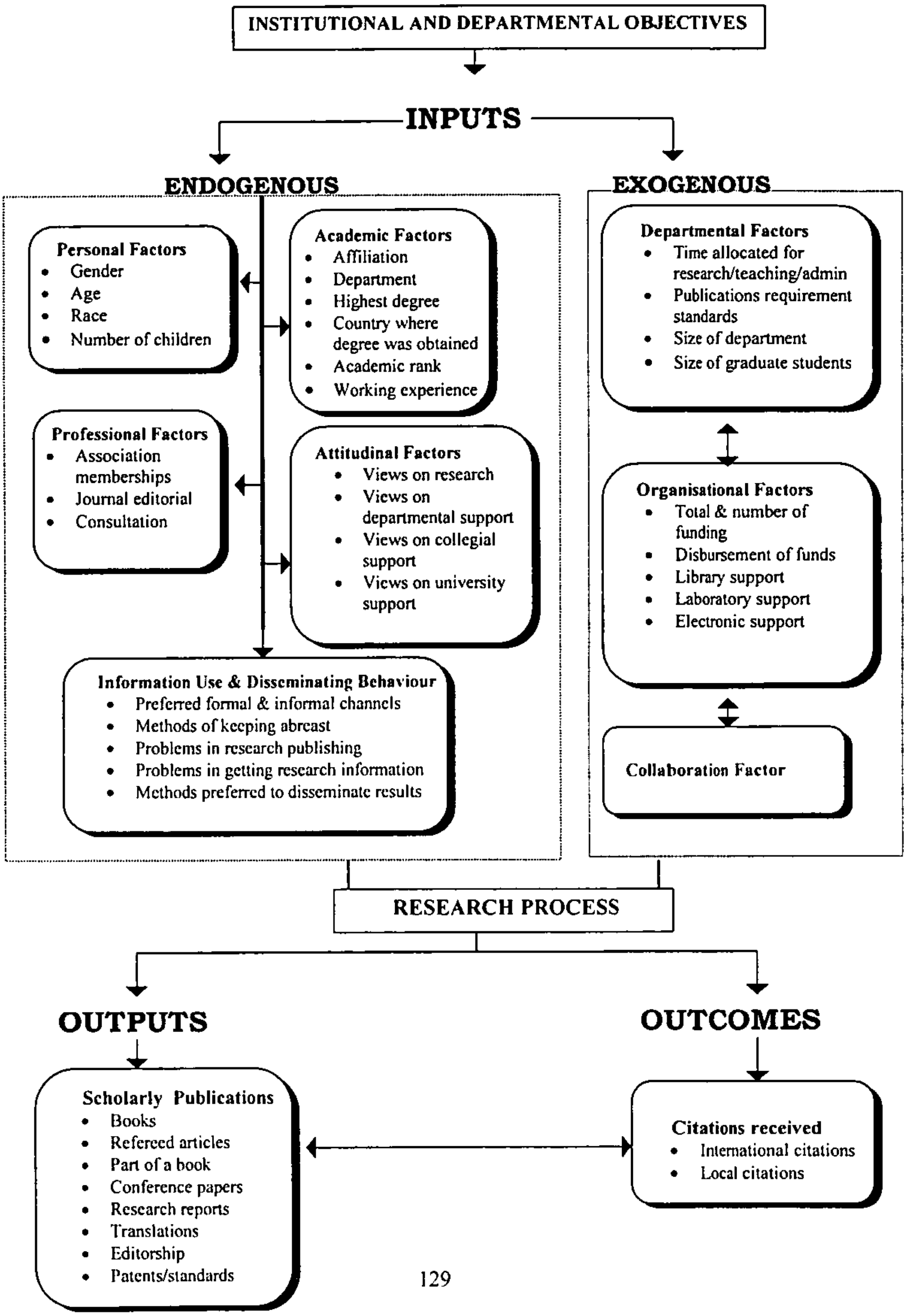


Figure 3.2: FACTORS RELATED TO PUBLICATION PRODUCTIVITY



(a) Endogenous Input Variables

The five broad endogenous variables considered are: (i) Personal factors, (ii) Academic factors, (iii) Professional factors, (iv) Attitudinal factors, (v) Research information use and disseminating behaviour

(i) Personal Factors.

Personal factors encompass the personal traits of the academic staff member such as his/her gender, age, race, and the size of his/her family. These personal variables may be related to an academic staff research publication performance.

(ii) Academic Factors

Academic staff are recruited on the basis that they are academically qualified to teach and undertake research in a particular discipline for the advancement of knowledge in that discipline. As such, academics are expected to possess a minimum standard of academic qualification in order to successfully perform effectively in these roles. Those members who possess academic qualifications above the minimum requirements may be able to perform better. The country where they obtained their highest qualification and the number of years passed after the qualifications were obtained, may be related to their publication habits. A member of academic staff, who has been practising his/her trade for a longer period would have assimilated the research culture and that would influence his/her research publication performance. The academic variables in this context, comprise factors related to academic staff education and training. This is sometimes referred to as "cumulative" advantage, that is, factors that the person cumulate so as to be in an advantageous position as a teacher and researcher [Fox, 1992; Jungnickel and Creswell, 1994). These factors include the institution academic staff are affiliated to, their department, (an established institution or department may stimulate higher research activities); the highest degree acquired (the better qualified and trained are expected to be more active in research); the country where the degree was obtained (those trained in established universities in the West should find fewer problems in obtaining and disseminating research results); the number of years accrued as an academic staff (those more experienced should have accumulated the know-how of undertaking research and technical writing and, hence, may have no problems in disseminating quality research publications). and; the academic rank achieved (those who have achieved certain academic rank may be more reinforced towards greater productivity and may achieve an impressive publication record throughout their career). Each of the above variables will be compared to the total number of publication output in order to ascertain whether there are relationships.

(iii) <u>Professional Factors</u>

Prpic (1996) studied the relationship between publication productivity among eminent bioscientists and active membership of various associations. In this study, professional factors include the degree of involvement of the academics in professional associations, consultation or advisory committees and editorial work for scholarly publications. These activities may enhance academic's research expertise.and improve his/her departmental and institutional prestige. These factors are considered reinforcement variables that help to provide incentives for academics to continue to produce quality research publications. Each of these variables will be compared to the total number of publication output to ascertain the degree and strength of the relationships, if any.

(iv) <u>Attitudinal Factors</u>

Babu and Singh (1998) include personal factors, especially attitudinal variables, when studying publication productivity. In this study, attitudinal factors comprise "psychological" or attitudinal inputs that make up the academic staffs' perceptions and attitudes towards their environment and their work. These variables may influence academic staffs' motivation towards their work and hence affect their research output. The variables considered are: academic staff views on the research activity; their views on the environmental support received from the department (departmental and collegial support) and university (perceived institutional support). A positive attitude is an indication of their acceptance of the importance of research in their career and as such, this attitude should be reflected by their research publication performance. Views of the department include academic staffs' perceptions on the research environment provided by their department such as whether they think their department are highly research oriented; whether they perceive their colleagues as prolific writers and always willing to discuss research ventures and problems; whether regular research seminars are carried out to discuss research activities; whether the allocated teaching and administration loads are balanced with that of research, and whether there are regular exchanges of research articles and reports among colleagues. Views on departmental support comprise academic staffs' perceptions on the institutional support provided such as start-up financial support for research; sufficient support to attend international and national conferences, availability of quality laboratories, library resources, computing facilities and research students. Each of these attitudinal variables will be compared with academic's publication output to ascertain whether there are relationships.

(v) <u>Research Information Use and Communication Behaviour</u>

White (1994) studied the relationship between publication productivity and the frequency of use of informal and formal channels of communication. In this study, the variables considered are academics' habits and behaviour in using various information channels and services in order to obtain information needed for the research process and to disseminate research results. The inter-relationship between researchers and information is a close one, as researchers themselves are not only producers of knowledge but also consumers of it. They disseminate knowledge in the form of research publications using various communication means (journals, books, conference papers) and are themselves responsible for using other research publications as inputs in their own research process. Research information is mutually used as an input in the production of new knowledge. To access these research information publications, academic staff uses both formal and informal channels of information.

The behavioural variables considered for this study are: the behaviour academic staff adopts to keep abreast; their views on the usefulness of the various types of library services; their perception of the problems faced in disseminating research results and in obtaining information for research and the preferred channels used for disseminating information needed for research. Problems regarding research publication include their perceived skills in technical writing; their courage to write and confidence in writing in English; the problems of getting papers published in local and foreign journals; their knowledge as to where to send articles to be published and the conduciveness of their home environment for writing papers. The most preferred methods of disseminating research results may coincide with the universally agreed upon methods and any variations may be due to discipline differences. Academic staff is also expected to know which channels are most useful in meeting their research information needs. Their preference for formal channels such as journals, books, conference proceedings, library catalogues, indexes, abstracts, the Internet, and bookstores would help provide useful tips to the information provider who manages some of these channels.

Views on the usefulness of informal channels such as correspondences, telephone conversations, e-mail facilities, dialogues, discussions and facsimiles may indicate the preferred channels and the reasons for such preferences. Academic staffs' views on the methods used to keep abreast in their discipline and the library services they most used should help the information provider find out which channels and services can be targeted for improvements in order to meet academics' research needs in the various disciplines under study. Each of these behavioural variables will be compared with research publication productivity.

(b) Exogenous Input Variables

Exogenous factors include inputs which are environmentally generated and which are outside the academic staff's control. The three broad exogenous factors considered are: (i) Departmental factors, (ii) Organisational variables, (iii) Collaboration factors.

(i) **Departmental Factors**

Jordan, Meador and Walter (1988) investigated the relationship between department size and publication productivity, while Fonseca, et al. (1997) studied the relationship between research student support and publication productivity. Ramsden (1994) studied the relationship between time spent on research and publication productivity. In this study, the departmental factors considered include the per cent of time allocated for research as compared to teaching and administrative activities; publications requirement standards set by the departments; the size of the department in terms of number of tenured academic staff and the number of postgraduate students registered with the department (since most Masters programmes require the candidate to undertake some degree of research to produce a dissertation). Each of these departmental variables will be compared to research productivity to ascertain the degree and strength of the relationships.

(ii) **Organisational Factors**

Factors such as access to the literature, library facilities, reference databases and the relationship to publication productivity was studied by Babu and Singh (1998) and Bonzi (1992). The organisational variables considered in this study are those inputs that can only be obtained from the university's central management. As such, these factors are beyond the control of the individual academic staff, who could only indicate his perception on the adequacy of organisational support provided. These include the allocation of central funding for research and the perceived adequacy of the disbursements of such funds; the adequacy of the library in providing access to research information sources; perceived adequacy of the laboratory support to undertake effective scientific and technological research and the availability of computer facilities to support the preparation, communication and dissemination of research results. An academic staff member who perceives each of these constructs positively may achieve higher publication productivity.

(c) **Collaboration factors**

Prpic (1996a, 1996b) and Waworuntu (1986) studied the relationship between eminent scientists' involvement in collaborative research and their publication productivity. The present study will also investigate such a relationship.

3.1.4. Research Output

The concept of productivity in a production system generally connotes units of output per unit of time exemplified by products manufactured over a given period of time. In the academic research system, output consists of various types of publication, oral presentations, informal discussions or correspondences about research results (Martin and Irvine, 1983). Research productivity in this study refers only to academic staff publication output even though it is realised that there are other measures that could be considered, such as citation counting, peer rating and awards received. Publication count has been regarded as a reasonable measure of scientific productivity even though it is less adequate as an indicator of impact or quality (Martin, 1996). Within the Malaysian context, the total number and types of publication are important in promotion exercises. A glance at the format of the application form for the post of associate professorship reveals a great deal of focus on total and types of publication achieved, consultation work undertaken, prizes and awards won, and graduate and postgraduate supervisory activities (Universiti Malaya, 1993). Publications are taken as research results which appear in print and are usually embodied in research communications in the formal sense (research papers and reports, books, journal articles, papers presented at seminars, sections of a book, consultation reports, translations, edited works, patents, standards and pre-prints) or informally (oral presentations, personal conversations and correspondence). These research communications are quantifiable and can be used to indicate the degree of faculty member's success in terms of publishable results. For this study, total publication is the simplest measure used as an indication of research productivity. The time frame taken is publications published between 1990-1995.

Total publications, which have been ranked into five productivity categories, are compared to all independent endogenous and exogenous inputs in order to identify which factors are possibly related to publication productivity.

Another measure of research productivity relates to counting citations to published works. In this study citation is not taken into account for two reasons. Malaysia's contribution to the world's publication output was estimated at only 0.04% between 1985 and 1989 and the number of citations received in 1985 was 24 (5.22%) and 36 (4.43%) in 1992 (Abdullah, 1995; Braun, et al. 1994). As such, the use of the *Science Citation Index* may not reveal sufficient data for fair analysis. Secondly, citations are not taken into account in promotion exercises.

Other measures such as peer evaluation, awards and prizes received are often used to measure esteem and quality. Peer evaluation measures have not been used in this study because the pool of experts in the fields under study are too small to tap upon to be able to simulate an effective peer review exercise. Awards and prizes too are not considered, as information about awards received cannot be easily obtained from publicly available official sources. Information about awards received is often imbedded in academic staffs' personnel records, which are confidential. There are also other outcomes which cannot be measured such as the transfer of knowledge and skills; new knowledge acquired; new ideas expounded; and self-fulfilment as a result of research accomplished. As a result of the cultural differences in the assessment of academic research performance in Malaysia, only total and type of publication productivity is taken into account for this study.

3.2. POPULATION AND SELECTION OF SAMPLE

The target population for this study is the tenured academic staff employed in the faculty of engineering and science from two universities in Malaysia. Other science and engineering departments from other universities have been excluded because the disciplines offered are not similar to those offered at UM and UKM. The universities are: University of Malaya

(UM) in Kuala Lumpur and the National University of Malaysia (UKM) in Bangi. These universities are chosen for the following reasons:

(a) Both universities are very much alike in their offering of academic disciplines. As comparing and sampling of "like" departments are favoured (Zachos, 1989, 1991), academic staff from similar departments within the two faculties in the two universities are considered to be a suitable basis for the study. The departments selected offered very similar academic disciplines even though the emphasis and names of the degrees offered may differ.

(b) Both the universities are the two oldest universities in Malaysia and have been in existence for more than 10 years and, hence, it is assumed that the research culture have "set in" within the institutions concerned. As such, academic staffs from both universities are perceived to have equal publishing opportunities.

(c) Both the universities are public universities and the academic staffs are expected to publish and contribute to the frontiers of knowledge besides undertaking the task of teaching and other duties as allocated by their departments.

(d) Both universities have roughly equivalent number of academic staff in the various faculties under study.

(e) It is expected that in both universities, academic staff publish their research results in international as well as national scholarly journals and should also be active in oral dissemination of their research findings at national and international conferences.

(f) University of Malaya is situated in the city of Kuala Lumpur and UKM is located about 30 miles from Kuala Lumpur. Therefore, it is assumed that all social and environmental factors that may affect productivity bear equal influence on the academic staff from both universities.

The science faculties from both the universities comprise 7 "like" departments, which account for a total of 311 academic staff members. The chemistry and mathematics departments are the largest with both having 59 tenured academic staff each. The department of physics with 46 academic staff follows this. The number of academic staff in the departments of geology, biochemistry, botany, and zoology range between 31 and 38 (Table 3.1).

The engineering faculty is comparatively smaller and comprises 4 "like" departments (Civil, Electrical, Chemical and Mechanical Engineering) with a total of 125 academic staff members. The sizes of most of the departments are fairly small having fewer than 20 academic staff (Table 3.2).

Table 3.1: Tenured Science Academic Staff from the UM and UKM between 1994/95*

FACULTY OF SCIENCE	**Total Number of Academic Staffs**			
Departments	**UM**	**UKM**	**Total**	**%**
1. Botany	18	13	31	10.0
2.Chemistry	36	23	59	19.0
3. Genetics	20	24	44	14.0
4. Geology/Earth Sciences	15	22	37	12.0
5. Mathematics	42	17	59	19.0
6. Physics	26	20	46	15.0
7. Zoology	19	16	35	11.0
TOTAL	176	135	311	100.0

* Source: University calendars of UKM and UM for 1994/95

Table 3.2: Tenured Engineering Academic Staff from UM and UKM Between 1994/95*

FACULTY OF ENGINEERING	**Total Number of Academic Staffs**			
Departments	**UM**	**UKM**	**Total**	**%**
1. Civil	19	16	35	28.0
2. Electrical	19	15	34	27.2
3. Chemical	13	12	25	20.0
4. Mechanical	19	12	31	24.8
TOTAL	70	55	125	100.0

* Source: University calendars of UM and UKM for 1994/95

It was decided to approach all 436 academic engineers and scientists from both the institutions. A list of respondents' names, academic rank and qualifications was obtained from the 1994/95 calendars published by both universities. The calendars arrange staff names by departments under each faculty. Under each department, staff names are listed under five categories; professors, associate professors; lecturers, temporary lecturers and tutors. For this study, only those in the first three categories are considered, since temporary lecturers and tutors are normally hired on a contractual basis and are therefore untenured staff. Each name in the list was assigned a numeric code, which was printed at the back of each questionnaire sent out. This was to ensure that reminders were not sent out to respondents who had responded.

Table 3.3 indicates the total sample for this study, which includes 83 from the engineering faculties and 239 from the science faculties, making a total of 322 respondents.

Table 3.3: Total Sample for this Study

FACULTIES	Sample Population	Actual Population	% of total Population
1. Engineering	83	125	66.4%
2. Science	239	311	76.8%
TOTAL	322	436	73.8%

Breakdowns of the sample from the engineering and science faculties from the two universities are given in Tables 3.4 and 3.5.

Table 3.4: Academic Engineers from UM and UKM (1995/96)

	Affiliation			
	UKM		UM	
	Department		Department	
	Count	%	Count	%
Civil	8	20.5%	14	31.8%
Chemical	8	20.5%	8	18.2%
Electrical	14	35.9%	9	20.5%
Mechanical	9	23.1%	13	29.5%
Total	39	100.0%	44	100.0%

Table 3.5: Academic Scientists from UM and UKM (1995/96)

	Affiliation			
	UKM		UM	
	Department		Department	
	Count	%	Count	%
Botany	11	10.2%	15	11.5%
Chemistry	19	17.6%	28	21.4%
Genetics	19	17.6%	15	11.5%
Geology	16	14.8%	13	9.9%
Mathematics	15	13.9%	27	20.6%
Physics	15	13.9%	19	14.5%
Zoology	13	12.0%	14	10.7%
Total	108	100.0%	131	100.0%

3.3. RESEARCH INSTRUMENT

The data collection instrument was a self-administered questionnaire designed to explore the publication behaviour and productivity of academic engineers and scientists from UKM and UM and the possible factors related to it (Appendix 2). This instrument was used because it was felt to be the most effective method of getting the necessary number of responses from a selection of over 400 respondents distributed in the 2 faculties from the 2 universities within the time frame available for the study.

The questionnaire was 15 pages long and respondents were given sufficient time to answer it at their own leisure.

3.3.1. Pre-testing

The first draft of the questionnaire was pre-tested on 30 academic staff members who comprise:

(i) Fifteen academic scientists from the Institute of Advanced Studies, University of Malaya, who were involved in multi-disciplinary research, and the Faculty of Computer Science and Information Technology, University of Malaya;

(ii) Fifteen academic staff from the Engineering Faculty of the Technological University of Malaysia in Johor Bahru (South of Malaysia, near Singapore).

The first draft of the questionnaire was sent to individuals in the sample in the month of September 1996 and by the end of the month of October, 11 responses were received, 6 from sample (i); and 5 from sample (ii). The purpose of the pre-test was to identify weaknesses in the wording of questions formulated. The following changes were made to the questionnaire:

(a) A more detailed instruction was provided for an item, which requires "ticking" and "ranking". When asked to both tick and rank a series of statements, respondents often complied by ticking but did not rank. Three respondents indicated that they would like to be shown the measures used when ranking.

(b) Some numbering sequences in the questionnaire were changed when questions were subsumed under a previous section. This was used for items, which require a "yes" or "no" answer.

(c) Typographical and spelling errors were corrected.

(d) Wordings for some questions were rephrased "more politely" on the advice of respondents.

3.3.2. Distribution of the Questionnaire

The amended questionnaire was sent out to all 436 academic staff in the month of November 1996. This coincided with the universities' first semester break of three weeks. This period was felt to be appropriate since most academic staff would be free from teaching commitments and hence should be able to respond accordingly. The questionnaire was sent out with an accompanying letter of appeal to academic staff to help co-operate by completing the questionnaire (Appendix 1). The academic staff members were also asked to indicate whether they prefer to be interviewed instead. None of the respondents indicated their willingness to be interviewed. A self-addressed stamped envelope was included for samples belonging to UKM, while those within UM were contacted through the university's internal mail system. Almost 80% of the 322 responses were obtained within 4 weeks from the mailing date. The rest "trickled" in till early February 1997. In May 1997, reminders were sent out and personal appeals via telephone calls were made. Telephone calls informing the academics that the researcher would personally pick up the questionnaire brought in the rest of the responses. Each questionnaire was given a numeric code corresponding to the numeric code assigned to the academic staffs' names listed in the UM and UKM's calendar. This was done for two reasons; (a) to identify the highly productive academic staff who would be approached for a further in-depth interview and; (b) to make sure that the same academic staff would not be sent a reminder letters if it was deemed necessary. The former strategy was thought to be necessary to ascertain findings from the questionnaire and to find out other possible factors that may have been missed.

3.3.3. The Components of the Questionnaire

The instrument is a fifteen-page questionnaire consisting of 9 sections. The following information was obtained from the questionnaire.

(a) Dependent Variables: Publications

(i) Total number and types of publications – Section I (4a-4k)

(ii) Journals used to publish – Section I(5).

(b) Independent Variables: Endogenous Input Variables

The following information were provided:

(i) ***Personal factors*** – Section A. Personal Background (no. 1-4)

(ii) ***Academic factors*** – Section B. Academic Background (no. 1-6).

(iii) ***Professional Background*** – Section D. Professional Background (no.1-6).

(iv) ***Attitudinal Factors*** – Views on research – Section K(1) ; Views on Department – Section K(2) ; Views on Institution – Section K(3).

(v) ***Research Information Communication Behaviour*** – Formal and informal channels – Section L(1) ; Reasons for choosing channels – Section L(2); Channels used to disseminate research information – Section L(7); Methods used to keep abreast – Section I(3); Problems in publishing research results – Section J(3); Problems in using services for research information – Section L(5).

(c) Exogenous Input Variables

(i) ***Departmental Factors*** – Time spent on research, teaching and administrative duties – Section C(1).; Departmental publication requirements – Section C(2); Department size – Section C(3); Number of postgraduate students – Section C(4).

(ii) ***Institutional Factors*** – Financial support for research – Section E (1-5); Library resources and services support – Section F(1-2), Section L(4); Laboratory support – Section G(1); Electronic support – Section H.

(iii) ***Collaboration Factors*** – Section J(1-2)

3.4. INTERVIEWING SELECTED ACADEMIC STAFF MEMBERS

Interviews and e-mail sessions were conducted between March and November 1998 with a selection of academic engineers and scientists to explore the findings of the survey. This approach was used in order to establish an informal electronic dialogue with each respondent who often gave detailed explanations to answers given or sought clarifications to questions which were not understood. The objectives were to determine academic staff's' agreement or disagreement with the survey findings and ascertain reasons or conditions prevailing behind certain results obtained. The approach of the questioning was aimed towards finding answers to the questions of "why" certain results were obtained from the survey. A total of 80 academic engineers and 40 academic scientists from 9 universities were randomly approached in the exploratory study. Ten academic staff from each discipline (engineering and pure science) were approached from both UKM and UM, most of whom were in the above average publication group, 10 academic staffs were picked from each of the seven public and private universities in Malaysia. Similarly for the pure scientists, the rest of the academic staff came from two other universities (University Science Malaysia and University of Tenaga Nasional). The inclusion of academic engineers and scientists from other universities helped to provide impartial opinions from outside the surveyed group. Most of those approached were either associate professors or professors who were willing to share their publication success experiences.

All respondents were initially contacted through their e-mails and were subsequently either interviewed or corresponded via the e-mail. The e-mail approach made it possible to contact respondents from universities in other states. Those interviewed were asked the same structured 38 questions listed under 13 headings that solicited views on: academic publication preference, the relationship between publication productivity and personal, academic, departmental, professional factors and their collaborative behaviour (Appendix 3). The respondents also gave their views on the desired research, departmental, institutional and leadership environment thought to be conducive for research. Their behaviour in searching, disseminating research information and the problems they faced when performing their research activity were queried. Those interviewed is indicated in Table 3.6.

Table 3.6: Demographic Summary of those Interviewed or Contacted Via E-mails

	Engineers (n=32)		Science (n=24)	
Demographic Characteristics	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Affiliation				
International Islamic University	3	9.4	-	-
University of Institute of Technology MARA	1	3.1	-	-
National University of Malaysia (UKM)	5	15.6	7	29.2
University of Malaya	7	21.9	5	20.8
University of Malaysia Sarawak	1	3.1	-	-
University of Telekom Malaysia	6	18.8	-	-
University Putra Malaysia	5	15.8	-	-
University Science Malaysia	4	12.5	10	41.7
University of Tenaga Nasional	-	-	2	8.3
Rank				
Lecturer	12	37.5	9	37.5
Associate Professors	18	56.2	11	45.8
Professors	2	6.3	4	16.7
Qualifications				
Masters	7	21.9	-	-
Ph.D.	25	78.1	24	100.0
Experience				
5 years and under	10	31.3	6	25.0
6-10 years	8	25.0	3	12.5
11-15 years	10	31.3	4	16.7
16 years and above	4	12.5	11	45.8
Thesis year				
=<5yrs	16	50.0	9	37.5
6-10yrs	6	18.8	6	25.0
11-15yrs	9	28.1	-	-
=>16yrs	1	3.1	9	37.5
Country of highest degree				
UK	21	65.6	6	25.0
USA	6	18.8	8	33.3
Others	3	9.4	4	16.7
Malaysia	2	6.2	6	25.0

Altogether a total of 56 academic engineers and scientists responded, comprising 32 engineers and 24 scientists. Of the 32 academic engineers, 12 academics interviewed came from UKM and UM, while the rest gave their views via the e-mail. For the 24 academic scientists, 12 respondents interviewed were from UKM and UM and 12 others responded through their e-mail.

3.5. DATA ANALYSIS

The information from the returned questionnaire was coded and transferred into the Statistical Package for Social Science (SPSS) version 7.5 for Windows. Data analysis of the responses included descriptive statistics to determine frequencies. The chi-square (x^2) test was used to compare nominal type variables such as affiliation, departments, race, and gender with the total number of publication productivity. The Spearman rank test for correlation was used for ordinal or categorised data such as age, working experience, academic rank, qualifications, percent time spent on research as well as other scaled variables compared with the categorised total number and types of publication counts. The dependent variables (total categorised publications) were tested with all exogenous and endogenous variables for correlation or the chi-square test of significance to ascertain relationships. It was decided that 0.05 level of significance would be appropriate for reporting in this study, but a rejection of any hypothesis would be data that is within the 0.01 level of significance.

Chapter 4

ANALYSIS OF RESPONSES FROM THE ACADEMIC ENGINEERS

4.1. INTRODUCTION

This chapter describes the results of the analysis of responses obtained from 83 engineering respondents from the two universities. The intention here is not so much to make institutional comparisons but to analyse the research publication characteristics and behaviour of academic engineers in similar departments and to identify possible factors that may be related to research publication productivity of these respondents.

4.2. DEMOGRAPHIC CHARACTERISTICS OF THE ENGINEERING SAMPLE

The respondents' demographic characteristics are displayed in Table 4.1. There were 39 (47.0%) respondents from UKM and 44 (53.0%) from UM. On the whole, the respondents represent about 66.4% of total academic engineering population from both the universities.

Table 4.1: Demographic Characteristics of the Academic Engineers

	Sample Population (N=83)		Actual Population (N=125)	
Demographic Characteristics	Frequency	Percentage	Frequency	Percentage
Affiliation				
UKM	39	47.0	55	44.0
UM	44	53.0	70	56.0
Departments				
Civil	22	26.5	35	28.0
Chemical	16	19.3	34	27.0
Electrical	23	27.7	25	20.0
Mechanical	22	26.5	31	25.0
Rank				
Lecturer	44	53.1	80	64.0
Associate Professors	31	37.3	34	27.0
Professors	8	9.6	11	9.0
Qualifications				
Masters	29	34.9		
Ph.D.	54	65.1		
Age				
Under 30	-	-		
31-40	50	60.2		
41-50	33	39.8		
51 and above	-	-		
Experience				
5 years and under	4	4.8		
6-10 years	50	60.2		
11-15 years	22	26.5		
15 years and above	7	8.5		
Gender				
Male	73	88.0		
Female	10	12.0		

Reporting of the results will be divided into the following sub-sections: publication characteristics of academic engineers; characteristics of possible factors related to publication performance of academic engineers; respondents' views on research, their department and institutional support; characteristics of the channels of information sources used for research; reasons for choosing channels rated as useful; methods academics used to keep abreast of current research information; methods used to disseminate research results; and problems related to academic research publications. All these factors will be compared with respondents' total and type of publication productivity to ascertain whether the variables are related.

4.3. PUBLICATION CHARACTERISTICS OF ACADEMIC ENGINEERS

Publication productivity in this study refers to three categories of publications: total publication count, total count by types of authorship (single or joint) and total count by type of works (books, book chapters, books edited, journal articles, conference papers, research reports, standard, patents and translated works) published between 1990-1995. The data for this section were obtained from the questionnaire as well as the annual research reports published by both the universities between 1990 and 1995. A database was created to control all published works reported in the annual reports.

4.3.1. Total Publications

The 83 academic engineers published a total of 1,344 publications, out of which 32% are single-authored and 68% are published jointly (Table 4.2). Total publications by academic engineers ranged from a minimum of 2 publications to a high of 72 between 1990-1995 with an average of 2.8 publications per year.

Table 4.2: Distribution of Total Publications between 1990-1995

	Number	Missing	Mean	Min	Max	Sum	%
Single Works	81	2	5.25	1	27	425	32%
Joint Works	80	3	11.49	1	57	919	68%
Total Publications	83	0	16.19	2	72	1344	100%

Total publications are grouped into five categories of low (1-5); minimum (6-10), average (11-20), high (21-30) and very high (equals or more than 31) and will be compared with other variables in the study. Even though it is not specifically spelt out in the academic terms of contract, lecturers are expected to publish at least one publication a year. Those who achieve below six publications over the six-year period, are categorised as low publishers. Those who publish above 3 publications (above the mean of 2.8) per year are grouped in the high or very high publishing categories. About 42.2% of total engineering respondents are among the minimum and low publishers and 11% are in the high and very high publication groups (Table 4.3).

Table 4.3: Categorised Total Publications of Academic Engineers

TOTAL PUBLICATIONS		Frequency	Percent	Cumulative Percent
Valid	Low (1-5)	11	13.3	13.3
	Min (6-10)	24	28.9	42.2
	Ave (11-20)	24	28.9	71.1
	High (21-30)	15	18.1	89.2
	V. High (=>31)	9	10.8	100.0
	Total	83	100.0	

Table 4.4 indicates that a total of eighty-one respondents have published singly. Single-authored works range from a minimum of one to a maximum of twenty-seven with an average of 5.25. The majority (63.0%) of single-authored works are produced by academics grouped as low publishers and a third are the average (6) or high/very high publishers (4).

Table 4.4: Categorised Single- and Joint-Authored Publications by Academic Engineers

SINGLE WORKS		Frequency	Percent	Cumulative Percent
Valid	Low (1-4)	51	63.0	63.0
	Min (5-10)	20	24.7	87.7
	Ave (11-15)	6	7.4	95.1
	High (17-22)	1	1.2	96.3
	V. High (=>23)	3	3.7	100.0
	Total	81	100.0	
JOINT WORKS		**Frequency**	**Percent**	**Cumulative Percent**
Valid	Low (1-4)	21	26.0	26.0
	Min (5-11)	31	39.0	65.0
	Ave (12-17)	13	16.0	81.0
	High (18-23)	5	6.0	87.0
	V. High (=>24)	10	13.0	100.0
	Total	80	100.0	

Eighty respondents reported writing jointly, which ranged from a minimum of one publication to a maximum of fifty-seven and an average of 11.49. Similarly, the majority of joint- authored works (65.0%) were produced by academics in the low or minimum publishing group.

4.3.2. Types of Publication

Of the total of 1,344 publications, more than half (828) comprised conference papers contributed by 80 respondents and only 3 did not report writings in this format (Table 4.5). This form of writing, therefore, is the most popular form of contribution by academic engineers ranging from a minimum of 1 to a high of 52 and an average of 10.35. Journal articles fell into second place followed by research reports. The rest of the contributions took the form of books, standards and patents, book chapters, translated works, and edited works.

Table 4.5: Types of Publications by Academic Engineers (1990-1995)

Publications	N	Mean	Min	Max	Sum (N=1344)	%
Books	18	1.33	1	5	24	1.8
Book Chapters	14	1.14	1	2	16	1.2
Conference Papers	80	10.35	1	52	828	61.6
Edited Books	7	1.43	1	3	10	0.7
Journal Articles	66	4.27	1	18	282	21.0
Research Reports	52	2.88	1	12	150	11.2
Standards/Patents	7	2.71	1	6	19	1.4
Translated Works	11	1.36	1	3	15	1.1

Table 4.6 gives a breakdown of publications by type of authorship. Books seem more likely to be single-authored compared to the other types of publications.

Table 4.6: Publications Authored Singly and Jointly

ALONE	N	Mean	Min	Max	Sum (n=425)	%
Books	13	1.15	1	2	15	3.5
Book Chapters	5	1.00	1	1	5	1.2
Conference Papers	67	3.49	1	24	234	55.1
Edited Books	1	1.00	1	1	1	0.2
Journal Articles	36	2.39	1	7	86	20.2
Research Reports	37	1.86	1	9	69	16.2
Standards/Patents	4	2.00	1	4	8	1.9
Translated Works	4	1.75	1	3	7	1.7
JOINTLY	**N**	**Mean**	**Min**	**Max**	**Sum (N=919)**	**%**
Books	7	1.29	1	3	9	1.0
Book Chapters	9	1.22	1	2	11	1.2
Conference Papers	78	7.62	1	41	594	64.6
Edited Books	6	1.50	1	3	9	1.0
Journal Articles	54	3.63	1	17	196	21.3
Research Reports	27	3.00	1	12	81	8.8
Standards/Patents	3	3.67	1	6	11	1.2
Translated Works	7	1.14	1	2	8	0.9

4.3.3.Correlation Matrix of Total and Types of Publications

This section presents the results of cross-tabulating total number and types of publication (Table 4.7). The correlated results are printed in bold.

Table 4.7: Correlation Matrix between Total Publications and Types of Publications

	Total pub.	Single works	Joint works	Books	Conf. papers	Books Edited	Journ. Article	Res. Reports	Std./ Patents
Total pub.	1.000	.490**	.600**	.007	.818**	.653	.538**	.238*	.886**
sig.	-	.001	.001	.978	.001	.111	.001	.031	.008
Single works	.490**	1.000	.185	.225	.402**	.671	.352**	.108	.625
sig.	.001	-	.094	.370	.001	.099	.004	.329	.133
Joint works	.600**	.185	1.000	.283	.597**	.522	.507**	.300**	.91`4**
sig.	.001	.094	-	.255	.001	.230	.001	.006	.004
Books	.007	.225	.283	1.000	.353	1.000**	.045	-.224	-
sig.	.978	.370	.255	-	.164	.001	.864	.371	-
Conf. Papers	.818**	.402**	.597**	.353	1.000	.832*	.265*	.340**	.824*
sig.	.001	.001	.001	.164	-	.020	.035	.002	.023
Books edited	.653	.671	.522	1.000**	.832*	1.000	.836*	.000	-
sig.	.111	.099	.230	.001	.020	-	.019	1.000	-
Journ. Articles	.538**	.352**	.507**	.045	.265*	.836*	1.000	.199	.311
sig.	.001	.004	.001	.864	.035	.019	-	.108	.548
Res. Reports	.238*	.108	.300**	-.224	.340*	.000	.199	1.000	.549
sig.	.031	.329	.006	.371	.002	1.000	.108	-	.202
Std/ patents	.886**	.625	.914**	-	.824*	-	.311	.549	1.000
sig.	.008	.133	.004	-	.023	-	.548	.202	-

* Correlation is significant at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

Those in the high total publishing category wrote a higher number of single (ρ =.490, sig. <0.01) and joint (ρ =.600, sig. <0.01) works. They are also likely to publish more conference papers (ρ =.818, sig. <0.01), journal articles (ρ =.538, sig. <0.01), research reports (ρ =.238, sig. <0.05) and achieve more standards and patents (ρ =.886, sig. <0.01) for their research. The respondents who wrote books are more likely to edit books (ρ =1.000, sig.<0.01).

4.3.4.Respondent's Earliest Research Publication

A total of 82 respondents gave the date when they wrote their first research publication (Table 4.8). The years given were re-coded into three categories; 1 = under 5 years; 2 = 6-10 years; 3 = more than 10 years. A total of 5 respondents wrote their first research publication within the last 5 years. The majority, constituting 56 respondents, published their first research publication between 5 and 10 years ago and 21 reported writing the same more than 10 years ago. The length of years when respondents first wrote their research publication was cross-tabulated with the categorised total publication scores. It is assumed that those who wrote their first research publication 10 or more years ago would have developed a regular publication habit that would be reflected on their maturity as authors.

Table 4.8: Categorised Year of First Research Publication Written

Categorised Year		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Under 5	5	6.0	6.1	6.1
	6-10 years	56	67.5	68.3	74.4
	>10 years	21	25.3	25.6	
	Missing	1	1.2		
	Total	83	100.0	100.0	100.0

The results indicate that the number of years that have elapsed since authors wrote their first publication is not related to respondents' total publication output.

4.3.5.Journals Used by Academic Engineers to Publish Research Results

This section is based on responses from 66 respondents who filled out Section I(4) of the questionnaire. The other 17 respondents did not publish any journal articles, even though they have published in other formats.

(a) Title of Journals Used

From the list of journal titles used to publish journal articles, three types of information were obtained - the refereed journal titles, frequency of submission and the geographical distribution of the journals used. Table 4.9 lists the title of journals in which the academic engineers reported publishing their articles.

The abbreviated form of each journal title was entered into SPSS to obtain the frequency counts and percentages. The expanded list of abbreviated journal titles is given in Appendix 4. The top 12 journal titles published 49.9% of the articles, with contributions ranging from 5 to 37. Seven out of the 12 journals were published in Malaysia such as, *Jurnal Kejuruteraan UKM* with 37 articles and ranked first. This is followed by *Bulletin of the Institution of Engineers Malaysia* (24 articles), *Journal of the Institution of Engineers Malaysia* (15 articles), 9 articles each from *Plastic News* and *Journal of the Institution of Chemical Engineers Malaysia*, *Building Technology & Management* (7 articles) and *Pertanika* (5 articles). The other 5 journals are published abroad comprising, *AEESEA Journal* (Thailand) with 10 articles, *IEE Proceedings: Part C* (UK) with 8 articles which were contributed by the electrical engineers from UM, 6 articles each from the *Microelectronics Journal* (UK) and *Journal of the American Oil Chemists Society* (USA) and *IEE Proceedings: Part J* (UK) (5 articles). These 12 titles published a total of 141 articles between them. A total of 33

Table 4.9: Journal Titles Ranked by the Number of Article Contributions

Group Rank	Journals	Frequency	Percent	Cum Percent
1	J Kej UKM	37	13.1	13.1
2	Bul IEM	24	8.5	21.6
3	J IEM	15	5.3	26.9
4	AEESEA J	10	3.5	30.4
5	Plastic News	9	3.2	33.6
	News. Inst Chem Eng Mal	9	3.2	36.8
7	IEE Proc: Part C	8	2.8	39.6
8	Build Tech & Manag	7	2.5	42.1
9	Microelectronic J	6	2.1	44.2
	J Am Oil Chem Soc	6	2.1	46.3
11	IEE Proc: Part J	5	1.8	48.1
	Pertanika	5	1.8	49.9
13	Chem Eng Sc	4	1.4	51.3
	Electronics Letters	4	1.4	52.7
	Indus Eng	4	1.4	54.1
	IEEE Trans	4	1.4	55.9
	Int J Elec Pow & Ener Sys	4	1.4	56.9
	Proc I Mech Eng	4	1.4	58.3
	J Elec & Contr	4	1.4	59.7
	J Phy Sc	4	1.4	61.1
21	Geotec Eng	3	1.1	62.2
	Bul Sci & Tech Mal	3	1.1	63.3
	Cem Con Res Int J	3	1.1	64.4
	Drying Tech	3	1.1	65.5
	J Chem Tech & Biotech	3	1.1	66.6
	Plastics Ind News	3	1.1	67.7
	Rem Sen Environ	3	1.1	68.8
	Soils & Found	3	1.1	69.9
	Sains Malaysiana	3	1.1	71.0
30	ACI Mat J	2	.7	71.7
	Asean J Sc & Tech	2	.7	72.4
	Bul MSSST	2	.7	73.1
	Comput & Cont Eng J	2	.7	73.8
	Control & Instru	2	.7	74.5
	Desalination	2	.7	75.2
	Mechanical Eng	2	.7	75.9
	In J Control	2	.7	76.6
	J Comput Civ Eng	2	.7	77.3
	Photo Rem Sen	2	.7	78.0
	J Fizik Mal	2	.7	78.7
	J Ind Tech	2	.7	79.4
	J Molec Catal	2	.7	80.1
	Maj PKKM	2	.7	80.8
	Solid Waste Manage & Res	2	.7	81.5
	Technology	2	.7	82..2
46	Rest of the Journals	50	17.8	100.0
			100.0	
	TOTAL	**282**		

journals contributed between 2 to 4 titles each totaling 91 articles. "The rest" comprised titles, which contributed 1 article each.

(b) Affiliations and Choice of Journals Used to Publish

When the journal titles were cross-tabulated by institutions, the results revealed that UM published 152 titles compared to 130 titles by UKM (Table 4.10).

Table 4.10: Journal Titles Used by Affiliations

	UKM		UM		
Journals	**Count**	**%**	**Count**	**%**	**Total**
J Kej UKM	37	28.59	-	-	37
Bul IEM	13	10.0	11	1.1	24
J IEM	3	2.3	12	7.9	15
AEESEA J	3	2.3	7	4.6	10
Plastic News			9	5.9	9
News. Inst Chem Eng Mal	9	6.9			9
IEE Proc: Part C	4	3.1	4	2.6	8
Build Tech & Manage	1	0.8	6	3.9	7
Microelectronics J	6	4.6			6
J Am Oil Chem Soc			6	3.9	6
IEE Proc: Part J	2	1.5	3	2.0	5
Pertanika	3	2.3	2	1.3	5
Chem Eng Sc	1	0.8	3	2.0	4
Electronics Letters			4	2.6	4
Indus Eng	1	0.8	3	2.0	4
IEEE Trans	2	1.5	2	1.3	4
Int J Elec Pow & Ener Sys	1	0.8	3	2.0	4
I Mech Eng Proc			4	2.6	4
J Elec & Contr			4	2.6	4
J Phy Sc	4	3.1			4
Geotec Eng			3	2.0	3
Bul Sci & Tech Mal	3	2.3			3
Cem Conc Int J	3	2.3			3
Drying Tech	3	2.3			3
J Chem Tech & Biotech			3	2.0	3
Plastics Ind News			3	2.0	3
Rem Sen Environ			3	2.0	3
Soils & Found			3	2.0	3
Sains Malaysiana	3	2.3			3
ACI Mat J	2	1.5			2
ASEAN J Sc & Tech			2	1.3	2
Bul MSSST	2	1.5			2
Comput & Contr Eng J			2	1.3	2
Cont & Instrumen			2	1.3	2
Desalination	2	1.5			2
Mechanical Eng			2	1.3	2
Int J Control	2	1.5			2
Int J Comp in Civil Eng			2	1.3	2
Photo Rem Sen			2	1.3	2
J Fizik Mal	2	1.5			2
J Ind Tech			2	1.3	2
J Molec Catal	2	1.5			2
Maj PKKM			2	1.3	2
Solid Waste Manage & Res	2	1.5			
Technology			2	1.3	2
Rest of the Journals	14	10.8	36	23.7	50
Total	130	100.0	152	100.0	282

$x^2 = 165.107$, df 45, $p < 0.01$

The academic engineers from UKM tended to publish more in the top 12 journals listed (81 articles) compared to those from UM (60 articles). Most of the academic engineers from UM published in a wider variety of foreign journals and this was clearly indicated by the distribution of publications by country which published these journals. Cross-tabulating journal titles and respondents' affiliation show significance at 0.01 level (x^2=165.107, df 45). There seems to be a trend of supporting one's own institutional journals first over other journals. *Jurnal Kejuruteraan UKM* was published by the Faculty of Engineering at UKM and more academic staff from UKM contributed to this journal over the 6 year period. *AEESEA Journal* (formerly *Journal of Engineering Education in Southeast Asia)* was a UNESCO supported journal, which up to 1990 was undertaken by the Faculty of Engineering at UM, and became Bangkok based after 1990. As a result, seven UM academic engineers published in this journal. The staff from both the institutions supported the local professional journals such as *Bulletin of the Institution of Engineers Malaysia* and *Journal of the Institution of Engineers Malaysia.*

(c) Department and Choice of Journals to Publish

The number of contributions to a journal and academic staffs' departments was significantly related (x^2 = 424.473, df 135 $p< 0.01$) (Table 4.11). Out of the 282 journal articles, the civil engineers accounted for 66, chemical engineers 72, electrical engineers 86 and mechanical engineers 21.

The pattern of contribution indicates that each department used 1or 2 titles exclusively to publish their articles in. Other than the mainstream local professional journals, civil engineers published in specialised journals such as *Building Technology & Management*, *Soils & Foundation*, *ACI Materials Journal*, *Journal of Industrial Technology*, and *Solid Waste Management*. Chemical engineers mutually published in journals within their discipline such as *Plastic News*, *Newsletter of the Institution of Chemical Engineers Malaysia*, *Industrial Engineering*, *Journal of Chemical Technology and Biotechnology*, *Chemical Engineering Science* and others. The electrical engineers exclusively published in about 14 journal titles.

Table 4.11: Journal Titles Used to Publish Articles by Departments

Journals	Civil	Chem	Elec	Mech	Total
J Kej UKM	10	7	13	7	37
Bul IEM	14	1	2	7	24
J IEM	5	2		8	15
AEESEA J	7	1	1	1	10
Plastics News		6		3	9
News. Inst Chem Eng Mal		9			9
IEE Proc; Part C			8		8
Build Tech & Manage	7				7
Microelectronic J			6		6
J Am Oil Chem Soc				6	6
IEE Proc: Part J			5		5
Pertanika	2	3			5
Chem Eng Sc		2	2		4
Electronics Letters			4		4
Indus Eng		4			4
IEEE Trans			4		4
Int J Elec Pow & Ener Sys			4		4
I Mech Eng Proc				4	4
J Elec & Contr Engl			4		4
J Phy Sc			4		4
Geotec Eng	3				3
Bul Sci & Tech Mal			3		3
Cem Con Res Int J	3				3
Drying Tech		3			3
J Chem Tech & Biotech		3			3
Plastics Ind News		1		2	3
Rem Sen Environ			3		3
Soils & Found	3				3
Sains Malaysiana		1		2	3
ACI Mat J	2				2
ASEAN J Sc & Tech		1		1	2
Bul MSSST			2		2
Comput & Contr Eng J		2			2
Cont & Instru			2		2
Desalination		2			2
Mechanical Eng				2	2
In J Control		2			2
J Comp Civil Eng		2			2
Photo Eng & Rem Sen			2		2
J Fizik Mal			2		2
J Ind Tech	1			1	2
J Molec Catal				2	2
Maj PKKM				2	2
Solid Waste Manag & Res	2				2
Technology				2	2
Others	7	19	15	8	49
Total	66	72	86	58	282

Chi Sq Value 424.473 df 135, $p<0.01$

(d) Geographical Distribution of Journals

The geographical distribution of the journals which Malaysian academic engineers used to publish their articles indicate that 131 (46.5%) of total publications were submitted to Malaysian journals (Table 4.12). Thirty-four (12.1%) articles were contributed to journals published in other Asia Pacific countries such as *AEESEA Journal*, *International Journal of Computing and Engineering Management*, *Geotechnical Engineering* (all three from

Thailand), *Asean Journal of Science and Technology for Development*, *Asia Pacific Engineering Journal* (both from Singapore), *Plastics Industries News* and *Soils and Foundation* (both from Japan). Academic engineers also published in 15 European journals such as *Journal of Molecular Catalysis* (France), *Solid Waste Management & Research* (Denmark), *Fuel Processing Technology* (Holland) and *Applied Microbiology and Biotechnology* (Germany). Academic engineers published about 60 (21.3%) of their articles in journals published in the United Kingdom and 42 (14.9%) articles were published in American or Canadian journals. A closer look at the total contributions to Malaysian journals reveals that, a larger percentage was contributed by civil engineers, followed by the mechanical engineers, chemical engineers and electrical engineers. More chemical engineers published in Asia/Pacific journals (12 out of 34). A higher number of electrical engineers published their articles in British journals (32 out of a total of 60) as well as journals published in America and Canada (19 out of 42).

Table 4.12: Departmental Publication by Geographical Distribution of Journals

Dept	Count & %	Malaysia	Asia/ Pacific	Europe	UK	USA & Canada
Civil	Count	41	11	2	4	8
	Column %	31.3%	32.4%	13.3%	6.7%	19.0%
Chemical	Count	31	12	5	17	7
	Column %	23.7%	35.3%	33.3%	28.3%	16.7%
Electrical	Count	28	4	3	32	19
	Column %	21.5%	11.7%	20.1%	53.3%	45.3%
Mechanical	Count	31	7	5	7	8
	Column %	23.7%	20.6%	33.3%	11.7%	19.0%
Total	Count	131	34	13	60	42
	Column %	100.0%	100.0%	100.0%	100.0%	100.0%

x^2= 41.546 (Critical value, 21.026), df 12, p <0.01

The results show a significant difference between departmental affiliation and the publishing behaviour of academic engineers in terms of the journals used to publish articles (x^2=41.546, df. 12, p <0.01). Academic engineers published about 46.5% of their articles in Malaysian journals. This behaviour is true for the civil, chemical and mechanical engineers, whilst the electrical engineers sent over 50% of their writings to British and American journals. This results support the finding by Bottle et al (1994), which observed that Nigerian chemists prefer to publish in foreign journals.

When the categorised geographic data was cross-tabulated with respondents' institutional affiliation status, it was found that academic engineers from UKM contributed more to Malaysian journals (83 out of 131) compared to those from UM (48) (Table 4.13). UM academic engineers tended to publish more in foreign journals. Academic engineers from UM published 24 articles (70.6%) in Asia-Pacific journals compared to 10 (29.4%) from UKM; 9 articles (60%) in European journals compared to 6 (40%) from UKM; 40 articles (66.7%) in British journals compared to 20 (33.3%) from UKM and 31 articles (73.8%) in American journals compared to 11 (26.2%) from UKM. The results indicate that affiliation and geographical distribution of the journals are significantly related (x^2=30.375, df. 4, p <0.01).

Table 4.13: Geographical Distribution of Journals by Respondent's Affiliation

Universities	Count & %	Malaysia	Asia/ Pacific	Europe	UK	USA & Canada
UKM	Count	83	10	6	20	11
	Column %	63.4%	29.4%	40.0%	33.3	26.2%
UM	Count	49	24	9	40	31
	Column %	36.6%	70.6%	60.0%	66.7%	73.8%
Total	Count	131	34	15	60	42
	Column %	100.0%	100.0%	100.0%	100.0%	100.0%

x^2=30.375 (critical value, 9.488), df 4, p <0.01

The geographical distribution of the journal indicates that 21 Malaysian journals were used to publish the 131 articles (Table 4.14). Only 7 journals published one article each. Other than those published by the engineering faculties in UKM and UM (*Jurnal Kejuruteraan UKM* and *AEESEAP Journal*), other publishers include the Institution of Engineers Malaysia (*Bulletin of the Institution of Engineers Malaysia, Journal of the Institution of Engineers Malaysia*), MARA Institute of Technology (*Plastic News*), Tengku Abdul Rahman College (TAR) (*Building Technology & Management*), Putra University Malaysia (*Pertanika*), Science University Malaysia (USM) (*Journal of Physical Science*), science department in UKM (*Sains Malaysiana*), the Malaysian Standards Institute (*Journal of Industrial Technology*) and the Ministry of Science, Technology and Environment (*Bulletin Science and Techonology Malaysia).*

Table 4.14: Journal Titles by Place of Publication

Journal	Malaysia	Asia/Pac	Europe	UK	USA & Can	Total
J Kej UKM	38					38
Bul IEM	24					24
J IEM	15					15
AEESEAP J	10					10
Plastic News	9					9
News Inst Chem Eng Mal	9					9
IEE Proc:Part C				8		8
Build Tech & Manage	7					7
Microelectronics J				6		6
J Am Oil Chem Soc					6	6
IEE Proc: Part J				5		5
Pertanika	5					5
Chem Eng Sc				4		
Electronics Letters				4		4
Indus Eng					4	4
IEEE Trans					4	4
Int J Elec Pow & Ener Sys				4		4
Proc Inst Mech Eng				4		4
J Elec & Contr					4	4
J Phy Sc	4					4
Geotec. Eng				3		3
Bul Sci & Tech Mal	3					3
Cem Con Res Int J					3	3
Drying Tech		3				3
J Chem Tech & Biotech				3		3
Plastics Ind News		3				3
Rem Sen Environ					3	3
Soils & Found		3				3
Sains Malaysiana	3					3
ACI Mat J					2	2
Asean J Sc & Tech		2				2
Bul MSSST	2					2
Comput & Contr Eng J				2		2
Cont & Instru					2	2
Desalination			2			2
Mechanical Eng			2			2
In J Control				2		2
Int J Comp Civil Eng		2				2
Photo Rem Sen				2		2
J Fizik Mal	2					2
J Ind Tech	2					2
J Molec Catal			2			2
Maj PKKM	2					2
Solid Waste Manage & Res			2			2
Technology	2					2
Others	7	9	4	15	14	49
Total	143	22	13	59	45	282

4.4. FACTORS RELATED TO PUBLICATION PRODUCTIVITY OF ACADEMIC ENGINEERS

This section presents the factors that may be related to academic engineers' research publication output. These include: (1) personal background; (2) academic background; (3) departmental background; (4) professional and consultation background; (5) institutional support – finance; (6) libraries; (7) laboratories, and (8) computers; (9) collaboration behaviour; (10) personal views on research; (11) departmental support; (12) institutional support; (13) formal channels; and (14) informal channels of information sources used for research as well as channels used to disseminate research results; (15) methods used to keep abreast in research for information advantage; and (16) perception of problems and hindrances in obtaining information for research and in writing research publications. Under each section, the description will involve frequency rating of responses, comparing the ratings with total publication scores, and testing the results for correlation or significance.

4.4.1. PUBLICATION OUTPUT AND RESPONDENTS' PERSONAL BACKGROUND

(a) Publications and Gender

On the whole, male academic engineers published more than their female colleagues. The distribution of publications by the male respondents was fairly similar in the three publication productivity groups. A higher percentage of the female engineers were in the low/minimum publication group (70%) compared to their male colleagues (38.4%). The results of the cross-tabulations indicate that gender and total publication productivity scores are not related. The number of female academic engineers is small and this is reflected in the calendars from both universities. As such, the female academics might not have an established network of collegial support in research and this might have affected their performance. All the female academic engineers who responded except for one (who is a professor), were lecturers and did not possess a doctorate degree. The results support the general findings from previous studies that indicated male academics published more than their female counterpart (Cole and

Zuckerman, 1984; Kyvik, 1990). However, because of the small number of female respondents the result from the present study cannot be generalized to other academic groups.

(b) Publications and Race

Over three-quarters of academic engineers in the sample are Malays (71%) and this pattern holds true for the actual population sample as well. The distributions of the other respondents are 9 Chinese, 1 Indian and 2 Eurasians. As the number of respondents of the other races is small they are grouped together under "Other races" in the analysis. The results of cross-tabulating the total publication productivity with the respondent's race indicate no significant difference.

(c) Publications and Age

The distribution of respondents by age groups is cross-tabulated with total publication scores (Table 4.15). The results indicate that, those above 41 years are more likely to be placed in the high/very high publication group compared to those below 40 year of age. Age correlates significantly with total publication productivity (p=.277, sig. <.01), indicating that the older academic engineers are more likely to achieve a higher number of publication productivity. Age in the context of this study refers to categorized chronological age. As longitudinal data was not collected, publication peaks (as indicated by Pelz and Andrews, 1966; Sodofsky, 1984; Kyvik, 1990a) could not be identified.

Table 4.15: Publication Distribution by Age

	Age			
	Under 30-40		41 and above	
	Total Publications		Total Publications	
	Count	%	Count	%
Low/Min(1-10)	26	52.0%	9	27.3%
Aver(11-20)	14	28.0%	10	30.3%
High/V.high(=>21)	10	20.0%	14	42.4%
Total	50	100.0%	33	100.0%

p=.277, sig. <.01

(d) Publications and the Number of Children

The academic engineers have fairly large families. Over 90% of academic engineers have more than 1 child, with the majority having 4 or more children (Table 4.16).

Table 4.16: Academic Engineer's Number of Children

Number of children	Count	%
1 child	4	4.9%
2 children	6	7.3%
3 children	14	17.1%
4 children	31	37.8%
≥ 5 children	27	32.9%
Total	82	100.0%

The variable "number of children" was categorised into three groups, 1-3 children (below average), 4 children (average) and 5 and above (above average) and cross-tabulated with scores on total publications. The results indicate no significant differences in publication productivity achieved (Table 4.17).

Table 4.17: Publication Distribution by Respondents' Number of Children

	Number of children					
	1-3 chil.		4 chil.		≥ 5 chil	
	Total Publications		Total Publications		Total Publications	
	Count	%	Count	%	Count	%
Low/Min(1-10)	13	54.2%	10	32.3%	12	42.9%
Aver (11-20)	7	29.1%	11	35.4%	6	21.4%
High/V.high(≥21)	4	16.7%	10	32.3%	10	35.7%
Total	24	100.0%	31	100.0%	28	100.0%

x^2=4.363, df.4, p< .359

Although previous studies have indicated the effect of family size on the productivity of women academics, it was not indicated in the present study. It is common for Malaysian working mothers to employ domestic help from countries such as Indonesia, Philippines and Thailand. As such, the size of the family or children's ages might not be a factor related to the work performance of female lecturers.

4.4.2. PUBLICATIONS AND RESPONDENTS' ACADEMIC BACKGROUND

This section compares eight academic variables with total publication productivity. The eight variables comprise institutional affiliation, academic discipline, highest academic qualifications, years since the highest degree was obtained, the country from which the degree was obtained, the length of years of work experience and academic rank.

(a) Publications and Institutional Affiliation

Table 4.18 indicates that the total publication productivity of academic engineers from both institutions are fairly similar, with 28% -29% in the high publication group, 25%-33% in the average group and 38%-45% in the low/minimum publication group. When affiliate status is compared with total publications, no relationship is indicated.

Table 4.18: Distribution of Publications by Institutional Affiliation

	Affiliation			
	UKM		UM	
	Total Publications		Total Publications	
	Count	%	Count	%
Low/Min(1-10)	15	38.5%	20	45.5%
Aver(11-20)	13	33.3%	11	25.0%
High/V.high(=>21)	11	28.2%	13	29.5%
Total	39	100.0%	44	100.0%

x^2=0.749, df 2, p<..688

(b) Publication Productivity and Academic Engineer's Departments

The majority of respondents tend to converge in the average to minimum publication group. The academic engineers from the four departments did not indicate significant differences in total publication productivity (Table 4.19). The results did not support previous findings, which indicated discipline differences in productivity in the sciences (Cole, 1979; Thagaard, 1986).

Table 4.19: Publication Productivity by Engineering Departments

Total Publications	Department							
	Civil.		Chemical		Electrical		Mechanical	
	Count	%	Count	%	Count	%	Count	%
Low/Min(1-10)	8	36.4%	7	43.8%	12	52.2%	8	36.4%
Aver (11-20)	8	36.4%	4	25.0%	6	26.1%	6	27.2%
High/V.high(≥21)	6	27.2%	5	31.2%	5	21.7%	8	36.4%
Total	22	100.0%	16	100.0%	23	100.0%	22	100.0%

x^2=2.381, df 6, p<.882

(c) Publications and Respondents' Highest Qualifications

There is a difference in the total publication productivity between those with the Masters qualifications and those with Ph.Ds (Table 4.20). Those with Masters degrees record a higher percentage (58.6%, 17 out 29) in the low/minimum publication category compared to those with Ph.Ds (33.3%, 18 out of 54). A higher percentage of those with Ph.Ds are in the average and high publication groups. Respondents' qualifications are correlated not only with total publications (ρ =.250, sig. <0.05) but also with total single works (ρ =.301, sig. <0.01) and journal articles authored (ρ =.244, sig. <0.05). The results from this study support findings from previous studies (Reskin, 1979; Chubin, 1981, Prpic, 1996b) that academic qualification is a good determinant of publication productivity. It is suggested that perhaps the Ph.D. training might have given academic engineers sufficient research and academic writing experience to help increase their publication performance.

Table 4.20: Publication Productivity by Respondents' Qualifications

	Highest qualification			
	Masters		Ph.D.	
	Total Publications		Total Publications	
	Count	%	Count	%
Low/Min(1-10)	17	58.6%	18	33.3%
Aver (11-20)	7	24.2%	17	31.5%
High/V.high(≥21)	5	17.2%	19	35.2%
Total	29	100.0%	54	100.0%

ρ=.250, sig. <.023

(d) Total Publication and the Years Since the Highest Qualification was Obtained

When the publication productivity of academic engineers was cross-tabulated with the variable "years since the highest qualification was obtained", the results indicated no difference in respondents' placement in the various publication groups (Table 4.21). However, further analysis indicated that those qualified more years ago, authored more works in the form of journal articles (ρ =.382, sig. <0.01) and research reports (ρ =.219, sig. <0.05).

Table 4.21: Publication Productivity and Years Since Highest Qualification was Received

	Total publications					
	Low/Min (1-10)		Ave (11-20)		High/V.high (≥21)	
	Year highest qualify. received		Year highest qualify. received		Year highest qualify. received	
	Count	%	Count	%	Count	%
≤ 5 yrs	3	8.6%	4	16.7%	4	16.7%
6-10 yrs	24	68.6%	17	70.8%	8	33.3%
11-15 yrs	8	22.8%	1	4.2%	7	29.2%
≥ 16 yrs			2	8.3%	5	20.8%
Total	35	100.0%	24	100.0%	24	100.0%

ρ=.141, sig. <.202

This result is contrary to Prpic's (1996b) finding that an early acquisition of a Ph.D was related to publication productivity among eminent Croatian scientists. This may be because the present study considered publication data between 1990 and 1995 only. The results might be different if total publication count since obtaining the academic degree is taken into account.

(e) Total Publication and "Country Where Highest Qualification was Received"

The largest proportion of academic engineers obtained their highest academic qualification from the United Kingdom (57, 68.7%). The rest graduated from the United States of America (14, 16.9%), 6 (7,2%) each from other countries abroad (Japan, Australia, New Zealand and Canada) and Malaysia. For analysis, the country data were further grouped into two categories; "Abroad" and "Local" and compared to the variable publication productivity. The results indicated that the percentage of distribution of academic engineers among the three publication groups was fairly similar regardless of whether they graduated from local or foreign universities (Table 4.22).

Table 4.22: Publication Productivity and "Country where Highest Qualification was Received"

	Country Highest QualificationObtained			
	Abroad		Local	
	Total Publications		Total Publications	
	Count	%	Count	%
Low/Min(1-10)	31	40.8%	4	57.1%
Aver(11-20)	23	30.3%	1	14.3%
High/V.high(=>21)	22	28.9%	2	28.6%
Total	76	100.0%	7	100.0%

$x^2 = .973$, df 2, $p < .615$

(f) Publication Productivity and Respondents' Working Experience

Academic engineers' working experiences were categorised into 4-year spans: 5 years or less, 6 to 10 years, 11 to 15 years, and 16 or more years. However, because of the small number in the "5 years or less" and "15 years & above" groups, the variable was further collapsed into just two categories; "≤ 10 years of working experience" and "≥ 11 years of work experience" (Table 4.23). This variable was cross-tabulated with scores on publication productivity. The results indicate that the more experienced academic staff authored a higher number of published works. Further analysis indicated that those more experienced not only achieve higher total publications (ρ=.386, sig. <.001) but also more total single works (ρ =.356, sig. <0.01), conference papers (ρ =.348, sig. <0.01), journal articles (ρ =.351, sig. <0.01) and book chapters authored (ρ =.586, sig. <0.05). Experience is therefore a good determinant of publication productivity.

Table 4.23: Publication Productivity and Working Experience

	Working experience			
	≤10		≥ 11	
	Total Publications		Total Publications	
	Count	%	Count	%
Low/Min(1-10)	29	53.7%	6	20.7%
Aver (11-20)	16	29.6%	8	27.6%
High/V.high(≥21)	9	16.7%	15	51.7%
Total	54	100.0%	29	100.0%

ρ=.386, sig. <.001

This result supports previous findings such as those obtained by Rushton, Murray and Paunonen (1987), who observed that the average number of publications increased when the number of years of professional experience is longer. Babu and Singh (1998) also indicated that vast research experience makes the scientist more productive in the number of chapters authored (ρ=.586, sig.<0.05). Experience is therefore a good determinant of publication productivity.

(g) Publication Productivity and Respondents' Academic Rank

Respondents' rank was cross-tabulated with scores on publication productivity. The result is displayed in Table 4.24. The professors are more likely to be placed in the high/very high publication group compared to respondents in the other two ranks. The results indicate that rank correlates with total publication productivity.

Table 4.24: Academic Rank and Publication Productivity

	Academic rank					
	Lecturer		Assoc prof		Prof	
	Total Publications		Total Publications		Total Publications	
	Count	%	Count	%	Count	%
Low/Min(1-10)	26	59.1%	8	25.8%	1	12.5%
Aver(11-20)	12	27.3%	10	32.3%	2	25.0%
High/V.high(=>21)	6	13.6%	13	41.9%	5	62.5%
Total	44	100.0%	31	100.0%	8	100.0%

ρ=.424, sig. <.001

Those higher in academic rank tend to author more joint (ρ =.296, sig. <0.01) and single works (ρ =.328, sig. <0.01); conference papers (ρ =.329, sig. <0.01) and journal articles (ρ

=.442, sig. <0.01). Rank is related to publication productivity for the academic engineers in this study. Previous studies (Blackburn, Behymer and Hall, 1978; Rushton, Murray and Paunonen, 1987) also found similar results.

In summary, the results indicate that for academic engineers, those with Ph.D., with more than ten years of working experience as an academic staff and who have attained the academic rank of associate professor or professor are likely to publish more. Other variables such as the university they are affiliated to, their department, the country where they obtained their highest qualification are not related to publication productivity.

4.4.3. PUBLICATIONS AND RESPONDENTS' DEPARTMENTAL BACKGROUND

This section describes the departmental background of respondents, which comprises; the percentage of time allocated for research, teaching and administrative work; the publication requirements set by the respective departments, the number of faculty members and the postgraduate research students enrolled within the departments.

(a) Percentage of Time Allocated for Research, Teaching and Administration.

Table 4.25 indicates that the majority of respondents allocate between 21-30 percent of available time for research. Only 4 respondents allocate more than 40 percent of their time for research. On the whole the mean percentage of time spent on research was 30.84.

Table 4.25: Percentage of Time Allocated to Research, Teaching and Administration.

Percentage time		Freq.	%	Mean	Min	Max
Research time	0-20	11	13.3	30.84	10	50
	21-30	53	63.9			
	31-40	15	18.0			
	=> 41	4	4.8			
Teaching time	0-30	11	13.3	47.05	10	75
	31-40	21	25.3			
	41-50	30	36.1			
	=>51	21	25.3			
Administration	0- 19	20	24.1	22.23	5	80
	20-29	38	45.8			
	30-39	20	24.1			
	=>40	4	6.0			

The majority of respondents allocate between 31-50 percent of their time to teaching, putting in an average of 47.05 percent of their time. About two-third of respondents spent between 20-39 percent of their time on administrative duties with an average of 22-23 percent of available time.

Table 4.26 indicates that the amount of time allocated to research is inversely correlated to the time allocated to teaching (ρ = -.476, sig. <0.01). Those who spend more time on teaching will spend less time on research and administrative work (ρ =-.770, sig. <0.01). This was also found by Ramsden and Moses (1992).

Table 4.26: Correlation Between Time Allocated for Research, Teaching and Administration

Spearman's rho	% Time on Research	% Time on Teaching	% Time on Admin.
% Hours on Research	1.000	-.476**	-.089
Sig. (2-tailed)	-	.001	.426
% Hours on Teaching	-.476**	1.000	-.770**
Sig. (2-tailed)	.001	-	.001
% Hours on Administration	-.089	-.770**	1.000
Sig.(2-tailed)	.426	.001	-

** Correlation is significant at the .01 level (2-tailed)

(b) Publication Productivity and Percentage of Time Spent on Research

Table 4.27 indicates that the distribution of publication counts among the four research per cent time-bands is fairly similar. In all publication categories, the majority (57%-70%) spend between 21-30 per cent of available time on research. No significant difference was indicated between publication productivity and percent time spent on research.

Table 4.27: Publication Productivity and Percentage of Time Spent on Research

Total publications	Percentage of Time on Research							
	0-20		21-30		31-40		=> 41	
	Count	%	Count	%	Count	%	Count	%
Low/Min(1-10)	6	54.5%	20	37.7%	8	53.3%	1	25.0%
Aver (11-20)	3	27.3%	17	32.1%	3	20.0%	1	25.0%
High/V.high(=>21)	2	18.2%	16	30.2%	4	26.7%	2	50.0%
Total	11	100.0%	53	100.0%	15	100.0%	4	100.0%

ρ =-.057, sig. <.546

This results did not support findings from previous studies, which observed a relationship between publication productivity and time spent on research (Parson and Platt, 1967; Halsey and Trow, 1971; Clark, Corcoran and Lewis, 1991; Calligaro et al., 1991).

(c) Publications and Percentage of Time Spent on Teaching

The estimated percentage of time allocated for teaching is categorized into 4 teaching per cent bands and cross-tabulated with publication scores (Table 4.28). Those respondents, who allocate 51 per cent of their time to teaching, recorded the highest percentage in the low/minimum (12 out of 21) publication group. The rest of the respondents were placed in the minimum and average publication bands. No significant difference was indicated between publication productivity and percent time spent on teaching.

Table 4.28: Publication Productivity and Percentage of Time Spent on Teaching

Total publications	Percentage of Time on Teaching							
	0-30		31-40		41-50		=> 51	
	Count	%	Count	%	Count	%	Count	%
Low/Min(1-10)	4	36.4%	8	38.1%	11	36.7%	12	57.1%
Aver (11-20)	4	36.4%	7	33.3%	10	33.3%	3	14.3%
High/V.high(=>21)	3	27.2%	6	28.6%	9	30.0%	6	28.6%
Total	11	100.0%	21	100.0%	30	100.0%	21	100.0%

$\rho = -.071$, sig. <.441

Even though those who allocate a greater percentage of their time to teaching tended to publish less, the publication scores across other time bands were quite similar causing a no significance of differences.

(d) Publications and Percentage Time Spent on Administrative Duties

Table 4.29 indicates that 4 out of 5 respondents who spent more time on administration are placed in the average publication group and only 1 is in the very high publication group. The percentage of time allocated to administration work was not related to the total number of publication productivity.

Table 4.29: Publication Productivity and Percentage Time Allocated to Administration

Total publications	Percentage of Time on Administration							
	0-19		20-29		30-39		≥ 40	
	Count	%	Count	%	Count	%	Count	%
Low/Min(1-10)	10	50.0%	16	42.1%	9	45.0%		
Aver (11-20)	3	15.0%	12	31.6%	5	25.0%	4	80.0%
High/V.high(≥21)	7	35.0%	10	26.3%	6	30.0%	1	20.0%
Total	20	100.0%	38	100.0%	20	100.0%	5	100.0%

$\rho = -.065$ sig. <.485

(e) Publication Requirements Set by Respondents' Departments

The majority of the respondents indicated that their department set no minimum number of publication requirements per year (Table 4.30). Only one respondent indicated that his department requires him to publish at least 3 publications a year. Generally, most academic staff members are unaware of the publications number that is required of them per year.

Table 4.30: Publication Requirements by Department

	Frequency	Percentage	Cumulative percentage
No minimum set	53	63.9	63.9
At least 1 per year	29	34.9	98.8
At least 3 per year	1	1.2	100.0
Total	83	100.0	

Cross-tabulating the ratings on publication requirements with total publications achieved indicated no significant difference in the publication scores between those who perceived that their department have no minimum publication requirements and those who perceived that their department expects them to publish at least 1 per year (Table 4.31).

Table 4.31: Publication Productivity and Ratings on Department's Publication Requirements

	Publication requirements by dept					
	No minimum set		At least 1 per yr		At most 3 per yr	
	Total Publications		Total Publications		Total Publications	
	Count	%	Count	%	Count	%
Low(1-5)	6	11.3%	5	17.2%		
Min(6-10)	13	24.5%	10	34.5%	1	100.0%
Ave(11-20)	19	35.8%	5	17.2%		
High(21-30)	9	17.0%	6	20.7%		
V.High(=>31)	6	11.3%	3	10.3%		
Total	53	100.0%	29	100.0%	1	100.0%

$\rho = -.108$, sig. <.331

(f) Number of Faculty Members and Research Student Enrolments

A total of 76 (91.6%) respondents indicate that their faculty comprises 20-30 members. Only 7 (8.4%) reported their department has less than 20 faculty members. All respondents indicated that their departments' postgraduate research students' enrolment is between 10-20 students. Because of the uniformity in rating across all scales, no comparisons can be made effectively. As such, the variables, faculty number and postgraduate student number, were dropped from further analysis.

4.4.4. PUBLICATIONS AND RESPONDENTS' PROFESSIONAL BACKGROUND

This section presents the professional background of academic engineers. This will include respondents' professional memberships, their editorial activity in journal publications, the number and type of consultation obtained. These professional variables will be compared to total publication productivity scores to ascertain relationships. The variables will also be compared to selected personal, academic and departmental variables to identify relationships.

(a) Respondents' Membership of Professional Associations

Table 4.32 summarises the membership pattern of respondents.

Table 4.32: Membership Pattern of Academic Engineers

Types of Membership	Total	%
Did not respond to question	6	7.2
Membership of 1 society	32	38.6
Membership of 2 societies	33	39.7
Membership of 3 societies	10	12.1
Membership of ≥ 4 societies	2	2.4

The majority of respondents are members of one or two societies. About 14% are members of three or more societies. A total of 76 (91.5%) respondents indicate being members of the Institution of Engineers Malaysia (IEM), and 25 (30%) are members of the Institution of Electrical Engineers UK (IEE). Most chemical engineers are members of their own professional associations such as the Institution of Chemical Engineers Malaysia (11 out 16). The 77 respondents who indicated their professional membership affiliation reported a total of 26 unique associations, out of which, some are listed by more than one respondent. The societies that were noted by more than one respondent are, IEEE, IEM (Malaysia), Institution of Chemical Engineers Malaysia, Minds (Malaysia), Malaysian Materials Society, Ensearch Malaysia and Malaysian Concrete Society.

(b) Publication Productivity and Membership of Professional Associations

Cross-tabulating respondents' responses to inquires about their membership of learned professional societies with total publication counts, indicates that members and non-members are equally placed in the low/minimum and average publication group (Table 4.33). No significant difference was indicated between the publication productivity achieved and membership activity.

Table 4.33: Publication Productivity and Professional Association Membership Status

Total publications	Membership of professional associations			
	Yes		No	
	Count	%	Count	%
Low/Min(1-10)	32	41.6%	3	50.0%
Aver (11-20)	21	27.2%	3	50.0%
High/V.high(=>21)	24	31.2%		
Total	77	100.0%	6	100.0%

x^2=2.959, df.2, p<.228

From the open-ended section of the questionnaire (D1(b)) where respondents listed their professional association memberships, the total number of membership were counted for each respondent and allocated into two groups, those who are members of 1-2 associations and those who are members of more than 2 associations.

Table 4.34 indicates that 7 out of 12 respondents who are in the high and very high publication group are members of more than 2 associations. For those academic staff who reported being members of 1-2 associations, a high number (29 out of 65) belong to the low/minimum group. The results indicate a correlation between the variable "number of professional association" and respondents' total publication productivity.

Table 4.34: Publication Productivity and the Number of Professional Membership (n=77)

Total publications	Number of memberships			
	1-2		More than 2	
	Count	%	Count	%
Low/Min(1-10)	29	44.6%	3	25.0%
Aver (11-20)	19	29.2%	2	16.7%
High/V.high(=>21)	17	26.2%	7	58.3%
Total	65	100.0%	12	100.0%

p=.270, sig.<.018

(c) Publication and Respondents' Editorial Activities

The number of academic engineers who held editorial responsibilities for scholarly journals was extremely small (9 out of 83) (Table 4.35). Cross-tabulating respondent's responses to their editorial activity with their publication scores, indicates that there is no difference in the publication productivity between those who are actively involved in editorial activities and those who are not.

Table 4.35: Publication Productivity and Respondents' Editorial Activity

Total publications	Editorial activity			
	Yes		No	
	Count	%	Count	%
Low/Min(1-10)	3	33.3%	32	43.2%
Aver (11-20)	2	22.2%	22	29.7%
High/V.high(=>21)	4	44.5%	20	27.1%
Total	9	100.0%	74	100.0%

x^2=1.185, df.2, p<.553

(d) Respondents' Consultation Work and Publication Productivity

About fifty-three respondents (63.9%) indicated that they were involved in consultation work, and 30 (36.1%) indicated that they did not undertake any such work. From Section 3 (b) of the questionnaire, it was possible to make a count of total respondents involved in consultation work. The numbers obtained were re-coded into four categories: 1,2,3,4 or more. Table 4.36a indicates that about 20 out of 53 respondents were involved in at least one consultation work, followed by 22 respondents in two, and 11 in three or more consultation works. The types of consultation work undertaken are indicated in Table 4.36b.

Table 4.36a: Number of Consultations Undertaken (n=53)

No. Consultation	Frequency	Percentage
1	20	37.7%
2	22	41.5%
3	9	17.0%
4 or more	2	3.8%
Total	53	100.0%

Table 4.36b: Types of Consultation Work Undertaken (n=53)

Types of Consultation	Frequency	Percentage
Central govt.	30	37.5%
State govt.	4	5.0%
Local/municipal govt.	4	5.0%
Private agencies	37	46.3%
Foreign/professional agencies	5	6.2%
Total	80	100.0%

The highest number of consultation work undertaken comprised those commissioned by private agencies (37, 44.6%). These include consultation done for local companies and industry. About 36% of total consultation work undertaken was commissioned by the central government.

The respondents' consultation status was cross-tabulated with total publication scores. Table 4.37a indicates that even though a high proportion of those who indicated "yes" to undertaking consultation work achieved placement in the high publication group, an equal number were also placed in the average and high publication groups, thus, showing no difference in publication distribution. This indicates that generally, academic engineers are actively involved in consultation work regardless of their publication achievements.

Table 4.37a: Publication Productivity and Respondent's Consultation Status

	Consultations			
	Yes		No	
	Total Publications		Total Publications	
	Count	%	Count	%
Low/Min(1-10)	18	34.0%	17	56.7%
Aver (11-20)	16	30.2%	8	26.7%
High/V.high(=>21)	19	35.8%	5	16.6%
Total	53	100.0%	30	100.0%

x^2=4.862, df.2, p<.088

The number of consultation works undertaken by respondents was cross-tabulated with respondents' total publication scores. The results indicate that a higher number of those who undertake 2 or more consultation works are placed in the high/very high publication group compared to those who are involved in 1 consultation work (Table 4.37b). This result supported Prpic's (1996a, 1996b) study, which indicated that one of the characteristics of eminent scientists was their high membership of scientific societies at national and international level.

Table 4.37b: Publication Productivity and Number of Consultations Undertaken

Total publications	Number of consultations			
	1		2 or more	
	Count	%	Count	%
Low/Min(1-10)	10	50.0%	8	24.2%
Aver (11-20)	6	30.0%	10	30.3%
High/V.high(=>21)	4	20.0%	15	45.5%
Total	20	100.0%	33	100.0%

p=.297, sig.<.031

(e) Editorial Activity of Respondents and Publications

Another activity, which enhances academic staff's professional status, is editorial involvement in scholarly publication of books or journals. Only 9 (10.8%) respondents indicated being involved in such activities and these are identified by those who indicated "yes" to question D(2a) in the questionnaire. Out of the 9 respondents, 8 indicated being editors of 1 to 2 journals and only one was on the editorial board of more than 2 journals. Country analysis of the titles indicate that 6 out of the 9 were Malaysian journals, and the remaining three were published abroad. All 9 respondents hold Ph.D. degrees, are editors of 1-2 journals (3 are from UKM and 5 are from UM), while the sole respondent who edits more than 2 journals is from UM. Age-wise, 5 respondents are between 31-40 years, and 4 are between 41-50 years. Rank-wise, the 9 respondents comprise 3 lecturers, 5 associate professors and 2 professors.

Cross-tabulating the total number of journals edited with total publication scores indicated that none of the 9 respondents are placed in the low/minimum publication group. The 8 who edit 1 to 2 journals are placed in the high publication group. The one who reported being on the editorial board of more than 2 journals is placed in the very high publication group. This result therefore supports the finding from previous studies which indicated a relationship between active editorial and high research productivity (Prpic, 1996a,1996b; Baldwin, 1990)

(f) Selected Departmental Variables and Personal / Academic Variables

Total professional membership, total number of consultations are not related with variables such as affiliation, department, age, race, gender, qualification, rank and work experience.

4.4.5. PUBLICATIONS AND FINANCIAL SUPPORT FOR RESEARCH

This section presents an organizational variable, that is, the funding available for research obtained by the respondents between 1990 and 1995. The respondents' views were also sought as to whether they felt limited in terms of funds and the efficiency of fund disbursement for research.

(a) Sources of Funding for Research

Table 4.38 indicates the source of funding obtained by academic engineers between 1990 and 1995.

Table 38: Source of Funds Obtained by Academic Engineers (n=83)

Type of Sponsors	Frequency	Percentage
University	80	96.4%
Federal funding through R & D	44	53.0%
Government not R & D	4	4.8%
Private sector .	28	33.7%
Foreign agencies	5	6.0%

The majority of funding came from within the university research fund itself (80 respondents indicated this). About half of funds came from Federal funding (44 respondents indicated this) through the IRPA (the central government's intensified research in priority areas) allocation. Other source of funds are obtained from specific government agencies, local governments, the private sector (mainly from business corporations and industries), and foreign sources such UNESCO, FAO, Asian Foundation and the Japan Foundation.

(b) Number and Amount of Grants Received and Publication Productivity

The majority of respondents received one grant each (37 out of 83) while 34 respondents obtained grants from 2 sources. A total of 12 respondents obtained funding from 3 or more sources (Table 4.39a). The amount of grants received is displayed in Table 4.39b.

Table 4.39a: Total Number of Grants Received (n=83)

Total number of grants	Frequency	Percentage
1	37	44.5%
2	34	41.0%
3 or more	12	14.5%
Total	83	100.0%

Table 4.39b: Amount of Grant Received by Respondents during the last 5 Years (n=83)

Amount of grant (RM)	Frequency	Percentage
Under 20,000	11	13.3%
21,000-50,000	24	28.9%
51,000-100,000	11	13.3%
More than 100,000	37	44.5%
Total	83	100.0%

The majority of respondents obtained more than RM100,000 (44.6%) in grant money. When the total publication scores are cross-tabulated with the amount of grants received, the results indicate that, those who received larger grants are also those who publish more (Table 4.39c).

Table 4.39c: Amount of Grant Received and Publication Productivity

Total publications	Amount of grants for the last 5 years (1990-1995) (RM)							
	Under 20,000		21,000-50,000		51,000-100,000		More than 100,000	
	Count	%	Count	%	Count	%	Count	%
Low/Min(1-10)	7	63.6%	13	54.2%	6	54.5%	9	24.4%
Aver (11-20)	3	27.3%	8	33.3%	2	18.2%	11	29.7%
High/V.high(=>21)	1	9.1%	3	12.5%	3	27.3%	17	45.9%
Total	11	100.0%	24	100.0%	11	100.0%	37	100.0%

p=.375, sig. <.001

Table 4.39d displays the cross-tabulated data between publication categories and the number of grants received by respondents as some respondents indicated receiving 1 grant, which was large in amount, while others indicated receiving several grants of smaller amounts. The results indicate that those respondents who received more than 1 grant are more likely to achieve higher publication productivity.

Table 4.39d: Publication Distribution by Total Number of Grants Received

	Total number of grants			
	1		= >2	
	Total Publications		Total Publications	
	Count	%	Count	%
Low/Min(1-10)	25	67.6%	10	21.7%
Aver(11-20)	9	24.3%	15	32.6%
High/V.high(=>21)	3	8.1%	21	45.7%
Total	37	100.0%	46	100.0%

p=.499, sig. < .001

(c) Publication and Respondents' Perception of Funding

Table 4.40 indicates that a higher proportion of respondents who rated "yes" to the lack of research funds, are placed in the low/minimum publication group. A higher percentage of those who indicated getting funding was "not a problem" are in the high publication group. The results indicate a difference in the publication productivity between the two groups of raters.

Table 4.40: Perceived Lack of Fund and Publication Productivity

Total publications	Lack of funding as a problem			
	Yes		No	
	Count	%	Count	%
Low/Min(1-10)	23	59.0%	12	27.2%
Aver (11-20)	8	20.5%	16	36.4%
High/V.high(=>21)	8	20.5%	16	36.4%
Total	39	100.0%	44	100.0%

x^2=8.520, df.2, sig. <.014

Respondents were also asked to indicate the level of efficiency in the disbursement of funds for research, and this rating was cross-tabulated with the publication productivity scores (Table 4.41).

Table 4.41: Efficiency of Fund Disbursement and Publication Productivity

	Efficiency of fund disbursement					
	Efficient		Fairly Efficient		Inefficient	
	Total Publications		Total Publications		Total Publications	
	Count	%	Count	%	Count	%
Low/Min(1-10)	2	16.7%	30	47.6%	3	37.5%
Aver(11-20)	4	33.3%	18	28.6%	2	25.0%
High/V.high(=>21)	6	50.0%	15	23.8%	3	37.5%
Total	12	100.0%	63	100.0%	8	100.0%

The results indicate that the majority of respondents find research fund disbursement fairly efficient (63 out of 83) and a large number in this group are low/minimum publishers. Twelve respondents found research fund disbursement to be efficient and half of this group (n=6) are high publishers.

(d) Financial Support and Selected Departmental / Personal / Academic Variables

Respondents' responses on the total and amount of financial support they received for research were cross-tabulated with a selection of personal and academic variables to find out whether these variables are related. Only correlated results is described.

Affiliation, department, gender and race. Only "affiliation" was significantly related to the amount of grant received. A higher percentage of respondents from UKM received grants amounting to more than RM100,000 (61.5%) compared to respondents from UM (29.5%). Also, a higher percentage of academic engineers from UM received grants under RM20,000 (22.7%) compared to those from UKM (2.6%). The results indicate a significant differences in the amount of grants received between the academic engineers from UKM and UM (x^2 =12.819, df. 3, p<0.01).

Working experience. Those who are more experienced are more likely to receive a higher number (p= .303, sig. < 0.01) and amount (p= .251, sig. < 0.05) of grants.

Rank. Those who are higher in academic rank are more likely to obtain a larger number ($p= .297$, sig. < 0.01) and amount ($p= .328$, sig. < 0.01) of grants.

Time spent on research. Those who spent more time on research tend to be those who receive a higher number of grant ($p= .256$, sig. < 0.05).

In summary, those who obtained placement in the high/very high publication group were those who obtained above 50,000 in grant money. The results corroborate with the findings from previous studies which observed that funding has an effect on research performance (Woods, 1990; Johnston, 1994; Fonseca, 1997). Those who received a higher number and amount of grants were found to be older, more experienced as academics, higher in academic rank and allocated more time for research.

4.4.6. LIBRARY SUPPORT FOR RESEARCH

This section presents organizational variable comprising library resources and services to support research needs of academic engineers. These are elements that institutions often use as indicators of the adequacy of an institution to support academic and research programmes.

(a) Sufficiency of Library Resources for Research

Respondents' ratings on the sufficiency of library resources to support their research is given in Table 4.42. For tabulation, the ratings have been collapsed to three categories of "Never used/insufficient; Fairly sufficient; and Sufficient/very sufficient".

Table 4.42: Ratings on the Sufficiency of Library Resources

	Sufficiency of library resources	
	Count	%
Never used/Insufficient	15	18.1%
Fairly sufficient	46	55.4%
Sufficient/V. sufficient	22	26.5%
Total	83	100.0%

Mean=2.08

The mean score obtained (m=2.08) indicates that over 55% of the respondents felt their library resources to be fairly adequate to service their research needs.

(b) Research Publications and Rating on Library Resources

The ratings on the sufficiency of library resources indicate non relationship with respondents' total number of publication productivity scores (Table 4.43).

Table 4.43: Publications and Ratings on Library Resources

Total publications	Sufficiency of library resources					
	Never used/insufficient		Fairly sufficient		Sufficiently/V.sufficient	
	Count	%	Count	%	Count	%
Low/Min (1-10)	6	40.0%	21	45.7%	8	36.4%
Aver (11-20)	3	20.0%	14	30.4%	7	31.8%
High/V. high (≥ 21)	6	40.0%	11	23.9%	7	31.8%
Total	15	100.0%	46	100.0%	22	100.0%

ρ=.007, sig. 948

(c) Ratings on Library Resources and Selected Demographic Variables

When the ratings on the sufficiency of library services was cross-tabulated with nominal variables such as department, race and gender, the results indicated no evident relationship. The results do indicate that a higher percentage of academic engineers from UM rated their library resources as sufficient (15 out of 22) compared to those from UKM (7) (x^2=6.245, df 2, p<0.05).

The ordinal variables such as age, work experience, qualifications, rank and percentage time allocated for research are not correlated with ratings on the sufficiency of library resources.

(d) Ratings on the Different Types of Library Services

All 83 respondents gave their ratings to 7 types of services listed on a 5-point scale (1=not used to 5=very useful). Table 4.44 lists the frequency and mean score ratings on the seven types of library services. The services can be grouped into two types; loans (which comprise book loans, inter-library loans, book reservations, periodicals loans), and search and retrieval (includes photocopying, help with database searching, help with locating resources) services. The services that achieved a score of above 3 are photocopying services, book loan services, and book reservations, indicating that academic engineers found these services "fairly useful". The rest of the services achieved a mean of between 2.29 to 2.70 indicating that academic engineers found these services less useful for their research needs. On the whole, the distribution of mean scores does not show great variations. The results indicate that respondents find the services offered by libraries as either fairly useful or less useful and the service that tops the list as useful for research is photocopying services.

Table 4.44: Ratings on the Usefulness of Library Services for Research Information

	Useful, V. useful		Fairly useful		Both		Not useful, Not used			
Library services	Freq	%	Freq	%	Total	Rank most used	Freq	%	Rank lest used	Mean
Photocopying services	60	72.3	17	20.5	77 (92.8%)	1	6	7.2	7	3.78
Book loan services	52	62.7	22	26.5	74 (89.2)	2	9	10.8	6	3.64
Book reservations	34	41.0	35	42.2	69 (83.2%)	3	14	16.8	5	3.24
Inter-library loans	29	34.0	19	22.9	48 (56.9)	4	35	42.1	4	2.70
Library staff search online databases	15	18.0	30	36.0	45 (54.0)	5	38	46.0	3	2.35
Library staff help locate sources	18	21.7	24	28.9	42 (50.6)	6	41	49.6	2	2.31
Borrowing periodicals	26	31.0	9	11.0	35 (42.0)	7	48	58.0	1	2.29

This may be due to greater dependence on journal literature, conference proceedings and research reports which normally cannot be borrowed and which most researchers prefer to make copies. The low ratings given to other services provide some indications to the libraries from both institutions on the need to promote higher usage of the services available.

(e) Rating on Types of Library Services and Publication Productivity

Total publications. The results indicate that only "inter-library loans" correlates with total publications (p=.224, sig.<0.05) (Table 4.45). A higher percentage of the productive publishers rated inter-library loan services as useful/very useful. Total publications were not correlated with ratings on the other types of library services.

Table 4.45: Inter-library Loan Ratings and Publications Productivity

	Inter-library loans									
Total publications	Never used		Not useful		Fairly useful		Useful		V.useful	
	Count	%	Count	%	Count	%	Count	%	Count	%
Low/Min (1-10)	18	60.0%	2	40.0%	3	15.8%	8	44.4%	4	36.4%
Aver (11-20)	7	23.3%	3	60.0%	8	42.1%	5	27.8%	1	9.1%
High/V. high (≥ 21)	5	16.7%			8	42.1%	5	27.8%	6	54.5%
Total	30	100.0%	5	100.0%	19	100.0%	18	100.0%	11	100.0%

p=.224, sig.< 0.05

(f) Usefulness of Library Services and Personal / Departmental Variables

The ratings on the seven types of library services were cross-tabulated with selected personal and departmental variables to find out whether they were related. Only correlated results will be described.

Affiliation. Affiliation is related to the rating on the usefulness of professional help in locating sources. The percentage of academic engineers from both UKM and UM who never sought professional staff help is quite high (41 out of 83). However, a higher proportion of respondents from UM indicated seeking professional librarians' help as useful/very useful for their research (14 out of 44, 31.8%) compared to those from UKM (4 out of 39, 10.3%)) (x^2= 8.170, df.2, $p<0.017$).

Department. There are differences in departmental ratings on the usefulness of book loan services (x^2=14.010, df.6, $p<0.030$) and book reservations (x^2=19.447, df.6, $p<0.003$). The mechanical engineers are the largest group in number who consider book loans (18 out of 52, 34.6%) and book reservations (14 out of 34, 41.2%) as useful or very useful. The civil engineers is the largest group that never used or do not find useful book loan services (5 out of 9, 55.6%) and book reservations (6 out of 14, 42.9%). No differences are indicated in the ratings on the other 5 library services.

Age, experience, academic qualification, rank and time allocated to research. Only "qualifications" correlate to positive ratings on book loan services. A higher percentage of academic engineers with Ph.D. rated book loan services as useful/very useful compared to those with Masters (p=.254,sig.< 0.05).

(g) Comments on Library Services

Question F(2b) of the questionnaire sought respondents' comments on library services that should be improved. A total of 50 respondents (60%) gave their comments. Thirty-three respondents did not fill in this section. The comments are grouped into 5 categories: (1) access to other libraries; (2) acquisition of reprints from other libraries; (3) need to acquire new titles and full text databases; (4) photocopying facilities and (5) others. Most of the comments (46%) expressed the need for newer journal titles especially in the form of full text databases. The other two most expressed need is for more self-operating photocopying machines exclusively for lecturers' use (30%) and the need for better handling of request for reprints of journal articles not available in the library (19%).

From the comments, a pattern of information source needs seem to emerge. There is much emphasis on the need of periodicals for research. Very rarely are monographs mentioned even though respondents were merely asked to comment generally on how they feel library services could be improved.

In summary, the majority of academic engineers found library resources fairly sufficient to support research. However, this did not relate to their publication performance. This result is related to the findings by Lorenz (1973) who observed that academics at the University of Nebraska perceived the importance of the library but admitted to infrequent use. This is implied in the academic's rating on the usefulness of library services. The ratings given seemed random and did not indicate any significant pattern of use. It is suspected that academics rated randomly for services they are not very acquainted with. Hence, academics gave high ratings to familiar services such as photocopying, book loans and book reservation services. Further approach need to be adopted to ascertain whether academic engineers are aware that they can 'request' for help from professionals to search for information and resources. This may be the reason why library services such as obtaining professional library's help to locate sources, and help in searching online databases are rated poorly. Only those who wrote more journal articles tended to seek professional librarian's help to locate sources or search online databases for references. This highlights the type of authors who would seek professional librarians' help, thus allowing the library to develop appropriate strategies.

4.4.7. LABORATORY SUPPORT AND RESEARCH PUBLICATIONS

Another organizational variable considered relevant is the adequacy of laboratory support which is expected to help promote research directly and research publication indirectly. This section aims to identify academic engineers' satisfaction with the laboratories available in their departments for research. Their ratings would be compared with scores on total and types of publication achieved to find out whether they are correlated.

(a) Adequacy of Laboratories for Research

Table 4.46 indicates that the majority of respondents reported that their laboratory facilities are either sufficient (43 out of 83) or highly sufficient (3) for their research needs. The ratings indicates that on the whole, respondents regard their laboratory facilities as "sufficient/highly sufficient" in meeting their research needs.

Table 4.46: Ratings on the Sufficiency of Laboratory Support for Research

Laboratory support	Count	Percent
Never used/Insufficient	3	3.6
Fairly sufficient	34	41.0
Sufficient/highly sufficient	46	55.4
Total	83	100.0

Mean 2.52

(b) Publications and Ratings on Laboratory Support

The ratings on the sufficiency of laboratories to support research needs are compared to respondents' total publication scores (Table 4.47).

Table 4.47: Sufficiency of Laboratory Support and Publication Productivity

	Sufficiency of laboratory support					
	Insufficient		Fairly sufficient		Sufficient/v.sufficient	
	Total Publications		Total Publications		Total Publications	
	Count	%	Count	%	Count	%
Low/Min(1-10)	2	66.7%	15	44.1%	18	39.1%
Aver(11-20)			9	26.5%	15	32.6%
High/V.high(=>21)	1	33.3%	10	29.4%	13	28.3%
Total	3	100.0%	34	100.0%	46	100.0%

ρ=044, sig. .695

The results indicate a generally positive rating by all respondents and significant differences in ratings is not indicated.

(c) Sufficiency of Laboratory Support and Personal / Departmental Variables

Affiliation, department, gender and race. Respondents' affiliation, gender and race are not related to the ratings on the adequacy of laboratory support. There is a significant difference in the ratings on the laboratory status for research among respondents from the four departments (x^2 =22.767, df. 5, p<0.001). Those who rated highly on their laboratory support are civil engineers (20 out of 46) and electrical engineers (13). In general, the majority of academic engineers are fairly satisfied with this facility but it is not related to their publication performance.

4.4.8. ELECTRONIC SUPPORT AND RESEARCH PUBLICATIONS

The final organizational variable included in this study is electronic support, which, in this context refers to the availability of computers for research activities. This section aims to find out the degree of use academic engineers made of computers, the location of the computers used and the type of usage. The ratings obtained will be tested for correlation with the total research publications achieved.

(a) Computer Use Amongst Academic Engineers

All academic engineers reported using the computer (Table 4.48a). In general, academic engineers seems to have easy access to various types of computer.

Table 4.48a: Types of Computers Used (N=83)

Types of computers used	**N**	**Percent**
Stand alone microcomputers	34	41.0%
Networked computers	13	15.7%
Both	36	43.3%

The computers used were located on respondent's desk, in laboratories within their departments, at their Computer Centre, and in the library (Table 4.48b). In a number of cases respondents noted using computers from more than one location.

Table 4.48b: Locations of the Computers Used (N=83)

Location of computers	N	Percent
On desk	78	94.0%
Computers available in the department	32	38.6%
Computers at the Computer Centre	9	10.8%
In the library	2	2.4%

(b) Frequency of Computer Use for Research

Eighty respondents used computers frequently for their research (Table 4.48c). The usage amongst academic engineers is fairly high as indicated by the mean rating value of 3.98.

Table 4.48c: Frequency of Computer Use for Research

	Frequent	Very frequent	Total	Mean
Frequency of computer use	2 2.4%	80 96.4%	82 100.0%	3.98

(c) Types of Computer Use for Research

Question H(3) listed eleven types of computer use and respondents were asked to indicate the degree of frequency with which they used each type on a five point rating scale (1=never to 5=very frequently). For each type of computer use, the total mean score was computed, listed and ranked in the descending order of mean use. The results are displayed in Table 4.49.

Table 4.49: Frequency of the Types of Computer Used by Academic Engineers (n=83)

	Useful, V.useful		Sometimes useful		Both		Seldom, never useful			
Types of computer use	**Freq**	**%**	**Freq**	**%**	**Total**	**Rank most used**	**Freq**	**%**	**Rank least used**	**Mean**
Word processing	83	100.0	-	-	83 (100.0%)	1	-	-	11	4.69
Graphics	60	72.3	21	25.3	81 (97.5%)	2	2	2.4	10	3.93
Send/receive e-mails	55	66.3	24	28.9	79 (95.1%)	3	4	4.8	9	3.93
Infor via internet	34	41.0	40	48.2	74 (89.2%)	6	9	10.8	8	3.37
Statistical analysis	38	45.8	34	41.0	72 (86.7%)	5	11	13.2	7	3.37
Programming	56	67.5	13	15.7	69 (83.1%)	4	14	16.8	4	3.63
Slide presentations	28	33.7	41	49.4	69 (83.1%)	9	14	16.8	5	3.27
File trasfer	43	51.8	24	28.9	67 (80.7%)	7	16	19.3	6	3.34
Create database	38	45.8	27	32.5	65 (78.3%)	8	18	21.7	3	3.27
Search CD-ROM db	7	8.4	16	19.3	23 (27.7%)	10	60	72.3	2	2.22
Personal bib. index	7	8.4	14	16.9	21 (25.3%)	11	62	74.7	1	2.02

Academic engineers used their computers very frequently to word-process research communications. This type of use tops the list with the highest mean score of 4.69. Computer use with mean scores of above 3.0 includes using computers for graphics, sending/receiving e-mails, programming, statistical analysis, getting information via the internet, file transfer, creating databases and preparing slide presentations. Computer use with mean scores under 3.0 includes using the computer for searching CD-ROM databases or creating personal bibliographical indexes.

(d) Types of Computer Use and Research Publications

The frequency ratings of types of computer use to support research were cross-tabulated with total publication scores and the results indicate that the ratings on all types of computer use are not correlated to total publication productivity. Academic engineers are frequent users of computers and used it for various purposes. However, it is not related to their publication productivity.

(e) Computer Use and Selected Personal / Departmental Variables

The ratings on the types of computer used were cross-tabulated with selected personal and departmental variables to find out whether the variables are related. Only significant result will be highlighted.

Departments. The variable "department" is a strong determinant of the extent of use made of computers. This variable is related to six types of computer use (Table 4.50).

Table 4.50: Types of Computer Use and Personal / Departmental Variables

Personal/Departmental Variables	x^2	**df.**	Crit. x^2	Sig
Dept. & create database	**24.858****	12	21.026	**.016**
Dept. & statistical analysis	**23.536***	12	21.026	**.024**
Dept. & creating graphical rep. of data	**20.788****	9	16.919	**.014**
Dept. & preparing slide shows	**35.786****	12	21.026	**.001**
Dept. & access information via the internet	**21.882***	12	21.026	**.039**
Dept. & programming	**34.444****	12	21.026	**.001**

* Sig. at the 0.05 level of significance ** Sig. at the 0.01 level of significance

Among the four departments, the civil engineers are the most frequent users of computers. A higher number of civil and chemical engineers indicated frequent/very frequent use of computers for creating databases and for searching information on the Internet. The civil engineers together with the mechanical engineers are frequent users of computers for statistical analysis and creating graphics. The electrical engineers frequently use computers for programming.

Age. Age is significantly related to the use of computers for creating databases (p=267, sig. <.05), sending and receiving mail (p=-.270, sig <.014). A higher percentage of the older academic engineers reported the frequent use of computers for creating databases while the younger academic engineers rated frequent use of e-mails for research.

Work experience. The more experienced academic engineers rated frequent use of computers for creating databases (*p*=.254, sig<0.05) and slide shows (*p*=.241, sig<0.05).

Academic rank. The academic engineers who have attained higher academic rank (professors, associate professors) make frequent use of computers to create databases (*p*=.240, sig.<0.05).

Academic qualifications. The majority of those with the Masters qualification (22 out of 29, 75.9%) make frequent use of computers for file transfer (*p*=-. 340, sig<0.01), compared to those with Ph. Ds (*p*=-. 340, sig.<0.01)

In summary, ratings on the eleven types of computer use indicate that academic engineers are high users of computers and used it for varied purposes. This is consistent with the findings from previous studies such as Abel, Liebscher and Denham (1996) and Applebee, Clayton and Pascoe (1997) who also indicated high use among their respondents. However, use of computers is not related to publication productivity in this study. A more qualitative approach is needed to ascertain how computer use helps academics to perform research.

4.4.9. COLLABORATION AND RESEARCH PUBLICATIONS

Collaboration is an important ingredient in ensuring successful research. Section J (1) of the questionnaire sought the respondents to indicate on a Likert scale of 1 to 5 (never, hardly ever, sometimes, often and always) the frequency of collaboration. The aim was to identify the collaboration behaviour amongst academic engineers and whether this correlates with their publication productivity.

(a) Collaboration Behaviour of Academic Engineers

Table 4.51 indicates the total responses for each type of collaboration situation. Academic engineers would first opt to collaborate with colleagues within their own department (mean=3.78) or alternatively, collaborate with colleagues outside their university (mean=2.63). Only 17 respondents reported collaborating with colleagues outside the country (mean=1.73), while 6 respondents reported undertaking other types of collaboration, not listed.

Table 4.51: Frequency and Mean Scores for Five Types of Collaboration Behaviour

Types of Collaboration	**Never**	**Hardly ever**	**Some-times**	**Often**	**Always**	**Mean**	**Rank**
Collaborate / colleagues within department	-	-	28	45	10	3.78	1
Did research by myself	1	-	37	38	7	2.60	2
Collaborate / colleagues from other universities	5	31	40	4	3	2.63	3
Collaborate / researchers outside the country	43	23	13	4	-	1.73	4
Other types of collaboration	77	-	-	5	1	1.23	5

The results also indicate that about 45 academic engineers in the sample from both universities often or always undertook research alone.

(b) Publication Distribution According to Five Types of Collaboration

The ratings on the 5 types of collaborative behaviour were cross-tabulated with respondents' total and types of publication scores. The correlated results are displayed in bold (Table 4.52).

Table 4.52: Publication Scores and Ratings on Five Types of Collaboration

Spearma's rho	**Collab / colleagues within dept**	**Collab/ colleagues other universities**	**Collab /researchers outside country**	**Other collab**
Total publications	-.018	**.223***	**.249***	.158
Sig. (2-tailed)	.870	**.043**	**..023**	.153
Joint works	.018	**.287****	**.335****	**.255***
Sig. (2-tailed)	.873	**.009**	**.002**	**.020**
Books	.459	**.486***	.187	-.158
Sig. (2-tailed)	.056	**.041**	.457	.532
Book chapters	-.297	.304	.434	**.645***
Sig. (2-tailed)	.302	.290	.121	**.013**
Conference papers	.108	**.261***	**.268***	.146
Sig. (2-tailed)	.340	**.020**	**.016**	.197
Journal articles	-.138	.142	**.252***	.165
Sig. (2-tailed)	.268	255	**.041**	.187
Research reports	-.076	**.305***	**.322***	.125
Sig. (2-tailed)	.591	**.028**	**.020**	.378

* Correlation is sig. at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

Total publications. The results indicate that out of the five collaborative situations, "collaboration with colleagues from other universities" (p=.223, sig.<0.05) and "collaboration with researchers outside the country" (p=.249, sig.<0.05) is positively correlated with total publication productivity scores. A higher number of those who indicated collaborating are placed in the high/very high publication group.

Further analysis indicates that those who collaborate with colleagues from other universities and researchers from outside the country achieve higher total publication productivity in the form of joint works, conference papers, journal articles and research reports. The results indicate that the recurrent factors that seem to be correlated to high number of publication situations are "collaboration with colleagues from other universities", and "collaboration with researchers outside the country".

(c) Collaboration Situations and Personal / Departmental Variables

The ratings on the five types of collaboration situations are cross-tabulated with selected personal and departmental variables to find out whether the variables are related. Only significant results will be highlighted.

Department. A larger percentage of the mechanical engineers (5 out 10, 50%) tend to indicate 'often' or 'always' collaborating with colleagues within their departments compared to the engineers from other departments (x^2= 13.194, df.6, p<0.05). The results indicate that there is a difference in the ratings on this type of collaboration among respondents from the four departments. There is also a difference in the ratings of respondents from the various departments with regard to collaborating with colleagues from other universities (x^2= 16.099, df.6, p<0.01).

Work experience. Those who have 6 or more years of working experience, are more likely to collaborate 'sometimes' or 'often' with researchers outside the country (p=.308, sig.<0.01),. Those who have 5 or less years of working experience never or hardly ever undertake such collaboration

The number of respondents who undertake "other types of collaboration" is small (6 out of 83). However, all 6 respondents have 11 or more than 15 years of working experience, indicating that the more experienced academics undertook collaboration with industry and government agencies (p=.381, sig.<0.01).

Qualifications. Only those with Ph.D. indicated that they were likely to collaborate "often" with colleagues outside their university (p=.310, sig.<0.01).

Academic rank. Those who are higher in academic rank are more likely to collaborate with colleagues outside the university (ρ =.246, sig. <0.05), with other researchers outside the country (ρ=.264, sig. <0.05), and undertake other types of collaboration (ρ=.238, sig. <0.05).

Percentage of time allocated to research. Those who allocate more than 30 per cent of their time to research reported often collaborating with colleagues outside their university (ρ=.279, sig. <0.01).

Generally, although a high percentage of academic engineers reported collaborating with colleagues within their department, this behaviour is not related to their publication productivity. In summary, the types of collaboration which are related to high publication productivity are; (a) collaboration which involves working with colleagues outside the respondent's university, and (b) with fellow researchers from universities outside the country. Remarks made by the respondents in the questionnaire revealed that most collaborative ventures with other universities or outside the country often obtained large amount of grant allocations which facilitate bigger research activities and also closer monitoring and reporting procedures in order to justify the money allocated. The active collaborators are also more likely to be experienced academicians with more than 10 years of working experience, usually holding the post of professors or associate professors, and who allocate 30 percent of their time to research.

4.4.10. VIEWS ON RESEARCH AND PUBLICATION PRODUCTIVITY

Views on research is an attitudinal variable included in this study. A positive attitude is considered an advantage that helps to promote research interest directly and research writing indirectly. This section aims to (a) describe academic engineers' general attitude towards research and (b) find out whether this attitude has any bearing on their research publication productivity.

(a) Views on Research

Table 4.53 indicates the frequency ratings on seven research-view statements. Respondents rated "true"/"very true" to the following statements: research as a means of advancing knowledge (90.4%), research activity as a factor that adds to one's reputation as a scientist (89.2%), and research activity provides an opportunity to present papers at conferences (83.2%). Over 70% of respondents agree that research increases their prestige and respect as well as help enhance their career opportunity. Fewer respondents think that their research activities help increase the prestige of their department or university or provide them with an opportunity to develop new products.

Table: 4.53: Frequency Ratings on the Seven Views on Research

Research Views N=83	Not true	Quite un true	Fairly true	True	Very true	Total true/ very true	Mean
Advances knowledge	2	-	6	25	50	75	4.46
	2.4%	-	7.2%	30.1%	60.2%	90.3%	
Adds to reputation	-	-	9	20	54	74	4.54
	-	-	10.8%	24.1%	65.1%	89.2%	
Opportunity to present papers	1	1	12	15	54	69	4.45
	1.2%	1.2%	14.5%	18.1%	65.1%	83.2%	
Gives prestige & respect	4	2	11	23	43	66	4.19
	4.8%	2.4%	13.3%	27.7%	51.8%	79.5%	
Enhances career opportunity	-	-	19	17	47	64	4.34
	-		22.9%	20.5%	56.6%	77.1%	
Gives prestige to dept. & univ.	-	4	20	24	33	57	4.04
	-	4.8%	26.7%	28.9%	34.8%	63.7%	
Opportunity to develop products	-	4	29	18	32	50	3.94
	-	4.8%	34.9%	21.7%	38.6%	60.3%	

The results indicate that professional outcomes from research are more sought after by the academic engineers (advancing knowledge, scientific reputation, presenting results and earning self prestige and respect) than personal outcomes (enhancement of career prospects).

(b) Publication Output by Strength of Views on Research

Respondents' total publication productivity scores (5 categories) were cross-tabulated with their ratings on the seven research-view statements (5-point scale) in order to find out whether the variables are correlated The correlated results are displayed in Table 4.5). Total publications achieved is correlated (<0.05) to statements that research advances knowledge, gives prestige as well as respect to the individual, and gives prestige to the departments or universities an academic is affiliated to. Total publication is significantly correlated (<0.01) to two statements that research enhances career prospect and provide opportunities for academics to present papers at conferences. This result helps explain the publishing behaviour of academic engineers who wrote more conference papers (Table 4.5). Those who published more conference papers would give higher ratings to "opportunity to present papers", which would help "enhance career prospects".

Table 4.54: Correlation Values between Publication Scores and Views on Research

Spearman's rho (p)	Adds to reputation	Advances knowledge	Gives prestige & respect	Gives dept/univ prestige	Enhances career prospect	Opportunity develop products	Opportunity present papers
Total publications	.242*	.233*	.221*	.222*	.334**	166	.292**
Sig (2-tailed)	.027	.034	-.044	.043	.002	.134	.007

* Correlation is sig at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

Generally, academic engineers rated positively on the seven views on research and those who rated higher on some of the views also achieve higher publication productivity.

(c) Views on Research and Selected Personal and Academic Variables

Only the significant results will be shown.

Affiliation. There is a significant difference in respondents' ratings from the two universities with regard to the view that research provides an opportunity to present papers at conferences.

A higher percentage of academic engineers from UM (41 out of 44, 93.2%) agreed with this statement compared to those from UKM (28 out of 39, 71.8%) (r^2=13.778, df 4, p <0.01).

Department. Table 4.55a indicates the 7 views, which are related to the variable "department", and of these, only 2 are significant (<0.01).

Table 4.55a: Department and Views on Research

Variables	x^2	df	Critical x^2	Sig. (2 tailed)
Dept. & res. advances knowledge.	18.812**	6	12.592	**.004**
Dept. & res. adds to reputation	16.650	9	16.919	.054
Dept. & res. gives opportunity to present papers	23.148*	12	21.026	.026
Dept. & res. gives self-prestige & respect	41.807**	9	16.919	**.001**
Dept. & res. enhances career opportunity	15.021*	6	12.592	.020
Dept. & res. gives department & university prestige	7.159	9	16.919	.621
Dept. & res. gives opportunity to develop products	16.327	12	21.026	.177

* Sig at the .05 level (2-tailed) ** Significant at the .01 level (2-tailed)

Table 4.55b presents other correlated results.

Age. Those who are older agree that research adds to one's reputation, advances technological knowledge, and strongly feel (<0.01) that it helps enhance career opportunities, as well as provide them with an opportunity to present papers at conferences.

Working experience. Those who have longer working experience as academics agree that research advances knowledge, helps promote institutional prestige, and strongly agree (<0.01) that it enhances career opportunity as well as provides the opportunity to present papers at conferences.

Table 4.55b: Views on Research and Selected Demographic Variables

Spearman's rho (p)	Adds to reputation	Advances knowledge	Gives prestige & respect	Gives dept/univ prestige	Enhances career prospects	Opportunity to present papers
Age	223*	.245*	.128	.088	.421**	.355**
Sig (2-tailed)	.043	.026	.249	.429	.001	.001
Work experience	.184	.239*	.153	.235*	.326**	.292**
Sig (2-tailed)	.096	.030	.166	.032	.003	.007
Qualifications	.249*	.265*	.158	.279*	.357**	.247*
Sig (2-tailed)	.023	.015	.154	.011	.001	.024
Rank	.177	.251*	.074	.218*	.297**	.278*
Sig (2-tailed)	.110	.022	.507	.048	.006	.011
Time given to res.	.236*	.223*	.282*8	.265*	.209	-.045
Sig (2-tailed)	.032	.042	.010	.016	.058	.684

* Correlation is sig at the .05 level (2-tailed)** Correlation is significant at the .01 level (2-tailed)

Academic qualification & Academic rank. Those who possess Ph.Ds and have attained higher academic rank are more likely to agree that research adds to one's reputation, advances knowledge, improves institutional prestige, enhances career prospects and provides the opportunity to present papers at conferences.

Percentage of time allocated to research. Those who spend more time on research have positive views on research as adding to their reputation, helping advance knowledge, giving prestige to the researcher as well as to the institution he is attached to.

In general, the results indicate that academic engineers have very positive views on research and undertake research for intrinsic reasons (as shown in Table 4.53). This is consistent with the findings from other studies (Abu Hassan, 1978; Startup, 1979; Baldridge, 1978; Fox, 1992). Those with positive views on research are also older, with longer work experience, academically qualified (with Ph.D.) and are higher in academic rank. It is uncertain however, whether academics who are active publishers results in positive views on research or those with positive views results in higher research performance.

4.4.11. VIEWS ON DEPARTMENTAL ENVIRONMENT

Another attitudinal variable considered is respondents' views on their department as a suitable environment for research. Question K (2) sought respondents' views on seven departmental environment situations on a 5 point scale (not true to very true).

(a) Views on the Departmental Environment for Research

Table 4.56 indicates that about a third of the academic engineers rate fairly positive to views on the conduciveness of departmental environment for research. The two highest positive ratings are given to "read colleagues publications" (26, 31.3%), and "department arranges useful seminars" (26, 31.3%). Although academic engineers read their colleagues' publications, only 17 (20.5%) indicate that they discuss research matters with colleagues and only 14 (16.9%) feel that their colleagues encourage scholarly activities. In most views, the respondents tend to rate on the middle scale (3) implying that the majority of respondents has only a fairly positive attitude towards their department providing a conducive environment for research.

Table 4.56: Frequency Ratings on the Seven Views on Departmental Environment

Views on Departmental Environment (N=83)	Not true	Quite untrue	Quite true	True	Very true	Total true/ v.true	Mean
Read colleagues' publications	1 1.2%	19 22.9%	37 44.6%	24 28.9%	2 2.4%	26 31.3%	3.08
Dept. arranges useful seminars	9 10.8%	15 18.1%	33 39.8%	26 31.3%	- -	26 31.3%	2.92
Teaching/admin load does not deter research	7 8.4%	36 43.4%	18 21.7%	15 18.1%	7 8.4%	22 26.5%	2.75
Dept is highly research-oriented	3 3.6%	8 9.6%	51 61.4%	21 25.3%	- -	21 25.3%	3.08
Discuss research matters with colleagues	1 1.2%	12 14.5%	53 63.9%	15 18.1%	2 2.4%	17 20.5%	3.06
Colleagues are prolific writers	6 7.2%	8 9.6%	54 65.1%	15 18.1%	- -	15 18.1	2.94
Colleagues encourage scholarly activities	3 3.6%	24 28.9%	42 50.6%	13 15.7%	1 1.2%	14 16.9%	2.82

(b) Publication Productivity by Strength of Views on Departmental Environment

Total number of publications. The results indicate that, regardless of how the academic engineers view their department and colleagues (positively or negatively), their views are generally not related to their publication productivity.

(c) Views on Departmental Environment and Personal and Academic Variables

Departments. There are variations in departmental ratings by the four engineering departments. A higher percentage of chemical engineers (11 out of 16) rated "colleagues are prolific writers" as true (x^2=41.624, df. 9, p<0.01) and a higher percentage of the mechanical engineers rated "discuss research with colleagues" (11 out of 22) as either true or very true (x^2=27.700, df. 12, p<0.01). Between 40% and 50% of the civil and chemical engineers rated "department arranges useful seminars" as true (x^2=31.905, df. 9, p<0.01). Departmental variations are also found for ratings on "colleagues encourage scholarly activities" (x^2=33.836, df.12, p<0.01) and "teaching/ administration does not deter research" (x^2=31.964, df. 12, p<0.01).

Race. This variable is related to "the views that the department is highly research-oriented" (x^2=22.659, df. 9, p<0.01); "colleagues are prolific writers" (x^2=18.362, df. 9, p<0.05); "department arranges useful seminars" (x^2=31.905, df. 9, p<0.01); and "read colleague's publications" (x^2=27.397, df.12, p<0.01). In all these cases, a larger number of the Malay respondents rated positively on the departmental view statements.

Affiliation. A higher number of academic engineers from UKM (11 out of 39) rated "colleagues encourage scholarly activities" as either true or very true compared to those from UM (3 out of 44) (x^2=9.655, df.49, p<0.05). Similarly, a higher number of those from UKM (14 out of 39) rated "teaching/administration load does not deter research" as either true or very true compared to those from UM (8 out of 44) (x^2=9.763, df. 4, p<0.05).

In general, academic engineers indicate a fairly positive attitude towards their departments as a conducive environment for research. In all seven situations, the ratings converge on "true/very true" with the majority rating on "quite true". However, the attitude orientation of the ratings is not related respondents' total publication productivity.

4.4.12. VIEWS ON INSTITUTIONAL SUPPORT

Respondents' ratings on 8 statements about institutional environment (5-point scale - bad to excellent) would indicate their general attitude towards institutional support for research.

(a) Views on Institutional Support for Research

Table 4.57 indicates that there are wide variations in respondents' opinion on their institutional support. A very noticeable response is the high positive rating given to the "quality of computing facilities" which is rated as either good or excellent by 64 (77.1%) of the 83 respondents and achieve the highest mean of 3.78. About 34 (40.9%) respondents thought that institutional support for presenting papers at local conferences as either good or excellent and 20 (24.4%) rated the quality of library resources as good or excellent. Nearly 50% of respondents are not satisfied with the quality of research students and the laboratory assistants within their departments. Adequate startup support is rated as fair by more than 60% of respondents.

Table 4.57: Frequency Ratings on the Eight Views on Institutional Environment

Views on Institutional Environment N=83	Bad	Not good	Fair	Good	Excellent	Total good/ excellent	Mean
Quality of computing facilities	-	6 7.2%	13 15.7%	57 68.7%	7 8.4%	64 77.1%	3.78
Support for presenting papers locally	1 1.2%	9 10.8%	39 47.0%	31 37.3%	3 3.6	34 40.9%	3.31
Quality of library resources	- -	31 37.8	31 37.8%	19 23.2%	1 1.2%	20 24.4%	2.88
Provision of quality laboratories	- -	7 8.4%	58 69.9%	18 21.7%	- -	18 21.7%	3.13
Adequate startup support	2 2.4%	16 19.3%	52 62.7%	13 15.7%	- -	13 15.7%	2.92
Support for presenting papers abroad	10 12.0%	30 36.1%	32 38.6%	11 13.3%	- -	11 13.3%	2.53
Quality research students	9 10.8%	37 44.6%	31 37.3%	6 7.2%	-	6 7.2%	2.41
Quality lab. Assistants	9 10.8%	46 55.4%	23 27.7%	5 6.0%	-	5 6.0%	2.29

The results indicate that academic engineers from both UKM and UM acknowledge the adequacy of basic facilities such as the library and laboratories for research needs. However, the majority feel that startup support is inadequate, and the quality of future researchers in terms of research students is not satisfactory. About 80% are not satisfied with the support given to those who want to present their research results abroad.

(b) Publication Distribution by Views on Institutional Environment

The ratings on the institutional views were cross-tabulated with respondents' publication scores and tested for correlation. The total publication scores does not correlate with any of the ratings given to views on institutional support for research.

(c) Ratings on Institutional Support and Personal / Academic Variables

The ratings on the eight statements were cross-tabulated with selective personal and academic variables to find out whether there are any relationship. The significant results are displayed in Table 4.58.

Table 4.58: Views on Institutional Support for Research and Personal / Academic Variables

Variables	x^2	df	Critical x^2	Sig. (2 tailed)
Adequate startup support & affil.	11.124*	3	7.815	.011
	x^2	df	Critical x^2	Sig. (2 tailed)
Dept. & support for presenting papers locally	25.900*	12	21.026	.011
Dept. & support for presenting papers abroad	34.188**	9	16.919	.001
Dept. & quality laboratory support	19.500**	6	12.592	.003
Dept. & quality of library resources	18.736*	9	16.919	.028
Dept. & quality of computing facilities	27.146**	9	16.919	.001
	x^2	df	Critical x^2	Sig. (2 tailed)
Race & support for presenting papers abroad	17.641*	9	16.919	.040
Race & quality technical assistants	18.377*	9	16.919	.031
Race & quality of computing facilities	22.302**	9	16.919	.008

* Correlation is sig at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

Table 4.58 indicates that only the ratings on two statements are related to total publication productivity and these are respondents' departments and race. There are differences (<0.05) in the ratings among academics in the various departments concerning views about presenting papers locally and the quality of library resources (p <0.05), and significantly so (<0.01) about presenting papers abroad, the quality of laboratories and the quality of computing facilities.

Affiliation. The respondents' affiliation was related to ratings on the adequacy of financial startup support (x^2=11.124, df. 3, p <0.05). Respondents from UKM (35 out of 39) rated this support as fair or good compared to those from UM (30 out of 44).

Race. The variable race was related to two institutional support statements; presenting papers abroad (x^2=17.641, df. 9, p <0.05) and quality of computing services (x^2=22.302, df 6, p <0.01).

Age, Work experience and Qualifications. Cross-tabulation of the variables - age, work experience and academic qualifications with the 8 views on institutional support indicated only three correlated situations. Those who have longer years of working experience also rated very positively on institutional support to provide startup research support (ρ=.218, sig. <0.05). Those who are older in age and with Ph.D. rated positively the institutional support for presenting papers abroad (ρ=.225, sig. <0.05; ρ=.216, sig. <0.05 respectively).

The results indicate that while more than 70% of academic engineers are satisfied with the computing facilities provided for them, they are generally not happy with the other institutional support. Conference papers are the main channel for presenting or disseminating research results for this group, and adequate financial support for presenting papers at conferences locally or abroad is much needed. Only 40% of academic engineers rated positively regarding support for "presenting papers at local conferences" while 13% for "presenting papers abroad". This is especially true for the younger and less experience academics.

4.4.13. CHANNELS OF INFORMATION: FORMAL SOURCES USED

Questions L (1) asked the respondents to rate 13 formal channels, which they regard as useful in providing information, needed for their research. The aim is to find out whether the respondents' use of information sources for research is related to their publication productivity.

(a) Formal Channels: Frequency of Use for Research

Respondents generally rated positively on the 13 formal sources (Table 4.59). Journals obtain the highest mean score (4.59), which indicates that academic researchers unanimously agree on the importance of journals for research information. High mean scores are also indicated for conference proceedings (4.43) and research reports (4.31). Slightly above average scores (3) are indicated for sources such as books, the Internet, online/CD-ROM databases, and indexes/abstracts/ bibliographies. An average rating (2.5 and above) is indicated for sources such as standards/ specifications, library catalogues and patents. Below average mean scores (below 2.5) are given to bookstores, reference librarian, and the library's accessions list.

Table 4.59: Ratings on the Usefulness of Formal Channels for Research Information

	Useful, V. useful		Fairly useful		Both		Not useful, not used			
Formal channels (n=83)	**Count**	**%**	**Count**	**%**	**Total %**	**Rank**	**Count**	**%**	**Rank**	**Mean**
Journals	83	100.0			100.0	1				4.90
Conference proceedings	76	91.6	7	8.4	100.0	2				443
Research reports	66	79.5	17	20.5	100.0	3				4.31
Books	52	62.7	31	37.3	100.0	4				3.84
Internet	46	55.4	34	41.0	96.4	5	3	3.6	9	3.61
Online/CD-ROM database	46	55.5	29	34.9	90.4	6	8	9.6	8	3.53
Indexes/abstr./bibs	44	53.0	28	34.0	87.0	7	11	13.0	7	3.41
Standards	24	28.9	39	47	75.9	8	20	24.1	6	2.96
Library catalogues	19	22.9	38	45.8	68.7	9	26	31.3	5	2.76
Patents	12	14.4	37	44.6	59.0	10	34	41.0	4	2.59
Bookstores	11	13.0	18	22.0	39.8	11	50	60.2	3	2.20
Reference librarian	12	14.4	21	25.4	35.0	12	54	65.0	2	2.07
Library's accessions list	9	11.0	20	24.0	35.0	13	54	65.0	1	1.92

Journals are rated unanimously as either useful or very useful and are therefore ranked first among sources found useful for research followed by conference proceedings, research reports, books and the Internet. Library-related channels such as the library catalogues, the reference librarians and the library's accessions list are ranked 9th, 11th and 12th respectively. Only 19 respondents rated the library catalogue as useful or very useful and 26 rated it as not useful or not used. The reference librarian also performs poorly as only 12 rated this channel as useful or very useful, and 50 rated it as not useful or not used. Academic engineers indicated that the library's accessions list is not important for research as this channel received the lowest useful rating and 54 rated it as either not useful or not used. The results indicate that the engineering faculties do not find the services provided by their libraries or the intermediary information provider (the reference librarians) useful for their research needs. However, they did indicate sources which they might have used in the library or subscribed to themselves as useful. These include journals, conference proceedings and research reports. For libraries, these results indicate that indexes or guides to these three sources have proven to be useful in order to accommodate research needs. This means providing both commercially available indexes as well as developing special local indexes and bibliographies for local S & T research needs.

(b) Publication Distribution by Formal Channels Preferred

The respondents' rating scores on the 13 formal channels were cross-tabulated with the total of publication output and the correlated results are displayed in Table 4.60a.

Table 4.60a: Formal Channels Used and Publication Productivity

Spearman's rho (p)	Journals	Books	Research reports	Conference proceedings	Library catalogues	Reference librarian
Total pub.	.161	-.014	**.253***	**.271***	.078	.009
Sig (2-tailed)	.147	.903	**.021**	**.013**	.482	.935

* Correlation is significant at the 0.05 level ** Correlation is significant at the 0.01 level

Total number of publications is correlated to the ratings on 2 formal channels. Those placed in the high/very high total publication group, rated research reports (p=.253, sig. <0.05 level) and conference proceedings (p=.271, sig. <0.05 level) as either "useful" or "very useful" channel. (Table 4.60b and 4.60c).

Table 4.60b: Publication Productivity and Use of Research Reports

Research reports	Total Publications					
	Low/Min (1-10)		Aver (11-20)		High/v. high ≥ 21	
	Count	%	Count	%	Count	%
Fairly useful	10	28.6%	5	20.8%	2	8.3%
Useful	11	31.4%	6	25.0%	6	25.0%
Very useful	14	40.0%	13	54.2%	16	66.7%
Total	35	100.0%	24	100.0%	24	100.0%

p=.253, sig. <0.05 level

Table 4.60c: Total Publication Productivity and the Use of Conference Proceedings

Conference proceedings	Total Publications					
	Low/Min (1-10)		Aver (11-20)		High/v. high ≥ 21	
	Count	%	Count	%	Count	%
Fairly useful	5	14.3%	2	8.3%	-	-
Useful	18	51.4%	7	29.2%	8	33.3%
Very useful	12	34.3%	15	62.5%	16	66.7%
Total	35	100.0%	24	100.0%	24	100.0%

p=.271, sig. <0.05 level

(c) Formal Channels of Information and Departmental and Academic Variables

Affiliation, gender and race are not related to all 13 formal channels. The variable "department" is related to 5 formal channels: journals (<0.05), accessions list published by libraries (<0.01), standards and specifications (<0.01), and patents (<0.05). All the chemical and electrical engineers rated journals as very useful for obtaining information needed for research compared to 81.2% of civil and mechanical engineers. A higher proportion of chemical and mechanical engineers rated the library's accessions list as useful (fairly, useful or very useful) compared to the civil and electrical engineers (Table 4.61a).

Table 4.61a: Formal Information Channels and Research Publication Scores

	x^2	df	Crit. Value (0.05)	Sig. (2 tailed)
Dept & journals	7.847*	3	7.815	**.049**
Dept & library catalogues	**32.235****	12	21.026	**.001**
Dept & lib accession list	**26.430****	12	21.026	**.009**
Dept & standard/specific.	**45.329****	12	21.026	**.001**
Dept & patents	**27.854****	12	21.026	**.006**

* Significant at the 0.05 level (2-tailed) ** Significant at the 0.01 level (2-tailed)

Table 4.61b indicates that academic engineers above 40 years of age, who are higher in academic rank, possess Ph.D., and are experienced, perceive formal channels such as journals, research reports, conference proceedings, and indexes/abstracts as useful.

Table 4.61b: Selected Demographic Variables and Use of Formal Channels

Spearman's rho (p)	Journals	Research reports	Conference proceedings	Indexes/Abstracts
Age	.265*	..453**	541**	.297**
Sig. (2-tailed)	.015	.001	.001	.006
Work experience	.239*	.273*	.416**	.222*
Sig. (2-tailed)	.029	/013	.001	.044
Qualifications	.360*	.263*	.309**	.161
Sig. (2-tailed)	.001	.016	.004	.145
Rank	.298**	.475**	.457**	.354**
Sig. (2-tailed)	.006	.001	.001	.001

* Correlation is sig at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

3.14. CHANNELS OF INFORMATION: INFORMAL SOURCES USED

Questions L (2) ask the respondents to rate 8 informal channels with regard to usefulness in providing information needed for their research. The aim is to find out whether respondents' use of informal information sources is related to their publication productivity.

(a) Informal Channels: Frequency of Use for Research

Table 4.62 indicates the ratings observed for the eight informal channels of information.

Table 4.62: Ratings Given to the Eight Informal Channels

Informal channels	Useful, v. useful		Fairly useful		Both		Not useful, not used			Mean
	Count	%	Count	%	Total %	Rank	Count	%	Rank	
Discuss at conferences	59	71.1	23	27.7	98.8	1	1	1.2	8	3.89
E-mail colleagues	63	75.9	19	22.9	97.6	2	1	1.2	7	4.07
Dialogues with colleagues within department	49	59	26	31	90.0	3	8	10.0	6	3.59
Dialogues with colleagues from other departments	34	41.0	37	44.6	85.6	4	12	14.4	5	3229
Correspondence./letters	48	57.8	20	24.1	81.9	5	15	18.1	4	3.34
Telephone conversation	31	37.3	36	43.4	80.7	6	16	19.3	3	3.07
Fax coll.outside the univ.	41	49.4	17	20.5	69.9	7	25	30.1	2	3.10
Dialogues with coll. from outside the university	28	33.7	26	31.3	65.0	8	29	35.0	1	2.80

E-mailing colleagues is rated highly by most respondents, followed by discussions at conferences, dialogues with colleagues within the department, correspondence with co-researchers, faxing colleagues outside the university and conversations over the telephone.

The frequency and percentage of ratings given to the 8 informal channels indicated the importance given to discussion at conferences by academic engineers. Only 1 respondent rated this channel negatively. E-mailing colleagues ranked second with 81 respondents rating it as useful. The other channels found useful are dialogue with colleagues within the respective departments (ranked 3rd), dialogue with colleagues from other departments (ranked 4th), communicating through letters (ranked 5th) and telephones (ranked 6th). Communicating with colleagues from other universities either by faxing or conversation are used less as a means of obtaining information needed for research. About 30% of respondents rated these two channels as either not useful or not used.

(b) Publication Distribution by Informal Channels

The respondents' rating scores 1(not used) to 5 (very useful) were cross-tabulated with their total publication output and tested for correlation (Table 4.63). The total publication productivity is correlated to four informal channels. Those who achieved high publication scores indicated finding the following informal channels useful: dialogues with colleagues from other departments (p = .247, sig.< 0.05), dialogues with colleagues from other universities (p = .269, sig. < 0.05), discussion at conferences (p = .247, sig. < 0.05) and faxing colleagues located outside the university (p = .222, sig. <0.05).

Table 4.63: Informal Channel Ratings and Total / Types of Publications

Spearman's rho (p)	Corres-pondence/ letters	Telephone Conver-sation	E-mail colleagues	Dialogue/ Colleagues. within department	Dialogue / colleagues. from other department	Dialogue with colleagues outside the university	Discussion at conferences	Fax colleagues outside the university
Total pub.	.104	.084	-.029	.062	**.247***	**.269***	**.241***	**.222***
Sig. (2-tailed)	.060	.123	.521	.470	**.041**	**.051**	**.057**	**.016**

* Correlation is sig. at the 0.05 level (2-tailed) ** Correlation is sig. at the 0.01 level (2-tailed)

The results indicate that although respondents use e-mail frequently, this behaviour does not influence their research publication activity. It is discussions with co-researchers, either from other departments within the universities or from other universities that seem to be related positively to high research publication productivity. The likely types of publications that resulted from these discussions and dialogues are conference papers and journal articles.

(c) Informal Channels of Information and Selected Demographic Variables

Table 4.64a indicates that a higher number of civil and electrical engineers rated telephone conversation as useful /very useful (x^2=32.669, df. 12, p<0.05). Chemical and electrical engineers rated dialogue with colleagues from other universities as useful/very useful (x^2 = 27.639, df. 12, p<0.01) and a higher proportion of civil and electrical engineers rated faxing colleagues outside the university as a useful/very useful channel for research (x^2 = 27.185, df. 12, p<0.01) (Table 4.64a).

Table 4.64a: Publication Productivity and Respondent's Department

Variables	x^2	df	Crit. Value (0.05)	Sig (2 tailed)
Dept & telephone conversation	32.669**	12	21.026	.001
Dept & dialogue with coll. from other universities	27.639**	12	21.026	.006
Dept & fax colleagues outside universities	27.185**	12	21.026	.007

* significant at the 0.05 level (2-tailed) ** significant at the 0.01 level (2-tailed)

Age. Table 4.64b indicates that older academic engineers found correspondence / letters (p = 376, sig<0.00) and faxing colleagues outside the university (p=.235, sig<0.05) useful for research.

Table 4.64b: Informal Channels and Selected Demographic Variables

Spearman's rho (p)	Age	Work experience	Highest qualifications	Academic rank
Correspondence	376**	333**	.278*	.341**
Sig. (2-tailed)	.001	.002	.011	.002
Telephone conversation	228*	.115	.150	.222*
Sig. (2-tailed)	.038	.301	.175	.044
E-mailing colleagues	-.109	-.231*	-.232*	-.072
Sig. (2-tailed)	.329	.035	.035	.518
Dialogues with colleagues within department	-.065	-.208	.029	-.053
Sig. (2-tailed)	.559	.059	.794	.637
Dialogues with colleagues from other departments	.139	.229*	.209	.187
Sig. (2-tailes)	.210	.037	.057	.090
Dialogues with colleagues from other universities	.166	.282**	.261*	.233*
Sig. (2-tailed)	.133	.010	.017	.034
Discussion at conferences	.172	.232*	.203*	.323**
Sig. (2-tailed)	.120	.035	.066	.003
Fax colleagues outside the university	.235*	.287**	.125	.333**
Sig. (2-tailed)	.033	.009	.260	.002

* Correlation is sig. at the 0.05 level (2-tailed) ** Correlation is sig. at the 0.01 level (2-tailed)

Qualification. Academic engineers with Ph.Ds rated correspondence (p = .278, sig.< 0.05), e-mailing colleagues (p = .-232, sig.< 0.05), dialogue with colleagues outside the university (p = .261, sig.< 0.05), and discussion at conferences (p = .203, sig.< 0.05) as useful/very useful.

Working experience. Those with more years of working experience rated correspondence or letters (p = .333, sig.< 0.05), e-mailing colleagues (p = -.231, sig.< 0.05), dialogues with colleagues from other departments (p = .229, sig.< 0.05), dialogues with colleagues from other universities (p = .282, sig.< 0.05), discussion at conferences (p = .232, sig.< 0.05), and faxing colleagues outside the university (p = .287, sig.< 0.01) as useful/very useful.

Rank. The associate professors, and especially the professors, are more likely to rate these channels as useful: correspondence (p = .341, sig.< 0.01), dialogues with colleagues from other universities (p = .233, sig.< 0.05), discussion at conferences (p = .323, sig.< 0.01) and faxing colleagues outside the university (p = .333, sig.< 0.01).

The responses to the Likert scaled items indicated that even though academic engineers felt strongly about the usefulness of informal channels in obtaining information for research as indicated by the strong mean scores for most channels, this is not related to publication performance. Only four informal channels were found to be related to total publication scores, i.e. dialogue with colleagues from other departments within the same university, from other universities, discussion at conferences and faxing colleagues outside the university.

(d) Reasons for Choosing Channels Rated as Useful

The respondents were asked to tick in boxes, which was displayed alongside five reason statements. The results are indicated in Table 4.65. The highest count was obtained by "keeping me aware of new developments" (80, 96.4%), followed by "channels contained information needed" (79, 95.2%), and the "channels are authoritative, accurate, objective" (68, 81.9%). Very few chose reasons such as, "nearest at hand or accessible" (27, 32.5%), "free and inexpensive" (14, 16.9%) and "easy to use" (5, 6.0%). Academic engineers prefer information channels which: are current and keeps them aware of new developments in their research areas; contain relevant, accurate, reliable and authoritative information. Other factors, such as proximity, cost, and ease of use seem to be less important to the respondents.

Table 4.65: Reasons for Choosing Information Channels as Useful or Very Useful

Reasons	Counts	%	Missing	%	Total	Rank
Keeps aware of new developments	81	98.0%	2	2.0%	83	1
Contain information needed	79	95.2%	4	4.8%	83	2
Authoritative, accurate, objective	68	81.9%	15	18.1%	83	3
Nearest at hand/accessible	27	32.5%	56	67.5%	83	4
Free/inexpensive	14	16.9%	69	83.1%	83	5
Easy to use	5	6.0%	78	94.0%	83	6

4.4.15. METHODS USED TO KEEP ABREAST OF REASEARCH INFORMATION

The method used to keep abreast of research information should reflect the ability of respondents to effectively identify and use sources. This behaviour should indirectly stimulate research and result in better publication productivity. This section describes: (a) the methods preferred by respondents to keep abreast of current research information; (b) the frequency counts according to the rating scales given, and (c) the cross-tabulation of respondents' rating on the methods used to keep abreast and their publication productivity.

(a) Methods Used to Keep Abreast

Table 4.66 presents the rating that academic engineers give to 11 methods used to keep abreast of research information. Respondents generally keep abreast mainly by attending conferences and professional meetings (mean of 4.24) and browsing current periodical shelves (mean 4.02).

Table 4.66: Ratings Given to the Methods Used to Keep Abreast

	Useful, v.useful			Fairly useful			Not useful, not used			
Methods used to keep abreast	**Count**	**%**	**Rank**	**Count**	**%**	**Rank**	**Count**	**%**	**Rank**	**Mean**
Attend conferences /meetings	72	86.7	1	11	13.3	8				4.24
Browse current periodical shelves	68	81.9	2	11	13.3	9	4	4.8	9	4.02
Subscribe to journals	63	76.0	3	9	10.8	11	11	13.2	7	3.90
Browse Abstracts/ indexes in the field	44	53.0	4	37	44.6	4	2	2.4	10	3.52
Contact with those in the same field	30	36.1	5	37	44.6	5	16	19.3	5	3.08
Talk to colleagues within the departments	29	35.0	6	46	55.4	2	8	9.6	8	3.18
Browse special biblio-graphies in subject area	18	22.0	7	40	48.0	3	25	30.0	4	2.61
Browse Internet for information	14	16.9	8	56	67.5	1	13	15.6	6	2.90
Publishers' catalogues	10	12.0	9	19	23.0	7	54	65.0	3	1.89
Browse online catalogues	2	2.4	10	20	24.1	6	61	73.5	2	1.60
Browse library's accessions lists	2	2.4	11	10	12.0	10	7.1	85.6	1	1.31

Other methods rated highly (mean above 3) to keep abreast of current literature are subscribing to journals, browsing abstracts and indexes in their field of research, talking to colleagues within their department , and contacting others working in the same field. The methods that academic engineers indicated as not useful are: publishers' catalogues and the library's accessions lists. The frequency counts for the various categories indicate that the majority of respondents rated attending conferences and professional meetings as useful or very useful (72, 86.7%) in keeping abreast of research information. The use of channels provided by the libraries, such as browsing online catalogues (2.4%) and the library's accessions lists (2.4%), is very discouraging as a considerable amount of time and effort is often invested to provide such services. The majority of respondents (73.5% and 85.5% respectively) found these methods either not useful or not used.

(b) Publication Productivity and Preferred Methods of Keeping Abreast

Respondents' ratings on the 11 methods of keeping abreast on a five-point scale (not used to very useful) were cross-tabulated with their publication scores to find out whether the methods preferred are related to respondents' publication output. Table 4.67(a) to (k) display the publication distribution according to ratings given to the 11 methods used to keep abreast of research information. There are similarities in the publication scores on the three types of rating scales (useful/very useful; fairly useful; not use/not useful).

Table 4.67: Publication Distribution by Ratings on Methods Used to Keep Abreast

(a)	Subscribe to journals					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	2	18.2%	1	11.1%	8	12.7%
Min /Ave (6-20)	6	54.5%	5	55.6%	37	58.7%
High/V.High (21 above)	3	27.3%	3	33.3%	18	28.6%
Total	11	100.0%	9	100.0%	83	100.0

(b)	Browse library's accessions list					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	10	14.1%	1	10.0%		
Min /Ave (6-20)	42	59.2%	4	40.0%	2	100.0%
High/V.High (21 above)	19	26.8%	5	50.0%		
Total	71	100.0%	10	100.0%	2	100.0

(c)	Browse current periodicals' shelves					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)			3	27.3%	8	11.8%
Min /Ave (6-20)	3	75.0%	3	27.3%	42	61.8%
High/V.High (21 above)	1	25.0%	5	45.5%	18	26.5%
Total	4	100.0%	11	100.0%	68	100.0%

Table 4.67 (continues

(d)	Browse abstracts/indexing publications					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)			7	18.9%	4	9.1%
Min /Ave (6-20)	2	100.0%	23	62.2%	23	52.3%
High/V.High (21 above)			7	18.9%	17	38.6%
Total	2	100.0%	37	100.0%	44	100.0%
(e)	Browse through special bibliographies					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	3	12.0%	6	15.0%	2	11.1%
Min /Ave (6-20)	14	56.0%	22	55.0%	12	66.7%
High/V.High (21 above)	8	32.0%	12	30.0%	4	22..2%
Total	25	100.0%	40	100.0%	18	100.0%
(f)	Browse library's online catalogue periodically					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	8	13.1%	3	15.0%		
Min /Ave (6-20)	34	55.7%	12	60.0%	2	100.0%
High/V.High (21 above)	19	31.1%	5	25.0%		
Total	61	100.0%	20	100.0%	2	100.0%
(g)	Look at publishers' / booksellers' catalogues					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	3	5.6%	6	31.6%	2	20.0%
Min /Ave (6-20)	36	66.7%	8	42.1%	4	40.0%
High/V.High (21 above)	15	27.8%	5	26.3%	4	40.0%
Total	54	100.0%	19	100.0%	10	100.0%
(h)	Browse Internet for information sources					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	1	7.7%	7	12.5%	3	21.4%
Min /Ave (6-20)	9	69.2%	33	58.9%	6	42.9%
High/V.High (21 above)	3	23.1%	16	28.6%	5	35.7%
Total	13	100.0%	56	100.0%	14	100.0%
(i)	Contacts others working in the same field					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	2	12.5%	4	10.8%	5	16.7%
Min /Ave (6-20)	8	50.0%	24	64.9%	16	53.3%
High/V.High (21 above)	6	37.5%	9	24.3%	9	30.0%
Total	16	100.0%	37	100.0%	30	100.0%
(j)	Attend conferences/professional meetings					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)			3	27.3%	8	11.1%
Min /Ave (6-20)			4	36.4%	44	61.1%
High/V.High (21 above)			4	36.4%	20	27.8%
Total			11	100.0%	72	100.0%
(k)	Talk to colleagues within the department					
	Not used/not useful		Fairly useful		Useful/very useful	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	2	25.0%	5	10.9%	4	13.8%
Min /Ave (6-20)	1	12.5%	28	60.9%	19	65.5%
High/V.High (21 above)	5	62.5%	13	28.3%	6	20.7%
Total	8	100.0%	46	100.0%	29	100.0%

The results indicate that the total publication scores are not correlated to all the 11 types of method employed to keep abreast of research information. In general, Although respondents unanimously rated attending conferences/professional meetings, browsing current periodicals shelves and subscribing to journals as important means of keeping abreast of current research, these methods is not related to their publication productivity.

Inter-method correlation. Correlation tests amongst the 11 channels indicated that those who rated highly on subscribing to journals to keep abreast of current research, also rated positively on attendance at conferences and meetings (Table 4.68). Those who rated highly on browsing library's accessions list also tend to rate highly on other library related sources for keeping abreast such as browsing special subject bibliographies, and other non-library related methods such as looking at publishers' catalogues, contacting others in similar field of research and browsing for information in the Internet. Those who rated positively on contacting those in the same field of study to keep abreast also rated highly on talking to colleagues within their own departments.

The results from Table 4.68 also indicate the academic engineers' preferences for the types of methods to keep themselves abreast of current information.

Table 4.68: Methods of Keeping Abreast of New Developments in Research

Spearman rho (p)	Subscribe journals	Browse library's accessions lists	Browse current periodical shelves	Browse abstracts/ indexes/ bibliographies	Browse special biblio-graphies	Browse library's online catalogues
Browse library's accessions lists	.003	1.000	-.202	.676	**.236*** **.032**	.161
Browse abstracts/ indexes/ bibliographies	-.066	.076	.180	1.000	**.225*** **.041**	084
Browse special bibliographies	.076	.236	-.189	**.225*** **.041**	1.000	.165
Browse publishers' catalogues	-.011	**.252*** **.022**	-.209	.035	-.060	.158
Browse internet for information	-.057	**.228*** **.038**	-.136	.030	.135	.076
Contact those in same research field	-.007	**.304**** **.005**	.133	-.022	.157	-.074
Attend conferences/ meetings	**.310**** **.004**	.166	**.286**** **.009**	.069	.035	.185

* Correlation is sig at the 0.05 level (2-tailed) ** Correlation is sig. at the 0.01 level (2-tailed)

Table 4.68 (contd): Methods of Keeping Abreast of Research Information

Spearman rho (p)	Publishers' catalogues	Browse the Internet for information	Contact those in the same field	Attend conf/ meetings	Talk to colleagues within dept.
Subscribe to journals	-.011	-.052	-.007	**.310**** **.004**	-.652
Browse library's accessions lists	.252* .022	**.220*** **.038**	**.304**** **.005**	.166	-.006
Browse current periodicals shelves	-.209	-.136	-.133	**.286**** **.009**	.065
Browse publisher's catalogues	1.000	**.248*** **.024**	.180	-.097	.123
Browse Internet for information	**.248*** **.024**	1.000	.150	-.082	.165
Contact those in same field of research	.100	.50	1.000	-.027	**.363**** **.001**
Talk to colleagues within dept	.123	.165	**.363**** **.001**	.085	1.000

* Correlation is sig at the 0.05 level (2-tailed) ** Correlation is sig. at the 0.01 level (2-tailed)

These include attending conferences and professional meetings, browsing current periodical shelves and subscribing to journals. These findings has implications for library service providers. Firstly, there is a need to provide and process current periodicals rapidly to accommodate this "browsing" behaviour amongst the respondents, and secondly, to view cutbacks on periodical subscription cautiously. If the mission of the university is to provide for excellent research needs, then the subscription to mainstream as well as relevant periodicals must be maintained either in print or electronic versions, since research information needs are heavily dependent on the use of periodical literature. There is also the need to provide relevant abstracts and indexes in the engineering field which respondents find useful in keeping themselves abreast of current research. Instead of publishing the accessions list that most respondents did not find useful, libraries should perhaps focus on providing special bibliographies in areas of engineering which faculty members are researching. This might involve special efforts, such as downloading the relevant sources from online databases and repackaging this into special bibliographical listings. This might also be supplemented with current content services of engineering journals subscribed to by the library.

(c) Methods of Keeping Abreast and Departmental and Academic Variables

The significant results of cross tabulating respondents' affiliation, departments, gender and race with ratings on the 11 methods used to keep abreast, are displayed in Table 4.69

Table 4.69: Methods of Keeping Abreast and Selected Personal / Academic Variables

Variables	x^2	df	Crit. Value (0.05)	Sig (2 tailed)
Affil. & browse publisher's catalogues	8.779*	2	5.991	.012
Dept. & browse current period shelves	21.934**	6	12.592	.001
Dept. & browse Internet	14.759*	6	12.592	.022
Dept. & contact those in same field	16.584*	6	12.592	.011
Dept. & attend conferences / meetings	10.492*	3	7.815	.015

* significant at the 0.05 level (2-tailed) ** significant at the 0.01 level (2-tailed)

Affiliation. More respondents from UM rated publishers' catalogues as useful/very useful (8) compared to those from UKM (2) (x^2 =8.779, df. 2, $p<0.05$).

Department. Academics from the four engineering departments indicated differences in their ratings on four methods, of which one is significant at the 0.01 level. These methods are: browsing current periodical shelves (x^2 =21.934, df. 6, $p<0.01$); browsing the Internet for information (x^2 =14.759, df. 6, $p<0.05$); contacting those doing research in the same field (x^2 =16.584, df. 6, $p<0.05$); and attending professional conferences and meetings (x^2=10.492, df. 3, $p<0.05$).

Working experience. The academic engineers who are more experienced professionally rated highly on subscribing journals to keep abreast (ρ =258, sig. <0.05).

Academic rank. Professors and associate professors rated positively on subscribing to journals to keep abreast of research information (ρ =258, sig. <0.05).

Respondents' age, qualifications and percentage of time spent on research, are not related to methods used to keep abreast of research information.

(d) Channels Academic Engineers Used to Disseminate Research Results

Academic engineers were asked to rank the three channels they prefer to disseminate their research results from among 10 channels listed. Table 4.70 displays the results.

Channels ranked first. The channel that is ranked first by the highest number of respondents, is publishing articles in foreign refereed journals (67.5%). Publishing in proceedings (30.1%), oral presentation at conference (9.6%) and articles in local refereed journals (7.2%) follow this.

Channels ranked second. The four top channels ranked second are: conference proceedings (57.8%), oral presentation at conferences and publishing articles in foreign refereed journals (16.9% each), and articles in local refereed journals (14.5%).

Table 4.70: Channels Academic Engineers Used to Disseminate Research Results

Channels	Rank 1 (out of 83)	Rank 2 (out of 83)	Rank 3 (out of 83)	Total (out of 83
Articles in foreign refereed journals	56 67.5%	14 16.9%	5 6.0%	75 90.4%
Published proceedings	25 30.1%	48 57.8%	9 10.8%	82 98.8%
Oral presentation	8 9.6%	14 16.9%	38 45.8%	60 72.3%
Articles in refereed local journals	6 7.2%	12 14.5%	54 65.1%	72 86.7%
E-mail colleagues	-	2 2.4%	2 2.4%	4 4.8%
Preprints	-	1 1.2%	4 4.8%	5 6.0%
Deposit a copy at the library	-	-	2 2.4%	2 2.4%
Reprints	-	-	-	-
Letter/correspondence to colleagues	-	-	-	-

Channels ranked third. The channels ranked third are: articles in refereed local journals (65.1%), oral presentation at conferences (45.8%), published proceedings (10.8%), and articles in foreign refereed journals (6.0%).

The three methods most preferred by academic engineers are publishing their work in foreign-refereed journals, publishing in proceedings and submitting to local refereed journals.

4.4.16. PROBLEMS RELATING TO ACADEMIC RESEARCH PUBLICATIONS

This section investigates possible problems relating to academic research publications to ascertain the extent of its relation to publication productivity. Two aspects are considered: (1) problems in publishing research communication and (2) problems in obtaining information needed for research.

(a) Problems in Publishing Research

Eight possible problems were listed and respondents were asked to rate on a 5-point scale the degree of seriousness they perceived in communicating the research results. For ease of display, and discussion the 5-point scale is collapsed into 3 categories: serious problems, quite a problem, not a problem.

More that 70% of respondents did not regard technical writing skills, confidence of writing in English and home environment as problems in their research communication (Table 4.71). About 60% indicated that they do not lack the courage to write and know where to send their articles for publication. Factors that respondents considered as problematic (whether serious or quite problematic) were the poor frequency of local journals, few local scholarly journals available as avenues for their publications, and more than 70% admitted that they found difficulty in getting articles published abroad.

Table 4.71: Respondents' Rating on Problems of Communicating Research Results (N=83)

Possible problems N=83	Serious problem	Quite a problem	Not a problem	Mean
Technical writing skills	3 3.6%	15 18.1%	65 78.3%	2.75
Home environment	4 4.8%	14 16.9%	64 77.1%	2.73
Confidence/writing in English	1 1.2%	22 26.5%	60 72.3%	2.71
Do not know where to send	-	33 39.8%	50 60.2%	2.60
Courage to write	5 6.0%	24 28.9%	54 65.1%	2.59
Few local scholarly journals	9 10.8%	37 44.6%	37 44.6%	2.34
Difficult to publish abroad	11 13.3%	50 60.2%	22 26.5%	2.13
Poor frequency of local journals	17 20.5%	57 68.7%	9 10.8%	1.90

(b) Research Publications and Problems in Writing

Table 4.72 presents a summary of the cross-tabulated results between the ratings on the 8 publishing problems and respondents' total publication productivity scores.

Table 4.72: Publication Distribution by Types of Problems Affecting Research Communication

(a)	Technical writing skills					
	Serious problem		Quite a problem		Not a problem	
Publication Categories	Count	%	Count	%	Count	%
Low(1-5)	1	33.3	3	20.0	7	10.8
Min /Ave (6-20)	2	66.7	10	66.7	36	55.4
High/V.High (21 above)			2	13.3	22	33.8
Total	3	100.0	15	100.0	65	100.0
(b)	Courage to write					
	Serious problem		Quite a problem		Not a problem	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	1	20.0	5	20.8	5	9.3
Min /Ave (6-20)	4	80.0	15	62.5	29	53.7
High/V.High (21 above)			4	16.7	20	37.0
Total	5	100.0	24	100.0	54	100.0

(c)	Confidence in writing in English					
	Serious problem		Quite a problem		Not a problem	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)			5	22.7	6	10.0
Min /Ave (6-20)	1	100.0	15	68.2	32	53.3
High/V.High (21 above)			2	9.1	22	36.7
Total	1	100.0	22	100.0	60	100.0
(d)	Few local scholarly journals					
	Serious problem		Quite a problem		Not a problem	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	1	11.1	5	13.5	5	13.5
Min /Ave (6-20)	5	55.6	23	62.2	20	54.1
High/V.High (21 above)	3	33.3	9	24.3	12	32.4
Total	9	100.0	37	100.0	37	100.0
(e)	Poor frequency of local scholarly journals					
	Serious problem		Quite a problem		Not a problem	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	2	11.8	7	12.3	2	22.2
Min /Ave (6-20)	10	58.8	36	63.2	2	22.2
High/V.High (21 above)	5	29.4	14	24.6	5	55.6
Total	17	100.0	57	100.0	9	100.0
(f)	Do not know where to send articles					
	Serious problem		Quite a problem		Not a problem	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)			5	15.2	6	12.0
Min /Ave (6-20)			23	69.7	25	50.0
High/V.High (21 above)			5	15.2	19	38.0
Total			33	100.0	50	100.0
(g)	Home environment					
	Serious problem		Quite a problem		Not a problem	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	1	25.0	4	28.6	6	9.4
Min /Ave (6-20)	2	50.0	7	50.0	38	59.4
High/V.High (21 above)	1	25.0	3	21.4	20	31.3
Total	4	100.0	14	100.0	64	100.0
(h)	Difficulty in getting articles published abroad					
	Serious problem		Quite a problem		Not a problem	
Publication Categories	Count	%	Count	%	Count	%
Low (1-5)	1	9.1	5	10.0	5	22.7
Min /Ave (6-20)	8	72.7	31	62.0	9	40.9
High/V.High (21 above)	2	18.2	14	28.0	8	36.4
Total	11	100.0	50	100.0	22	100.0

In most cases, academic engineers who indicated having no problem on the 8 statements were mostly average to high publishers. The ratings on the eight factors were cross-tabulated with respondents' categorised total publication scores and tested for correlation. The correlated results are displayed in Table 4.73a.

Table 4.73a: Publishing Problems and Research Publications Output

Spearman's rho (p)	Technical writing Skills	Courage to write	Confident writing English	Few local scholarly journals	Poor frequency of local journals	Don't know where to send	Home environ-memt	Prob. in publishing abroad
Total pub.	.308**	.346**	.362**	.084	.091	.279*	.245*	.077
Sig. (2-tailed)	.005	.001	.001	.452	.413	.011	.026	.490

*Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed)

Five problem situations were found to correlate with total publication scores, three of which are significant at the 0.01 level. Those who achieved high total publication scores are those who are more confident of their technical writing skills (ρ=368, sig. < 0.01); are brave in writing research papers (ρ=346, sig. < 0.01); are confident in writing in the English language (ρ=362, sig.<0.01); know where to send articles for publication (ρ=279, sig. <0.05) and regard their home environment as non-problematic (ρ=245, sig. <0.05).

(c) Problematic Research Situations and Selected Demographic Variables

Departments: The rating of academic engineers from the four departments indicates differences in three problem situations: the availability of few locally published scholarly journals (x^2= 13.991, df, 6, p<0.051), the poor publication frequency of these journals (x^2= 15.343, df, 6, p<0.05)and not knowing where to send articles for publication (x^2=9.922, df, 3, p<0.05) (Table 4.73b).

Table 4.73b: Research Publication Problem Situations and Selected Demographic Variables.

Problems	x^2	df	crit. x^2(0.05)	Sig.
Dept. & few local scholarly journals available	13.991*	6	12.592	.030
Dept. & poor frequency of local scholarly journals	15.343*	6	12.592	.018
Dept. & do not know where to send articles for publication	9.922*	3	7.815	.019

***Age*:** The older academic engineers (51 years and above) have significantly (<0.01) higher level of confidence in communicating research results, are more confident of their technical writing skills, have more courage to write, are confident in writing in the English language, and are not deterred by the few local scholarly journals.

Table 4.73c: Ratings on Problem Situations and Selected Demographic Variables

Spearman's rho (p)	Technical writing Skills	Courage to write	Confident writing English	Few local scholarly journals	Poor frequency of local journals	Don't know where to send	Home environ -memt	Prob. In publishing abroad
Age	**.368****	**348****	**.342****	**.211****	.171	.179	**.219***	-.057
Sig (2-tailed)	**.001**	**.001**	**.002**	**.050**	.121	.106	**.048**	.606
Work experience	**.337****	**.298****	**.399****	.059	.037	**.254***	.168	.052
Sig. (2-tailed)	**.002**	**.006**	**.001**	.597	.739	**.020**	.131	.641
Highest qualif.	**.408****	**.260***	**.336****	.024	-.045	**.277***	.057	.187
Sig (2-tailed)	**.001**	**.017**	**.002**	.826	.687	**.011**	.610	.090
Academic rank	**.417****	**.376***	**.456****	.129	.196	**.388***	.161	.136
Sig (2-tailed)	**.001**	**.001**	**.001**	.244	.076	**.001**	.142	.221
Percent time on res.	.091	.150	.121	**-.231***	**-.301****	.063	.060	.094
Sig (2-tailed)	.411	.176	.275	**.036**	**.006**	.572	.593	.397

*Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed)

A higher number of respondents in the younger age group indicated "technical writing skills", "courage to write" and "confidence in writing in English" as serious or quite problematic.

Working experience. Academic engineers who are more experience professionally (11 or more years) indicated that they have no problems in technical writing (ρ=337, sig. <0.01), have the courage to write (ρ=298, sig. <0.01), are confident in writing in the English language (ρ=.399, sig. <0.01), and know where to send articles for publication (ρ=254, sig. <0.05). Those with less experience have less than 10 years of working experience indicated "not knowing where to send their articles for publication" as quite a problem.

Qualification. The cross-tabulated data indicated that 45 to 49 out of 54 respondents with Ph.Ds significantly indicated "technical writing skills" (ρ=408, sig. <0.01) and "confidence in writing in English" (ρ=336, sig. <0.01) are not a problem compared to those with the Masters degree. Those with Ph.Ds also indicated less problem in having the courage to write (ρ=260, sig. <0.05),) and not knowing where to send articles for publications (ρ=277, sig. <0.05).

Rank. All professors (n=8), and 30 out of 31 associate professors, rated "technical writing skills" as not a problem compared to lecturers (27 out 44) (ρ=417, sig. <0.01). The situation is somewhat similar for "courage to write" (ρ=376, sig. <0.01), "confidence in writing in English" (ρ=456, sig. <0.01) and "don't know where to send articles" (ρ=388, sig. <0.01).

Percentage of time spent on research. Academic engineers who allocated 41 per cent of their time on research indicated that the few local scholarly journals (ρ=-.231, sig. <0.05) and their poor frequency (ρ=-.301, sig. <0.01) pose a problem for them to publish their research articles.

The results generally indicate that the variables - age, rank, working experience and qualifications are related to the confidence level of academic engineers in undertaking research writing, writing in their second language that is English, and knowing where to send written research results for publication.

(d) Problems in Obtaining Information Needed for Research

Throughout the research activity, the need for information may vary depending on the stage of the research. Gupta (1993) identified six information need situations, ranging from initial stage of searching for literature to making results public. At all stages, not obtaining the right and relevant information at the right time is detrimental to the success of the research. This section aims to find out respondents' perception of the problems they faced when trying to obtain information needed for their research. Focus is given to formal sources and services offered by the information centres or libraries. A total of 15 problem situations were listed and respondents are asked to give their ratings on a scale from 1 to 4 on whether each situation was applicable to them most of the time or rarely. Table 4.74 presents the results.

Table 4.74: Ratings on Problem Situations in Obtaining Information for Research

Problems	Not applicable	Most of the time	Occa-sionally	Rarely or never	Mean
Don't know where to look for information	8	4	29	42	3.27
Cannot find relevant Information	6	7	43	27	3.10
Don't know how to search CD/ROM online databases	20	1	16	46	3.06
Don't know how to choose relevant databases	17	3	22	41	3.05
Inadequate photocopying services	4	9	52	18	3.01
Receive information too late	10	6	59	8	2.78
No help in finding information	11	9	51	12	2.77
Colleagues not helpful in providing materials wanted	21	11	40	11	2.49
Library books are outdated	4	37	42	-	2.46
No time to look for information	3	47	25	7	2.44
Too much irrelevant information from the library	36	4	24	19	2.31
Cannot find wanted books on the shelves	3	54	24	2	2.30
Delay in journal arrivals	3	57	23	-	2.24
Insufficient funds to order articles from abroad	6	53	21	2	2.23
Professional librarian not willing to perform searches	40	8	24	10	2.05

The occasional problems faced by the respondents are "receive information too late"; "inadequate photocopying services"; "no help in finding information"; "cannot find relevant information" ; "library books are outdated" and "colleagues not helpful in providing materials wanted".

The situations that respondents indicated to be problematic most of the time are; delay in journal arrivals, cannot find wanted books on the shelves, insufficient funds to order articles from abroad, no time to look for information and library books are outdated. The engineers rarely have problems in knowing where to look for information, choosing relevant databases, and searching CD/ROM online databases. They hardly approach professional librarians help when searching for information.

(e) Publication Productivity and Research Problem Ratings

The ratings on the 15 problem situations (1 to 4) were cross-tabulated with respondents' categorised publication scores (1 to 5) in terms of total and types of publications and tested for correlation. Only the correlated results are indicated in Table 4.75a. The scores on the total number publications are negatively related to one research information problem statement, that is, "colleagues are not helpful in providing materials needed" (ρ=-.242, sig. < 0.05). A high and very high publication groups rated their colleagues as rarely helpful most of the time (5 out of 11). Alternatively, a higher proportion of those who are placed in the low and minimum group rated this situation as not problematic (6 out of 11).

Table 4.75a: Research Problem Situations and Respondent's Publications Output

Spearman's rho (p)	Library books outdated	Delay in journal arrivals	No help in finding infor.	Don't know where to look for infor.	Cannot find relevant infor.	Receive infor. too late	Inadequate photocopy-ing services	No time to look for infor.
Research rep. Sig (2-tailed)	-.174 .217	**-.278*** **.046**	-.146 .302	-.142 .314	.024 .869	-.167 .236	**-.280*** **.045**	-.144 .309

Spearman's rho (p)	Don't know how to choose relev. databases	Too much irrelevant infor from librarian	Librarian not willing to perform searches	Cannot find wanted books from shelves	Colleagues not helpful in providing mat. wanted	Insufficient funds to order articles from abroad	Do not know how to search CD-ROM db.
Total pub. Sig (2-tailed)	.085 .446	-.144 .195	-.037 .743	.084 .448	**-.242*** **.027**	.007 .950	-.069 .537

*Correlation is significant at the 0.05 level (2-tailed)

The results indicate that those who reported the library books are outdated, also regarded delay in journal arrivals, and not having the time to look for information, as not a problem. Those who know where to obtain information also rated positively on nearly all situations as rarely or never giving them problems. Respondents' ratings on the 15 variables are independent of their achieved publication scores.

(f) Rating on Problem Situations and Selected Demographic Variables

Departments. Table 4.75b indicates that there are significant variations (<0.01)in the ratings given academic engineers from the various departments on "books are outdated", "cannot find relevant information" and "no time to look for information". Variations (<0.05) are also indicated on ratings for "delay in journal arrivals", "do not know where to look for information", "receive information too late", "inadequate photocopying services", "do not know how to choose databases", "do not know how to search CD-ROM / online database services", "too much irrelevant information from the library", "colleagues are not helpful in providing needed information", and "insufficient funds to order articles from abroad".

Table 4.75b: Problem Situations and Selected Demographic Variables

Problems	x^2	df	crit. x^2	Sig.
Dept. & Library books outdated	27.250**	6	12.592	.001
Dept. & Delay in journal arrivals	13.659*	6	12.592	.034
Dept. & Don't know where to look for information	18.949*	9	16.919	.026
Dept. & Cannot find relevant information	21.713**	9	16.919	.010
Dept. & Received information too late	17.497*	9	16.919	.041
Dept. & Inadequate photocopying services	17.272*	9	16.919	.045
Dept & No time to look for information	36.527**	9	16.919	.001
Dept. & Don't know how to choose relevant databases	26.033**	9	16.919	.002
Dept. & Don't know how to search CD/ROM online databases	21.989**	9	16.919	.009
Dept. & Too much irrelevant information from the library	23.994**	9	16.919	.004
Dept. & Colleagues not helpful in providing materials wanted	25.559**	9	16.919	.002
Dept. & Insufficient funds to order articles from abroad	20.393**	9	16.919	.016

* Correlation is sig. at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

Age. Older academic engineers significantly (ρ =427, sig.< 0.01) indicate no problem to finding relevant information (Table 4.75c). They also indicate no problem in looking for information (ρ =254, sig.< 0.05),

Working Experience. The only problem situation that is significantly related to respondent's length of working experience is, "cannot find relevant information" (ρ =387, sig.< 0.01). Those with 10 or less years of working experience tend to find this situation problematic occasionally and 7 from this group rate this situation as giving them problems most of the time. A higher number of those with 11 or more years of working experience rarely or never find this situation problematic.

Table 4.75c: Rating on 15 Problem Situations and Selected Ordinal Demographic Variables

Spearman's rho (ρ)	Age	Working experience	Highest qualification	Academic Rank	Percent time on research
Don't know where to look for information	.254*	.069	.038	.240*	.035
Sig (2-tailed)	.021			.029	
Cannot find relevant information	.427**	.387**	.332**	.498**	.065
Sig (2-tailed)	.001	.001	.002	.001	

*Correlation is significant at the 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed)

Academic Qualification. A larger number of respondents with Masters degree reported not finding relevant information occasionally a problem (ρ =332, sig.< 0.01). The Ph.D. holders seem to be more competent in finding relevant information as they rarely or never found this situation a problem.

Academic rank. Lecturers (n=7) indicate not knowing where to look for information (ρ =240, sig.< 0.05) and cannot find relevant information (ρ =498, sig.< 0.01) as problematic situations most of the time. This situation arise because of lecturers' inexperience as researchers.

In summary, the results indicate that academic engineers' perceptions of their writing competency and the availability of channels to publish locally or abroad is not related to their publication performance. The highly productive academic engineers depended less on their colleagues compared to their less productive colleagues. This may be due to the probability that they have an already established network of research team members on which they depend upon to communicate research ideas.

4.5. HYPOTHESES TESTING

This section reports the results from testing the ten null hypotheses formulated in Chapter 1. The hypotheses take a "null" stand because, firstly, previous studies have reported results that are sometimes non-conclusive, and secondly, it is not possible to assume that such results apply to the Malaysian situation.

4.5.1. Endogenous Variables

(a) Personal Factors

Hypothesis 1 - The total number of publications achieved by academic engineers are independent of their personal background such as gender, race, age, and the number of children they have.

Gender – No relationship is indicated between gender and total number of publication productivity achieved by academic engineers and the null hypothesis is accepted.

Race – No relationship is indicated for the academic engineers, and in this case, the null hypothesis is accepted.

Age – Age is significantly related to higher total number of publication productivity for academic engineers ($p=.277, sig<0.01$ respectively). The older academic staffs are more likely to be placed in the high and very high publication group. For this reason, the null hypothesis is not accepted. This result corroborates the findings of other studies that uses chronological age to compare with research productivity (Lehman, 1953, 1958, 1960; Pelz and Andrews, 1966; Cole, 1979). No peaks in publication can be ascertained because the publication data collected is limited to a 5-year period only.

Family size – The number of children academic engineers have is not related to their total publication productivity achieved. The null hypothesis is therefore accepted.

(b) Academic Factors

Hypothesis 2 - The respondents' institutions, the departments they are attached to, the highest academic qualification obtained, the number of years since their highest degree was obtained, the country from which they had obtained their highest qualification, the length in years of working experience and their academic rank are not related to the total number of publication productivity.

Affiliation – The relationship between higher total number of publication productivity and affiliation is not indicated for academic engineers and the null hypothesis is accepted.

Discipline – The variable "department" is not related to higher total number of publication productivity achieved for academic engineers, and the null hypothesis is accepted.

Academic qualifications – There is a difference in the total number of publication productivity achieved between those having the Masters qualifications and those with Ph.D. among the engineers ($p=.250$, sig. <0.05) and the null hypothesis is not accepted. This finding is similar to other studies such as Meltzer (1949), Folger and Gordon(1962) and Astin (1984) which indicated that those who held Ph.D. tend to be more productive.

Country where highest qualification was obtained – A high number of publication productivity is not related to the country from where respondents had acquired their academic qualifications for the academic engineers and the null hypothesis is accepted. Even though a high number of Malaysian academic engineers received their academic training in more developed countries, this training is not related to their research performance.

Years since the highest qualification was obtained – A high number of publication productivity is not related to the years that elapsed since the highest qualification was obtained for academic engineers and therefore, the null hypothesis is accepted.

Working experience – Longer working experience is significantly related to higher publication productivity for the academic engineers ($p=.386$, sig.<0.01) and the null hypothesis is not accepted. This finding supports those of Rushton, Murray and Paunonen (1987) also found that the average number of publication increases for those with longer years of professional experience.

Academic rank – Academic rank is significantly related to higher number of publication productivity for the academic engineers ($p=.424$, sig.<0.01) and the null hypothesis is not accepted. The associate professors and full professors achieve not only higher total number of publications but are also productive in a variety of scholarly works compared to the lecturers.

(c) Professional Factors

Hypothesis 3 - The total number of publications achieved are not related to the number of professional association memberships, the number of consultation and editorial work undertaken.

Number of professional memberships – The number of professional memberships is related to higher total number of publication productivity for the engineers (p=270, sig.<0.01) and the null hypothesis is not accepted. This finding is in line with that of Prpic (1996b) who indicated that eminent Croatian scientists were more likely to be members of national and international scientific societies. Babu and Singh (1998) found that their 325 eminent scientists had strong professional commitments.

Number of consultation activities undertaken – A higher number of consultation activities is related to high total publication productivity for the engineers (p=.292, sig.<0.05) and the null hypothesis is not accepted. The result obtained is similar to that of Blackburn, Behymer and Hall (1978) who observed that high publishers also undertook more consultation work.

Number of professional journals edited – Editorial activity is not related higher total number of publication productivity for the engineers and the null hypothesis is accepted.

(d) Attitudinal Variables

Hypothesis 4 - The respondents' views on research outcome statements, departmental and institutional view statements are independent of the total number of publications achieved.

Views on research – For the academic engineers, a higher number of publication productivity scores is positively correlated to six of the seven research view statements: research adds to reputation (p=242, sig.<05), advances knowledge (p=233, sig.<0.05), gives prestige and respect (p=.221, sig.<0.05), gives departmental/university prestige (p=.222, sig.<0.05), enhances career prospect (p=.334, sig.<0.05), and provides opportunity to present papers (p=.292, sig.<0.05). In these cases, the null hypothesis is not accepted. The results support previous studies which indicated that academics undertook research because it gave them enjoyment, helps them advance knowledge and increases their chances for promotion (Halsey and Trow, 1971; Startup, 1979; Fox, 1992).

Views on departmental support –Among the academic engineers, both the low and high publishers do not rate their department as positively supportive and no correlation is indicated between high number of publication productivity and the seven departmental view statements. In this case, the null hypothesis is accepted.

Views on institutional support – A higher number of publication productivity is not related to any of the nine views on institutional support for research for academic engineers and the null hypothesis is therefore accepted.

(e) Channels of Information Used and Research Dissemination Behaviour

Hypothesis 5 – The respondents' ratings of formal and informal channels that they use to obtain and disseminate research information are not related to the total number of publications achieved.

Formal channels - A higher number of total publication productivity is not related to the ratings on eleven of the thirteen formal channels listed for academic engineers and in most cases the null hypothesis is accepted, except for two formal channels, research reports (p=.253, sig.<0.05) and conference proceedings (p=.271, sig. 0.01). Only in these two cases, the null hypothesis not accepted.

Informal channels – For academic engineers, the high number of publication productivity is related to four out of eight informal channels listed which included, the usefulness of maintaining dialogues with colleagues from other departments (p=.247, sig.<0.05), with colleagues outside the university (p=.269, sig.<0.05), discussions at conferences (p=.241, sig.<0.05) and faxing colleagues (p=.222, sig.<0.05). For these instances, the null hypothesis is not accepted. This preference for informal channel by engineers is also indicated by Kremer (1980) and Kaufman (1983).

(f) Methods Used to Keep Abreast with Research Literature

Hypothesis 6 - The respondents' ratings of methods of keeping abreast with the literature are not related to the total number of publications achieved.

Higher total number of publication productivity is not correlated to any of the ratings of eleven methods used to keep abreast with research information and the null hypothesis is accepted.

(g) Problems in Publishing, Using or Obtaining Information Needed for Research

Hypothesis 7 – The respondents' ratings of their research writing and library related problems are not related to the total number of publications achieved.

Problems of publishing research results – For the academic engineers, the total publication productivity scores are correlated to the ratings on five problem situations. The highly productive engineers regard the following situations as not problematic: technical writing skills ($p=.308$, sig.<0.01); the courage to write ($p=.346$, sig.<0.01); confidence in writing in English ($p=.362$, sig.<0.01); not knowing the target periodical to which to send articles ($p=.279$, sig.<0.01); and conducive home environment ($p=.245$, sig.<0.05). For all the correlated situations, the null hypothesis is not accepted. The results indicate that in most situations the highly productive engineers do not find problems in publishing their research results.

Library related problems – For academic engineers, the results indicate that the ratings on the fifteen variables are independent of their achieved total publication scores, except one. In the fourteen cases the null hypothesis is accepted. However, a negative correlation is indicated between total publication scores and the statement "colleagues are not helpful in providing materials needed" ($p=.242$, sig.<0.05). In general, the results imply that the importance of library-related services is less important to the productive academic engineers. This may be because of their preference for the more informal channels to communicate their findings.

4.5.2. Exogenous variables

(a) Departmental Factors

Hypothesis 8 -The percentage of time allocated to research, teaching and administration, the minimum publication requirements set by departments, the number of faculty members employed and research students enrolled within each department would have no effect on the total number of publications achieved.

Time allocated for research, teaching and administration - No correlation is indicated between academic engineers' total publication scores and time allocated for research, teaching and administration, and in these cases, the null hypothesis is rejected. Wood (1990) revealed that engineers often undertook experimental type of research that needs continuity in time involvement, in order to achieve publishable results. This may be the reason why the majority of engineers in the present study who allocate 21%-30% of their time to research, are not placed in the high publishers group.

Minimum publication set by the respective department – No correlation is indicated between respondents' ratings on their departments' publication requirements and higher number of publication productivity among the academic engineers. In this case, the null hypothesis is accepted. Most academic engineers perceived the need to publish at least one publication per year. However this is not related to their publication productivity. The situation may be explained by tenure status of Malaysian academics that can be easily obtained since the shortage of supply ensures tenure for those appointed as lecturers

Size of academic staff – For the academic engineers, no cross-tabulations can be carried out since the size of the academic staff among the four departments at both universities are similar (between 20-30). The null hypothesis in this case, is accepted.

Size of student enrollment - In the case of the academic engineers, this variable was dropped from analysis because all departments indicated student enrollment of between 10-20 students. The null hypothesis in this case, is accepted.

(b) Organisational Factors

Hypothesis 9 – The total as well as the amount of grants received, the ratings of the library, laboratory services provided and the ratings on the type of computer use are independent of respondents' total number of publications achieved.

Total and amount of grants – For the academic engineers, the total number and amount of grants obtained is significantly and positively related to higher total publication productivity (p=.375, sig.<0.01; p=.499, sig.<0.01 respectively). In these cases, the null hypothesis is not accepted. This result is in line with a number of previous studies that found a positive relationship between amount of support for research and research productivity (Folger and Gordon, 1962; Salisbury, 1980; Johnston, 1994).

Library services – For academic engineers, a higher total publication productivity is correlated to the rating on inter-library loan service (p=224, sig.<0.05) as well as on "professional staff help in online searching" (p=.273, sig.<0.05) and in these two cases the null hypothesis is not accepted. For the other library services listed, the null hypothesis is accepted. The ratings indicate that most types of services provided by the library are not related to academic staffs' publication productivity. Libraries play an important role in providing bibliographic information needed for research (Vieira and Faraino, 1997) and carry out online searches for users (Wood, Wallingford and Siegal, 1997). However, research success depends on how academics exploit the sources and facilities available to them.

Laboratory services – The rating on the sufficiency of laboratories for research is not related to higher number of publication productivity for academic engineers and the null hypothesis is accepted.

Types of computer use –All types of computer use are not correlated to the total number of publication productivity scores for academic engineers and in this case, the null hypothesis is accepted. Very few studies have connected computer use to productivity. Hesse, Sproull, Kiesler and Walsh (1993) found a significant correlation between network use and publication productivity. A similar relationship was found by Cohen (1996). It is expected that the use of computer networks to retrieve and disseminate information will increase in future for the Malaysian sample, when such facilities becomes more accessible to academics.

(c) Collaboration factors

Hypothesis 10 - The respondents' total number of publication productivity are independent of their ratings on the five types of collaborative situations frequently undertaken

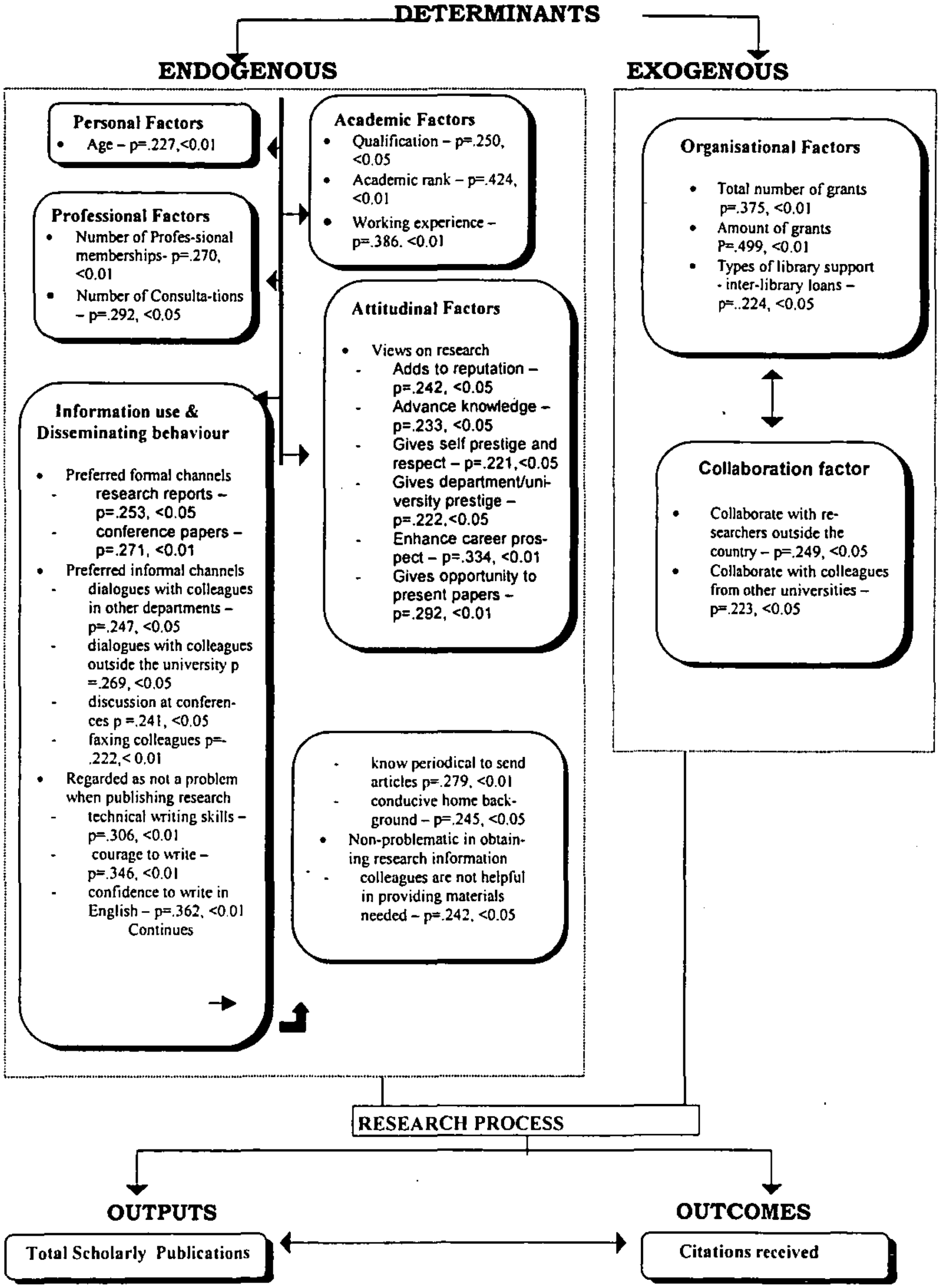
Types of collaboration – Of the four types of collaboration situations, only two are found to be correlated with higher number of publication productivity for the academic engineers. These are collaboration with colleagues from other universities (p=.223, sig. <0.05) and collaboration with researchers outside the country (p=.249, sig.<0.05). In these cases, the null hypothesis is not accepted. The results indicate that the more productive academic staff collaborate actively. Previous studies have indicated that collaboration is instrumental to scholarly productivity (Austin and Baldwin, 1992; Babu and Singh, 1998).

4.6. SUMMARY

This chapter describes the analyses of responses from 83 academic engineers from four engineering departments affiliated to the University of Malaya and National University of Malaysia (UKM). The engineer's publication behaviour, the factors which are related to high publication productivity and the problems faced in obtaining, using and disseminating research results are also presented. This chapter ends with the results of testing the ten hypotheses presented in chapter three.

Figure 4.1 provides a summary of correlated results between total number of publications and relevant endogenous and exogenous variables for the academic engineers. Fewer significant results are obtained in the case of the academic engineers, perhaps indicating that other variables need to be taken into consideration when studying academic engineers, which this study may have failed to identify.

Figure 4.1: Summary of Correlated Results between Total Number of Publications and Endogenous and Exogenous Factors: Academic Engineers



Chapter 5

ANALYSIS OF RESPONSES FROM THE ACADEMIC SCIENTISTS

5.1. INTRODUCTION

This chapter presents the analysis of responses obtained from 239 academic scientists from UKM and UM. This includes the pure science departments of botany, chemistry, genetics, geology, mathematics, physics, and zoology from the University of Malaya (UM) and the National University of Malaysia (UKM). Similar to the engineering sample, the intention here is not to make comparisons between the universities but to study the research publication characteristics of the pure sciences academic community and identify factors that may be related to publication productivity.

5.2.DEMOGRAPHIC CHARACTERISTICS OF THE SAMPLE

Table 5.1 displays the demographic characteristics of the 239 scientists from the two universities.

Table 5.1: Demographic Characteristics of the Academic Scientists

		Sample Population(n=239)		Actual Population (n=311)	
Demographic Characteristics		Frequency	Percentage	Frequency	Percentage
Affiliation -	UKM	108	45.2	135	43.4
	UM	131	54.8	176	56.6
Departments –	Botany	26	10.9	31	10.0
	Chemistry	47	19.7	59	19.0
	Genetics	34	14.2	44	14.1
	Geology	29	12.1	37	12.0
	Mathematics	42	17.6	59	18.9
	Physics	34	14.2	46	14.8
	Zoology	27	11.3	35	11.2
Rank -	Lecturer	89	37.2	12.1	39.0
	Associate Professors	117	49.0	15.4	49.5
	Professors	33	13.8	36.0	11.5
Qualifications -	Masters	35	14.6		
	Ph.D.	204	85.4		
Age -	Under 30	2	0.8		
	31-40	89	37.2		
	41-50	120	50.2		
	51 and above	28	11.7		
Experience –	5 years and under	1	0.4		
	6-10 years	77	32.2		
	11-15 years	87	36.4		
	15 years and above	74	31.0		
Gender -	Male	182	76.2		
	Female	57	23.8		

There are 108 (45.2%) respondents from UKM and 131 (54.8%) from UM. On the whole, the respondents represent about 76.8% of the total population of the seven science departments from both universities. The number of respondents in each department is quite similar in percentages when compared to the actual population distribution. In general, the respondents in the sample are fairly mature in age with sufficient years of working experience as lecturers to be established and active authors of scholarly publications.

5.3. PUBLICATION CHARACTERISTICS OF ACADEMIC SCIENTISTS

5.3.1. Total Number of Publications

The scientists included in the sample published a total of 5,323 research publications (Table 5.2). None of those who responded to the questionnaire reported not publishing. One respondent reported having 3 publications only. The highest reported number of publications is 86 and the mean is 22.27, which indicates an average of 3.7 publications per year.

Table 5.2: Total publications between 1990-1995 of Academic Scientists

	Number	Missing	Mean	Min	Max	Sum	%
Single-authored Works	213	26	7.69	1	43	1639	31%
Joint-authored Works	234	5	15.74	1	68	3684	69%
Total Publications	239	0	22.27	3	86	5323	100%

Like the academic engineers, the academic scientists also publish more works jointly rather then singly. A total of 26 respondents did not publish any work singly and only 5 respondents did not publish any work jointly. Solo works account for 1,639 of total publications, with a minimum of 1, a maximum of 43, and a mean of 7.69 publications. About 3,684 works are published jointly, ranging from a minimum of 1 to a maximum of 68 and a mean of 15.74 publications.

Similar to the engineering sample the total number of publications are categorised into 5 productivity groups:- (low (1-5); min (6-10); average (11-20); high (21-30) and very high (=>31) and will be cross-tabulated with other variables later in the study. The distribution of scientists in the various publication categories is indicated in Table 5.3.

Table 5.3: Categorisation of Academic Scientists on the Basis of Total Publication Count

TOTAL PUBLICATIONS		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low (1-5)	7	2.9	2.9	2.9
	Min (6-10)	42	17.6	17.6	20.5
	Ave (11-20)	80	33.5	33.5	54.0
	High (21-30)	52	21.8	21.8	75.7
	V. High (=>31)	58	24.2	24.3	100.0
	Total	239	100.0	100.0	

The academic scientists in this sample are active publishers, with about 90% publishing at least 1 or more works per year, with the majority of the works written jointly. For joint-authored works, a higher percentage (37.3%, 89) are placed in the high/very high publishing group with between 18 to 24 or more joint publications.

Table 5.4: Categorised Types of Publications by Academic Scientists

SINGLE-AUTHORED WORKS		Frequency	Valid Percent	Cumulative Per cent
Valid	Low (1-4)	77	36.2	35.2
	Min (5-10)	90	42.3	78.4
	Ave (11-16)	27	12.7	91.1
	High (17-22)	12	5.6	96.7
	V.High (= >23)	7	3.2	100
	Total	213	100.0	
JOINT-AUTHORED WORKS		**Frequency**	**Valid Percent**	**Cumulative Per cent**
Valid	Low (1-4)	44	18.8	18.8
	Min (5-11)	58	24.8	43.6
	Ave (12-17)	43	18.3	62.0
	High (18-23)	39	16.7	78.6
	V. High (= >24)	50	21.4	100.0
	Total	234	100.0	

5.3.2. Types of publication

The majority of the academic scientists from this study prefer to publish their research results in the form of conference papers, journal articles and research reports. About 234 out of 239 of the respondents published 2,221 conference papers comprising 42% of total publications produced by the sample (Table 5.5).

Table 5.5: Types of Publications by Malaysian Academic Scientists (1990-1995)

Publications	N	Mean	Min	Max	Sum N=5,323	%
Books	73	2.08	1	6	152	2.9
Book Chapters	108	2.59	1	11	280	5.3
Conference Papers	234	9.49	1	58	2,221	41.7
Edited Books	50	1.82	1	6	91	1.7
Journal Articles	227	9.07	1	45	2,058	38.7
Research Reports	148	2.80	1	10	415	7.8
Standards/Patents	25	1.80	1	5	45	0.8
Translated Works	41	1.49	1	4	61	1.1

The mean number of conference papers published is about 9.49. A total of 2,058 journal articles are published by 227 respondents and 415 research reports are published by 148 respondents. The journal articles achieved a mean of 9.07 while the research reports reached a mean of 2.80 for the 6-year period.

Table 5.6 gives a breakdown of types of publication by authorship types (single and joint works). Books, research reports and translated works seem more likely to be single-authored compared to the other types of publications and more so in the case of translated works. More than 70% of the conference papers and journal articles are more likely to be joint works.

Table 5.6: Single and Joint-authored Works by Malaysian Academic Scientists

Publications SINGLE-AUTHORED	N	Mean	Min	Max	Sum N=1,639	%
Books	48	1.65	1	5	79	4.8
Book Chapters	55	1.95	1	7	107	6.5
Conference Papers	156	4.21	1	33	656	40.0
Edited Books	33	1.52	1	5	50	3.1
Journal Articles	124	3.57	1	24	443	27.0
Research Report	110	2.22	1	10	244	14.9
Standards/Patents	14	1.43	1	4	20	1.3
Translated Works	29	1.38	1	3	40	2.4
Publications JOINT-AUTHORED	**N**	**Mean**	**Min**	**Max**	**Sum N=3,684**	**%**
Books	47	1.55	1	4	73	2.0
Book Chapters	76	2.28	1	8	173	4.7
Conference Papers	216	7.25	1	41	1565	42.5
Edited Books	25	1.64	1	6	41	1.1
Journal Articles	205	7.88	1	45	1615	43.8
Research Report	58	2.95	1	10	171	4.6
Standards/Patents	14	1.79	1	5	25	0.7
Translated Works	17	1.24	1	2	21	0.6

5.3.3. Correlation Matrix of Total and Types of Publication: Academic Scientists

Table 5.7 indicates the total publication scores were cross-tabulated with single, joint works and other types of publications.

The highly productive scientists authored higher number of single- (ρ (213)=.392, sig.<0.01) and joint-authored works(ρ (234)=.799, sig.<0.01). This group tends to write more book chapters (ρ (73)=.388, sig.<0.01), conference papers (ρ (232)= .720, sig. <0.01), journal articles (ρ (225)=.657, sig.<0.01) and research reports (ρ (143)=.359, sig.<0.01).

Table 5.7: Correlation Matrix of Total Publications and Types of Publications

	Total pub.	Total solo works	Total joint works	Total books	Total book chapters	Total conf. papers	Total books edited	Total journal articles	Total research reports	Total standard patents	Total trans. works
Total pub.	1.000	.392**	.799**	.197	.388**	.720**	.169	.657**	.359**	.323	.130
Sig.	-	.001	.001		.001	.001		.001	.001		
Total single	.392**	1.000	-.028	.283*	.272**	.278**	.104	.220**	.260**	.101	.002
Sig.	.001	-		.016	.007	.000		.002	.002		
Total joint	.799**	-.028	1.000	.160	.245*	621**	.115	.601**	.261**	.332	.236
Sig.	.001				.011	.001		.001	.002		
Total books	.197	.283**	.160	1.000-	.280	.031	.218	.016	.334*	-.027	.380
Sig.		.016							.014		
Total bk. Chap.	.388**	.272**	.245*.	.280	1.000	.280**.	.122	.208*	.089	.144	.066
Sig.	.001	.007	011			003		.031			
Total conf.	.720**	.278**	.621**.	.031	.280*	1.000-	.0856	.277**	.166	.067	.163
Sig.	.001	.001	001		.003			.001			
Total books ed.	.169	.104	.115	.218	.122	.085	1.000	-.179	-.061	.203	.525*
Sig.							-				.010
Total jour. art.	.657**	.220**	.601**	.016	.208*	.277**	-.179	1.000	.157	.309	-.298
Sig.	.001	.002	.001		.031	.001		-			
Total res. rep.	.359**	.260**	.261**	.334*	.089	.166	-.061	157	1.000	.436*	-.259
Sig.	.001	.002	.002	.014					-	.042	
Total std/ pat.	.323	.101	.332	-.027	.144	.067	.203	.309	.436*	1.000	-.371
Sig.									.042		
Total Trans.	.130	.002	.236	.380	.066	.163	.525*	-.298	-.259	-.371	1.000
Sig.							.010				

* Correlation is significant at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

5.3.4. Respondents' Earliest Publication

All respondents (239) gave the year in which they wrote their first research publication. The years given were re-coded into four categories (Table 5.8). The categorisation adopted is slightly different from the engineering sample because of the larger sample size and the wider variations in years reported. A larger number of respondents started publishing more than 16 years ago and as such, it is felt that there is a need for a separate categorization for those who have been publishing for the last 16 years, in this study. Table 5.8 indicates that the majority of respondents began publishing 6 years before 1996/1997, the date of the distribution of the questionnaire. A total of 102 scientists indicate their first publication as between 11 to 15 years ago and 83 (a third) indicate publishing between 6 to 10 years ago.

The majority of the respondents (91.6%, 219) indicate that their first publication was based on their thesis. The results suggest two things. Firstly, the majority of the academic scientists are fairly experienced writers since more than half began publishing 11 or more years ago and this may also account for the fairly high total and mean publishing rate among the respondents. Secondly, the role played by academic research such as thesis writing seems to be in most cases, the launching pad for an academic publishing career. Only 20 respondents (8.4%) indicate that their first publication was not based on their thesis.

Table 5.8: Categorised Year of First Research Publication

Categorised Year		Frequency	Percent	Cumulative Percent
Valid	Under 5	7	2.9	2.9
	6-10 yrs	83	34.7	37.7
	11-15 yrs	102	42.7	80.3
	=> 16 yrs	47	19.7	100.0
	Total	239	100.0	

The length of years computed from the year of the respondent's first report writing was tested for correlation with total publication scores. The results indicate that respondents who started publishing earlier have achieved higher publication score (p=.408, sig.<0.01). This was also indicated by previous studies which observed that early productivity was related to higher later publication (Meltzer, 1949; Dennis, 1954; Gaston, 1978; Blackburn, Behymer and Hall, 1978; Reskin, 1979).

5.3.5. Journal Articles Academic Scientists Published

Journal articles ranked second to conference papers as the form of publication most preferred by the academic scientists and the journal titles scientists used to publish is further analysed.

(a) Total Number of Journals Used by Academic Scientists

The academic scientists published their research articles in a total of 418 journals titles, of which 240 titles published more than one article each. About 57.8% of the journal articles were published in 45 titles, and these titles published 10 or more articles each. (Table 5.9). Of the 45 titles, 22 titles are published from Malaysia, 8 titles from the United States, 6 titles each from the United Kingdom and European countries and 3 from the Asia-Pacific region. The top ten journals which published the highest number of academic scientists' research articles are: *Sains Malaysiana* (155 articles), *Warta Geologi* (116 articles), *Malaysian Journal of Science* (88 articles), *Malaysian Applied Biology* (62 articles), *Phyochemistry*

(UK) (46 articles), *Pertanika* (44 articles), *Journal of Physical Sciences* (37 articles), *Journal of Organometallic Chemistry* (34 articles), *Tetrahedron* (33 articles) and *Jurnal Fizik Malaysia* and *Transactions of the Malaysian Society of Plant Physiology* (both share the 10th place with 31 articles).

Table 5.9: Journals which Published 10 or More Articles of Academic Scientists

Journal titles	Frequency	Percent	Cumulative Percent	Country
Sains Malaysiana	155	7.5	7.5	M'SIA
Warta Geologi	116	5.6	13.2	M'SIA
Mal J Sc	88	4.3	17.4	M'SIA
Mal Appl Biol	62	3.0	20.5	M'SIA
Phytochemistry	46	2.2	22.7	UK
Pertanika	44	2.1	24.8	M'SIA
Physical Sc	37	1.8	26.6	M'SIA
J Organo Chem	34	1.7	28.3	EUR
Tetrahedron Lett	33	1.6	29.9	UK
J Fiz Mal	31	1.5	31.4	M'SIA
Trans Mal Soc Plant Physiol	31	1.5	32.9	M'SIA
Acta Crystal	27	1.3	34.2	UK
Nature Malaysiana	26	1.3	35.5	M'SIA
Bul Geol Soc Mal	25	1.2	36.7	M'SIA
Bul Sol State Sc & Tech	23	1.1	37.8	M'SIA
Mal Naturalist	22	1.1	38.9	M'SIA
Bul Math Soc Mal	21	1.0	39.9	M'SIA
J Nat Prod	18	.9	40.8	USA
J Sol State Sc & Tech	18	.9	41.6	M'SIA
J Cryst & Spect Res	17	.8	42.5	USA
J SEA Earth Sc	17	.8	43.3	UK
Mycological Res	17	.8	44.1	UK
J Appl Polym Sc	16	.8	44.9	USA
Mal Nat J	16	.8	45.7	M'SIA
J Matematik UTM	15	.7	46.4	M'SIA
Menemui Matematik	15	.7	47.1	M'SIA
Hydrobiologica	14	.7	47.8	EUR
Sabah Mus J	14	.7	48.5	M'SIA
J Molec Catal	13	.6	49.1	EUR
Physics Lett	13	.6	49.8	EUR
Sing J Physics	13	.6	50.4	SING
Nat Prod Lett	11	.5	54.3	EUR
Trop Biomed	11	.5	54.9	M'SIA
Asia Pacific J Mol Biol & Biot	10	.5	55.3	M'SIA
Bull Environ Contam & Toxicol	10	.5	55.8	USA
J Chem Res	10	.5	56.3	UK
J Colloid Interface Sc	10	.5	56.8	USA
Mycotaxon	10	.5	57.3	USA
Wallaceana	10	.5	57.8	M'SIA

The geographical distribution of the journals that published the 2,058 articles were cross-tabulated according to respondents' affiliation (Table 5.10). The results indicate that academic scientists from UM contributed 62.5% of total articles, and those from UKM contributed 37.5% articles. Respondents from UKM prefer to publish in local journals (62.6%) compared to those from UM (33%). It is observed that a larger number of scientists from UM prefer to publish in foreign journals, especially those published from the United States (25.5%) and the United Kingdom (18.6%). The differences between the geographical distribution of the journals used to publish articles by those from UKM and UM, are found to be significant at 0.01 level.

Table 5.10: Geographical Distribution of All Journals and Respondents' Affiliation

	Affil					
	UKM	%	UM	%	Total	%
Malaysia	483	62.6	424	33.0	907	44.1
UK	81	10.5	328	25.5	409	19.9
USA	90	11.7	239	18.6	329	16.0
Europe	76	9.8	160	12.4	236	11.5
Asia-pacific	42	5.4	135	10.5	177	8.5
Total	772	100.0	1286	100.0	2058	100.0

x^2 =182.240, p <.01

There is also a significant difference in the geographical distribution of journals used to publish research articles by the seven departments (Table 5.11). Of the contributors to Malaysian journals, the geology department comes first with 197 articles, followed by the departments of physics with 163 articles and chemistry with 129 articles. A higher number of academic chemists prefer to publish in British (207 articles), American (133 articles) and European (102 articles) journals.

Table 5.11: Geographical Distribution of Journals by Respondents' Department

	COUNTRY					
	M'SIA	UK	USA	EUROPE	ASIA/PAC	Total
Botany	118	39	29	34	11	231
Chemistry	129	207	133	102	32	603
Genetics	112	35	53	33	59	292
Geology	197	20	2	6	4	229
Mathematics	82	36	40	24	9	191
Physics	163	42	63	17	24	309
Zoology	106	30	9	20	38	203
Total	907	409	329	236	177	2,058

x^2 =484.866, df 24, p < .01

5.4. FACTORS RELATED TO PUBLICATION PRODUCTIVITY OF ACADEMIC SCIENTISTS

Analysis of the factors follows the sequences adopted for the academic engineers: (1) personal , (2) academic, (3) departmental, (4) professional and consultation background, (5) institutional support such as finance, (6) laboratories, libraries and computers, (7) research collaborative behaviour, (8) personal views on research, departmental and institutional support, (9) researchers' behaviour in using information channels and disseminating research results, (10) approaches used to keep abreast with research information, (11) possible problems in obtaining and writing research publications are compared to respondents' categorised total publication productivity between 1990 and 1995.

5.4.1 PUBLICATION PRODUCTIVITY AND PERSONAL BACKGROUND

(a) Publication and Gender

The personal variable "gender" was cross-tabulated with the total publication productivity scores. The results indicate that the majority of both male and female academic scientists were placed in the high/very high publication group (48.9% and 36.8% respectively). For both, between 18.1%-28.1% were placed in the low or minimum publication group and 33% to 35% were average publishers. There was no vast difference in the total publication productivity between male and female academic scientists.

(b) Publications and Race

Over 70% of the respondents were Malays, 23% Chinese, 5.9% Indians and 1% belonged to other races. The Chinese, Indians and Eurasians were grouped together in "Other" racial group to ease analysis (Table 5.12). The table indicates that a higher percentage of "Other" racial group is placed in the high/very high publication group even though they are small in number. A higher percentage of the Malays are placed in the low or minimum publication group. The result indicates that there are variations in the publication productivity of the Malay academic scientists and those of "Other" races.

Table 5.12: Publication Distribution of Academic Scientists by Race

Total Publications	Race			
	Malays		Others	
	Count	%	Count	%
Low/Min (1-10)	42	24.9%	7	10.0%
Ave (11-20)	52	30.8%	28	40.0%
High/v. high (≥ 21)	75	44.3%	35	50.0%
Total	169	100.0%	70	100.0%

x^2=6.925, df.2, $p < .031$

(c) Publications and Age

Those respondents whose age is 51 years and above achieved a higher percentage of placement in the high/very high publication groups (67.9%, 19 out of 28) (Table 5.13). The majority of those under 40 years are placed in the minimum and average publication group (66.3%, 59 out of 89). The results indicate that the older academic scientists achieve higher productivity compared to scientists in the other age groups.

Table 5.13: Publication Distribution of Academic Scientists by Age

	Age							
	=<30		31-40		41-50		=>51	
Pub. Categories	**Count**	%	**Count**	%	**Count**	%	**Count**	%
Low (1-5)	-	-	7	7.8%	-	-	-	-
Min (6-10)	1	50.0%	27	30.3%	14	11.7%	-	-
Ave (11-20)	-	-	32	36.0%	39	32.5%	9	32.1%
High (21-30)	-	-	11	12.4%	33	27.5%	8	28.6%
V.High (=>31)	1	50.0%	12	13.5%	34	28.3%	11	39.3%
Total	2	100.0%	89	100.0%	120	100.0%	28	100.0%

p=.367 (n=239), sig.< .01

(d) Publications and Respondents' Family Size

Family size here refers to the number of children that the respondents have. The majority of academic scientists have 2 to 3 children (62.8%,) and about 28.9% have 4 or more children. For those who have 1 to 2 children, the majority are high/very high publishers (44.7%). Similarly, a high proportion of those who have more children are placed in the high / very high publication category. The results indicate no differences in the publication productivity of those who have fewer and more number of children.

5.4.2. PUBLICATION PRODUCTIVITY AND RESPONDENTS' ACADEMIC BACKGROUND

(a) Publications and Academic Scientists' Institutional Affiliation

On the whole, the academic scientists from UKM performed better in terms of placement in the high/very high publication groups (Table 5.14).

Table 5.14: Publication Distribution by Respondents' Affiliation

Total publications	Affiliation			
	UKM		UM	
	Count	%	Count	%
Low/Min (1-10)	24	22.2%	25	19.1%
Ave (11-20)	26	24.1%	54	41.2%
High/v. high (≥ 21)	58	53.7%	52	39.7%
Total	108	100.0%	131	100.0%

x^2=8.008, df 2, critical chi. 5.991, p <.018

A higher percentage of respondents from UKM are placed in the very high publication group (30.6%), while those from UM are placed in the average publication group (41.2%). The results indicate that there are differences in academic scientists' total publication productivity between respondents from UKM and UM.

(b) Publications and Academic Scientists' Departments

The highest percentages of placement in the low/minimum publication group are those from the mathematics department (Table 5.15). The departments that achieved a higher number of placements in the high/very high publication category are the chemistry (29, 26.4%) and the physics departments (21, 19.1%). The department, which had over 50% of their respondents, placed in the high / very high publication groups were the departments of geology and botany. The results indicate some degree of differences in the publication distribution of respondents between the various departments.

The results also show that the chemists and physicists recorded the highest number in the high/very high publication group in terms of joint works (x^2 =69.363, df 12, critical chi.21.026, p <.01) and journal articles (x^2 =21.766, df 12, critical chi.21.026, p <.05).

Table 5.15: Total Publication Distribution by Departments

Departments	Total publications					
	Low/min(1-10)		Ave (11-20)		High/v.high (≥ 21)	
	Count	%	Count	%	Count	%
Botany	4	8.2%	9	11.2%	13	11.8%
Chemistry	1	2.0%	17	21.3%	29	26.4%
Genetics	7	14.3%	13	16.2%	14	12.7%
Geology	3	6.1%	10	12.5%	16	14.5%
Mathematics	25	51.0%	13	16.2%	4	3.6%
Physics	6	12.2%	7	8.8%	21	19.1%
Zoology	3	6.2%	11	13.8%	13	11.9%
Total	49	100.0%	80	100.0%	110	100.0%

x^2 =61.880, df 2, critical chi. 5.991, p <.01

There were also differences in the total number of conference papers (x^2 =24.222 df 12, p <.01) and research reports (x^2 =25.495, df 12, p <.01) authored by respondents from the seven departments. The physicists recorded the highest percentage of conference papers published and the chemists authored the highest number of research reports.

(c) Publications and Respondents' Highest Qualifications

There are differences in the publication achievement of those having Masters qualifications and those with Ph.D. (Table 5.16). A higher number of those with Ph.D. (103 out of 204, 50.5%) were placed in the high/very high publication category compared to those with Masters qualifications (7 out of 35, 20.0%).

Table 5.16: Total Number of Publication by Academic Scientists' Qualifications

Total publications	Highest qualifications			
	Masters		Ph.D.	
	Count	%	Count	%
Low/Min (1-10)	20	57.1%	29	14.2%
Ave (11-20)	8	22.9%	72	35.3%
High/v. high (≥ 21)	7	20.0%	103	50.5%
Total	35	100.0%	204	100.0%

p.=.314, sig <0.01

(d) Publication and the Number of Years since the Highest Qualification was Obtained

Fourteen (14) respondents obtained their highest qualification less than 5 years ago. Of these, ten contributed between 1 to 3 publications and are placed in the minimum and average publication group. The pattern is reversed for those with 15 or more years of working experience, who figure prominently in the high publication group (34 out of 45), with contributions ranging from 3 to 5 publications per year. Table 5.17 indicates that as the number of years since the highest qualification increases, the publication output of the respondents also increases.

Table 5.17: Publication Productivity and Years Since Highest Qualification was Received

Year highest qualification was received	Total publications					
	Low/min(1-10)		Ave (11-20)		High/v.high (≥ 21)	
	Count	%	Count	%	Count	%
≤ 5 yrs	5	10.2%	6	7.5%	3	2.7%
6-10 yrs	32	65.3%	41	51.3%	44	40.0%
11-15 yrs	9	18.4%	25	31.2%	29	26.4%
≥ 15 yrs	3	6.1%	8	10.0%	34	30.9%
Total	49	100.0%	80	100.0%	110	100.0%

x^2=34.266, df 2, p <0.01

(e) Publication Distribution and the Country Where the Highest Qualification was Obtained

Academic scientists in this study were mainly trained at universities in the west and this is indicated in Table 5.18. About 54.0% of scientists obtained their highest qualification from the United Kingdom, followed by other countries in Asia and the United States.

Table 5.18: Country Where Respondents Obtained their Qualifications

	Country highest qualification received	
	Count	%
UK	129	54.0%
USA	33	13.8%
Others foreign	44	18.4%
Malaysia	33	13.8%
Total	239	100.0%

Table 5.19 indicates that there is no difference between respondents' total publication productivity and the country from where they obtained their highest qualification. Regardless of the country where scientists receive their academic training, the distribution of scientists among the publication categories is similar. Those who were trained in the United Kingdom (54%) was mainly placed amongst the high/very high publishers. This pattern is also true of those who obtained their highest qualifications from the United States, or other foreign countries such as Australia, New Zealand, and Canada.

Table 5.19: Total Publication by the Country where the Highest Qualification was Obtained

	Country highest qualif received							
	UK		USA		Other foreign		Malaysia	
	Tot. publication		Tot. publication		Tot. publication		Tot. publication	
	Count	%	Count	%	Count	%	Count	%
Low/min(1-10	27	20.9%	8	24.2%	5	11.4%	9	27.3%
Ave(11-20)	39	30.2%	12	36.4%	16	36.4%	13	39.4%
High/v.high(=>21)	63	48.8%	13	39.4%	23	52.3%	11	33.3%
Total	129	100.0%	33	100.0%	44	100.0%	33	100.0%

$x^2 = 5.774$, df.6, $p < 0.44$

(f) Publication Distribution and Respondents' Academic Rank

A lower percentage of the associate professors and professors are placed in the low publication group (7.7% and 3.0% respectively), compared to the lecturers (43.8%) (Table 5.20). At the same time, 84.8% of professors, and 57.3% of associate professors are in the high/very high publication category compared to 16.8% of lecturers. The results indicate that there are differences in the publication productivity of academic scientist by academic rank.

Table 5.20: Total Publication Distribution of Academic Scientists by Academic Rank

	Academic rank					
	Lecturer		Assoc prof		Prof	
	Tot. publication		Tot. publication		Tot. publication	
	Count	%	Count	%	Count	%
Low/min(1-10)	39	43.8%	9	7.7%	1	3.0%
Ave(11-20)	35	39.3%	41	35.0%	4	12.1%
High/v.high(=>21)	15	16.9%	67	57.3%	28	84.8%
Total	89	100.0%	117	100.0%	33	100.0%

$x^2 = 73.843$, df.4, $p < 0.01$

(g) Publication and Respondents' Working Experience

Those with 11 or more years of working experience are likely to achieve higher publication productivity (Table 5.21). A higher percentage of those with 15 or more years of working experience is placed in the high/very high publication category (21 to more than 31 publications between 1990 and 1996) compared to those in the other age groups. None of those with 5 or less years of working experience are high publishers.

Table 5.21: Total Number of Publications and Scientists' Work Experience

	Tot. publication					
	Low/min(1-10)		Ave(11-20)		High/v.high(= >21)	
	working experience		working experience		working experience	
	Count	%	Count	%	Count	%
5 yrs & under			1	1.3%		
6-10yrs	32	65.3%	26	32.5%	19	17.3%
11-15yrs	10	20.4%	39	48.8%	38	34.5%
15yrs & above	7	14.3%	14	17.5%	53	48.2%
Total	49	100.0%	80	100.0%	110	100.0%

$x^2 = 52.783$, df.6, $p < .01$

In summary, the results indicate that academic scientists with Ph.D., with more than 10 years of working experience, are associate professors or professors are more likely to achieve higher publication productivity.

5.4.3. PUBLICATIONS AND ACADEMIC SCIENTISTS' DEPARTMENTAL ENVIRONMENT

(a) Percentage of Time Scientists Spent on Research, Teaching and Administration.

The percentage of time an academic faculty member spends on research is dependent on each member's own initiative, motivation and interest, as it is not an activity that is time-tabled. The percentage of time spent on teaching and administrative work, on the other hand, is department-dependent. All three factors may be related to each other and would inevitably be related to an academic's publication productivity.

Table 5.22a indicates the percentage of time respondents allocate for research, administration and teaching. The time allocated for each activity is grouped into ranked categories representing percentage time bands. The majority of the respondents (135 out of 239) allocate between 21 to 30 per cent of their available time on research and some allocate up to a maximum of 55 per cent of their time.

Teaching takes between 40 to 60 percent of respondents' time with a high mean of 50.90. Some respondents' allocate a maximum of 85 percent of their time to teaching. The amount of time allocated for administrative duties tends to be the lowest with the majority allocating under 20 per cent of their time, averaging about 18.14 per cent. On the whole, the majority of academic scientists, regardless of their departments, allocate about 50% of their time to teaching, 30% to research and 20% to administration.

Table 5.22a: Percentage of Time Allocated to Research, Teaching and Administration.

Percentage Time Allocation		**Freq.**	**%**	**Mean**	**Min**	**Max**
Research time	10-20	37	15.5	39.92	10	55
	21-30	135	56.5			
	31-40	55	23.0			
	41-50	12	5.0			
Teaching time	10-30	20	8.4	50.90	10	85
	31-40	36	15.1			
	41-50	95	39.7			
	51-60	75	30.5			
	=>61	15	6.3			
Administration	5- 10	104	43.5	18.14	0	60
	11-20	87	36.4			
	21-30	30	12.6			
	31-40	14	5.9			
	=> 41	4	1.6			

Table 5.22b indicates that the percentage of time allocated to research is inversely correlated to the time allocated to teaching (ρ (239) = -.444, sig. <0.01) and administration (ρ (239) = -.176, sig. <0.01).

Table 22b: Correlation Between the Time Spent on Research, Teaching and Administration

Spearman's rho	% Time on Research	% Time on Teaching	% Time on Administration.
% time on Research Sig (2-tailed)	1.000 -	-.444** .001	-.176** .006
% time on Teaching Sig (2-tailed)	-.444** .001	1.000 -	-.694** .001
% time on Administration Sig(2-tailed)	-.176** .006	-.694** .001	1.000 -

** Correlation is significant at the .01 level (2-tailed)

(b) Publication Productivity and Percentage of Time Spent on Research

Table 5.22c indicates that the publication counts among the four research percentage-bands are fairly similar. In all publication categories, the majority spends between 21-30 per cent of their time on research. The 6 high publishers who spent 41 or more percentage of their time on research were professors or associate professors and have 15 or more years of working experience.

Table 5.22c: Publication and Percentage of Time Spent on Research

Percentage of Time on research	Total publications					
	Low/min(1-10)		Ave (11-20)		High/v.high (≥ 21)	
	Count	%	Count	%	Count	%
10-20	13	26.5%	10	12.5%	14	12.7%
21-30	24	49.0%	52	65.0%	59	53.6%
31-40	10	20.4%	14	17.5%	31	28.2%
≥ 41	2	4.1%	4	5.0%	6	5.5%
Total	49	100.0%	80	100.0%	110	100.0%

ρ (239)=.131*, sig. 0.04

(c) Publication Productivity and Percentage of Time Spent on Teaching

Academic scientists spend an average of 50.90 percentage of their time on teaching. The estimated time allocated for teaching are categorized into four percentage bands and cross-tabulated with publication counts achieved by the respondents (Table 5.22d). Those respondents who allocated 51 or more per cent of their time on teaching, constitute the highest percentage of those placed in the minimum (42.8%, 18 out of 42) and low publication groups (85.7%, 6 out 7). On the other hand, a higher number of those who spent 30 or less percentage of their time in teaching are placed in the high/very high publication group. The results indicate an inverse relationship between the variable 'percentage of time spent on teaching' and 'publication productivity'.

Table 5.22d: Publication Distribution by Percentage of Time Spent on Teaching

Percentage of Time on teaching	Total publications					
	Low/min(1-10)		Ave (11-20)		High/v.high (≥ 21)	
	Count	%	Count	%	Count	%
≥ 30	1	2.0%	3	3.8%	16	14.5%
31-40	5	10.2%	11	13.8%	20	18.2%
41-50	19	38.8%	33	41.2%	43	39.1%
51-60	15	30.6%	28	35.0%	30	27.3%
≥ 61	9	18.4%	5	6.2%	1	0.9%
Total	49	100.0%	80	100.0%	110	100.0%

ρ (239)=-.260, sig. 0.01

(d) Publication Productivity and Percentage of Time Spent on Administration Duties

Academic scientists allocate an average of 18.14 per cent of their time on administration work. Table 5.22e indicates that those who spent 10 per cent or less of their time on administrative work were placed in the low or minimum publication group. The four respondents who spent 41 or more percentage of their time on administrative work were high publishers. A closer look at these respondents reveal that 1 is an associate professor and 3 are professors, with 11 and more than 15 years of working experience respectively, come from the chemistry (1), genetics (2) and physics (1) departments of UKM. The results indicate a significantly inverse relationship between the percentage of time spent on administration and publication output.

Table 5.22e: Publication Distribution by Percentage of Time Spent on Administration

Percentage of time on administration	Total publications					
	Low/min(1-10)		Ave (11-20)		High/v.high (≥ 21)	
	Count	%	Count	%	Count	%
≥ 10	27	55.1%	36	45.0%	41	37.4%
11-20	17	34.7%	32	40.0%	38	34.5%
21-30	5	10.2%	9	11.2%	16	14.5%
31-40	-	-	3	3.8%	11	10.0%
≥ 41	-	-	-	-	4	3.6%
Total	49	100.0%	80	100.0%	110	100.0%

$\rho(239)=-.190$, sig. <0.01

The results indicate that administrative duties do not affect respondents' publication productivity adversely. This finding supports Knorr et al.'s (1979a) that administrative work fostered rather than inhibit scientist's performance.

(e) Publication Requirements Set by Departments

Similar to the academic engineering respondents, the majority of academic scientists in this sample indicated that their departments either do not set publication requirement (120) or require them to produce at least 1 publication per year (114) (Table 5.23a). The responses indicate that the publication requirements, which are often used as criteria for promotion, are not made clear to the majority of academic scientists.

Table 5.23a: Publication Requirements by Department

	Frequency	Per cent	Cumulative per cent
No minimum number set	120	50.2	50.2
At least 1 per year	114	47.7	97.9
At most 3 per year	4	1.7	99.6
Other requirements	1	0.4	100.0
Total	239	100.0	

Cross-tabulating the ratings on publication requirements with total publications achieved revealed that the majority of respondents who indicated that their departments had not set any minimum requirements were placed in the minimum/average group (69 out of 120, 57.5%) (Table 5.23b). Those respondents who indicated that their department requires at least 1 publication per year differ only slightly among the low, minimum/average and high/very high publication group. Four respondents indicated that their departments require at most 3 publications per year, and 3 of them are in the very high publication group, which means that these three had exceeded the minimum requirement set for them. On the whole, the results indicate a positive relation between respondents' perceived publication requirements of their department and their research publication output. Those who reported that their department requires them to publish 1 or more publication per year, are more likely to be more productive than those whose departments do not set any publication requirements. It is noted that respondents often exceed the minimum set by their departments.

Table 5.23b: Publication Requirements Set by Departments and Publication Productivity

	Publication requirements set by departments					
	No minimum set		At least 1 per yr		At most 3 per yr	
	Total publications		Total publications		Total publications	
	Count	%	Count	%	Count	%
Low/min(1-10)	31	25.8%	17	14.9%	1	20.0%
Ave(11-20)	41	34.2%	39	34.2%		
High/v.high(=>21)	48	40.0%	58	50.9%	4	80.0%
Total	120	100.0%	114	100.0%	5	100.0%

ρ (239)= . 150, sig. <0.02

(f) Size of Faculty Members, Research Student Enrolment and Publication Productivity

A total of 96 out of 239 faculty members reported that their departments have between 21-30 faculty members and 81 reported less than 21 faculty members. Cross-tabulations with total publication scores indicated an inverse relationship (Table 5.24). The departments with more than 40 faculty members are low or minimum publishers, while the departments with between 31-39 faculty members or below 21 members have 50% representation in the high publishing group. This may imply that department size contributes to research productivity among scientists. Previous studies have suggested this relationship (Gallant and Prothero, 1972; Blume and Sinclair, 1973;Jordan, Meador and Walter, 1988, 1989).

Table 5.24: Size of Faculty Members and Total Publication Productivity

	Number of faculty members							
	=< 21		21-30		31-39		=> 40	
	Total publications		Total publications		Total publications		Total publications	
	Count	%	Count	%	Count	%	Count	%
Low/min(1-10)	10	10.4%	21	25.9%	1	3.6%	17	50.0%
Ave(11-20)	33	34.4%	28	34.6%	11	39.3%	8	23.5%
High/v.high(=>21)	53	55.2%	32	39.5%	16	57.1%	9	26.5%
Total	96	100.0%	81	100.0%	28	100.0%	34	100.0%

ρ (239)= - .207, sig. <0.01

The respondents reported a fairly equal distribution of research students enrolled across the four student groups. Cross-tabulation with total publication productivity scores also indicate an inverse but insignificant relationship (Table 5.25).

Table 5.25: Size of Postgraduate Students and Faculty's Total Publication Productivity

Total publications	Postgraduate enrolments					
	=< 9		10-14		=> 15	
	Count	%	Count	%	Count	%
Low/Min (1-10)	19	22.9%	8	13.1%	22	23.2%
Ave (11-20)	23	27.7%	19	31.2%	38	40.0%
High/v. high (≥ 21)	41	49.4%	34	55.7%	35	36.8%
Total	83	100.0%	61	100.0%	95	100.0%

ρ (239)= - .088, sig. <.178

5.4.4. PUBLICATION AND RESPONDENTS' PROFESSIONAL BACKGROUND

(a) Respondents' Membership of Professional Associations

About 219 (91.6%) academic scientists indicated that they were members of professional societies. The total number of membership counts is indicated in Table 5.26a.

Table 5.26a: Membership Pattern of Academic Engineers

Types of Membership	Total	%
Did not respond to question	20	8.4
Membership of 1 society	102	42.7
Membership of 2 societies	55	23.0
Membership of 3 societies	36	15.0
Membership of 4 or more societies	26	10.9
Total	239	100.0

From annotations given by respondents with regard to membership of professional associations, a total of 48 Malaysian professional associations and 74 foreign associations were mentioned. Two kinds of information are obtained from the listing: (a) the names of professional associations by departments, and (b) total number of associations that the respondents are members of. A cursory glance at the departmental listings indicates that a few associations, usually local-based, form the core of associations to which most members in a particular discipline belong. The botanists and geneticists respectively indicated being members of 14 Malaysian and 13 foreign professional associations. The chemists belong to 10 Malaysian and 11 foreign associations. The zoologists indicated that they are members of 9 Malaysian and 13 foreign associations.

The academic scientists in this sample are also members of a wide variety of foreign professional associations reflected by the large number of single membership. The Royal Society of Chemistry (UK) tops the list with 7 members from this sample. The Malaysian associations with more than 10 members from this sample are: Malaysian Mathematical Association (41), Malaysian Institute of Physics (31), Geological Society of Malaysia (28), Malaysian Institute of Chemists (28), Malaysian Society of Applied Biology (25), Malaysian Scientific Association (25), Malaysian Genetic Society (17), Malaysian Nature Society (16), Malaysian Analytical Science Society (15) Malaysian Society of Plant Physiology (12). The list of associations indicates that the scientists are involved in a wide range of professional activities.

(b) Publication Productivity and Total Membership of Professional Associations

A total of 219 respondents indicated that they were members of professional associations and 20 were non-members (Table5.26b). Cross-tabulation with publication productivity scores indicate that there is no difference in the distribution of publication productivity between active professional members and non-members

Table 5.26b: Professional Association Membership and Publication Productivity

	Prof associations membership			
	Yes		No	
	Tot. publication		Tot. publication	
	Count	%	Count	%
Low/min(1-10)	43	19.6%	6	30.0%
Ave(11-20)	71	32.4%	9	45.0%
High/v.high(=>21)	105	47.9%	5	25.0%
Total	219	100.0%	20	100.0%

x^2=3.923, df.2, p <.149

Table 5.26c indicates the number of memberships held by academic scientists. A total of 102 are members of at least one professional association, 55 are members of two, and 62 are members of 3 or more associations.

Table 5.26c: The Number of Membership of Professional Associations

	Number of membership	
	Count	%
1	102	46.6%
2	55	25.1%
3 or more	62	28.3%
Total	219	100.0%

Table 5.26d indicates that the majority of those who belong to 3 or more professional associations are high/very high publishers (44 out of 62, 71%).

Table 5.26d: Membership of Professional Associations and Publication Productivity

	Number of membership					
	1		2		3 or more	
	Tot. publication		Tot. publication		Tot. publication	
	Count	%	Count	%	Count	%
Low/min(1-10)	31	30.4%	10	18.2%	2	3.2%
Ave(11-20)	31	30.4%	24	43.6%	16	25.8%
High/v.high(=>21)	40	39.2%	21	38.2%	44	71.0%
Total	102	100.0%	55	100.0%	62	100.0%

p=.292, sig.<.01

The majority of those who are members of 2 or less professional associations are average publishers. The results indicate that the variable "number of professional associations" is related to a respondent's publication productivity.

(c) Publication Productivity and Respondents' Editorial Activity

The number of academic scientists who hold editorial responsibilities for scholarly journals is slightly larger than the academic engineers, that is, (59 out of 239, 24.3%). Among the 59 scientists, 37 are on the editorial board of at least one journal title. Editorial involvement of the rest ranges from 2 journals to 4 or more journals (Table 5.27a).

Table 5.27a: Number of Journals Edited by Academic Scientists

Number of Journals Edited	Total	%	Cum %
1 journal title	37	62.7	62.7
2 journal titles	17	28.8	91.5
3 journal titles	4	6.8	98.3
4 or more jour. Titles	1	1.7	100.0
Total	59	100.0	

Cross-tabulation the number of journals edited and publication productivity indicate that there is no difference in the publication performance between those who edit one and those who edit more journals. Both are equally high publishers (Table 5.27b).

Table 5.27b: Number of Journal Titles Edited and Publication Productivity

	Number of journals edited			
	1		2 or more	
	Tot. publication		Tot. publication	
	Count	%	Count	%
Low/min(1-10)	2	5.4%	1	4.5%
Ave(11-20)	10	27.0%	3	13.6%
High/v.high(=>21)	25	67.6%	18	81.8%
Total	37	100.0%	22	100.0%

x^2=1.749, df.2, p<.417

This is a general indication that those who are active in editorial work are also the high publishers. This is evident when publication productivity is cross-tabulated with editors and non-editors (Table 5.27c).

Table 5.27c: Publication Distribution by Respondents' Editorial Activity

	Editorial activity			
	yes		no	
	Tot. publication		Tot. publication	
	Count	%	Count	%
Low/min(1-10)	3	5.1%	46	25.6%
Ave(11-20)	13	22.0%	67	37.2%
High/v.high(=>21)	43	72.9%	67	37.2%
Total	59	100.0%	180	100.0%

x^2=24.421, df.4, p<.001

(d) Consultation Activity and Publication Productivity

About 120 (50.2%) academic scientists indicated undertaking consultation work. Of this 120 consulting scientists, 62 undertook single consultation job within the 6 year period. The rest of the consultation pattern ranges from 2 to 3 or more consultation works (Table 5.28a).

Table 5.28a: Number of Consultation Undertaken (n=120)

No. Consultation	Frequency	%	Cumulative %
1	62	51.7%	51.7%
2	33	27.5%	79.2%
3	12	10.0%	89.2%
4 or more	13	10.8%	100.0%
Total	120	100.0%	100.0%

Table 5.28b indicates the type of consultation work undertaken by the 120 respondents. Private agencies and local industries comprised the biggest type of consultation work undertaken (28.5%), followed by work commissioned by the central government (27.2%) (the Ministry of Science, Technology and Environment), foreign and professional agencies (14.6%), state governments (11.3%) and local or municipal governments (5%).

Table 5.28b: Types of Consultation Undertaken by Academic Scientists

Type of Consultation	Frequency	Percentage
Central government	65	27.2%
	27	11.3%
State government	12	5.0%
Local/municipal government	68	28.5%
Private agency	35	14.6%
Foreign/professional agencies		

Table 5.28c indicates that those who undertake consultation works are clearly above average publishers compared to the respondents who do not.

Table 5.28c: Consultation and Publication Productivity

Total publications	Consultation			
	yes		no	
	Count	%	Count	%
Low/Min (1-10)	10	8.4%	39	32.8%
Ave (11-20)	31	25.8%	49	41.1%
High/v. high (≥ 21)	79	65.8%	31	26.1%
Total	120	100.0%	119	100.0%

x^2=42.155, df.2, p <.001

When the number of consultation works undertaken was cross-tabulated with publication scores, the results indicated that the majority of those who undertook 2 or more consultation works were above average publishers (Table 5.28d).

Table 5.28d: Publication Productivity by the Number of Consultation Jobs Undertaken

	Number of consultation			
	1		2 or more	
	Tot. publication		Tot. publication	
	Count	%	Count	%
Low/min(1-10)	7	11.3%	3	5.2%
Ave(11-20)	22	35.5%	10	17.2%
High/v.high(=>21)	33	53.2%	45	77.6%
Total	62	100.0%	58	100.0%

x^2=7.822, df.2, p <.020

5.4.5. PUBLICATIONS AND FINANCIAL SUPPORT FOR RESEARCH

(a) Source, Number, Type of Grants Received

Only 2 respondents indicated that they were not receiving any form of grants for research. Of those who indicated receiving grants, 121 stated receiving only 1 grant, 88 respondents obtained 2, and 28 respondents obtained 3 or more grants (Table 5.29a). Grants were obtained from their own university (185), from federal funding (139) such as the grants disbursed by the Ministry of Science, Technology and Environment.

Table 5.29a: Number of Grants Obtained (n=239)

No. of Grants	Frequency	Percentage
1	121	51.1%
2	88	37.1%
3 or more	28	11.8%
Total	237	100.0%

A small number of respondents obtained grants from non-R & D funding by the government (5.9%), private sector (8.4%) and foreign agencies (19.2%) (Table 5.29b).

Table 5.29b: Source of Grants Obtained (n=239)

Source of Grants	Frequency	Percentage
University	185	77.4%
Federal funding through R & D	139	58.2%
State / municipal agencies	14	5.9%
Private sector	20	8.4%
Foreign agencies	46	19.2%

(b) Amount and Total Number of Grants Received and Publication Productivity

A cursory glance at the amount of grants received by academic scientists indicates that the scientists received larger amount of allocation compared to allocations received by academic engineers. (Table 5.30a). Eighty-five (35.6%) scientists obtained grants amounting to under RM20,000. About 88 (44%) received between RM51,000 and RM500,000.

Table 5.30a: Amount of Grant Received by Respondents Between 1990 and 1995

Amount of grant(RM)	Frequency	Percentage
Under 20,000	85	35.9%
21,000-50,000	17	7.2%
51,000-100,000	33	13.9%
101,000-500,000	74	31.2%
501,000-999,000	14	5.9%
= >1,000,000	14	5.9%
Total	237	100.0%

Fourteen respondents received RM1 million for research. Those who received larger amount of grant, indicated that the amount was allocated to the project group and seldom to individuals.

Cross-tabulation of the respondents' publication scores with the amount of grants received indicates that none of those receiving more than RM501,000 worth of grant money were low publishers (Table 5.30b). The larger the amount of grant obtained, the higher the percentage of scientists in the high/very high publication group. Those who received RM50,000 or less were mainly average to minimum publishers.

Table 5.30b: Publication Distribution by Amount of Grant Received

Total publications	Grant amount for the last 5 years					
	50,000 and under		51,000-500,000		501,000 or more	
	Count	%	Count	%	Count	%
Low/Min (1-10)	38	37.3%	10	9.3%		
Ave (11-20)	41	40.2%	32	30.0%	6	21.4%
High/v. high (≥ 21)	23	22.5%	65	60.7%	22	78.6%
Total	102	100.0%	107	100.0%	28	100.0%

p=.469, sig. <0.01

Cross-tabulating the scores for total number of grants received with total publication scores indicates that twenty-six (82.1%) respondents who obtained 2, 3 or more grants are placed in the high/very high publication group and none are low publishers. Those who received one grant only are mainly average and minimum publishers (Table 5.30c).

Table 5.30c: Publication Distribution by Total Number of Grants Received

Total publications	Total number of grants received					
	1		2		3 or more	
	Count	%	Count	%	Count	%
Low/Min (1-10)	39	32.2%	8	9.1%	1	3.6%
Ave (11-20)	47	38.8%	28	31.8%	4	14.3%
High/v. high (≥ 21)	35	29.0%	52	59.1%	23	82.1%
Total	121	100.0%	88	100.0%	28	100.0%

p=.408, sig<.0.01

(c) Publication and Respondents' Perception of Funding as a Problem

One hundred and fifty-two (60%) academic scientists indicated that lack of funding posed a problem in research undertakings (Table 5.31).

Table 5.31: Publication Distribution by Respondents' Agreement to Funding as a Problem

Total publications	Lack of funding as a problem			
	yes		no	
	Count	%	Count	%
Low/Min (1-10)	40	26.3%	9	10.3%
Ave (11-20)	59	38.8%	21	24.2%
High/v. high (≥ 21)	53	34.9%	57	65.5%
Total	152	100.0%	87	100.0%

x^2=21.738, df.2, sig <0.01

The Table indicates that about 64% of those who acknowledged lack of funding as a problem are either minimum or average publishers and the majority who indicates no funding problem are high publishers (65.5%). There was, therefore, a difference in publication scores between those who indicated "yes" and "no" to research funding problems.

(d) Publication Productivity and Respondents' Perception of Fund Disbursement

More than half of the respondents, numbering 161 (67.6%), indicated fund disbursement as fairly efficient (Table 5.32a). Only 44 (18.5%) respondents considered research fund disbursement as either efficient or very efficient and 33 found it either inefficient or very inefficient. Of the 44 respondents who found fund disbursement as efficient, 30 were high/very high publishers.

Table 5.32a: Frequency Ratings on the Efficiency of Fund Disbursement

Efficiency in fund disbursement	Frequency	Per cent
Very inefficient	4	1.7
Inefficient	29	12.2
Fairly efficient	161	67.6
Efficient	40	16.8
Very efficient	4	1.7
Total	238	100.0

As the number of positive opinions about the efficiency of the disbursement of research fund decreases, placement in the high /very high publication group also decreases (Table 5.32b).

Table 5.32b: Publication and Perception of the Efficiency of Fund Disbursement

Total publications	Efficiency of fund disbursement					
	V.inefficient/inefficient		Inefficient		Efficient/V.efficient	
	Count	%	Count	%	Count	%
Low/Min (1-10)	3	9.1%	40	24.9%	5	11.4%
Ave (11-20)	17	51.5%	54	33.5%	9	20.5%
High/v. high (≥ 21)	13	39.4%	67	41.6%	30	68.1%
Total	33	100.0%	161	100.0%	44	100.0%

ρ^2=.137, sig.<0.03

The results indicate that those who opined that the disbursement of funds is efficient, are also those who are, generally, high publishers (ρ=.137, sig. <0.05).

5.4.6. LIBRARY SUPPORT FOR SCIENTIFIC RESEARCH

(a) Sufficiency of Library Resources for Research

Table 5.33 indicates the ratings given to respondents' opinion on the sufficiency of library resources to support their research.

Table 5.33: Ratings on the Sufficiency of Library Resources

Sufficiency of library support	**Count**	**Percentage**	**Cum. percent**
Never used/insufficient	7	2.9	2.9
Fairly sufficient	169	70.7	73.6
Sufficient /very sufficient	63	26.4	100
Total	239	100.0	

Mean= 2.23

The mean score obtained (2.23) indicates that respondents generally view their library resources as fairly sufficient. Only one respondent indicated not using the library and 6 regarded their library resources as not sufficient at all times when they need it.

(b) Research Publications and Rating of Library Resources

The rating on the sufficiency of library resources indicate that the publication productivity of respondents are not related to their ratings on the sufficiency of library resources (Table 5.34).

Table 5.34: Publications and Ratings on Library Resources

	Sufficiency of library resource for research					
	Never use/insufficient		Fairly sufficient		Sufficient/v.sufficient	
	Tot. publication		Tot. publication		Tot. publication	
	Count	%	Count	%	Count	%
Low/min(1-10)	3	42.9%	37	21.9%	9	14.3%
Ave(11-20)			61	36.1%	19	30.2%
High/v.high(=>21)	4	57.1%	71	42.0%	35	55.6%
Total	7	100.0%	169	100.0%	63	100.0%

p=.117, sig.<0.07

(c) Library Resources and Personal / Departmental Variables

Cross-tabulating respondents' rating on the library resources with respondents' affiliations, gender, race and department indicate no relationship. The library ratings are significantly related to respondents' academic rank (p=.157, n=239, sig.<0.05). The associate professors and professors are more likely to rate their library resources as either, sufficient most of the time or sufficient at all times compared to the lecturers. In general, the academic scientists find their institutional library resources fairly sufficient for their research needs.

(d) Ratings of Different Types of Library Services

The ratings of 7 types of library services are presented on a 5 point scale (1=not used to 5=very useful) in Table 5.35. The services, which achieve a mean score of more than three, are assumed to be "fairly useful". The pattern of ratings indicated by the academic scientists is fairly similar to that of the engineering respondents. The services, which obtained mean scores of more than 3 were: book loan services (3.91), photocopying services (3.86), inter-library loans (3.38), and book reservations (3.27). The least mean value obtained is for borrowing periodicals (1.44) which academic scientists did not find useful. This could be due to the fact that periodicals are not permitted for borrowing in both the institutional libraries.

Table 5.35: Usefulness of Library Services for Research Information: Academic Scientists

	Useful, V.useful			Fairly useful		Not useful, not used			
Library services	Freq.	%	Rank useful	Freq.	%	Freq.	%	Rank not useful	Mean
Book loan	229	95.8%	1	64	26.8%	10	4.2%	6	3.91
Photocopying	230	96.3%	2	74	31.0%	9	3.8%	7	3.86
Inter-library loans	111	46.5%	3	93	38.9%	35	14.7%	5	3.38
Book reservations	100	41.8%	4	102	42.7%	37	15.5%	4	3.27
Library staff search online db	80	33.5%	5	61	25.5%	98	41.0%	2	2.74
Library staff help locate sources	75	31.4%	6	86	36.0%	78	32.6%	3	2.91
Borrowing periodicals	2	.8%	7	2	.8%	235	98.3%	1	1.44

Similar to the engineering sample, the services offered by library staff have been generally found to be fairly useful or not fully used.

(e) Ratings of the Types of Library Services and Publication Productivity

Total publications. Two library services are correlated with the total publication scores (Table 5.36a). The first is "inter-library loans" (p=.140, sig.<0.05), which more than half of the high /very high publishers (56 out of 110) rated as useful or very useful.

Table 5.36a: Inter-Library Loan Ratings and Total Publication Productivity

	Tot. publication					
	Low/min(1-10)		Ave(11-20)		High/v.high(= >21)	
	Inter-library loans		Inter-library loans		Inter-library loans	
	Count	%	Count	%	Count	%
Never use/not useful	7	14.3%	17	21.3%	11	10.0%
Fairly useful	19	38.8%	31	38.8%	43	39.1%
Useful/v.useful	23	46.9%	32	40.0%	56	50.9%
Total	49	100.0%	80	100.0%	110	100.0%

p=.140, sig.<0.05

Table 5.36b indicates that the high publishers are also more likely to rate library staffs' help in searching online database as useful or very useful. The low and minimum publishers are more likely to indicate either not soliciting library staffs' help or finding it not useful.

Table 5.36b: Library Staff's Help in Searching for Information and Publication Productivity

	Lib staff search online databases					
	Never use/not useful		Fairly useful		Useful/v.useful	
	Tot. publication		Tot. publication		Tot. publication	
	Count	%	Count	%	Count	%
Low/min(1-10)	21	21.4%	12	19.7%	16	20.0%
Ave(11-20)	42	42.9%	14	23.0%	24	30.0%
High/v.high(=>21)	35	35.7%	35	57.4%	40	50.0%
Total	98	100.0%	61	100.0%	80	100.0%

p=.140, sig.<0.05

(f) The Usefulness of Library Services and Personal / Departmental Variables

Cross-tabulating the ratings on the seven types of library services with variables such as gender, number of children, and race have not found significant differences. Table 5.37 indicates the two demographic backgrounds, which are related to some or all of the ratings on the 7 library services.

Table 5.37: Ratings of Library Services and Personal / Departmental Variables

Personal/Departmental Variables	x^2	df	Crit. x^2	Sig
Affil. & Photocopying services	**12.650****	2	5.991	**.002**
Dept. & Book loan services	**33.778****	12	21.026	**.001**
Dept. & Book reservations	**59.062****	12	21.026	**.001**
Dept. & Borrowing periodicals	**29.459****	12	21.026	**.003**
Dept. & Inter-library loans	**42.401****	12	21.026	**.001**
Dept. & Prof. staff help search for sources	**32.224****	12	21.026	**.001**
Dept. & Prof. staff help search online databases	**36.450****	12	21.592	**.001**

* Sig. at the 0.05 level of significance ** Sig. at the 0.01 level of significance

Affiliation. More respondents from UM (74.8%) rated photocopying services as useful/very useful than those from UKM (53.7%) (p<0.01).

Department. The differences in the ratings are clearly indicated among the seven science departments on the usefulness of book loan services, book reservation, inter-library loans services, library staffs' help to locate sources needed for research, and the usefulness of the library staffs' help with online database searches. A total of 98 respondents indicated never seeking help from the library staff or found their help not useful and they were mostly from the departments of chemistry, geology or zoology.

Age. Academic scientists who are 41 or above are more likely to rate professional help in locating resources for research needs as either useful or very useful (p=.221, sig.<0.01). The younger respondents (age 40 or below) are more likely not to approach library staff for help or to find their help useful. This indicate the possibility that the older academic staff are more confident and aware of their right to library facilities and services, making them more likely to approach professional librarians when they need help.

Work experience. A higher percentage of those with 11 or more years of working experience indicate book loan services (p=.173, sig<0.01), as either not useful or fairly useful for their research needs, while the contrary was indicated by those with 10 or less years of working experience. A negative relationship is therefore observed. A positive relationship is indicated between those with 11 or more years of experience with inter-library loan services (p=.201, sig.<0.01), library staffs' help in locating sources (p=.163, sig.<0.05), and library staffs' help in searching online databases (p=.163, sig.<0.05). The younger respondents (10 or those with less number of years of working experience) are more likely to never use or found these services not useful.

This situation indicates that the more experienced academic scientists are more likely to utilise their library resources and services. There is a need to make known to those academics, who are younger and with fewer years of working experience, the availability of such help in order to improve research in both the institutions.

Academic rank. The associate professors and more so the professors rated positively on inter-library loans services (p=.246, sig.<0.01), library staffs' help in locating sources (p=.281, sig.<0.01), and library staffs' help in searching online databases (p=.291, sig.<0.01).

(g) Comments on Library Services

A total of 166 respondents (61.5%) gave comments on the type of library services that they would like to see improved and below is a summary of the comments.

Acquisitions. Similar to the engineering sample, the majority of the comments are concerning the acquisition of new books or periodical titles (31.9%), and the inclusion of sources in the form of full text databases. The acquisition of recent and relevant periodical titles is mentioned repeatedly, with some giving specific areas of their research that needed specific periodical titles.

Access to databases. The second most expressed need is for the availability of CD-ROM databases that both libraries should make accessible on the campus network so that search could be carried out from the faculties and departments. There is also a suggestion that the library should offer foreign online database services equivalent to BIDS at Bath University.

Administration policy. Academic scientists are also concerned with the need to increase the efficiency of the inter-library loan services, and the extension of such a service to other universities abroad so that they can obtain articles "from obscure journals".

Improvement of services. There were 11 suggestions to improve the processing, shelving of new titles and re-shelving of used journal titles to ease the locating of titles needed. There are 5 to 6 suggestions concerning improvement to the binding process of loose journals, provision of current contents service of scientific periodicals subscribed by the library and allowing the borrowing of periodicals. Some academic scientists suggest ways of improving staff-user relationships such as being more sensitive to client's need, provide search services, and be more "pro-active".

From the comments, the general resource needs of the academic scientists can be identified. The importance of journals to satisfy research needs has been much emphasized. The academic scientists consistently suggest having adequate coverage of journals especially in the area of their research. They repeatedly stress their opposition to budget cuts for periodical subscriptions, and the cancellation of journal titles. They want the journals to be processed, bound and shelved more efficiently. They want easier access to articles needed from their literature search with a more efficiently serviced inter-library loans system (nationally and internationally) and they would like to be given the option to borrow journal titles, even if it is only on an "overnight" basis. Other resources, which are important for academic scientists are the CD-ROM and online scientific databases that they want to access from their own desks.

5.4.7.LABORATORY SUPPORT AND RESEARCH PUBLICATIONS

(a) Adequacy of Laboratories for Research

Table 5.38a indicates the ratings given by the academic scientists on the sufficiency of laboratory support for research.

Table 5.38a: Ratings on the Sufficiency of Laboratory Support

Laboratory support	Count	Percentage
Never used/ insufficient	45	18.8
Fairly sufficient	76	31.8
Sufficient / v. sufficient	118	49.4
Total	239	100.0

Mean = 3.05

The respondents generally feel that they have sufficient laboratories to support their research needs. A total of 118 (49.4%) respondents indicate this, while 76 (31.86%) respondents indicated that their laboratory support is fairly sufficient. Most of the 43 respondents who indicated not using the laboratories are academic mathematicians who do not usually use laboratories to carry out their research.

(b) Publications and Rating on Laboratory Support

The results indicate that those who rated their laboratory support positively achieved higher total publication output (p=.378, sig.<0.01) (Table 4.38b).

Table 5.38b: Publication Productivity and the Usefulness of Laboratories for Research

Total publications	Sufficiency of laboratory support					
	Never used/not useful		Fairly useful		Useful/v. useful	
	Count	%	Count	%	Count	%
Low (1-10)	26	60.0%	9	11.8%	13	11.0%
Ave (11-20)	13	28.9%	31	40.8%	36	30.5%
High/ v.high	5	11.1%	36	47.4%	69	58.5%
Total	45	100.0%	76	100.0%	118	100.0%

p=.378, sig.<0.01

(c) Sufficiency of Laboratory Support and Personal / Departmental Variables

The ratings on academic scientists' affiliation status, gender and race are independent of their ratings on the sufficiency of laboratory support in research.

Departments. The results indicate that respondents from the department of physics, chemistry and zoology rated laboratory support very positively, while more of those from the departments of genetics and geology rated this only "fairly sufficient"(x^2=243.934, df.12, $p<0.01$). All academic mathematicians reported that they do not use laboratories for their research.

Table 5.38c indicates positive ratings on the adequacy of laboratory support by older academic scientists (p=.149, sig.<0.05), who most likely holds a Ph.D. (p=.180, sig.<0.01), and are either associate professors or professors (p=.156, sig.<0.05).

Table 5.38c: Sufficiency of Laboratory Support and Selected Demographic Factors

Spearman rho (p)	**Sufficiency of lab. support for research**	**Sig. (2 tailed)**
Sufficiency of lab. support for research	1.000	.
Age	**.149***	**.021**
Work experience	.064	.322
Highest academic qualifications	**.180****	**.005**
Academic rank	**.156***	**.019**

* Sig at the .05 level (2-tailed) ** Significant at the .01 level (2-tailed)

5.4.8. ELECTRONIC SUPPORT AND RESEARCH PUBLICATIONS

(a) Computer Use Amongst Academic Scientists

All academic scientists reported using the computers. Five respondents reported that they used stand-alone microcomputers, 1 indicated using networked computers and the majority, 233 respondents used both types of computers for research (Table 5.39a). A total of 237 respondents indicated that the computers they used are on their desk, 22 also used computers available within their respective departments, 4 reported using computers at the Computer Centre and 6 reported using computers in the library (Table 5.39b). A number of respondents indicated that they used computers from more than one location.

Table 5.39a: Types of Computers being Used (n=239)

Types of computers used	N	Percentage
Stand-alone microcomputers	5	2.1%
Networked computer	1	0.4%
Both	233	97.5%

Table 5.39b: Location of Computers Used (n=239)

Location of computers	N	Percentage
On own desk	237	99.2%
Computers available in the department	22	9.2%
Computers at the Computer Centre	4	1.7%
In library	6	2.5%

(b) Frequency of Computer Use and Research Publications

Two hundred and twenty-six (94.6%) academic scientists used the computers very frequently for their research, 6 (2.5%) reported using it frequently, 5 (2.1%) used it sometimes and 2 (0.8%) seldom used computers. Since the ratings on the frequency of computer use are unanimously positive, cross-tabulation with the total number and types of publications does not indicate a relationship.

(c) Types of Computer Use for Research

The academic scientists' response to 11 types of computer use is indicated in Table 5.39c.

Table 5.39c: Frequency of the Types of Computer Use (n=239)

	Frequent/very frequent			Sometimes		Seldom/never used			
Types of computer use	**Freq**	**%**	**Rank useful**	**Freq**	**%**	**Freq**	**%**	**Rank not useful**	**Mean**
Word processing	216	90.4	1	18	7.5	5	2.1	11	4.54
Send/receive e-mails	171	71.6	2	35	14.6	33	13.8	10	4.03
Information via Internet	122	51.0	3	71	29.7	46	19.3	8	3.44
Graphics	114	47.8	4	84	35.1	41	17.1	9	3.35
Create database	98	41.0	5	75	31.4	66	27.6	7	3.21
File transfer	91	38.1	6	73	30.5	75	31.4	4	3.06
Slide presentations	85	35.6	7	87	36.4	67	28.0	6	3.06
Statistical analysis	78	32.6	8	93	39.0	68	28.4	5	3.04
Search CD-ROM databases	43	18.0	9	80	33.5	116	48.5	3	2.58
Programming	67	28.0	10	36	15.1	136	56.9	2	2.44
Personal biblio-graphical Index	26	10.9	11	69	28.9	144	60.2	1	2.25

The highest usage of computers amongst the academic scientists, with mean scores of 4 or above, is for word processing (90.4%) and sending/receiving email (71.6%). Also high on the use list are using computers to obtain information via the Internet (51.0%), preparing graphics (47.8%), and creating databases (3.21). Academic scientists seldom use the computer for programming and for creating personal bibliographical index.

(d) Types of Computer Use and Research Publications

The types of computer use to support research needs were compared to respondents' total publication output. The variables, which are correlated are displayed in Table 5.39d. The results indicate that total publication scores is correlated to 7 of the 11 types of computer use: to create databases (p=.286, sig.<0.01), maintain personal bibliographical index (p=.244, sig.<0.01), word process (p=.210, sig.<0.01), create slide presentations (p=.194, sig.<0.01), send/receive e-mail (p=.176, sig.<0.01), obtain information needed for research from the Internet (p=.176, sig.<0.01), and analyse statistics (p=.139, sig.<0.05).

Table 5.39d: Types of Computer Use and Research Publications

Publications	Create database	Statis-tical analysis	Gra-phics	Word proces-sing	Slide show	Search CD-ROM db	Send/ receive email	File transfer	Infor via Internet	Perso-nal bib index	Program-mming
Total pub.	**.286****	**.139***	.122	**.210****	**.194****	-.021	**.176****	.068	**.176****	**.244****	-.095
Sig. (2 tailed)	**.001**	**.032**	.059	**.001**	**.003**	.751	**.006**	.294	**.006**	**.001**	.141

* Sig at the 0.05 level of significance ** Sig at the 0.01 level of significance

(e) Types of Computer Use and Selected Personal / Departmental Variables

Only correlated results at the 0.05 level are reported (Table 5.40a). The personal variables such as respondents' gender and race are independent of the ratings on the types of computer use.

Table 5.40a: Types of Computer Use and Personal / Departmental Variables

Affiliation	x^2	df	Crit. x^2	Sig
Affil. & send/receive e-mail	**10.354***	4	9.488	**.035**
Affil. & access information via the Internet	**10.190***	4	9.488	**.037**
Affil. & programming	**11.497***	4	9.488	**.022**
Department	x^2	df	Crit. x^2	Sig
Dept. & create database	**60.268****	24	36.415	**.001**
Dept. & statistical analysis	**41.762****	24	36.415	**.014**
Dept. & word processing	**39.926****	24	36.415	**.002**
Dept. & preparing slide shows	**73.753****	24	36.415	**.001**
Dept. & search databases on CD-ROMs	**64.834****	24	36.415	**.001**
Dept. & send/receive e-mail	**55.617****	24	36.415	**.001**
Dept. & file transfer	**73.467****	24	36.415	**.001**
Dept. & access information via the Internet	**57.444****	24	36.415	**.001**
Dept. & personal bibliographical index	**61.557****	24	36.415	**.001**
Dept. & programming	**136.093****	24	36.415	**.001**

* Sig at the 0.05 level of significance ** Sig at the 0.01 level of significance

Affiliation. The respondents' affiliation is related to three types of computer use: sending/ receiving email (x^2 =10.354, df=4, p<0.05), locating information from the Internet (x^2 =10.190, df=4, p<0.05) and programming (x^2 =11.497, df=4, p<0.05) (Table 5.40a). In all the three instances, the academic scientists from UM are likely to rate more positively on the three types of computer use.

Department. Cross-tabulating the respondents' ratings on the types of computer use from the various departments with personal / departmental variables indicate a difference on ten of the eleven types of computer used for research (Table 5.40a).

Age. The older academic scientists rate positively on the use of computers for word processing (p=.132, sig<0.05) and preparing slide presentations to disseminate research result (p=.130, sig<0.05) (Table 5.40b).

Table 5.40b: Computer Use and Personal/Department Variables

Publications	Age	Work experience	Academic rank	Time allocated for research
Create database	.114	.097	**.143***	.017
Sig (2 tailed)	.078	.136	**.027**	.793
Graphics	.039	**.134***	.052	-.018
Sig (2 tailed)	.550	**.038**	.422	.785
Word processing	**.132***	**.164***	.099	.069
Sig (2 tailed)	**.042**	**.011**	.129	.285
Slide shows	**.130***	**.204****	**.167****	.103
Sig (2 tailed)	**.045**	**.001**	**.010**	.111
Send/receive email	.006	.001	.111	**.134***
Sig (2 tailed)	.922	.985	.087	**.038**
Infor via internet	-.056	-.008	**.147***	.051
Sig (2 tailed)	.392	.908	**.023**	.431
Programming	-.062	-.099	.015	**.163***
Sig. (2 tailed)	.337	.127	.812	**.012**

* Sig. at the 0.05 level of significance ** Sig. at the 0.01 level of significance

Work experience. The more professionally experienced scientists rated very positively on the use of the computer for word processing (p=.164, sig.<0.05), preparing graphics for data presentation (p=.134, sig.<0.05) and preparing slide shows (p=.204, sig.<0.01).

Academic rank. Academic scientists who have attained higher academic rank are more likely to use computers frequently for creating databases, preparing slide shows and looking for information in the Internet.

Time allocated to research. Those who spent more time on research are more likely to use computers for sending/receiving emails and programming.

5.4.9.COLLABORATION AND RESEARCH PUBLICATIONS

(a) Collaboration Behaviour of Academic Scientists

Table 5.41 indicates the frequency of responses to four types of collaborative behaviour. In general, most academic scientists in this sample do not collaborate as 169 out of 239 (70.7%) of them indicated that they often or always undertake research on their own. Of those who collaborate, 125 (52.3%) indicate participating in it often or always collaborating with colleagues within their own department, 67 (28.1%) with colleagues from other university, and 49 (20.5%) with researchers outside the country. A few are involved in other types of collaboration and they only undertake such collaboration with research students or with industrial agencies. When asked about their collaborative roles, 78.7% (n=188) of respondents indicate they are equal partners with their collaborators, and 21.3% (n=51) are heads of the collaborative team.

Table 5.41: Frequency of the Types of Collaborative Behaviour

Types of Collaboration	Never	Hardly ever	Some-times	Often	Always	Mean
Collaborate with colleagues within the same department / university	3 1.%	18 7.5%	93 38.9%	80 33.5%	45 18.8%	3.61
Collaborate with colleagues at other university	23 9.6%	46 19.2%	103 43.1%	53 22.2%	14 5.9%	2.95
Collaborate with researchers outside the country	40 16.7%	54 22.6%	96 40.2%	38 15.9%	11 4.6%	2.64
Other types of collaboration	- -	- -	3 27.3%	2 18.2%	6 54.5%	4.27

(b) Types of Collaboration and Research Publications of Academic Scientists

The frequency ratings on 5 types of research behaviour are compared with respondents' total and types of publication productivity. The correlated results are tabulated in Table 5.42.

Table 5.42:Publication Output and Ratings on Collaboration Situations

Spearman's rho	Research by myself	Collaborate with colleagues within same dept./univ.	Collaborate with colleagues at other universities	Collaborate with researchers outside the country	Other types of collaboration
Total publications	-.016	.194**	.327**	.372**	.366
Sig (2-tailed)	.803	.003	.001	.001	.268

* Correlation is sig at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

Those who achieved high/very high publication productivity are more likely to collaborate with colleagues within their departments or universities (p=.194, sig.<0.01), with colleagues at other universities (p=327, sig<0.01) and researchers from other country (p=.372, sig.<0.01). The results indicate that not all types of collaborative behaviour are related to the total research publication output. The recurrent behaviour that correlates to a high number of publication situations are "collaboration with colleagues from other universities" and "collaboration with researchers outside the country". As such, these two situations appear to be possible determinants of publication productivity.

(c) Ratings on the Collaborative Situations and Personal / Departmental Variables

Affiliation. Academic scientists from UM collaborate sometimes (48.9%) or often (22.1%) with researchers from other countries, compared to those from UKM, where 51.9% indicated hardly ever or never undertaking such collaboration (x^2=13.680, df2, p<0.001). (Table 5.43a).

Department. The variable "department " is also related to collaborative situations such as, collaboration with colleagues in own department or university (x^2 = 27.533, df.12, p<0.001), with researchers from other universities (x^2 = 50.474, df.12, p<0.001) and with researchers from abroad (x^2 = 45.002, df.12, p<0.001).

Table 5.43a: Ratings of Types of Collaboration and Personal / Departmental Variables

Personal/Departmental Variables	x^2	df	Crit. x^2	Sig
Affil. & collab. /researchers outside country	**13.689****	2		**.001**
Dept. & collab. /colleagues within departments	**27.533****	12		**.006**
Dept & collab/colleagues other universities	**50.474****	12		**.001**
Dept & collab. /researchers outside country	**45.002****	12		**.001**

* Sig at the .05 level (2-tailed) ** Significant at the .01 level (2-tailed)

The academic scientists who reported collaborating often with colleagues from other universities are the chemists (29.9%) and the geneticists (19.4%). The majority of scientists who reported having hardly any or no collaboration are the mathematicians (30.4%) and the geologists (18.8%). The majority of academic scientists collaborate with other universities only sometimes (x^2 = 50.474, df.12, p<0.001)

Those who collaborate with researchers outside the country are again the chemists (42.9%) and geneticists (19.4%). A larger number of the mathematicians (30.4%) and geologists reported having hardly any or no collaboration with colleagues from abroad (χ^2=45.002, df2, p<0.001).

Age. Table 5.43b) indicates that those who are older are more likely to undertake a higher degree of collaboration with colleagues within the department or university (p=.169, sig.<0.01), with colleagues from other universities (p=.218, sig.<0.001), and researchers outside the country (p=.192, sig.<0.01).

Table 5.43b: Demographic Variables and Ratings on Five Collaborative Situations

Spearman's rho	Research by myself	Collaboration / colleagues within dept./univ.	Collaboration/ colleagues other universities	Collaboration /researchers outside country	Other collaboration
Age	-.010	**.169****	**.218****	**.192****	.409
Sig (2-tailed)	.883	**.009**	**.001**	**.003**	.211
Work experience	-.025	**.169****	**.227****	.124	**.631***
Sig (2-tailed)	.697	.009	**.001**	.056	**.037**
Academic Qualif.	.045	.080	**.148***	**.185****	.442
Sig (2-tailed)	.486	.217	**.022**	**.004**	.173
Rank	-.032	.192**	**.300****	**.337****	-.452
Sig (2-tailed)	.620	.003	**.001**	**.001**	.163
Percent time on res.	-.040	.069	.107	**.145***	-.044
Sig (2-tailed)	.542	.292	.099	**.025**	.898

* Correlation is sig at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

Work experience. The academic scientists with more years of working experience (16 years and above) collaborate with colleagues within their department or university (p=.169, sig.<0.01) and colleagues from other universities (p=.227, sig.<0.001).

Academic qualifications. Those who have a Ph.D. tend to collaborate more with colleagues from other universities (p=.148, sig.<0.05) and from outside the country (p=.185, sig.<0.01).

Academic rank. Those who are higher in academic rank tend to collaborate more with their colleagues within their departments or university (p=.192, sig.<0.01), colleagues from other universities (p=.300, sig.<0.001) as well as colleagues from outside the country (p=.337, sig.<0.001).

Time spent on research. This factor is not related to most collaborative behaviour except collaboration with researchers outside the country (p=.145, sig.<0.05).

The results indicate that the three types of collaborative behaviour, which are related to publication productivity, are collaboration within departments and university, collaboration undertaken with other universities and collaboration with researchers outside the country. The academic scientists who exhibit this collaborative behaviour tend to achieve high total publication productivity, especially in joint-authored works, conference papers and journal articles. They also tend to be older, more experienced, with a Ph.D. and are of associate or full professorial status. Those who often undertake research alone and seldom collaborate are more likely to be placed in the average publication group.

5.4.10. ACADEMIC SCIENTISTS' VIEWS ON RESEARCH AND THEIR PUBLICATION PRODUCTIVITY

(a) Type of Views on Research

Academic scientists are presented with seven types of research views and are required to give their ratings on a 5-point Likert scale ranging from 1= not true to 5= very true. Table 5.44 indicates the frequency ratings on all seven statements.

Table 5.44: Frequency Ratings on the Seven Views on Research

Research Views N=239	Not true	Quite untrue	Fairly true	True	Very true	Total true/ v.true	Mean
Advance knowledge			10	51	178	229 95.8%	4.70
Adds to reputation	1	1	15	40	182	222 92.8%	4.68
Opportunity to present papers	1	3	23	65	147	212 88.7%	4.48
Enhances career opportunity	4	4	18	58	152	210 87.8%	4.45
Gives prestige to department & university	2	4	24	64	145	209 87.4%	4.45
Gives self prestige & respect	1	6	39	57	136	193 80.7%	4.34
Opportunity to develop products	12	29	87	29	82	111 46.4%	3.59

A higher number of academic scientists rated "true"/"very true" on: research as a means of advancing knowledge (95.8%, 229), research activity helps to add to one's reputation as a scientist (92.8%, n=222), and the results from research activity provided them with opportunities to present papers at conferences (88.7%, n=212). Over 70% of the respondents agree that research increases their prestige and respect as well as helps to enhance their career opportunity. Fewer respondents think that their research activities help to increase the prestige of their departments or universities and provide them with an opportunity to develop new products.

(b) Publication Output by Strength of Views on Research

Research scientists' total publication scores were cross-tabulated with their ratings on the seven research-view statements to find out whether the variables are correlated.

Adds to reputation. A total of 222 (92.8%) academic scientists strongly agree that research helps to improve their reputation. Out of these, 106 (47.7%) are in the high/very high publication group, 76 (34.2%) are average, and 4 (18.0%) are low/minimum publishers ($\rho = .237$, sig. < 0.01).

Advances knowledge. The view that research helps to advance knowledge is accepted by over 95% of academic scientists who rated this statement as true or very true. Out of this group, 108 (47.2%) are "high/very high" publishers, 77 (33.6%) are average and 44 (19.2%) are low/ minimum publishers ($\rho = .192$, sig. < 0.01). None of the academic scientists adopted negative views.

Self- prestige and respect. Only 7 out of 239 academic scientists rated negatively on the statement that research gives individual prestige and respect. Of the 193 respondents who indicate this statement as true/very true, 90 (46.6%) are placed in the high publication group, 67 (34.7%) are in the average and 36 (18.77%) in the low publication groups ($\rho = .150$, sig. < 0.01).

Department/university prestige. A total of 209 respondents agree that research gives their respective departments and universities prestige. Out of this, 97 (46.4%) respondents are placed in the high/very high, 69 (33.0%) in the average and 43 (20.6%) in the low publication groups ($\rho = .150$, sig. < 0.01).

Opportunity to develop products. Even though only 111(46%) of academic scientists indicated that research provides them the opportunity to develop products, a high percentage (63, 56.8%) of those in this group are high publishers, 34 (30.6%) average and 14 (12.5%) low publishers ($\rho = .193$, sig. < 0.01).

Enhance career prospects. Of the 210 respondents who rated this statement as true/very true, 96 (45.7%) are high, 72 (34.3%) average and 42 (20.0%) low publishers (ρ =.117, sig. <0.07).

Opportunity to present papers. A total of 212 respondents rated this statement as true and of these 101 (47.6%) are high publishers, 72 (34.0%) average and 36 (18.4%) low publishers (ρ = .193, sig. < 0.01).

(c) Research Views and Selected Personal and Academic Variables

Departments. There are variations in the ratings on 5 out of the 7 research-view statements among the academic departments. Generally, academic botanists, chemists, mathematicians, and physicists almost never rated the research statements negatively (not true). The academic chemists consistently rated all the five related research statements as "very true", making the chemistry department the one which almost always agrees on the positive effect of the research outcome statements (Table 5.45).

Table 5.45: Views on Research and Personal / Academic Background

Variables	x^2	df	Critical x^2	Sig. (2 tailed)
Dept. &Research advances knowledge	**24.664***	12	21.026	**.016**
Dept. & Research gives self- prestige and respect	**65.499****	24	36.415	**.001**
Dept. & Research gives department / university prestige	**68.850****	24	36.415	**.001**
Dept. & Research helps enhances career prospect	**45.219****	24	36.415	**.005**
Dept. & Research gives opportunity to develop products	**69.825****	24	36.415	**.001**
Dept.& Research gives opportunity to present papers at conferences	27.210	24	36.415	.295

*Significant at the .05 level (2-tailed) ** Significant at the .01 level (2-tailed)

Age. A higher percentage of those respondents who are 51 years or older rate this statement as true/very true (26 out of 28, 93%) (p=.141, sig.< 0.05).

Academic rank. A higher percentage of professors rated that research "adds to reputation" (p=.138, sig.< 0.05) as true/very true (32 out of 33, 97.0%) compared to associate professors (112 out of 117, 95.7%) and lecturers (78 out of 89, 87.6%).

About 19 out of 33 (57.6%) of the professors agree with the statement that research gives them the opportunity to develop products compared to 62 out of 117 (53.0%) associate professors and 30 out of 89 (33.7%) lecturers (p=.178, sig.< 0.01). A higher number of lecturers rated this statement as not true compared to those in the higher academic rank.

Respondents' length of working experience, their academic qualifications, the percentage of time they allocate to research, the time elapsed since they obtain their highest academic qualification and the country from where the qualification was obtained, are not related to attitudes towards research.

5.4.11. ACADEMIC SCIENTISTS' VIEWS OF THEIR DEPARTMENTAL ENVIRONMENT AND THEIR PUBLICATION PRODUCTIVITY

(a) Views on the Departmental Environment for Research

Academic scientists do not regard their teaching and administration load as deterrents to undertaking research. One hundred (41%) academic scientists rated the statement that their teaching load does not deter their research activity (Table 5.46). Ninety-nine (41%) scientists indicated that they discuss research matters with colleagues within their departments, while 93 (39%) felt their department was very research-oriented, 87 (36%) indicated that they read what their colleagues have written and 62 (26%) said that their departments arranged useful seminars to discuss current research.

In general, the mean score of the ratings on each of the seven departmental environment statements ranges from 2.87 to 3.37, indicating that the academic scientists "fairly agree" with the seven departmental statements put to them.

Table 5.46: Frequency Ratings on the Seven Departmental View Statements

Departmental Views N=239	Not true	Quite untrue	Quite true	True	Very true	Total true/ v.true	Mean
Teaching/administration load does not deter research	23	72	44	64	36	100 41.8%	3.28
Discuss research matters with colleagues	8	37	95	81	18	99 41.4%	3.27
Dept. highly research oriented	6	20	120	65	25	93 38.9%	3.37
Read colleagues publications	11	40	101	62	25	87 36.4%	3.21
Dept. arranges useful seminars	11	44	122	53	9	62 25.9%	3.02
Colleagues encourage scholarly endeavor	16	59	119	35	10	45 18.8%	2.85
Colleagues are prolific writers	12	47	136	39	5	44 18.5%	2.91

(b) Publications by Strength of Views on Departmental Environment

The respondents' publication scores (5 categories) were cross-tabulated with their ratings on departmental views (5-point scales) to find out whether the variables are correlated.

The total publication productivity is correlated to two types of departmental situations posed to respondents. Those who are high/very high publishers agree that their departments arrange useful seminars (p=.160, sig.< 0.05) and they read their colleague's research publications (p=.145, sig.< 0.05).

The results indicate that departmental environment is not a very strong factor in influencing the total publication productivity.

(c) Departmental Views and Selected Personal and Academic Variables

Affiliation. Table 5.47 indicates that a higher percentage of respondents from UKM rated on the statement "discuss research with colleagues" very positively (49 out of 108, 45.4%) compared to those from UM (50 out of 131, 38.2%) (x^2=14.794, df.4, p<0.01).

A higher percentage of respondents from UKM agreed that the teaching/administration load allocated to them does not deter their research activities (57 out of 108, 47.2%) and a higher number of those from UM disagreed with this statement (65 out of 131, 49.6%). The results indicate a difference in the rating behaviour on this statement (x^2=15.453, df.4, p<0.01).

Departments. About 93 respondents agree with the statement that their departments are highly research-oriented and out of these 30 are chemists, 17 are botanists and 15 are geneticists. The ratings of the respondents from the other departments converge on the "quite true" scale (x^2=83.755, df.24, p<0.01).

Table 5.47: Departmental Research Environment and Personal / Academic Background

Variables	x^2	df	Critical x^2	Sig. (2 tailed)
Affiliation and Discuss research with colleagues	**14.794****	4	9.488	**.005**
Affiliation and Teach/admin load does not deter research	**15.453****	4	9.488	**.004**
Dept. and Dept highly research oriented	**83.755****	24	36.415	**.001**
Dept and Colleagues are prolific writers	**71.742****	24	36.415	**.001**
Dept and Discuss research with colleagues	**38.549****	24	36.415	**.030**
Dept and Dept arranges useful seminars	**40.407****	24	36.415	**.019**
Dept and Coll. encourage scholarly activities	**65.578****	24	36.415	**.001**
Dept and Teach/admin load does not deter research	**69.045****	24	36.415	**.001**
Dept and Read colleagues publications	**47.464****	24	36.415	**.003**

* Significant at the .05 level (2-tailed) ** Significant at the .01 level (2-tailed)

A total of 44 respondents agree with the statement that their colleagues are prolific writers and out of this, the highest number comes from the chemistry department (23). About 17% of academic geologists totally disagree with this statement, while the majority of respondents in the various departments rated "quite true" on this statement. The results indicate a significant difference in the rating pattern of respondents in the various departments with regard to respondents' perceptions of their colleagues' publication performance (x^2=71.742, df.24, p<0.01).

The respondents from the departments of botany (15), chemistry (28) and genetics (14) record the highest agreement that they are more likely to discuss their research activities with their colleagues compared to those from the other departments (x^2=38.549, df.24, p<0.03).

A total of 62 respondents totally agree that their department held useful research seminars, and again the highest number comes from the chemistry (18), botany (11) and genetics (10) departments. A high number of disagreement comes from the departments of physics (10) and geology (9). The results indicate that there are significant differences in the ratings given by respondents from the various departments (x^2=40.407, df.24, p<0.01).

About 45 respondents indicate total agreement with the statement that their colleagues are supportive and out of this group, the highest number comes from the departments of chemistry (15) and genetics (13). The majority of those who disagree come from the geology (18) and mathematics department (18). The results indicate that there are definitely significant differences in the ratings given to the 7 departmental views by respondents from the various departments (x^2=65.578, df.24, p <0.01).

A total of 100 respondents agree that the percentage of time allocated for research does not affect their research activities. Again, the highest number in this group comes from the chemistry (18), physics (16) and zoology (15). A higher number of mathematicians (27) and chemists (18) disagreed with this statement. The results indicate a significant difference in the rating behaviour (x^2=69.045, df.24, p<0.01).

Eighty-seven academic scientists indicated that they read their colleagues' publications. The highest number in this group comes from the chemistry (20) and physics (16) departments, while a higher number of those who disagreed are mathematicians and geologists. The results again indicate a significant difference in the rating behaviour (x^2=47.464, df.24, p <0.003).

Race. The personal variable "race" is correlated to four statements, and these are: "Dept. are highly research-oriented" (x^2=26.408, df.12, p <0.001), "Colleagues are prolific writers" (x^2= 40.196, df.12, p.<0.01), "Discuss research with colleagues" (x^2=35.502, df.12, p<0.01) and "Read colleagues publications" (x^2=21.712, df.12, sig.<0.04). In all cases, the Malay academics tend to rate more positively than the academics from other racial groups.

Working experience, qualifications and rank. Those with less number of years of working experience agree that their colleagues are prolific authors (p=-.172, sig.< 0.01) and those with higher academic qualifications tend to read their colleagues' publications (p=-.168, sig.<0.01). Associate professors or professors are more likely to agree that their departments arrange useful seminars (p=-.163, sig.< 0.05).

Per cent time on research. Those who spent more time on their research indicated that teaching and administration load does not deter their research (p=.132, sig.< 0.05).

5.4.12. VIEWS ON INSTITUTIONAL SUPPORT AND PUBLICATION OUTPUT

(a) Views on Institutional Support for Research

Similar to the responses obtained from academic engineers, the academic scientists rated fairly positive on the computing facilities provided by their institutions (Table 5.48). One hundred and seventy-five (73.2%) respondents rated the computing facilities as good or excellent, indicating a fairly high mean of 3.90. Respondents rated the other seven institutional support statements as fairly useful. A total of 97 (40.6%) respondents thought that support for presenting papers at local conferences was either good or excellent. Eighty-two (34.3%) and 67 (28.0%) respondents respectively rated very positively on the quality of library resources and laboratories available to them. In most cases, except for the computing facilities, the majority of respondents rated "fair" on the facilities or services presented to them. The factors that received the highest "bad" ratings are the quality of laboratory and research assistants (47.3%) and support for presenting papers abroad (44.4%). Adequate startup support is rated as fair by more than 47% of respondents.

The results indicate that academic scientists from both UKM and UM acknowledge the adequacy of basic facilities such as the library and laboratories for research needs. The majority of respondents, however, felt that the quality of future researchers in terms of research students was not satisfactory and likewise, the financial support to present research results abroad.

Table 5.48: Frequency Ratings on the Eight Institutional View Statements

Institutional Views N=239	Bad	Fairly bad	Fair	Good	Excellent	Total good / excellent	Mean
Quality of computing facilities	-	11	53	124	51	175 73.2%)	3.90
Support for presenting papers locally	8	29	105	81	16	97 (40.6%)	3.28
Adequate startup support	7	35	113	69	15	84 (35.0%)	3.21
Quality of library resources	2	14	141	77	5	82 (34.3%)	3.29
Provision of quality laboratories	4	29	139	57	10	67 (28.0%)	3.17
Quality research students	7	41	145	46	-	46 (19.2%)	2.96
Support for presenting papers abroad	27	79	99	28	6	34 (14.2%)	2.61
Quality lab. Assistants	34	79	110	16	-	16 (6.7%)	2.45

(b) Publication Distribution by Institutional Views

The results of the ratings on the eight institutional support views are cross-tabulated with respondents' publications. The results indicate that total publication is not correlated to any of the ratings given to institutional support statements listed.

(c) Institutional Support and Personal / Academic Variables

Affiliation. Table 5.49 indicates that there is a difference between respondent's affiliation status and their ratings on institutional support such as "adequate start-up support" (x^2=9.870 ,df 2, $p <0.01$), support for presenting papers locally (x^2=6.259, df 3, $p <0.05$), and abroad (x^2=8.478, df 2, $p <0.05$). Academic scientists from UM do not seem as happy with the startup support provided to them compared with those from UKM. About 42 respondents rated this support as bad or not good, of which 32 (76.2%) are from UM compared to 10 (23.8%) from UKM. With regards to "presenting papers locally", a higher percentage of the academic scientists from UM (60, 61.9%) rated this support as good or very good, compared to those from UKM (37, 38.1%). The situation is quite similar to the ratings on "support for presenting papers abroad" which indicated that a higher percentage from UM appears to rate this as good or excellent (22 out of 34, 64.7%) compared to those from UKM (12, 35.3%).

Departments. There are significant differences in the ratings of 7 institutional support statements and respondents' department (Tabl4 5.49).

Table 5.49: Views on Institutional Support for Research and Personal / Academic Variables

Variables	X^2	df	Critical x^2	Sig. (2 tailed)
Affil & adequate startup support	**9.870****	2	5.991	**.008**
Affil. & support for presenting papers locally	**6.259***	2	5.991	**.044**
Affil. & support for presenting papers abroad	**8.478***	2	5.991	**.014**
Dept. & adequate startup support	**45.562**	12	21.026	**.001**
Dept. & support for presenting papers locally	**33.344**	12	21.026	**.001**
Dept. & support for presenting papers abroad	**23.295**	12	21.026	**.025**
Dept. & provide quality labs.	**39.705**	12	21.026	**.001**
Dept. & quality research students	**31.865**	12	21.026	**.001**
Dept. & quality library resources	**43.104**	12	21.026	**.001**
Dept. & quality computing facilities	**36.819**	12	21.026	**.001**

* significant at the .05 level (2-tailed) ** Significant at the .01 level (2-tailed)

Age. The academic scientists who are older tend to rate the quality of laboratory support for research positively (p= 217, sig.< 0.01) (Table 5.50).

Academic rank. The associate professors and professors rated positively (good / excellent) on the following institutional support: support for presenting papers locally (p= 156, sig.< 0.05 level), support for presenting papers abroad (p= 177, sig.< 0.01 level), provision of quality laboratories (p= 165, sig.< 0.05 level) and provision of quality laboratory assistants (p= 148, sig. <0.05 level).

Table 5.50: Selected Demographic Variables and the Institutional Views Statements

Spearman's rho (p) n=239	Support for presenting papers locally	Support for presenting papers abroad	Quality labora-tories	Quality library resources	Quality compu. facilities
Age	.050	.104	**.217****	.118	-.010
Sig (2-tailed)	.441	.110	**.001**	.069	.881
Work experience	.105	.125	.179**	**.176****	-.060
Sig (2-tailed)	.105	.054	**.006**	**.006**	.357
Academic rank	.156*	.177**	.165*	**.148***	..041
Sig (2-tailed)	**.016**	**.006**	.011	**.023**	.527
Percent time on research	-.059	-.096	-.007	-.031	**.168****
Sig (2-tailed)	.360	.137	.911	.629	**.009**

* Correlation is sig at the .05 level (2-tailed) ** Correlation is significant at the .01 level (2-tailed)

Work experience. The academic scientists who have more years of working experience (5 or more years) indicated satisfaction with the laboratories and laboratory assistants, while those with fewer years of working experience rated this facility as either not good or bad. A similar rating pattern is indicated for "provision of quality assistants". Those with more than 10 years of working experience (32 out of 46) rated that the quality of their research student as good or excellent, compared to 16 of those below ten years of working experience.

The academic scientists who allocate a higher percent of their time on research also rated quality of computing facilities as good or excellent (p= 168, sig. 0.01 level).

5.4.13. CHANNELS OF INFORMATION USED: FORMAL CHANNELS

The aim of this section is to establish the frequency of use of formal information sources for research and its correlation to publication productivity.

(a) Formal Channels: Frequency of Use for Research

The results of the rating of 13 formal channels are given in Table 5.51. There was unanimous agreement on the usefulness of journals as a channel of information needed for research and over 99% rated journals as either useful or very useful. This is followed by conference proceedings (rated as useful/very useful by 83.7% of academic scientists) and research reports (rated as useful by 79.5% scientists). Five formal channels received "fairly useful" ratings and these are: books (68.2%), indexes/abstracts/ bibliographies (66.8%), online/ CD-ROM databases (64.8%), Internet (58.5%) and the library catalogue (34.7%).

Table 5.51: Frequency Ratings on the Thirteen Formal Channels of Information

Formal channels N=239	Never used	Not useful	Fairly useful	Useful	Very useful	Total useful/ v.useful	Mean
Journals	-	1	1	31	206	237 (99.2%)	4.85
Research reports	1	7	41	108	82	190 (79.5%)	4.10
Conference proceedings	-	4	35	152	48	200 (83.7%)	4.02
Books	1	1	74	99	64	163 (68.2%)	3.94
Indexes/abstracts/bibs.	2	12	66	96	63	159 (66.8%)	3.86
Online /CD-ROM databases	12	9	63	93	62	154 (64.8%)	3.77
Internet	12	16	71	73	67	140 (58.5%)	3.70
Library catalogues	15	28	113	56	27	83 (34.7%)	3.22
Reference librarian	43	35	107	42	12	54 (32.6%)	2.77
Library's accessions list	43	63	78	43	12	55 (23.0%)	2.66
Standards/specifications	54	49	96	31	9	40 (16.8%)	2.55
Bookstores	46	87	68	32	6	38 (15.9%)	2.44
Patents	90	69	54	17	9	26 (10.9%)	2.10

Channels which academic scientists find less useful are: the reference librarian, library accessions list, standards and specifications, and least of all, the bookstores and patents.

(b) Publication Distribution by Formal Channels Preferred

The respondents' ratings on the 13 formal channels were cross-tabulated with the total publication scores. Of the 13 formal channels of information rated, only one channel has a positive and significant correlation with the total publication score (Table 5.52), and this is the use of library accessions list (p=.289, sig. <0.01 level).

Table 5.52: Ratings on the Library's Accessions List and the Total Publication Productivity

Total publications	Library's accessions list									
	Never used		Not useful		Fairly useful		Useful		Very useful	
	Count	%	Count	%	Count	%	Count	%	Count	%
Low/min (1-10)	16	37.2%	15	23.8%	9	11.5%	8	18.6%	1	8.3%
Ave (11-20)	16	37.2%	25	39.7%	27	34.6%	10	23.3%	2	16.7%
High/v. high (≥21)	11	25.6%	23	36.5%	42	53.8%	25	58.1%	9	75.0%
Total	43	100.0%	63	100.0%	78	100.0%	43	100.0%	12	100.0%

p=.289, sig. <0.01 level

In general, the respondents' use of other formal channels does not indicate a distinctive pattern and is not related to the total number of publication productivity.

(c) Formal Channels of Information and Selected Departmental / Academic Variables

The results indicate that the respondent's age, work experience, academic qualifications, academic rank, and percentage of time spent on research, are not related to the use of formal channels to obtain information needed for research.

Affiliation. The results indicate that affiliation is related to respondent's rating on the usefulness of conference proceedings (x^2= 10.052, df. 3, $p<0.05$), and significantly to the use of the Internet (x^2= 13.477, df. 4, $p<0.01$) in providing information needed for research (Table 5.53).

Departments. Table 5.53 also indicates that there are differences in the ratings ($p<0.05$) between the various departments on the usefulness of four channels for research comprising research reports, journals, books, library catalogues and indexes/abstracts/bibliographies. The ratings are significantly different (<0.01) for channels such as, the reference librarian, online CD-ROM databases, library accessions list, standards/specifications, the Internet, bookstores, and patents. In most cases those from the chemistry, mathematics, genetics, and geology departments rated more on the "very useful" scale.

Table 5.53: Ratings on Formal Information Channels and Research Publications

	x^2	df	Crit. Value (0.05)	Sig (2 tailed)
Affiliation & conference proc.	10.052**	3	7.815	.018
Affiliation & Internet	13.477**	4	9.488	.009
Dept & journals	32.382*	18	28.869	.020
Dept & books	38.764*	24	36.415	.029
Dept & research reports	37.929*	24	36.415	.040
Dept & library catalogues	80.471**	24	36.415	.001
Dept & reference librarian	70.340**	24	36.415	.001
Dept & online CD-ROM db	77.855**	24	36.415	.001
Dept & indexes/abstr/bibs	41.674**	24	36.415	.014
Dept & library accessions list	52.575**	24	36.415	.001
Dept & standard/specific.	51.389**	24	36.415	.001
Dept & Internet	43.852**	24	36.415	.008
Dept & bookstores	50.426**	24	36.415	.001
Dept & patents	67.684**	24	36.415	.001
Gender & conference proc.	8.964*	3	7.815	.030
Race & journals	18.266*	9	16.919	.032
Race & research reports	29.213**	12	21.026	.004
Race & reference librarian	22.337*	12	21.026	.038

* significant at the 0.05 level (2-tailed) ** significant at the 0.01 level (2-tailed)

Gender. Gender is not related to all but one of the formation channels, and this channel is conference proceedings ($x^2 = 8.964$, df 4, $p<0.05$).

Race. The variable, race is related ($p<0.05$) to three formal channels which include, the use of research reports, approaching the reference librarian for help, and using journals.

Library catalogues and percentage of time spent on research. Those who found library catalogues useful normally spent 21-30 per cent of their time on research, while those who spent more than 31 percent of their time on research tended to rate this channel as either fairly useful or not useful (p=-.151, sig. <0.05).

Reference librarian. Those who indicated that reference librarians are useful are also those who are in the older age group ((p=-.191, sig. <0.01), have longer working experience (p=-.171, sig. <0.01), and qualified with Ph.D. (p=-.199, sig. <0.01). The may imply that the more experienced researcher need a more specialised and personalised service.

Patents. A higher percentage of those under 10 years of working experience and who spent under 21 hours on research rated patents as useful or very useful for research information (p=-.164, sig. <0.05 and p=-.152, sig. <0.05 respectively

On the whole, academic chemists, mathematicians, and geneticists, tend to rate most of the channels useful. Academic scientists' age, work experience and ranks are more likely to be related to the ratings on library services and reference librarians as useful.

5.4.14. CHANNELS OF INFORMATION USED: INFORMAL CHANNELS

(a) Informal Channels: Frequency of Use for Research

Table 5.54 indicates that the ratings of the 8 informal channels are fairly similar to those obtained from the academic engineers. E-mailing colleagues was rated highly by most respondents (m=4.05). This is followed by discussion at conferences (m=3.98), corresponding with fellow researchers (m= 3.59), dialogues with colleagues within the respective departments (m=3.57), dialogues with colleagues from other departments within the same university (m=3.45), dialogues with colleagues from other universities (m=3.44), telephone conversation (m=3.08) and faxing colleagues outside the university (m=3.03).

When the useful or very useful scales are observed, discussion at conferences emerged as the most useful channel (79%), followed closely by e-mailing colleagues (73.2%).

Table 5.54: Ratings on the Informal Channels of Information Used for Research

Informal channels	Never use	Not useful	Fairly useful	Useful	Very useful	Total useful/ v.useful	Mean
E-mail colleagues	5	-	59	88	87	175 73.2%	4.05
Discussion at conferences	3	5	42	133	56	189 79.0%	3.98
Correspondence/letters	17	8	73	99	42	141 59.0%	3.59
Dialogues with colleagues within dept.	5	19	88	89	38	127 53.1%	3.57
Dialogues with colleagues from other dept.	13	18	88	89	31	120 50.2%	3.45
Dialogues with colleagues from other universities	16	13	92	85	33	118 49.4%	3.44
Telephone conversation	23	27	110	66	13	79 33.0%	3.08
Fax colleagues outside university	44	22	78	73	22	83 34.7%	3.03

(b) Publication Distribution by Formal Channels Preferred

Academic scientists' ratings on the 8 informal channels used for research (from not used to very useful, on a 5-point scale) are cross-tabulated with their publication scores. Results, which reach 0.05 level of significance, are reported.

The results indicate that high /very high publishers are more likely to rate correspondence (p = .241, sig<0.01) and faxing colleagues outside the university (p = .228, sig<0.01) as either useful or very useful.

The results indicate that, although respondents heavily use e-mail heavily, it is not related to their publication productivity. It is corresponding, faxing facilities and discussions at conferences, which seem to be related to research publication productivity. The types of publications, which resulted from the frequent use of these channels, are conference papers, journal articles and research reports, which are mostly written jointly.

(c) Informal Channels of Information and Selected Departmental and Academic Variables

Department. The variable "department" was found to be significantly related to channels such as, faxing colleagues outside the university (x^2 = 48.408, df. 24, p<0.01), dialogues with colleagues from other departments within the university (x^2 = 45.634, df. 24, p<0.01), correspondence and letters (x^2 = 45.104, df. 24, p<0.1), conversing through the telephone (x^2 = 44.066, df. 24, p<0.01), and e-mailing colleagues (x^2 = 33.492, df. 24, p<0.01) (Table 5.55). In general, the positive ratings came from the chemists, physicists and geneticists.

Affiliations. The academic scientists from UM are more likely to rate e-mailing colleagues and discussion at conferences as useful or very useful (58 out of 87, 66.7%) compared to those from UKM (29, 33.3%) (x^2 = 9.299, df 3, p<0.05). However, academic scientists from UKM rated more positively on dialogues with colleagues from other universities (18 out of 33 (54.5%) (x^2 = 11.468, df 4, p<0.05). A higher percentage of the academic scientists from UM rated discussion at conferences as useful, compared to those from UKM (x^2 = 13.022, df 3, p<0.05).

Table 5.55: Ratings on Informal Information Channels and Personal /Academic Variables

(a)	x^2	df	Crit. Value (0.05)	Sig (2 tailed)
Affiliation & email colleagues	9.299*	3	7.815	.026
Affiliation & dialogues outside univ.	11.468*	4	9.488	.022
Affiliation & discussion at conferences	13.022*	3	7.815	.011
Dept & corres./letters	45.104**	24	36.415	.008
Dept & telephone conversation	44.066**	24	36.415	.007
Dept & email colleagues	33.492*	18	28.869	.015
Dept & dialogue with coll. from other depts.	45.634**	24	36.415	.005
Dept & dialogue with coll. from other univ.	71.655**	24	36.415	.001
Dept & fax coll. outside univ.	48.408**	24	36.415	.002
Gender & fax coll. outside univ.	14.379**	4	9.488	.006
Race & dialogue with coll. outside dept.	22.871*	12	21.026	.029

* significant at the 0.05 level (2-tailed) ** significant at the 0.01 level (2-tailed)

Gender and race. The factors gender and race are not related to the ratings on the use of informal channels for research.

Academic rank. The associate professors, and especially the professors, rated as useful, "corresponding with fellow researchers" (p = .231,sig<0.01 level), "discussion at conferences" (p = .139,sig.<0.05 level) and "faxing colleagues outside the university" (p = .164, sig<0.05 level).

Age. Those who are under 41 are likely to rate dialogue with colleagues from other departments as very useful, while the older academic scientists converge on the "fairly useful" scale (Table 5.56).

Table 5.56: Selected Personal/Academic Factors and Formal Channels Used

Spearman's rho (p)	Corres./ letters	Dialogue/coll. within dept.	Dialogue /coll. from other depts.	Discussion at conferences	Fax colleagues outside the univ
Age	.107	-.110	-.179**	-.004	.062
Sig (2-tailed)	.098	.090	.006	.953	.343
Work exper.	.087	-.132*	-131*	-.018	.039
Sig (2-tailed)	.178	.041	.043	.781	.550
Academic rank	.231**	.008	-.009	.139*	.164*
Sig (2-tailed)	.001	.901	.888	.035	.011
Percent time on research	.054	-.093	-.192**	.110	.096
Sig (2-tailed)	.403	.153	.003	.091	.140

* significant at the 0.05 level (2-tailed) ** significant at the 0.01 level (2-tailed)

Working experience. Those who have less than 15 years of working experience and who allocate less than 30 per cent of their time to research, tend to rate dialogue with colleagues from other departments as very useful.

(c) Reasons Academic Scientists Choose Channels Rated as Useful

The reasons given for choosing channels rated as useful for research information is indicated in Table 5.57. A rank is also given to each reason, which is dependent on total counts received. The highest count was given to the reason, "contain information needed" (220 counts, 92.1%). The other highly rated reasons are the channels chosen keep them aware of new developments (215 counts, 90.0%), the channels are nearest at hand or are easily accessible (204 counts, 85.4%), and the channels are authoritative, accurate and objective (189 counts, 79.1%). Academic scientists clearly give less emphasis to channels which are "easy to use" (28 counts, 11.7%) or are "free and inexpensive" (25 counts 10.5%).

These responses, imply that academic scientists are more concerned in using channels which give them the needed information, keep them aware of new developments in their research areas and are easily accessible, regardless of the cost or difficulty of use.

Table 5.57: Reasons for Choosing Information Channels as Useful or Very Useful

Reasons	Counts	%	Rank
Contains information needed	220	92.1%	1
Keeps aware of new developments	215	90.0%	2
Nearest at hand	204	85.4%	3
Authoritative, accurate, objective	189	79.1%	4
Easy to use	28	11.7%	5
Free/Inexpensive	25	10.5%	6

In summary, the academic scientists in general feel strongly about the usefulness of informal channels in providing information for research as indicated by the strong mean scores for most channels (above 3). However, this rating behaviour has little relation on their publication productivity. Of the eight informal channels, only four are found to be correlated to total and joint-authored publication productivity. These are the usefulness of correspondences, faxing colleagues, telephone conversations and talking to colleagues outside the university. These channels are also the preferred channels by the more professionally experienced scientists (under 41years with 11-15 years of working experience), have attained the rank of at least an associate professor and are most probably chemists, physicists and geneticists.

5.4.15. METHODS USED TO KEEP ABREAST OF REASEARCH INFORMATION

The methods academic scientists use to keep abreast of research information should reflect respondents' behaviour and ability to effectively locate and use sources. This ability might, indirectly, improve research performance. This section describes the method preferred by academic scientists to keep abreast of current information and will be compared to the total publication productivity.

(a) Methods Chosen to Keep Abreast

Table 5.58 indicates respondents' ratings on 11 methods listed. The mean scores for all 11 statements indicate that respondents generally keep abreast mainly by browsing the current issues of periodicals (88.7%), attending conferences and professional meetings (85.0%). The other five methods scientists found fairly useful are maintaining contacts with other researchers in the same field (74%); browsing through abstracts/ indexes in the field (64.8%); browsing through the Internet (65.3%); talking to colleagues within their departments (43.1%); and browsing through special bibliographies in their own subject areas (38.9%). The methods academic scientists found not useful are subscribing to journals, browsing the library's accessions lists, browsing the library's online catalogue and publishers' catalogues.

Table 5.58: Ratings Given to Methods Used to Keep Abreast

Methods of Keeping Abreast	Useful, v.useful			Fairly useful		Not useful, not used		
	Count	%	Rank	Count	%	Count	%	Mean
Browse current periodical shelves	212	88.7%	1	23	9.6%	4	1.7%	4.36
Attend conf/prof meetings	203	85.0%	2	35	14.6%	1	0.4%	4.29
Contact with those in the same field	177	74.0%	3	60	25.1%	2	0.8%	3.93
Browse abstracts/ indexes in field	155	64.8%	5	82	34.3%	2	0.8%	3.68
Browse the Internet	156	65.3%	4	69	28.9%	14	5.8%	3.74
Browse abstracts/ indexes in field	155	64.8%	5	82	34.3%	2	0.8%	3.68
Talk to colleagues within the dept.	103	43.1%	6	130	54.4%	6	2.6%	3.48
Browse special bibs in subject area	93	38.9%	7	138	57.8%	8	3.3%	3.39
Browse library's accessions list	11	4.6%	8	63	26.4%	165	69.0%	2.19
Subscribe to journals	36	15.1%	9	21	8.8%	182	76.1%	2.07
Publishers' catalogues	5	2.1%	10	43	18.0%	191	79.9%	1.83
Browse library's online catalogues	4	1.7%	11	33	13.8%	202	84.5%	1.81

(b) Publication Productivity and Preferred Methods of Keeping Abreast

The respondents' rating scores, between 1(not used) and 5 (very useful), on the methods used to keep abreast are cross-tabulated, with their total publication output.

Total publication productivity. A total of 7 out of the 11 channels are positively correlated with total publications. Those who achieved high publication productivity, indicated keeping abreast by subscribing to journals (p=.157, sig.<0.05); browsing through the library accessions list (p=.167, sig.<0.01); browsing special bibliographies in their field of research (p=.173, sig.<0.01); browsing the library's online catalogue (p=.156, sig.<0.05); looking at publishers' catalogues (p=.136, sig.<0.05 level); contacting researchers in the same field (p=.136, sig.<0.05) and talking to colleagues within the respective departments (p=.158, sig.<0.05). The results indicate that the productive academic scientists use several methods to keep themselves abreast and tend to be those who use library related sources even though the ratings by total respondents show these sources are considered less useful than the other sources.

Cross tabulation of the eleven methods. When the eleven methods are cross-tabulated, some pattern of channel use behaviour in order to keep abreast becomes evident (Table 5.59). Those who search their library's online catalogue to keep abreast, also browse accessions list (p=.181, sig.<0.01), special bibliographies in their subject areas (p=.237, sig.<0.01) and publishers' catalogues (p=.238, sig.<0.01). Those who use more informal channels tend to use other informal channels as well; such as preferring to talk to colleagues to keep abreast, maintaining contacts with those in the same field of research (p= .211 sig.<0.01), attending conferences (p=.337, sig.<0.01) and browsing the Internet (p=.158, sig.<0.05).

Those who browse through abstracts/bibliographies or bibliographies to update themselves, tend to also browse current periodicals shelves (p=.194, sig.<0.01) and browse through special bibliographies (p=.357, sig<0.01) available in their subject area.

Table 5.59: Methods of Keeping Abreast of Developments in Research

Spearman rho (p)	Subscribe journals	Browse library's accessions lists	Browse current periodicals shelves	Browse abstracts/ indexes/ bibliog.	Browse special bibliog. in field	Browse library's online catalogues
Subscribe journals	1.000	.118	-.043	-.021	.083	.105
Browse library's accessions lists	.118	1.000	-.104	.085	009	**.181**** **.005**
Browse current periodicals shelves	-.043	-.104	1.000	**.194**** **.003**	.078	-.041
Browse abstracts/ indexes/ bibliographies	-.021	.085	**.194**** **.003**	1.000	**.357**** **.001**	.116
Browse special bibliographies	.083	.009	.078	**.357**** **.001**	1.000	**.237**** **.001**
Browse library's online catalogue	.105	**.181**** **.005**	-.041	.116	**.237**** **.001**	1.000
Publishers' catalogues	**.140*** **.030**	-.009	.022	.049	**.153*** **.018**	**.238**** **.001**
Contact those in same the field of research	.039	**.166**** **.010**	.032	.044	**.175**** **.007**	-.001
Attend conf/ meetings	-.067	**.136*** **.036**	**.260**** **.001**	.045	**.133*** **.040**	-.119
Browse the Internet for information	.031	**-.221**** **.001**	**.163*** **.012**	-.021	**.080**	-.005

Table 5.59 (continue): Methods of Keeping Abreast of Developments in Research

Spearman rho (p)	Publishers' catalogues	Contact those in same field / research	Attend conference/ meetings	Talk to colleagues within department	Browse the internet for information
Subscribe journals	**.140*** **.030**	.039	-.067	-.066	.031
Browse library's accessions lists	-.009	**-.166*** **.010**	**.136*** **.036**	.125	**-.221**** **.001**
Browse current periodicals shelves	.022	.032	**.260**** **.001**	.099	**.163*** **.012**
Browse special bibliographies	**.153*** **.018**	**.175**** **.007**	**.133*** **.040**	.113	.080
Browse library's online catalogue	**.238**** **.001**	-.001	-.119	.118	-.005
Publishers' catalogues	1.000	**.159*** **.014**	.018	**.128*** **.049**	.092
Contact those in same field of research	.159* .014	1.000	**.271*** **.001**	**.211**** **.001**	-.101
Attend conf/ meetings	.018	**.271**** **.001**	1.000	**.337**** **.001**	**-.158*** **.014**
Talk to colleagues within department	**.128*** **.049**	**.211**** **.001**	**.337**** **.001**	1.000	**-.205**** **.001**
Browse the internet for information	.092	-.101	**-.158*** **.014**	**-.205**** **.001**	1.000

*Correlation is significant at the 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed)

(c) Methods of Keeping Abreast and Departmental and Academic Variables

Affiliation. Table 5.60a indicates that a higher percentage of academic scientists from UKM (22 out of 36, 62.9%) rated subscribing to journals as useful compared to those from UM (13, 37.1%) and a higher number from UM rated this channel as not useful or not used (x^2 = 11.671, df. 4, p<0.05).

Table 5.60a: Methods Used to Keep Abreast and Selected Personal / Academic Variables

	x^2	df	Crit. Value (0.05)	Sig (2 tailed)
Affil. & subscribe to journals	11.671*	4	9.488	.020
Affil. & browse current periodical shelves	12.590**	4	9.488	.013
Affil. & browse indexes & abstracts	10.227**	3	7.815	.017
Dept. & subscribe to journals	101.502**	24	36.415	.001
Dept. & browse lib's accessions lists	40.733**	24	28.869	.018
Dept. & browse current periodical shelves	61.718**	24	36.415	.001
Dept. & browse indexes & abstracts	48.731**	18	28.869	.001
Dept. & browse library's online catalogues	59.551**	24	36.415	.001
Dept. & publishers' catalogues	59.334**	18	28.869	.001
Dept. & browse the Internet	49.287**	24	36.415	.002
Dept. & contact those in same field	29.990*	18	28.869	.038
Dept. & attend conferences / meetings	37.777**	18	28.869	.004
Dept. & talk to colleagues within department	56.014**	24	36.415	.001

* significant at the 0.05 level (2-tailed) ** significant at the 0.01 level (2-tailed)

The reverse is the case for the method "browsing current periodical shelves". Academic scientists from UM (125, out of 215, 58/1%) are more likely to rate this method useful compared to those from UKM (90, 41.9%) (x^2 = 12.590, df. 4, p<0.01).

Both respondents from UKM and UM indicated browsing abstracts, indexes in their discipline as useful to keep abreast but a higher proportion of the useful/very useful raters are affiliated to UM (86 out of 156, 55.1%) (x^2 = 10.227, df. 4, p<0.05).

Departments. The results indicate there are significant differences in the ratings on ten methods used to keep abreast with research information among academic scientists in the various department. This is indicated in Table 5.60a.

Age, working experience, academic qualifications and academic ranks. Table 5.60b indicates that those who keep abreast with current research by subscribing to journals or browsing through the library accessions list are more likely to be in the older age group, have longer working experience, with Ph.D. and are associate professors or professors. Academic scientists with these characteristics are also more likely to browse special bibliographies, use the library's online catalogues, attend conferences and talk to colleagues within their own departments to keep abreast.

Table 5.60b: Methods of Keeping Abreast and Selected Demographic Variables.

Spearman rho (p)	Age	Work experience	Highest qualification	Academic Rank	Percentage of time on research
Subscribe journals Sig. (2 tailed)	.155* .017	.172* .008	.165* .010	.190* .003	.075
Browse library's accessions lists Sig. (2 tailed)	.135* .036	.149* .021	262** .001	.258** .001	.108
Browse abstracts/ indexes/ bibliographies Sig. (2 tailed)	.138* .033	.077	.041	.023	-.026
Browse special bibliographies Sig. (2 tailed)	.181** .005	.120	.181** .005	.140* .030	.070
Browse library's online catalogue Sig. (2 tailed)	.163* .012	.075	.160* .014	.091	.004
Attend conference/ meetings Sig. (2 tailed)	.105	.094	.096	.175** .007	.182**. .005
Talk to colleagues within department Sig. (2 tailed)	.171** .008	.087	.098	.172** .008	.082

* significant at the 0.05 level (2-tailed) ** significant at the 0.01 level (2-tailed)

(d) Channels Academic Scientists Used to Disseminate Research Results

Academic scientists were asked to rank 1 to 3 on the channels they used to disseminate their research results. In most cases the scientists gave up to 4 ranks to channels they prefer, which is displayed in Table 5.61.

Channels ranked first. The channel, which a large number (145, 60.7%) of academic scientists ranked first as the channel they prefer to disseminate their research results is "to publish articles in foreign refereed journals". This is followed by submitting articles in local refereed journals (51 respondents rank this first), oral presentations (ranked 1st by 23 respondents) and submission to published proceedings (ranked 1st by 14 respondents).

Channels ranked second. The channel which received the highest count for second rank is publishing articles in local refereed journals (ranked second by 119 respondents), followed by published proceedings (ranked second by 70 respondents).

Channels ranked third. The channels which are ranked third are: published proceedings (100 respondents), oral presentation (63 respondents) and articles in local refereed journals (40 respondents).

Table 5.61: Channels Academic Scientists Used to Disseminate Research Results

Channels	Rank 1	Rank 2	Rank 3	Rank 4	Total responding out of 239
Articles in foreign refereed journals	145 60.7%	23 9.6%	12 5.0%	47 19.7%	227 95.0%
Articles in refereed local journals	51 21.3%	119 49.8%	40 16.7%	21 8.8%	231 96.7%
Oral presentation	23 9.6%	21 8.8%	63 26.4%	113 47.3%	220 92.1%
Published proceedings	14 5.9	70 29.3%	100 41.8%	43 18.0%	227 95.0%
Letter/correspondence to colleagues	2 0.8%	-	3 1.3%	4 1.7%	9 3.8%
E-mail colleagues	2 0.8%	-	4 1.7%	4 1.7%	10 4.2%
Preprints	1 0.4%	1 0.4%	7 2.9%	6 2.5%	15 6.3%
Deposit a copy at the library	-	2 0.8%	2 0.8%	1 0.4%	5 2.1%
Reprints	-	2 0.8%	4 1.7%	2 0.8%	8 3.3%

The results indicate that academic scientists would follow three possible courses of action to disseminate their research results. They would firstly submit to foreign refereed journals, secondly to local refereed journals, and thirdly to conference proceedings. Even though this may be the course of action taken, the reality may be different. As indicated earlier, when actual works published are analysed, academic scientists indicate publishing more conference papers, followed by journal articles and research reports.

5.4.16. PROBLEMS RELATING TO ACADEMIC RESEARCH PUBLICATIONS

The section aims to find out whether the problems perceived by academic scientists when researching, writing and disseminating articles is related to their total publication productivity.

(a) Problems in Publishing Research

Eight possible problems in publishing research results were listed and respondents were asked to rate on a 5-point scale the degree of seriousness they perceived the problems to be. Table 5.62 indicates that academic scientists do not regard any of the eight situations as problematic. The majority of scientists know where to send their articles for publication (74.1%); are confident in writing in the English language (71.1%), the major language in scientific communication but a second language to most Malaysians; have adequate skills in technical writing (62.8%), have unproblematic home environment (60.3%) and do not lack the courage to write (59.0%). The problematic situations are quite clearly indicated. More than a third indicated finding difficulties in publishing their papers in foreign journals. The inadequate state of local scholarly journals is also indicated as a serious problem for some scientists and this is exacerbated by the poor frequency of such journals.

Table 5.62: Problems in Publishing Research Results

Possible problems	Serious problem	Quite a problem	Not a problem	Mean
Don't know where to send	7 2.9%	55 23.0%	177 74.1%	2.71
Confidence /writing in English	8 3.3%	61 25.5%	170 71.1%	2.68
Technical writing skills	11 4.6%	78 32.6%	150 62.8%	2.58
Home environment	18 7.5%	77 32.2%	144 60.3%	2.53
Courage to write	7 2.9%	91 38.1%	141 59.0%	2.56
Few local scholarly journals	15 6.3%	87 36.4%	137 57.3%	2.51
Poor frequency of local journals	31 13.0%	98 41.0%	110 46.0%	2.33
Difficult to publish abroad	42 17.6%	129 54.0%	68 28.5%	2.11

(b) Research Publications and Problems in Writing

Total number of publications. Out of the eight problematic situations only one is correlated significantly with the total publication scores. The correlation is, however, a negative one (Table 5.63). Those who are high/very high publishers are more likely to rate the poor frequency of local journals as a serious problem (ρ= -.210, sig. <0.01 level).

Table 5.63: Poor Frequency of Local Journals by Total Publication Productivity

Total publications	Poor frequency of local journals									
	V. serious problem		Serious problem		Fairly problematic		Fairly unproblematic		Not a problem	
	Count	%	Count	%	Count	%	Count	%	Count	%
Low/min (1-10)	-	-	1	4.5%	7	24.1%	10	14.5%	31	28.2%
Ave (11-20)	2	22.2%	7	31.8%	8	27.6%	25	36.2%	38	34.5%
High/v. high (≥21)	7	77.8%	14	63.6%	14	48.3%	34	40.3%	41	37.3%
Total	9	100.0%	22	100.0%	29	100.0%	69	100.0%	110	100.0%

ρ= -.210, sig. <0.01 level

Those who published a higher number of journal articles are more likely to have no problem in knowing where to submit their articles for publication (ρ= .178, sig. <0.01 level) and profess that they have no problems in getting their articles published abroad (ρ= .139, sig. <0.05 level). The results indicate that the level of confidence scientists have of their technical writing skills, and their courage to write are not related to their total or types of publication productivity.

(c) Rating on Problem Situations and Selected Demographic Variables

Affiliation. The affiliation status of academic scientists is related to their ratings on technical writing skills, confidence of writing in English and home environment [as problematic to their research publication activity]. A higher percentage of academic scientists from UM (125 out of 220, 56.8%) indicated that research writing is not a problem for them compared to those from UKM (95, 43.2%) (x^2= 10.062, df, 2, p<0.01) (Table 5.64a).

A higher percentage of academic scientists from UM are also more confident in writing in English (54.7%) compared to those from UKM (45.3%) (x^2 = 6.323, df, 2, p<0.05). Home environment is not a problem to 116 respondents from UM while the majority of those from UKM regard this problem as fairly serious (x^2 = 6.827, df, 2, p<0.05).

Table 5.64a: Ratings on the Problem Situations and Selected Demographic Variables.

Problems	x^2	df	crit. x^2(0.05)	Sig..
Affil. & skills in writing technical papers	**10.062****	2	5.991.	**.007**
Affil. & confidence of writing in English	**6.323***	2	5.991	**.042**
Affil. & home environment	**6.827***	2	5.991	**.033**
Dept. & courage to write	**28.200****	12	21.026	**.005**
Dept. & few local scholarly journals available	**23.862***	12	21.026	**.021**
Dept. & poor frequency of local scholarly journals	**39.703****	12	21.026	**.001**
Dept. & difficulty of getting articles published abroad	**29.093****	12	21.026	**.004**
Gender & few local scholarly journals available	**6.495***	2	5.991	**.039**

* Significant at the 0.05 level (2-tailed) ** Significant at the 0.01 level (2-tailed)

Department. There are variations in respondents' ratings from the seven departments on six problem situations. The problematic situations are: the courage to write (x^2 = 28.200, df, 12, p<0.01); the availability of few local scholarly journals (x^2 = 23.862, df, 12, p<0.05); poor frequency of local scholarly journals (x^2 = 39.703, df, 12, p<0.01); and the difficulty of getting articles published in foreign journals (x^2 = 29.093, df, 12, p<0.01).

Gender. There are significant differences in the rating on "few local scholarly journals" among female and male academic scientists. Even though the women are smaller in terms of numbers, fewer women academics regard this as a serious problem.

Academic rank. Table 5.64b indicates that those who are higher in academic rank do not find technical writing a problem for them (ρ= .144, sig. <0.05 level). However, a higher percentage still indicate that they do not know where to send articles for publication (ρ=.181, sig. <0.01 level).

Table 5.64b: Ratings on Problem Situations and Selected Demographic Variables

Spearman's rho (ρ)	Technical writing Skills	Courage to write	Confident writing English	Few local scholarly journals	Poor frequency of local journals	Don't know where to send	Home environ -memt	Prob. In publishing abroad
Work experience Sig. (2-tailed)	.037	.025	.009	.035	-.075	**.166*** **.010**	.091	-.038
Highest qualif. Sig. (2-tailed)	.047	.037	-.016	.062	-.040	.115	**.198**** **.002**	**.128*** **.048**
Academic rank Sig. (2-tailed)	**.144*** **.026**	.125	.056	.047	-.046	**.181**** **.005**	.108	.041
Percent time on res. Sig. (2-tailed)	.029	.084	-.013	-.114	-.047	.093	.079	.078

*Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed)

Work experience. Those who have longer years of working experience indicate that they do not know where to send their materials for publication (ρ= .166, sig. <0.05 level).

Qualifications. Those who are highly qualified academically still find their home environment (ρ= .198, sig. <0.01 level) and publishing abroad (ρ= .128, sig. <0.05 level) a problem.

(d) Problems in Obtaining Information Needed for Research

This section gives emphasis to formal sources and services offered by libraries and information centres. Indirectly, this helps to identify the information source used by academic scientists in their research process. Respondents are asked to indicate on a four point scale (1=not applicable, 2=most of the time, 3=occasionally, 4=rarely or never), the extent to which the 15 situations are problematic for them (Table 5.65a).

Table 5.65a: Ratings on Problems in Obtaining Information for Research

Problems	Not applicable	Most of the time	Occasio-nally	Rarely or never	Mean
Inadequate photocopying services	13 5.4%	49 20.5%	125 52.3%	52 21.7%	2.91
Don't know how to choose relevant databases	50 20.9%	16 6.7%	86 36.0%	87 36.4%	2.88
Don't know how to search CD/ROM or online databases	55 23.0%	20 8.4%	63 26.4%	101 42.3%	2.88
Cannot find relevant information	33 13.8%	20 8.4%	151 63.2%	35 14.6%	2.79
Receive information too late	34 14.2%	38 15.9%	129 54.0%	38 15.9%	2.72
Don't know where to look for information	62 25.9%	21 8.8%	109 45.6%	46 19.2%	2.71
Library books are outdated	11 4.6%	66 27.6%	150 62.8%	12 5.0%	2.68
No help in finding information	30 12.6%	60 25.1%	119 49.8%	30 12.6%	2.62
Colleagues are not helpful in providing information	61 25.5%	16 6.7A%	125 52.3%	37 15.5%	2.58
No time to look for information	33 13.8%	70 29.3%	114 47.7%	22 9.2%	2.52
Cannot find wanted items on the shelves	23 9.6%	93 38.9%	103 43.1%	20 8.3%	2.51
Delay in journals arrival	6 2.5%	133 55.6%	81 33.9%	19 7.9%	2.47
Professional librarian not willing to perform searches	86 36.0%	15 6.3	79 33.1%	59 24.7%	2.47
Too much irrelevant information from librarian	85 35.6%	15 6.3%	100 41.8%	39 16.3%	2.39
Insufficient funds to order articles from abroad	36 15.1%	122 51.0%	51 21.3%	30 12..5%	2.32

Academic scientists rated the 15 situations as problematic "most of the time" or "occasionally" when obtaining information needed for research. This is indicated by the mean values of between 2.32 and 2.91 on all 15 situations listed. The five situations, which academic scientists find problematic most of the time are: delay in journal arrivals (55.6%), insufficient funds to order articles from abroad (51.0%), cannot find wanted items from the shelves (38.9%), no time to look for information (29.3%) and outdated library books (27.6%).

The five situations which rarely or never pose as problematic are: searching CD-ROM or online databases (42.3%), choosing relevant databases (36.4%), engaging professional librarian's help to perform searches (24.3%), photocopying services (21.3%), and knowing where to look for information (19.2%).

(e) Publication Productivity and Research Problem Ratings

The ratings on the problem situations (1 to 4) are cross-tabulated with respondents' ranked total publication scores (1 to 5). The correlated results are indicated in Table 5.65b.

Table 5.65b: Fifteen Problem Situations and Publication Productivity

Spearman's rho (ρ)	Library books outdated	Delay in journal's arrival	No help in finding info.	Don't know where to look for info.	Cannot find relevant info.	Receive info. too late	Inadequate photocopying services	No time to look for info.
Total pub. Sig. (2-tailed)	**.124*** **.038**	-.032	**-.189**** **.003**	**-.222**** **.001**	**-132*** **.042**	**-.204**** **.001**	.023	-.004
Solo works Sig. (2-tailed)	.059	-.078	**-.245**** **.001**	**-.168*** **.014**	.008	-.036	-.103	-.084
Joint works Sig. (2-tailed)	.045	-.065	-.088	**-.145*** **.027**	**-.197**** **.002**	**-.221**** **.001**	.045	.075
Conf. papers Sig. (2-tailed)	**.181**** **.006**	-.092	-.113	**-.134*** **.041**	**-.142*** **.031**	**-.195**** **.003**	.009	.062
Jour. articles Sig. (2-tailed)	.043	-.107	**-.137*** **.040**	-.084	-.080	-.103	-.045	-.009
Research rep. Sig. (2-tailed)	.005	.039	**-.216**** **.010**	-.113	-.075	-.145	-.008	-.003
Stand/patents Sig. (2-tailed)	-.243	**-.455*** **.022**	-.065	.043	-.012	-.366	-.073	-.202

*Correlation is significant at the 0.05 level (2-tailed) ** Correlation id significant at the 0.01 level (2-tailed)

Table 5.65b (continue): Problem Situations and Publication Productivity

Spearman's rho (ρ)	Don't know how to choose relevant database	Do not know how to search CD-ROM	Too much irrelevant infor from librarian	Librarian not willing to perform searches	Cannot find wanted books from shelves	Colleagues not helpful in providing mat. wanted	Insufficient funds to order articles from abroad
Total pub. Sig.. (2-tailed)	**-.141*** **.029**	-.100	.048	**.144*** **.026**	.043	-.020	.031
Solo works Sig. (2-tailed)	-.075	.022	-.064	-.083	**-.138*** **.044**	-.120	**-.143*** **.038**
Joint works Sig. (2-tailed)	-.114	-.118	.087	**.171**** **.009**	.079	-.003	.058
Conf. papers Sig. (2-tailed)	-.029	.015	.087	**.157*** **.017**	.126	.024	.082
Jour. articles Sig. (2-tailed)	**-.159*** **.017**	-.127	-.005	.095	-.023	-.049	-.018
Research rep. Sig. (2-tailed)	-.098	-.101	-.079	-.017	-.043	**-.219**** **.009**	-.136

*Correlation is significant at the 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed)

Total number of publications. The scores on total number of publications are correlated to 7 out of the 15 problem statements. Those who achieved high total publication productivity indicated that the outdated library books (ρ=.124, sig. <0.05) and the librarian's unwillingness to assist in bibliographic searches (ρ=.144, sig. <0.05) are not a problem for them. There is a negative correlation between total publication scores and problem situations such as: no help in finding information (ρ=-.189., sig. < 0.01), do not know where to look for information (ρ=-.222., sig.<0.01), cannot find relevant information (ρ=-.132., sig. < 0.05l), receive information too late (ρ=-.204., sig. < 0.01) and do not know how to choose relevant databases (ρ=-.141., sig. < 0.05).

The results indicate that a higher number of those who are placed in the high and very high publication groups rated on the 5 situations as either not applicable or occasionally problematic, while a higher proportion of those who are placed in the low and minimum group rated this situation as non-problematic. In general, those who are highly productive still find occasional problems in obtaining information needed for research.

(f) Rating on Problem Situations and Selected Demographic Variables

Affiliation. There are differences in the ratings on "receiving information too late" (x^2=9.263, df.3, p<0.05), "inadequate photocopying services" (x^2=13.344, df.4, p<0.01); and "professional librarians are not willing to perform searches" (x^2=10.766, df.4, p<0.05); among respondents from UKM and UM (Table 5.65c).

Department. The results indicate there are variations in the ratings by respondents in the various departments. Eleven of the fifteen problem situations are related to respondents' departments. These are "books are outdated" (x^2=31.001, df, 18, p<0.05); "no help in finding information" (x^2=58.757, df, 18, p<0.01); "do not know where to look for information" (x^2=47.982, df.24, p<0.01); "cannot find relevant information" (x^2=29.379, df.18, p<0.05); "receiving information too late" (x^2=48.724, df.18, p<0.01); "inadequate photocopying services" (x^2 =50.509, df.24, p<0.01); "do not know how to choose databases" (x^2=48.996, df.18, p<0.01); "do not know how to search CD-ROM / online database services" (x^2=45.026, df.18, p<0.01); "cannot find wanted books on the shelves" (x^2=48.059, df.24, p<0.01); and "insufficient funds to order articles from abroad" (x^2=47.216, df.24, p<0.01).

Gender. When the respondents' gender are compared to the 15 ratings, three situations indicate differences in ratings between the male and female academic scientists. These are "delay in journal's arrival" (x^2 =9.408, df.3, p<0.05); "too much irrelevant information from the librarian" (x^2 =9.665, df.3, p<0.05) and "cannot find books on the shelves (x^2 =10.075, df.4, p<0.05).

Race. The Malay academic scientists occasionally or rarely find problems in getting help to find information (x^2 = 17368, df9, p<0.05); or of not knowing where to look for information (x^2 =21267, df12, p<0.05); or in receiving information too late to be of use (x^2 = 19650, df9, p<0.05) compared to scientists of the other races.

Table 5.65c indicates the results of the rest of the demographic variables. Most of the correlated variables displayed are negative in nature, indicating that a selection of the 15 situations are sometimes or occasionally problematic to academic scientists who are older, having longer working experience and are higher in academic rank.

Table 5.65c: Rating on 15 Problem Situations and Selected Ordinal Demographic Variables

Spearman's rho (*p*)	Age	Working experience	Highest qualification	Academic Rank	Percent time on research
Delays in journal's arrival Sig. (2-tailed)	.014	-.109	-.098	**-.181**** **.005**	-.056
No help in finding information Sig. (2-tailed)	-.083	-.105	-.056	**-.148*** **.022**	-.034
Don't know where to look for information Sig. (2-tailed)	**-.142*** **.028**	**-.163*** **.012**	-.125	**-.169**** **.009**	.027
Receive information too late Sig. (2-tailed)	-.093	-.094	.000	**-.177**** **.006**	-.025
No time to look for information Sig. (2-tailed)	**.131*** **.043**	.008	.082	-.011	-.013
Don't know how to choose relevant databases Sig. (2-tailed)	**-.130*** **.045**	**-.223**** **.001**	.010	**-.160*** **.013**	-.004
Don't know how to search CD-ROM, online databases Sig. (2-tailed)	**-.148*** **.022**	**-.194**** **.003**	-.005	**-.188**** **.004**	-.069
Prof librarian not willing to perform searches Sig.. (2-tailed)	**.152*** **.019**	**.208**** **.001**	.014	**.240**** **.001**	.074

*Correlation is significant at the 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed)

The highly productive scientists rarely found "professional librarian not willing to perform searches" as problematic. In general, the results indicate that academic scientists do need help in terms of locating, searching and retrieving information needed for research. This is especially so in the case of the more older and experienced scientists who may be tied with administrative and consultation commitments.

5.5. HYPOTHESES TESTING

Similar to reasons indicated in section 4.5, in chapter 4, the hypotheses "null" stand is taken. The discussion of the results of the ten hypotheses follows.

5.5.1. Endogenous Variables

(a) Personal Factors

Hypothesis 1 - The total number of publications achieved by academic scientists are independent of their personal background such as gender, race, age, and family size.

Gender – No relation is indicated between gender and total number of publication productivity achieved by academic scientists and the null hypothesis is accepted. A similar result is indicated for academic engineers.

Race – Race is related to higher total publication productivity among academic scientists (x^2 = 6.925, df.2, sig. <0.05) with a larger percentage of "other" racial group placed in the high/very high publication groups even though their numbers are small. The null hypothesis is therefore not accepted.

Age – Age is significantly related to higher total number of publication productivity for academic scientists (p=367, sig <0.01). The older scientists are more likely to be placed in the high and very high publication group. For this reason, the null hypothesis is not accepted. A similar result is indicated for the academic engineers.

Family size – The number of children is not related to the total publication productivity achieved for academic scientists. The null hypothesis is therefore accepted. This is also found for academic engineers.

The results above indicate that personal factors that are related to the academic publication productivity for academic scientists are race and age.

(b) Academic Factors

Hypothesis 2 - The respondents' institutions, the departments they are attached to, the highest academic qualification obtained, the number of years since their highest degree was obtained, the country from which they had obtained their highest qualification, the length in years of working experience and their academic rank are not related to the total number of publication productivity achieved.

Affiliation – The relationship between higher total number of publication productivity and affiliation is significantly related for the academic scientists (x^2 = 8.008, df.2, sig.<0.01), and in this case the null hypothesis is definitely not accepted. Scientists from UKM achieved higher total publication scores.

Discipline – A definite significant difference is indicated for the academic scientists (x^2 =61.680, df.12, sig. <0.01). In this case the null hypothesis is not accepted. The physicists and chemists achieved higher placement in the high/very high publication category. A higher number of mathematicians are mainly low publishers.

Academic qualifications – There is a significant difference in the total number of publication productivity achieved between those having the Masters qualifications and those with Ph.D. among the scientists (p=.314, sig. <0.01), and the null hypothesis is not accepted. This finding is similar for the academic engineers.

Country where highest qualification was obtained – The country from where scientists had acquired their academic qualifications is not related a high number of publication productivity. In this case, the null hypothesis is accepted. A similar result is indicated for the academic engineers.

Years since the highest qualification was obtained – A significant relationship is indicated for academic scientists (p=.608, sig.<0.01) and the null hypothesis is definitely not accepted in this case. The varied pattern of academic writing among scientists may perhaps explain this difference. The higher number of scientists in this study are active publishers who authored varied types of publications between 1990 and1995.

Working experience – Longer working experience is significantly related to higher publication productivity for the academic scientists (p=.408, sig. <0.01). The null hypothesis is not accepted in this case. This finding is similarly indicated for academic engineers.

Academic rank – Academic rank is significantly related to higher number of publication productivity for the scientists (p=.333, sig.<0.01,) and the null hypothesis is not accepted. The associate professors and full professors achieve not only higher total number of publications but are also productive in a variety of scholarly works compared to the lecturers.

In summary, the results indicate that academic scientists with Ph.D., who are higher in academic rank, who obtained their highest academic qualification longer number of years ago, who are more experienced, generally achieve high publication productivity and are more versatile in their types of publication output.

(c) Professional Factors

Hypothesis 3 - <u>The total number of publications achieved are not related to the number of professional association memberships, consultation and editorial works undertaken.</u>

Number of professional memberships – The number of professional memberships is related to higher total number of publication productivity for the scientists (p=.292, sig.<0.01). The null hypothesis is not accepted. A similar result is obtained for academic engineers.

Number of consultation activities undertaken – A higher number of consultation activities is related to high total publication productivity for the scientists (p=.374, sig.<0.05). As such, the null hypothesis not accepted.

Number of professional journals edited – Editorial activity is not related to a higher total number of publication productivity for the scientists and the null hypothesis is accepted.

In summary, the results indicate that involvement in professional society and consultation activities are good determinants of higher total publication productivity for scientists.

(d) Attitudinal Variables

Hypothesis 4 - <u>The respondents' ratings on research outcome statements, departmental and institutional view statements are independent of the total number of publications achieved.</u>

Views on research – For the academic scientists, a higher total number of publication productivity is correlated to five of the seven research views statements. These are: research adds to reputation (p=237, sig.<0.01), advances knowledge (p=.192, sig.<0.01), gives prestige and respect (p=.160, sig.<0.05), gives prestige to university and department (p=.185, sig.<0.01), and gives opportunity to develop products (p=.193, sig. 0.01). For these instances the null hypothesis is not accepted. Woods (1990) also found that scientists tended to work evenings and weekends because of their interest in research.

Views on departmental support – The academic scientists have a "fair" view of their departmental support for research. The highly productive scientists, only rate positively on their department's effort to arrange useful seminars (p=.160, sig.<0.01) and support their colleagues by reading their publications (p=.145, sig.<0.05) and only in these instances is the null hypothesis not accepted. The null hypothesis is accepted for the rest of the five "departmental support" statements. The importance of colleagues as the supportive factor in research is accepted by the scientists. This is in line with the findings of Finkelstein (1984) whose American academics rated colleagues as important. However, as in the current study, Finkelsten could not ascertain whether colleagues changed the pattern of productivity or productivity created certain pattern of collegial interaction.

Views on institutional support – A higher number of publication productivity for the academic scientists is not related to any of the nine views on institutional support for research. The null hypothesis is therefore accepted. The results indicate that academic scientists do not feel strongly that their institutions are supportive enough of their research needs. For the active publishers, the limit set at one foreign conference every three years is inhibiting (for UM academic staff) when they need to present findings internationally more regularly. However, for the low publishers, the provision of facilities already offered seem adequate to cater for their needs. The importance of providing the right environment for productivity is highlighted by Snyder, McLaughlin and Montgomery (1991) who indicated that certain management styles trigger a better productive environment, such as locating and communicating funding opportunities and providing seed money for new faculty.

(e) Channels of Information Used and Research Dissemination Behaviour

Hypothesis 5 – The respondents' ratings of formal and informal channels that they use to obtain and disseminate research information are not related to the total number of publications achieved.

Formal channels - For the academic scientists, total publication productivity is not related to twelve of the thirteen formal channels listed, and the null hypothesis is accepted in all instances, except one. Those who are high publishers rated positively and significantly on the usefulness of the library accessions lists in providing them with useful information needed for their research ($p=.289$, sig.<0.01). The scientists do not regard most formal channels as useful for research information. This may be due to the fact that the more productive writers use other sources for their information needs, while the less productive (those who have not established their own informal networks) rely more on the formal sources. The formal channels used are those which are familiar and readily available, such as the online CD-ROM databases and accessions list. Allen (1977) and Rosenbloom and Wolek (1970) also indicated that their academic scientists made greater use of formal literature.

Informal channels – For the academic scientists, correlation is found only in two of the eight informal channels listed, and these are correspondence and letters ($p=.241$, 0.01) and faxing colleagues ($p=.228$, sig.<0.01). For these instances, the null hypothesis is not accepted.

The results generally support previous findings that engineers are more likely to use informal channels to meet their information needs than the scientists (Anthony, East and Slater, 1969; Kremer, 1980; Schuchman, 1981). The academic engineers show more preference for dialogues with colleagues either within the department or outside the university, while the academic scientists prefer correspondence and faxing colleagues

(f) Methods Used to Keep Abreast with Research Literature

Hypothesis 6 - The respondents' ratings of methods of keeping abreast with the literature are not related to the total number of publications achieved.

The results indicate that a higher total number of publications achieved is correlated to seven of the eleven methods listed for academic scientists. These include subscribing to journals (p=.157, sig.<0.01), browsing the library's accessions list (p=167, sig.<0.01), browsing special bibliographies in their field of research (p=.173, sig.<0.01), browsing the library's online catalogues (p=.156, sig.<0.01), browsing the publishers' catalogues (p=.136, sig.<0.05), contacting those in the same field of research (p=.136, sig.<0.05) and talking to colleagues in the department (p=.158, sig.<0.01). For the correlated variables, the null hypothesis is not accepted. The highly productive scientists use a variety of methods to keep abreast of research information and this is not indicated by the productive academic engineers. The variety of measures used range from library related sources (Crawford, Halbrook and Igielnik, 1986; Hurd, Weller and Curtis, 1992) to informal sources such as personal contacts, discussion with colleagues and gatekeepers (Rosenbloom and Wolek, 1970).

(g) Problems in Publishing, Using or Obtaining Information Needed for Research

Hypothesis 7 – The respondents' ratings of their research writing and library related problems are not related to the total number of publications achieved.

Problems of publishing research results – The high total number of publications produced is strongly and negatively correlated to "poor frequency of local journals" (p=-.210, sig. 0.01). The highly productive publishers tend to rate the poor frequency of local journals as a serious problem. A look at the rating trends among the scientists indicate that they have rated quite unproblematic or not a problem for the other problem situations. The unanimous positive ratings by both the high and low publishers resulted in non-correlated findings.

In general, the results show that while the productive academic engineers indicate no problems in publishing their research results, the academic scientists tend to be less satisfied with the support given by local scholarly journals. The academic scientists regard journals as an important channel to publish their research results and publish actively in local journals.

The poor frequency of such journals, therefore, would limit their chances of publishing more frequently, as limited space per issue must be shared between scientists throughout the country. Luukkonen (1992) reported that the typical scientists in their sample would first attempt to publish their articles in prestigious channels and would use a larger number of journals to publish. In the Malaysian context, the scientists would also first attempt to publish abroad. However, in the face of difficulty in getting their work published abroad, they would turn instead to the locally available scholarly journals. However, the poor frequency of local journals hampers, to a certain extent, this effort that results in the highly productive scientists rating negatively on this situation

Library related problems – Scores on total publications are correlated to seven out of fifteen problem situations. Positive correlation is indicated for the high total publishers who rated "library books are outdated" and "librarian not willing to perform searchers" as not problematic (p=.124, sig.<0.05; p=.144, sig.<0.05 respectively). Negative correlation is indicated for five situations, such as no help in finding information (p=-.189, sig.<0.01); do not know where to look for information (p=-.222, sig.<0.01); cannot find relevant information (p=-.132, sig.<0.05); receiving information too late (p=-.204, sig.<0.01) and do not know how to choose relevant databases (p=-.141, sig.<0.05). In these correlated cases, the null hypothesis is not accepted.

In general, the results indicate that the highly productive academic scientists still find problems in obtaining and using library related resources or services. This provides indications of possible courses of action that the library can initiate to improve the situations. Eminent Indian scientists indicated that they needed easy access to literature in order to perform well in the initial stage of their research (Babu and Singh, 1998; Srichandra, 1970).

5. 5.2. Exogenous variables

(a) Departmental Factors

Hypothesis 8 -The percentage of time allocated to research, teaching and administration, the minimum publication requirements set by departments, the number of faculty members employed and research students enrolled within each department would have no effect on the total number of publications achieved.

Time allocated for research, teaching and administration - Positive correlation are indicated between higher total publication productivity and percentage of time allocated for research ($p=.131$, $sig.<0.05$), administration ($p= .190$, $sig.<0.01$) and significantly negative correlation with the percentage of time allocated to teaching ($p=-.260$, $sig.<0.01$). In these cases, the null hypothesis is not accepted. In general, the more productive academic scientists allocate less time to teaching. Administrative work, however, has less effect on research. The scientists who allocate a higher percentage of their time to administration achieved not only a high total score but are also high publishers of single works ($p=.167$, $sig.<0.01$), conference papers ($p=.148$, $sig.<0.05$), and journal articles ($p=.204$, $sig.<.0.01$).

The results for the scientists agree with previous findings, that time spent on research is an important predictor of research productivity (Manis, 1951; Andrews, 1966; Allison and Steward, 1974; Harrington and Levine, 1986; Calligro et al, 1991).

Minimum publication set by the respective department – A positive correlation is indicated between scientists' ratings on their department's publication requirements and higher number of publication productivity ($p=.137$, $sig.<0.05$), and in this case, the null hypothesis is not accepted. About 50.2% (120 out of 239) of academic scientists indicate that their departments have not set any publication requirement but do accept that they should publish at least one publication per year. In the case of the academic scientists, those who perceive their department requires them to publish one or more publications per year, are themselves high publishers.

Size of academic staff – A significant negative correlation is indicated between the number of academic staff and total publication productivity (p=-.207, sig.<0.01) and in this case, the null hypothesis is not accepted. Over 50% of the group who reported having 21 or fewer faculty members are high/very high publishers, while 50% of those in departments with more than 40 academic staff are low publishers. This result support a previous research finding which indicates that productivity peaks when the department size is between 9 to 22 researchers and assistants (Fitschi, et al. 1980). This results is, however, not conclusive as other studies have proposed productive groups of variant sizes (Blackburn, Behymer and Hall, 1978; Gallant and Prothero, 1972; Etzkowitz, 1992). The studies do, however, imply firstly, that the optimum size varies with discipline, and secondly, large group size does not necessarily mean higher productivity.

Size of student enrollment - The results for the academic scientist reveal that higher total publication productivity is not related to the reported number of research students enrolled in a particular scientific department. The null hypothesis in this case, is accepted. Although previous studies have found that quality research students help promote research productivity (Berelson, 1960; Hagstrom, 1965; Fonseca, et al., 1997), this is not indicated in the present study. The weak effect of research student numbers on higher total productivity may be connected to staffs' views on the quality of their research students. Only 46 of the 239 scientists rated the quality of their research students as good or excellent with the majority (145 out of 239) rating them as "fair".

(b) Organisational Factors

Hypothesis 9 – The total as well as the amount of grants received, the ratings of the library, laboratory services provided and the ratings on the type of computer use are independent of respondents' total number of publications achieved.

Total and amount of grants – The total and amount of grants obtained is significantly and positively related with higher total publication productivity (p.469, sig.<0.01; p=.408, sig.<0.01 respectively) and the null hypothesis in this case is also not accepted.

The ratings indicate that those who published more also obtained larger amount of grant allocations. Wanner and Lewis (1981) found the relationship especially marked among natural scientists. Adequate funding is especially important for scientific research where funds are needed to obtain costly equipment, chemicals and finance travelling expenses (Lowe, 1987; Wood, 1990). In summary, the results indicate that those who obtained placement in the high/very high publication group are also those who received more than one grant and higher amount of grant money allocated between 1990 to 1995.

Library services – The results indicate that a higher total publication productivity is positively correlated to ratings on inter-library loan service (p=.140, sig.<0.05), professional staff help in online searching (p=.140, sig.<0.05), and for these cases the null hypothesis is not accepted. For the other five library services listed, the null hypothesis is accepted.

The ratings indicate that most types of services provided by the library are not related to academic staffs' publication productivity. This may be due to the fact that more than 80% of academic scientists rated the sufficiency of library services as either fairly sufficient or sufficient, regardless of their level of publication productivity. The results of the analysis also indicate that the older, more experienced academic scientists are either associate professors or professors, are more likely to rate services provided by their libraries positively.

Laboratory services – Higher total number of publications is significantly and positively correlated to the ratings on the adequacy of laboratory support for the academic scientists and in this case, the null hypothesis is not accepted (p=.378, sig.<0.01).

Types of computer use – For the academic scientists, correlation was found for seven types of computer use, six of which are significant. These include creating databases (p=.286, sig.<0.01), word processing (p=.210, sig.<0.01), creating slide shows (p=.194, sig.<0.01), sending/receiving e-mail (p=.176, sig.<0.01), obtaining information via the internet (p=.176, sig.<0.01), creating personal bibliographical index (p=244, sig<0.01) and undertaking statistical analysis (p=.139, sig<0.05). For these correlated results, the null hypothesis is not accepted.

(c) Collaboration factors

Hypothesis 10 - The respondents' total number of publication productivity are independent of their ratings on the five types of collaborative situations frequently undertaken

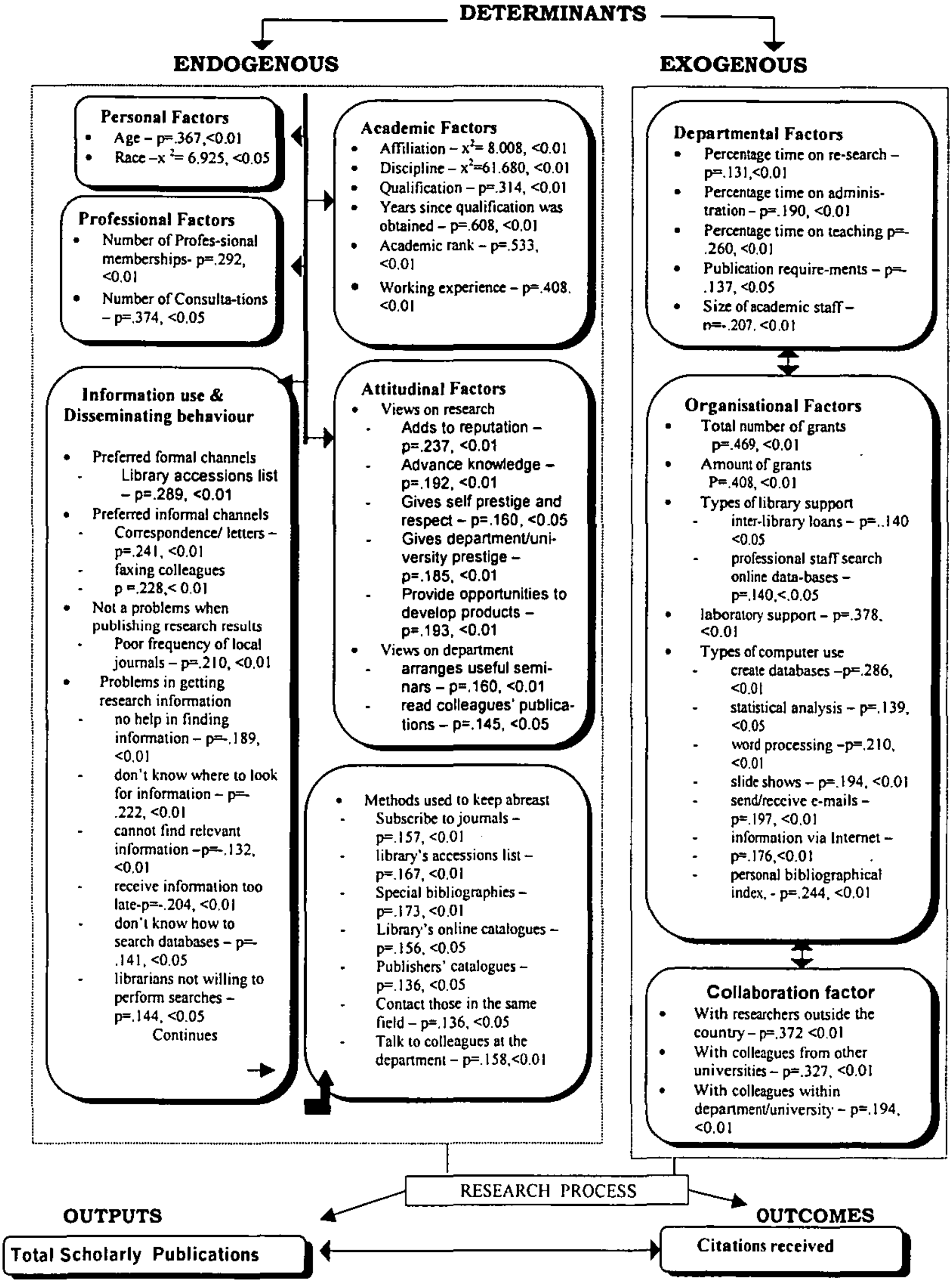
Types of collaboration – Of the four types of collaboration situations, three are correlated to total number of publication productivity for academic scientists. These are collaborating with colleagues within the department or university (p=.194, sig.<0.01), collaborating with colleagues from other universities (p=.327, sig. <0.01) and collaborating with colleagues outside the country (p=.372, sig. <0.01). In all the correlated instances, the null hypothesis is not accepted. The results indicate that collaboration with colleagues within respondent's own institutions, from other universities or those outside the country would result in higher total publication performance, especially in joint works, conference papers and journal articles. The chemists and geneticists, tended to collaborate more than those from other science departments. The influence of the department is also indicated by previous studies. Stankiewicz (1976) observed that collaboration was the highest in rapidly developing fields such as physics, chemistry and molecular biology. Collaboration was most common in "data disciplines" such as physics and chemistry and less in "word disciplines" such as sociology or political sciences (Over and Smallman, 1973; Smart and Bayer, 1986; Bayer and Smart, 1988).

5.6. SUMMARY

This chapter reports on the analyses of responses received from 239 academic scientists from seven science departments from the University of Malaya (UM) and the National University of Malaysia (UKM). The chapter also presents the publication behaviour of academic scientists, the factors that are related to high publication productivity and the problems faced in obtaining, using and disseminating research results. The final section in this chapter describes the results of testing the ten hypotheses presented in chapter three.

Figures 5.1 presents a summary of correlated results between total number of publications and relevant endogenous and exogenous variables for the academic scientists. The results indicate that a larger number of determinants are significantly correlated (at ≤ 0.01level) in the case of the academic scientists than the academic engineers. The publication productivity of the scientists are determined by a variety of factors which should be considered together in order to fully explain and understand the productive situation. The results also imply that the factors considered seem to be more appropriate for assessing academic scientists. Whether similar correlates apply to other disciplines cannot be ascertained.

Figure 5.1: Summary of Correlated Results between Total Number of Publications and Endogenous and Exogenous Factors: Academic Scientists



Chapter 6

EXPLORING THE SURVEY FINDINGS

6.1. INTRODUCTION

This chapter presents the results of the interviews and e-mail dialogue sessions conducted between March 1998 to November 1998 with 32 academic engineers and 24 scientists to explore the findings of the questionnaire survey. The responses comprise academics' views about various aspects of the findings obtained from the survey that subsequently provide some insight as to "why" certain results were indicated. As explained in Chapter three, the decision to use a combined approach is felt to be conducive for various reasons. Firstly, it allows the researcher to "cast the net" wider covering academics from universities which are geographically dispersed. The academics approached are productive academic engineers and scientists who have attained the ranks of associate professors or professors and has over 6 years of working experience. Most are willing to share their publication success experiences. Secondly, the e-mail sessions ensure a more flexible communication process. Respondents are not pressed for immediate response and not confined to the an allocated time period. Responses between the researcher and respondents often went back and forth over a span of a week. Respondents know that it is alright to "continue where I [they] left off the last time" . Thirdly, the e-mail sessions provided readily "transcribed" documentation of responses which saves the researcher a great deal of time during the analyses stage. The results of the interviews will be presented in tables (where the pattern of responses are identifiable enough for categorization) and quotes where it is necessary to substantiate categorized responses.

6.2. PUBLICATION BEHAVIOUR

The interview aims to find out: (a) academic staffs' opinion about their publication responsibility (b) their preferred form of publication (c) their attitude towards local journals as a channel for research publications, and (d) their views toward joint publications.

6.2.1. Number of Publications Per Year

More than half of academic engineers interviewed agree to at least one publication output per year (Table 6.1). Twelve (12) out of 32 engineers indicate that publication output per year must be more than one. The academic scientists has similar views on this issue, with 16 out of 24 agreeing to at least one publication per year as a realistic requirement.

Table 6.1: Agreement on Publication Requirements of at Least One Per Year

	Publication Requirements of at Least One Per Year			
	Engineers		Scientists	
	Count	%	Count	%
No	2	6.2%	2	8.3%
Yes	18	56.3%	16	66.7%
More	12	37.5%	6	25.0%
Total	32	100.0%	24	100.0%

Those who disagree feels that academic staff publications should not be measured in terms of numbers but rather on how far they contribute to knowledge. No opinion was volunteered as to how this can be measured. Those academic staff who agree, sees such a requirement as a positive device which helps provide academic staff with targets they can strive for, it helps to motivate academic staff to continuously undertake research, and it keeps researchers up-to-date in their area of research.

Those academic engineers and scientists who indicate that faculty members should publish more than one publication per year give reasons that can be categorised into two types: position and format dependent (Table 6.2). The former stress that those higher in academic rank should publish more while the latter stress the reasonability of one journal article per year

Table 6.2: Opinion About Publications Requirement

Position dependent	1. The number of publications should depend on the position of academic staff even though the minimum of 1 is quite realistic. 2. Agree if the academic staff member is holding an administrative post, otherwise it should be at least two papers 3. One paper per year for lecturers and 2 –3 for associate professors and above
Format dependent	1. One journal article – yes – if international conference paper – one is OK but if it is a local conference – at least 2 2. Preferably 1 journal article and 2 conference papers 3. At least one journal article and 2 conference papers 4. One journal article and 1 conference paper 5. Conference papers should be more than one as journal articles take time to write 6. Depends on the type of publications, journal probably 1 and conference papers 2

because of the difficulty of getting it published. At least 2 conference or other types of publications, however, must augment this number.

One scientist indicated that the one publication must be an article in an international journal. In the survey, however, 53 out of 83 of the academic engineers and 120 out of 239 academic scientists indicated that their departments did not set any minimum publication requirement. This shows that although there is no formal departmental requirement on the number of publications, most academic staff (productive or otherwise) is aware that they must publish at least one or more publications per year. In fact, some far exceed the requirements specified. Generally, the knowledge of this requirement, does not affect high publication productivity.

6.2.2. Preferred Forms of Publication

Twenty-five academic engineers interviewed agree with the survey finding that academic engineers prefer to publish in conference proceedings, while 7 disagree. This is similarly indicated by the academic scientists, of whom 16 (out of 24) agreed while 8 disagreed. Table 6.3 lists six reasons given by academics for preferring to publish in conference proceedings.

Table 6.3: Why Academics Prefer to Publish Conference Papers

Reasons	Engineers (32)		Scientists(24)	
	Count	Row %	Count	Row %
Easier to write conference paper	3	9.3	3	12.5
Less stringently peer review	4	12.5	14	58.3
Speedier channel to publish	2	6.2	-	-
Contacts with peers	10	31.2	3	12.5
Type of research	1	3.1	4	16.6
Chance to travel	1	3.1	1	4.1

A larger number of academic engineers (31.2%) than scientists (12.5%) indicate maintaining contact as the main reason. Contacts here refer to the possibility of exchanging ideas and results with researchers in similar fields, getting to know other professionals working in the same area, sharing experiences, having the opportunity to meet peers nationally and internationally. Scientists stress the importance of establishing personal contacts and feels that talking to fellow scientists in similar fields is both stimulating and rewarding.

A larger number of academic scientists (14, 58.3%) than engineers (4, 12.5%) indicate that it is easier to get papers published in conference proceedings because of its "less stringent peer review" process. This makes conference proceeding an attractive channel for publication. Most felt that conference papers are less strictly scrutinised, are often accepted without review and are therefore of lower quality than papers submitted to journals. One respondent dramatically described the ease of getting papers accepted at conferences: "Any fool can write a paper for conference – but to get a paper published in journals, one need to cough blood!"

The scientists also felt that conferences are suitable avenue for presenting certain type of papers such as shorter papers, reporting current findings, presenting preliminary findings, reporting Master's level research, addressing practical issues and presenting findings for locally-based research. One academic member of staff from each discipline regard presenting papers at conference as nothing more than a "chance to travel" on a paid holiday.

In summary, academic engineers prefer to publish in the form of conference papers because it is easier to write short papers. This is especially suitable for engineering research, which is more experimental in nature. Conference proceedings are regarded as avenues to get articles published in the shortest time (because it is not subjected to stringent reviewing system); an avenue to get feedback from peers (national and international) and to share experiences. For the academic scientists, conference proceedings are avenues where they can quite easily get their findings published because of the less rigorous reviewing process. Published proceedings are mechanisms used to obtain feedback on the findings of preliminary research before a more polished presentation to a relevant journal. The interviews and e-mail responses, therefore, help explain why academic engineers and scientists publish more conference papers than other types of publication.

The survey indicate that the three top forms of publication that academic engineers and scientists prefer are: 1 = conference papers, 2 = journal articles, and 3 = research reports. To verify this result, the respondents are asked to rank the three forms of publication (1 to 3) in terms of their preference (Table 6.4).

Table 6.4: Ranking on Preferred Forms of Published Work

ENGINEERS Types of publication	Rank 1		Rank2		Rank 3	
Research reports	8	25.0%	4	12.5%	20	62.5%
Conference papers	13	40.6%	18	56.1%	1	3.1%
Journal articles	11	34.4%	10	31.4%	11	34.4%
SCIENTISTS Types of publication	Rank 1		Rank2		Rank 3	
Research reports	2	8.3%	5	20.8%	17	70.8%
Conference papers	3	12.5%	17	70.9%	4	16.7%
Journal articles	19	79.2%	2	8.3%	3	12.5%

A higher number ranked conference papers as number one, followed by journal articles and research reports. This result confirms the findings from the survey.

6.2.3. Attitude Towards Local Scholarly Journals

The results of the survey indicated two types of behaviour regarding local journals. Firstly, even though both academics did not rate local journals very highly, they nevertheless publish more in local science and technology (S&T) journals. In both cases, over 40% of total journal articles authored are published in Malaysian S & T journals. Secondly, the majority of both academic engineers and scientists felt that the few numbers of local scholarly journals available and their poor frequency pose a problem to servicing their research needs. To understand this behaviour further, the interviews sought respondents' opinions on locally published scholarly journals in their fields. Table 6.5 displays the rating given to local journals on a scale of 0 (low) to 10 (high). The number of academics rating below 5 are more than those rating above 5, indicating that both academic groups rated local journals as either poor or average. Several reasons were given to substantiate such ratings (Table 6.6).

Table 6.5: The Ratings Given to Local Journals (Scale 0-10)

Local Journal Ratings	Engineers		Scientists	
	Count	Row %	Count	Row %
0	1	3.1	-	-
1	1	3.1	4	16.7
2	7	21.9	2	8.3
3	3	9.4	5	20.8
4	2	6.3	-	-
5	7	21.9	8	33.3
6	1	3.1	2	8.3
7	6	15.6	1	4.2
8	2	6.3	1	4.2
9	1	3.1	-	-
10	2	6.3	1	4.2

Table 6.6: Opinions on Local Journals

Opinions About Local Journals	Engineers		Scientists	
	Count	Row %	Count	Row %
Poor circulation & frequency	8	25.0	4	16.6
Few in number	1	3.1	-	-
Less prestigious/low reputation	8	25.0	2	8.3
Poor refereeing	7	21.8	7	29.1
Content: lacks quality	11	34.3	2	8.3
Lack of impact	6	18.7	1	4.1
Not considered for promotion	3	9.3	1	4.1
Nationalistic views: full support	6	18.7	4	16.6

The reasons given are grouped into 8 categories: (1) the poor circulation and frequency of journals; (2) the number of published S & T journals; (3) the prestige of the journals; (4) the poor refereeing system; (5) the lack of quality and significance; (6) the lack of impact; (7) the lack of institutional support; and (8) the nationalistic view about local journals.

The respondents interviewed indicated that they would consider publishing in local journals which have "picked up" in terms of circulation, frequency or which have attained international recognition, accepted more quality papers, have been considered by university officials in promotion exercises, and which have improved their speed and thoroughness in the article refereeing system. Faculty members were also asked whether they would submit more articles to local journals if the journals were indexed by commercial indexing agencies such as *INSPEC*, *COMPENDEX*, *CAB Abstracts*, and others. Among the academic engineers, a total of 24 (75%) indicated yes, 5 (15.6%) indicated "maybe" and only 3 (9.4%) indicated no. Likewise, amongst the academic scientists, 12 (50%) indicated yes, 7 (29.2%) indicated maybe and 5 (20.8%) indicated no. This is especially true among those from the newer university (such as Universiti Telekom Malaysia), where faculty members indicated that their university management requires them to publish only in journals. Respondents under "nationalistic views" gave some interesting responses that reflected strong commitments to support local journals. The following views were put forward: "I would rate local journals as 10 in certain research area"; " We should try to support local journals with all their short-comings"; "Local journals are equally good as some international journals"; "I would contribute even if they are not indexed because it is our responsibility to promote and improve the quality of our own journals". There is consensus that if the results of research have local applications, local channels would be the best publication outlets. Since the survey results indicated that both academic engineers and scientists use local journals substantially more to publish, it is assumed that Malaysian S & T academics mainly conduct Malaysian focused research.

6.2.4. Reasons for Preferring to Publish in Journals

The majority of academics from both disciplines accepted that conference proceedings are the most frequently used channel of publication. However, journals are still the "preferred" channel and three reasons were put forward (Table 6.7). Some gave more than one reason.

Table 6.7: Reasons for Preferring to Publish in Journals

Reasons for preferring journals	Engineers		Scientists	
	Count	Row %	Count	Row %
University requirements	2	6.2	1	4.1
Seeking recognition	2	6.2	2	8.3
To present significant work	6	18.7	2	8.3

The main reason indicated was the need to obtain expert views as well as feedback, which the international journals system provides. Equally important is the need to obtain recognition from expert peers who help explore the significance of the research itself. The universities' promotion procedures also motivate publications in journals, where (in most cases) more weight is given to works published in refereed journals.

6.2.5. Reasons for Preferring to Publish Joint Works

The results of the survey indicated that both academic engineers and scientists published more works jointly compared to single-authored works. In both cases joint works constitute between 68% and 69% of total publications. The respondents interviewed were informed of this result and were asked to indicate, in their opinion, whether this situation is true for them and volunteer possible reasons for this behaviour. All respondents interviewed agreed with this finding and reasons given are grouped into 5 categories (Table 6.8).

Table 6.8: Why Joint Works Are More Evident

Reasons for More Works Written Jointly	Engineers		Scientists	
	Count	Row %	Count	Row %
To obtain research funds	1	3.1	2	8.3
To cope with the complexity of the research area	11	34.3	14	58.3
To improve the quality of publications	2	6.2	1	4.1
A result of student-supervisor team	-	-	7	29.1
For the development of new ideas	2	6.2	4	16.6

It was accepted among academic scientists and engineers that working in groups would increase their chances of obtaining research grants where, "Application for research grants by a group is normally preferred". High agreement was indicated on the necessity to work jointly because of the complexity of current research in both fields. For the engineers many projects are multi-disciplinary which can be worked at better in a group, as members contribute to different aspects of the work. Engineers often share laboratories and equipment, and this makes collaboration a necessity. Engineering research is moving more towards application of systems and would involve a few people who worked on different aspects of the system. In this situation, writing jointly helps to present multiple aspects of the research undertaken and subsequently, help to increase publication rate. Similar situations occur in the sciences where research is also multi-disciplinary and (especially in experimental work) many different measurements and areas of expertise are required. In this situation, joint publication has become more likely and necessary and as one respondent describes, "it is no longer uncommon to see 8 to 10 names authoring a research paper". Working jointly also helps generate ideas during brainstorming sessions that are improved further with international research team members, resulting in better quality publications. The supervisor-student team has helped generate more joint-authored works and seven scientists mentioned the importance of this type of relationship.

6.2.6. Criteria for Choosing a Journal to Publish

The survey results indicated that both academic engineers and scientists use journals (mainly local S&T journals) as the second most preferred channel to publish their research results. (Table 6.9). Respondents gave reasons for choosing a journal to publish in, which are grouped into 6 categories. Both academic engineers and scientists stressed on factors such as prestige, relevance and frequency rather than circulation, costs or past successes.

Table 6.9: Criteria for Choosing a Journal to Publish In

Criteria	Engineers		Scientists	
	Count	Row %	Count	Row %
Circulation of the Journal	1	3.1	3	12.5
Relevant area of research	4	12.5	14	58.3
Prestige	7	21.8	15	62.5
Frequency	4	12.5	6	25.0
Costs	1	3.1	3	12.5
Past success	-	-	2	8.3

The journals chosen are reputable journals in their respective field of research. Three scientists mentioned choosing journals that have an impact factor as estimated by the *Journal Citation Report* of the Institute of Scientific Information. The journals chosen must be suitable and relevant to the academic staff's field of research. The journal frequency is also an important criterion because this would "help speed up the publication process when an article is accepted". Other criteria mentioned are wide circulation and past success with submission.

6.3. PERSONAL FACTORS

6.3.1. Gender, Race, Family Size and Publication Productivity

The survey results had indicated that gender and the number of children academic engineers and scientists have are not related to their publication productivity. Only age was correlated with total publication output for academic engineers and scientists. The respondents from the interviews generally agree with these findings. Table 6.10 indicates that the majority of both engineers and scientists agree that personal background would have little effect on their publication productivity.

Table 6.10: Personal Background Has No Effect on Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	5	15.6	8	33.3
Agree	27	84.4	16	66.7
Total	32	100.0	24	100.0

Those who disagree regarded the family as an extension of the individual and any problems besetting the family, such as their conditions and the age of their children, affect an academic staff's efficiency. A respondent pointed out that this may apply to women academics, who might be more affected by their personal environment. Those who agree stressed that academic staff should not let personal matters affect their teaching and research commitments. The respondents also gave other factors which they felt affected their publication productivity and this is included in the following section.

6.4. FACTORS INFLUENCING PUBLICATION PRODUCTIVITY

This section identifies and categorises the possible factors influencing research productivity as expressed by respondents in the exploratory study. From the responses given, it is possible to identify eight types of factors (Table 6.11). The right attitude figured frequently among both the engineers and scientists. For the academic engineers, the right attitude includes confidence in undertaking research, total dedication and commitment, the desire to go further and contribute to the field, interest and wanting to excel in research. For the scientists the right attitude means having an interest and passion for knowledge, the ability and maturity to handle research problems, and the desire to communicate and disseminate research results. A professor aptly commented, " I give this activity the highest priority in my daily life. I treat every publication as if it is my son and daughter", and "One should be willing to endure sweat and tears and yet maintain a positive attitude".

Table 6.11: Factors Influencing Publication Productivity

Factors	Engineers		Scientists	
	Count	Row %	Count	Row %
Ability	7	21.8	10	41.6
Attitude	20	62.5	20	83.3
Departmental support	19	59.3	8	33.3
Institutional support	11	34.3	4	16.6
Professional factors	7	21.8	-	-
Funding	6	18.7	4	16.6
Personal factors	5	15.6	8	33.3

Ability is also regarded as an important factor especially among academic scientists. To the academic scientists, productive researchers are those who are consistent in their work, able to plan their own work efficiently, have a clear perception of the research problem, scope of the research and plan of work, have the ability to analyse results and write up the work, proficient in their language skills, and are in the habit of writing. For the engineers the productive researcher is one who documents and reports everything that was done in the research process, one who has experience, and is able to manage his time efficiently.

Academic engineers regard the departmental environment as an important factor. A suitable departmental environment is where the administrative duties allocated to teaching staff are reduced, where peers are supportive, and which attracts a pool of able research students. For the academic scientists, a conducive departmental environment is one where those who are experienced longer in research are the more productive, where teams work well and collaborate with other teams, where adequate equipment is available, where the support staff and researchers maintain good relationships and where the research students are able, top-rated graduate students (first class).

Institutional supports mentioned include: adequate funding, better library facilities, and adequate computing facilities. Professional factors comprise the ability of academic staff to establish good contacts and network, to be actively involved in consultation activities (especially for the engineers), and the ability to work in teams.

Personal factors also figure prominently especially for academic scientists, and these factors include situations such as women academics who have to care for a young family, the number of children that respondents have (as most research writings is done at home), and the lack of confidence (especially among young lecturers). Academic engineers stressed the importance of family circumstances such as the health of family members and suitable accommodation as additional personal factors which may influence research productivity. Two professors volunteered their personal observations on the effect of age on publication productivity; " In Malaysia, the best productive age is between 35 and 55" and " In my experience, productivity peaks after 40, when I have gained more experience, obtained more contacts, achieved a stable family and working environment and have greater insight into research problems". In general, it is interesting to note that the academic staff stressed factors which are endogenous, that is, factors that only the individual can manipulate and change.

6.5. ACADEMIC FACTORS

6.5.1. Academic Qualification, Rank and Work Experience

The results of the survey of academic engineers indicated that respondents' affiliation, department, years since the highest qualification was obtained and the country where the highest qualification was obtained are not related to publication productivity. However, respondents' highest qualification ($p \leq 0.05$), and definitely working experience, and academic rank are correlated to publication productivity ($p \leq 0.01$). The situation is slightly different for the academic scientists where affiliation, department, academic qualification, years since the highest qualification was obtained, academic rank and work experience are related to publication productivity ($p \leq 0.01$). The interviews found similarities in the opinion among academic staff from both disciplines (Table 6.12) that qualifications have only a slight effect on publication productivity.

Table 6.12: Qualification is Related to Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	2	6.2	6	25.0
Agree	30	93.8	18	75.0
Total	32	100.0	24	100.0

Table 6.13: Academic Rank is Related to Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	3	9.4	10	41.7
Agree	29	90.6	14	58.3
Total	32	100.0	24	100.0

There was also general agreements among both sets of academics that academic rank is related to publication productivity (Table 6.13) and the strength of agreement is greater among the engineers. The majority of respondents explained at great length why they felt strongly about rank as a potential determinant of research productivity. The reasons given are listed and categorised into four groups (Table 6.14) and these are: (1) effect of the promotion exercise, (2) years of experience in research, (3) larger allocations from the support system and (4) reputation attained.

Table 6.14: Why Rank and Experience were Related to Publication Productivity

Reasons	Engineers		Scientists	
	Count	Row %	Count	Row %
Effect of institutional promotion exercise	9	28.1	3	12.5
Longer years in research	5	15.6	1	4.1
Bigger fund allocation	6	18.7	2	8.3
Established reputation	4	12.5	1	4.1

Academic engineers felt that it is the institution's promotional requirements that trigger publication productivity. Those who want academic promotion have to prove themselves first publication-wise, and institutions use this achievement, to gauge a researcher's contribution to his/her discipline. Hence, rank is obtained because of both experience and publications. As succinctly put by an academic scientist, "Professors and associate professors get where they are because they have a good publication track record, are experienced and committed to continue publishing".

Both engineers and scientists agree that those experienced are more likely to be mature, more involved in research, and tend to publish more. Professors have more years of research experience and are therefore expected to have written more. Professors are also more likely to supervise Ph.D. students and get bigger grant allocations, which in turn, enable them to have better facilities to support their research. Professors tend to have an established reputation which, in turn, attracts research students who will subsequently publish joint papers.

The academic staff who disagreed with the effect of academic rank on publication productivity were generally lecturers who were active publishers and who felt that rank does not necessarily ensure publication productivity. They described instances where professors and associate professors have not published anything of substance beyond their Ph.D. work, or of those who forget their academic role when they get overburdened with their administrative duties. This is true in cases where experience and rank is accompanied by more administrative duties. As one professor commented, "In my observation when a Malaysian faculty member obtains his associate professorship, he 'lowers his gear', and this separates those who will remain as associate professors and those who will continue to become professors".

There seems to be consensus regarding the relations between publication productivity and promotion. Hence, it is inevitable that associate professors and professors are higher publishers compared to the lecturers. This situation is shaped by the university promotion policy as commented by a respondent, "Promotion was obtained because of their productivity as lecturers...". Once the rank is obtained, funding, networking and reputation accumulates. There were also hints of the unfairness of the funding allocation system where "professors get more grant without so much of a fight...", or " those higher in academic rank supervise more postgraduate students which demands publication as the output". Only one faculty member indicated his reservations that higher productivity of those in higher academic ranks continues, believing that it can become static and those who continue to be productive will eventually become professors.

6.5.2. Foreign Degrees

The majority of Malaysian academics are trained abroad especially in the United Kingdom and United States of America. This is indicated by the survey results as well as those approached for this exploratory study. However, the majority of academic scientists and engineers felt that academics who obtained the highest qualification abroad are not necessarily more productive (Table 6.15). This confirms the survey findings that found no relationship between countries where the highest degree was obtained and publication performance of academic engineers.

Table 6.15: Foreign Trained Academics are More Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
No	23	71.9	17	70.8
Maybe	3	9.4	1	4.2
Yes	6	18.7	6	25.0
Total	32	100.0	24	100.0

Those who felt that foreign trained lecturers have certain advantages gave the following reasons; (a) they are trained to write papers according to international standard, (b) they have undergone strenuous hardship of survival and independent research, (c) they are able to undertake as well as publish more research, (d) they have an added advantage when writing in the English language and (e) they are exposed to better facilities. Those who disagreed generally felt that local trained academicians are just as good as those trained abroad.

6.5.3. Technical writing skills

The survey results indicated that those who are high publishers rated highly on their technical writing skills ($p \leq 0.01$) highly. Those who were confident in their writing skills were also those with more years of working experience, have Ph.D. and were higher in academic rank.

Less than half of the respondents in the exploratory study felt that they received adequate research writing skills from their thesis writing experience (Table 6.16a). Slightly more than half of respondents indicated either they did not receive adequate training or were just fairly satisfied with their writing skills.

Table 6.16a: Received Adequate Training to Write

	Engineers(n=32)		Scientists(n=24)	
	Count	**Row %**	**Count**	**Row %**
No	8	25.0	9	37.5
Satisfactory	9	28.1	4	16.7
Yes	15	46.9	11	45.8
Total	32	100.0	24	100.0

The exploratory study found a weak correlation between those who felt that they were sufficiently trained and academic qualification (p=.313, sig. ≤ 0.05). Those who were confident of their research writing skills indicated possible ways in which their writing skills were acquired (Table 6.16b). Both academic scientists and engineers felt that their writing skills were not acquired but developed with experience. A number of respondents mentioned picking up the skill over time and after a number of papers were written.

Table 6.16b: Ways in which Research Writing Skills are Acquired

	Engineers		Scientists	
	Count	Row %	Count	Row %
Experience	6	18.7	7	29.1
Ph.D program & supervisor's help	2	6.2	5	20.8
Self-acquired skill	2	6.2	2	8.3
Perseverance	2	6.2	-	-
Language ability	-	-	2	8.3

Also mentioned was the thesis writing experience undertaken for the Ph.D. degree as well proper guidance from supervisors. Within this context, respondents suggested how this was possible, such as: "supervisors have improved my writing skills", "When I was writing my Ph.D. thesis, my supervisor asked me to write papers out of the research myself and this helped to push me to write", "Ph.D. programmes are designed for this purpose", "Out of the thesis I wrote my first publication for journals". Thesis writing has contributed to about 60% of my research writing skills". Other means mentioned were learning through trial and error, acquiring writing skills through reading research papers, persevering until "one gets it right", and polishing language skills as "proficiency in the language in which the paper is being written helps".

6.5.4. Satisfaction with Current Publication Output

Over 50% of both academic engineers and scientists were not satisfied with their publication achievement (Table 6.17). This is a curious finding when compared to the confidence academics

Table 6.17: Satisfaction with Present Publication Achievement

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Not satisfied	20	62.5	12	50.0
Fairly satisfied	4	12.5	3	12.5
Satisfied	8	25.0	9	37.5
Total	32	100.0	24	100.0

indicated in their writing ability in the survey. Respondents gave reasons such as the lack of time, too many administrative duties, heavy teaching responsibilities and inadequate funding that prevents them from being more productive. One lecturer indicated that funding agencies have the habit of giving only half or a third of what has been asked for in grant proposals. This frustrates the researchers especially in instances where the research is equipment intensive. Those who were fairly satisfied or satisfied with their publication output were associate professors and professors, who were publishing actively but wanted to publish more. Typical comments are: "I had 4 published papers in 3 years. I think I should have at least 2 papers per year", "I had hoped to publish more even though I have published 7 papers in journals and conferences" [a professor]. These situations indicate that being confident in writing is not enough to result in higher publication productivity among academic staff. Conducive conditions such as a realistic administration and teaching load, adequate funding and exposure to good writing skills through hands-on technical writing skills workshops may help.

6.6. DEPARTMENTAL FACTORS

6.6.1. Percentage of Time Spent on Research

The survey results indicated that the majority of both academic engineers (53%) and scientists (56.5%) spent 21%-30% of their time on research. Publication productivity was not correlated to percentage of time spent on research for academic engineers and a weak correlation was indicated for the academic scientists ($p<0.05$). The respondents in the exploratory study disagree with this result (Table 6.18). Those who disagree gave several reasons for their opinions such as, experimental research require more time to test data in laboratories or on site; and spending more time on research ensures enough results are obtained before they can be reported in publications. For the scientists, more time is needed especially when there are no research assistants to help. In certain cases, the amount of time needed for research is area dependent. In genetic engineering, for instance, it takes some time before a suitable paper can be published.

Table 6.18 Percent Time Spent on Research is not Related to Publication Productivity

Opinion	Engineers (32)		Scientists (24)	
	Count	Row %	Count	Row %
Disagree	16	50.0	16	66.7
Maybe	1	3.1	2	8.3
Agree	15	46.9	6	25.0
Total	32	100.0	24	100.0

Those who agree that the percentage of time allocated to research has no influence on publication output, put forward personal factors such as motivation, efficient time management and the difference between the research and writing activity (the latter being more difficult) as important elements in ensuring publication productivity. A number put forward luck, hard work (especially in mathematics) and experience rather than time spent, as important in producing quality papers.

6.6.2. Research Students

The respondents in the exploratory study generally agreed with the statement that the number of research students in a department influences publication productivity (Table.6.19).

Table 6.19 Number and Quality of Research Students is Related to Publication Productivity

	Engineers (32)		Scientists (24)	
	Count	Row %	Count	Row %
Maybe	3	9.4	1	4.2
Agree	29	90.6	23	95.8
Total	32	100.0	24	100.0

The responses indicate a consensus on the importance of research students to boost departmental publication. Some comments are: "When one has a number of good students, one can ask them to write some papers under guidance and therefore can co-author more papers", and "Post graduate students help a lot in the number of publication achieved". However, even though the number of available research students is important in ensuring publication productivity, other conditions such as how the students are distributed between staff within the departments is perhaps more relevant and pertinent in ensuring that the less experienced lecturers received some research "help". One academic scientist stress that allocation of full-time research student supervision must not be "crony-dependent".

6.7. PROFESSIONAL FACTORS

6.7.1. Professional Membership

The survey results indicated that over 70.0% of academic engineers and 65.7% of academic scientists are members of between 1-2 societies. About 14% of academic engineers and 30%

of scientists are members of more than 2 societies. The survey results indicate a weak correlation between the number of professional membership and higher publication productivity of academic engineers and scientists ($p \leq 0.05$). The exploratory study does not echo the survey findings, as the majority of academics interviewed felt that professional membership is not related to high publication productivity (Table 6.20).

Those who agree gave reasons such as, "Generally a staff member active in his associations is also active in other areas" and "I think it works the other way round, highly productive academics tend to be those active in their professional associations because of their reputation".

Table 6.20: Active Professional Membership Results in Higher Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	21	65.6	12	50.0
Maybe	-	-	6	25.0
Agree	11	34.4	6	25.0
Total	32	100.0	24	100.0

The reasons given by those who disagree are as follows: "I don't see the connection", "It may work the other way round. A productive person gets approached to be editors or reviewers for professional journals", and "Academics who do not make the grade in terms of publications get involved in professional associations as an alternative means of getting some sort of recognition". In general, the responses indicate that academic engineers and scientists have less faith in the ability of their professional associations in improving their research productivity.

6.7.2. Consultation

The survey results indicated that about 79.2% of academic engineers and scientists undertook between 1 - 2 consultation activities (between 1990-1995) and this variable is weakly correlated to higher publication productivity ($p \leq 0.05$). The exploratory study indicates that both academic engineers and scientists do not agree that consultation activity help promote their publication productivity (Table 6. 21).

Table 6.21: Active Consultation Work Results in Higher Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	22	68.8	14	58.0
Maybe	2	6.2	5	21.0
Agree	8	25.0	5	21.0
Total	32	100.0	24	100.0

Those who disagreed gave several reasons. The academic engineers pointed out that the results of most consultation work are confidential and cannot be published, even though it helped to increase income. What were written after consultation were reports for clients who had commissioned the study. Furthermore, when the consultation involves supervision, testing or commissioning of projects, nothing of substance can be published. One scientist felt that the circumstances point to an opposite situation where those who publish more become experts and get the consultation jobs. What is publishable out of a consultation job is dependent on the type of work undertaken. If the work uses old technology the results might not be publishable.

6.8. COLLABORATION

6.8.1. Collaboration with Colleagues from Outside the University and Abroad

The survey results indicated that the academic engineers collaborate with colleagues outside their university only "sometimes". Collaboration with fellow researchers from other country rarely took place. However, collaboration with colleagues outside the university and abroad, were correlated to higher publication productivity for academic engineers ($p<0.05$) and scientists ($p<0.01$). The majority of academic staff interviewed agree that a higher degree of collaboration would result in higher publication productivity (Table 6.22a). Similarly, higher productivity would be related to collaboration undertaken with colleagues outside the university and abroad (Table 6.22b).

Table 6.22a: Higher Collaboration Results in Higher Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	1	3.1	1	4.1
Maybe	3	9.4	4	16.7
Agree	28	87.5	19	79.2
Total	32	100.0	24	100.0

Table 6.22b: Collaboration with Researchers from Other Universities and Abroad

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	6	18.7	-	-
Maybe	2	6.3	-	-
Agree	24	75.0	24	100.0
Total	32	100.0	24	100.0

There were a number of positive views about collaboration, such as its effect on funds, enrichment of ideas, commitment to complete projects and the production of quality publications. Collaboration was felt to allow researchers to venture into new fields of research with more confidence due to expert team members. The quality of the research paper was also thought to improve: "An active team always nurtures individual team members. When a team member writes a paper, the other member would contribute in terms of ideas on how to shape the publication into a better piece of work", and most academics felt that international journals tend to prefer collaborative work. Those who negate the effect on productivity gave reasons such as; "productivity has nothing to do with the team but depends more on the individual and the success of collaboration depends on whom one collaborates with".

6.9. FINANCIAL SUPPORT

6.9.1. Financial Awards and Grants

The survey results indicated that the majority of both academic engineers and scientists received 1 to 2 grants and the number of grants ($p \leq 0.01$) and the amount of grant received ($p \leq 0.01$) were strongly correlated to higher publication productivity. The academic staff interviewed agree with the results of the survey (Table 6.23a and 6.23b).

Table 6.23a: Number of Financial Awards Received is Related to Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	5	15.6	5	20.8
Maybe	-	-	2	8.4
Agree	27	84.4	17	70.8
Total	32	100.0	24	100.0

Table 6.23b: The Amount of Grant Received is Related to Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	8	25.0	13	54.2
Maybe	-	-	1	4.2
Agree	24	75.0	10	41.6
Total	32	100.0	24	100.0

Those who agreed on the effect of grants, gave the following comments, "Generally true since without healthy funding, publication productivity will definitely be a problem", " Yes, if the leader knows how to use the money properly", "With enough funds, one can have more research assistants and facilities to help", "Can hire more research students and this helps to generate more papers" and "Financial support is so important since it allows one to buy basic equipment needed. A simple analogy - you cannot expect a local football player to compete at international level when he does not even have proper boots".

Typical comments on the effect of larger amount of grants included, "Large grants are essential in order to employ research officers and buy equipment and the effect of these factors on publication productivity is indirect" and "Success breeds success, larger grants mean more stringent expectations and usually go to those with a proven track record".

Those who disagreed highlighted the importance of motivation rather than the total and amount of grants and a typical comment was "One could have large funds but waste it if one is not motivated enough to see through the research till its publication stage". Other views were, "There was an example where an academic staff received almost 1 million worth of grant for three years but only produced two proceeding papers in the end – the excuse was his data was not good enough for publication" and "Those who conduct theoretical research do not apply for any funding to conduct research".

The responses obtained from the interviews included information on means of getting funding. Respondents interviewed felt that it was easier to obtain grant for "novel ideas", "research that has a good potential economic returns", "new areas", "a good research proposal", "work in priority areas" (this was mentioned by 5 respondents), "collaborative work" (mentioned by 4 respondents) and "having someone well known in the team such as a well known professor" (mentioned by 3 respondents).

6.10. LIBRARY, LABORATORY AND ELECTRONIC SUPPORT

6.10.1. Library Support

The survey results indicated that about 55.4% (46) of academic engineers and 70.7% (169) of scientists regarded their library resources as fairly sufficient yet the ratings are not correlated to their publication productivity. When the results were put forward to those interviewed, it was found that there were differences in respondents' views of their library (Table 6.24a).

Table 6.24a: Library Facilities is not Related to Publication Productivity

	Engineers (32)		Scientists(24)	
	Count	Row %	Count	Row %
Disagree	10	31.3	2	8.3
Maybe	2	6.2	1	4.2
Agree	20	62.5	21	87.5
Total	32	100.0	24	100.0

The majority of academic engineers and scientists agreed that library facilities and publication productivity are not related. Those who agree provided several reasons for the unrelated factors such as: "Library provides information about research done by others but the shaping of the actual publication is totally self-driven", "The resources are there, but it depends on how one maximizes the sources", "Library search can provide the researcher with literature but cannot directly make him write good papers", and "A good library collection helps in the literature searching process but whether the research results get written or reported still depends on individual self discipline and motivation". Although academic staff accepted the importance of library facilities, they felt they do not affect their research because alternative channels are used, as one academic commented, "I have always requested reprints directly from the paper writers or obtained the information I need from the Internet and good library resources are accessible through the Net".

Those who disagree on the influence of the library on publication output also gave several reasons for their opinions, such as: "It does affect the initial phase of the research", "Quality and quantity of reading materials are important in good research", "Library is important in the initial stages (literature view) of research", "It is impossible to research properly without the support of the library", and "All scientific research starts with the literature review – this would help in problem formulation, choice of methodology and approach to analysis".

To understand how the library can help to improve publication productivity, the academic engineers interviewed gave four possible methods (Table 6.24b). A high number of academic engineers wanted the library to improve services to electronic databases (40.6%). Academic engineers felt that the library could help by increasing access to databases in relevant research areas, which should be made available over the campus network (6 engineers mentioned this). They felt that the library should provide online links to libraries throughout the world and notify users of useful web sites.

Table 6.24b: Ways in which the Library can Assists in Research

	Engineers		Scientists	
	Count	Row %	Count	Row %
Better access to electronic databases	13	40.6	4	16.6
Continue journal subscription & maintain currency	13	40.6	8	33.3
Speedy inter-library loan services	9	28.1	2	8.3·
Other support services	4	12.5	5	20.8

Both academic engineers and scientists stressed the importance of continuing subscriptions to up-to-date journals, which must be currently received and supported by a current contents service. The engineers (9) wanted free or subsidised inter-library loan services in order to "expedite getting papers requested at a reasonable cost". The academic engineers and scientists wanted help in tracing the location of journals required, in searching databases and providing good photocopying services.

6.10.2. Laboratory Support

Over 80% of academic engineers and scientists rated their laboratories as fairly sufficient or sufficient and this rating is not correlated to their publication productivity achieved. The exploratory study indicated that there were differences in respondents' degree of agreement on the perceived effect of the laboratory on publication productivity (Table 6.25).

Table 6.25: Laboratory Facilities is not Related to Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	20	62.5	15	62.5
Maybe	-	-	-	-
Agree	12	37.5	9	37.5
Total	32	100.0	24	100.0

About 60% of academics in both disciplines disagree that the adequacy of laboratories is not related to higher publication productivity. Those who agree stressed the importance of motivation rather than facilities that might influence publication productivity as indicated by this typical comment "It depends on the person's motivation and his thoroughness in reporting every findings from his research. This is important, because some wait so long that their findings get out-of- date by the time they decide to publish it". One scientist revealed his strategy for success, "It helps to suit oneself to available conditions. I was disappointed because I could not do the type of work I was trained for earlier. However, I changed my area of research to suit available facilities, and it works – adaptability is the key to survival".

Those who disagree gave comments such as: "One needs good tools to produce good results", "Laboratory support is the most important factor in increasing productivity", "Improper laboratory facilities deter good research", "Sufficient equipment will help in generating research activity, and in turn, publication productivity", and "Laboratories are the most important component of research".

It is felt that the academics interviewed failed to distinguish between the research activity and research writing. The former may need adequate facilities but the success of the latter depends on factors other than good laboratories. This conclusion is based on respondents' responses from both disciplines in the survey that indicated their satisfaction with their laboratories, which were perceived as adequate for their research needs. In this situation, where all researchers have adequate laboratory facilities, then the laboratories failed to be a factor that affected publication productivity when subjected to cross-tabulation.

6.10.3. Electronic Support

The survey results indicated that although the majority of academic engineers and scientists reported using the computers very frequently, the frequent types of use made of the computers connected with research are not correlated to total publication productivity. The exploratory study indicates that academics' views on this situation were roughly 50-50, that is between 45% -53% disagreed that electronic support is not related to publication productivity and 45% - 50% agreed with the findings (Table 6.26).

Table 6.26: Electronic Support is not Related to Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	17	53.1	11	45.8
Maybe	-	-	1	4.2
Agree	15	46.9	12	50.0
Total	32	100.0	24	100.0

Those who disagree gave comments such as: "Computers do not affect publication productivity as such but it helps", "Without computers it would be very difficult to prepare manuscripts as demanded by journal editorials", "Computers have become the single most important tool for research", "Computers are not directly linked to publication productivity". Those who agree gave the following views: "Time management is more important", "It would not have a direct influence – it just provides information", "Some researchers are computer dependent", "It is essential for communication and useful for complex calculations". The importance of information gathering, through the Internet is also indicated, "Allow access to articles available online", "It provides access to e-mail and World Wide Web resources" and "Direct effect of the Internet access is absolutely crucial, especially as library budgets are reduced" (mentioned by 6 respondents interviewed).

The results reveal the growing importance of computer support in research from the preparation of manuscripts, dissemination of preprints to peers, submission of finished work to publishers, accessing information from remote sites and databases and the communication of results.

6.11. RESEARCH VIEWS

6.11.1. Positive Research Views

The results of the survey indicated that over 80% of both academic engineers and scientists rated positively on all research outcome statements listed. The respondents interviewed also agreed that positive views on research are related to publication productivity (Table 6.27).

Table 6.27: Positive Views on Research is Related to Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	2	6.2	1	4.2
Agree	30	93.8	23	95.8
Total	32	100.0	24	100.0

Various comments were given to substantiate this view: "Positive attitude is particularly important for fundamental research. Many things are worth publishing, even when the results are negative. In fact sometimes a negative result may lead to the discovery of new phenomenon", "Positive thinking and motivation are important factors", "Where there is a will, there is a way", "Motivation helps in deprived circumstances", "Positive views spur positive activities - people who thinks positively will work harder", and "Yes, everything starts from having the right attitude". "An academic cannot have a negative attitude about research, if he has chosen academia as a career" and "with the right attitude, one will still undertake research even when given heavy teaching load" as "personal drive will overcome all hindrances".

6.11.2. Views on Colleagues and Departmental Duties

Colleagues - The survey results indicated that the respondents' views on their colleagues, and their department are not correlated to their publication productivity. In the exploratory sample, a higher proportion of scientists agree with this finding (Table 6.28) but the differences with those who disagree are not significant. Those who disagree, give typical remarks such as: "Less motivated colleagues are dangerous" and "Colleagues are a source of strength in research. If one is holding an administrative post you have little time to think about research and in this case colleagues help". This is especially true of newly appointed staff, who are often "bullied" into undertaking more administrative work.

Table 6.28: Colleagues and Departmental Duties are Related to Publication Productivity

	Engineers(n=32)		Scientists(n=24)	
	Count	Row %	Count	Row %
Disagree	17	53.1	11	45.8
Agree	14	43.8	12	50.0
Maybe	1	3.1	1	4.2
Total	32	100.0	24	100.0

Those who agree, stressed on other factors such as motivation: "It boils down to motivation there are academic staff who teaches the same number of hours as his colleagues and publishing more papers", and "Colleagues may be encouraging – but it still boils down to the person himself – whether he is disciplined enough to fervently report his research findings". The results indicated that academic staff are fully aware of the importance of colleagues and conducive departmental environment in supporting their research activity. However, the importance of personal factors such as self-motivation and self-discipline is equally accepted.

6.11.3. Preferred Institutional Environment

The types of institutional support preferred by academic staff are summarized in Table 6.29. Between 25% to 33% of academic engineers and scientists wanted sufficient and fair allocation of research funds. This entails "not getting RM$3,000 when asking for RM$20,000", "an appropriate start-up grant for new lecturers", "less red tapes when purchasing equipment" and a "monitoring mechanism to ensure that equipment bought do not become white elephants", and "better management of the financial resources".

Table 6.29: Institutional Environment and Publication Productivity

	Engineers		Scientists	
	Count	Row %	Count	Row %
Ensure quality researcher support	6	18.8	2	8.3
Support for excellence	4	12.5	8	33.3
Sufficient & fair funding support	8	25.0	8	33.3
Recognise job preference	2	6.2	-	-
Balance between teaching/research	1	3.2	-	-
Technical support	-	-	2	8.3
Research resource repository	3	9.3.	-	-

Academics interviewed wanted recognition for excellence from their institutions in terms of providing "vibrant research publication environment", "respect for hard work", and "rewarding those who can deliver". Good researcher support indicated by both groups of academics includes the hiring of "a highly skilled and permanent pool of technical support team" who can make sure that equipment bought is in working order, "offering more places for tutors doing higher degree", "providing reasonable pay for research assistants", and "encouraging bright students to do research by giving them scholarship or grant assistance". Other institutional factors suggested include the recognition that "there should be a balance between research and teaching", that there is "recognition between those who prefer teaching to research. The teaching load of the former can be increased, but minimal for the latter. The latter, however, must show evidence of publication productivity". A number of engineers suggested the establishment of a local depository of research documents, "a centralized centre for keeping local S & T conference/ journal/research reports which would be available to academics ". These views are useful cues for the library to initiate a research depository centre of local S & T research publications.

6.11.4. Preferred Research Environment.

The academic engineers interviewed volunteered information about the kind of research environment they would like to see in their department, which can be categorised into four groups. The first group is identified as "active interactions", which includes such situations as: (i) more interaction and collaboration between individuals within the department, (ii) weekly technical presentations of research being done, (iii) exchanging ideas electronically and in common rooms, (iv) sharing of experimental sources, (v) regular combined coffee hours for exchanging research ideas, and (vi) helping one another to effectively request research grants. The second involved "facilities" where the following proposals were put forward: (i) separate laboratory for teaching staff, (ii) sharing of equipment, and (iii) adequate machines and equipment. The third group is identified as "attitudinal" which comprises the following situations: (i) positive attitude, (ii) camaraderie spirit where everyone in the department is proud to be involved, because it is able to produce world class research, and (iii) members are cooperative, sharing and caring. The fourth type is grouped as "finance" which constitutes the following situations: (i) more financial support, (iii) a proper reviewing system, and (iv) funding for research assistants to attract top quality researchers. The fifth group is "Others" which include situations such as (i) less teaching load, (ii) the lack of necessity of justifying the economic value of one's research, (iii) the non-interference into day-to-day work, and (iv) giving more weight to research publications in reputable international journals.

6.11.5. Preferred Research Leadership.

The question about leadership in research was not touched upon in the survey but this question was put forward to academic engineers and scientists during the interviews. In general, academic engineers gave a number of comments on the type of research leadership they would like to see (Table 6.30).

Table 6.30: Leadership Role and Publication Productivity

Roles	Engineers		Scientists	
	Count	Row %	Count	Row %
Visionary & research oriented	7	21.8	1	4.1
Caring & supportive	5	15.6	7	29.1
Role model	4	12.5	7	29.1
Lead in collaboration	3	9.3	1	4.1
Management skills	2	6.2	2	8.3

Qualities which constitute "being visionary" and "research oriented" include: (i) providing a vision for each research group, (ii) setting a target for publication productivity for each researcher, (iii) providing information and sharing techniques on how to attract researchers, (v) trying to understand staff research areas, (vi) believing in the importance of the research activity itself and the benefits it brings to the institution and (vii) creating an environment where staff have a positive attitude towards departmental objectives. The leader is expected to be caring and supportive and one who: (i) makes occasional visit to the laboratories, (ii) is friendly and helpful, (iii) guides junior staff to be focused, (iv) understands staff problems and (v) makes an effort to socialise with staff and colleagues.

Leaders should be role models, exemplary as leaders, a mentor to fellow researchers, who published extensively in reputable international journals and an active researcher himself. The research leader should be active in seeking opportunities to collaborate with researchers outside the institutions and cajole them to work in groups. The leader is also expected to have good management skills.

6.12. CHANNELS OF COMMUNICATION AND DISSEMINATION

6.12.1. Channels Used to Find Out About Other Researches

In the survey, the Internet was ranked fifth and sixth among 13 other channels used for research information by academic engineers and scientists, respectively. In the exploratory sample, the Internet emerged as the most used channel (56.2% and 54.1% of academic engineers and scientists respectively) (Table 6.31) for research information. Journals, conference proceedings, colleagues, research reports, libraries and online databases follow this.

Table 6.31: Channels Used to Find Out About Other Researches

Channels	Engineers		Scientists	
	Count	Row %	Count	Row %
Internet	18	56.2	13	54.1
Journals	11	34.3	9	37.5
Conferences	7	21.8	7	29.1
Research reports	2	6.2	6	25.0
Colleagues	6	25.0	5	15.6
Libraries & online databases	5	15.6	4	16.6

The increasing importance of the Internet may be the result of the completion of the campus-wide computer networks for both UKM and UM from 1997 onwards, which provides Internet access from each lecturer's own desk. The use of libraries and online databases includes browsing abstracts from CD-ROM based databases, using the MASTIC (Malaysian Science and Technology Information Centre) database for reports of IRPA (Intensified research in priority areas) projects.

6.12.2. Channels Contacted in the Research Process

The academic engineers and scientists in the exploratory study mentioned 4 channels, which they use to obtain information during the research process (Table 6.32).

Table 6.32: Channels Contacted for Information during the Research Process

Channels	Engineers		Scientists	
	Count	Row %	Count	Row %
Colleagues and collaborators	12	37.5	16	66.6
Internet and e-mails	5	15.6	5	20.8
Libraries and librarians	7	21.8	2	8.3
Author(s)	3	9.3	1	4.1

A high proportion of academics from both disciplines sought information from their colleagues or collaborators. Example of persons approached were: team members, friends in the same field, professors in the field, colleagues abroad, colleagues from other institutions and research students helping with the research. Academics also used the Internet and e-mail to contact experts in their field of research. The first author of any technical paper needed was also contacted during the research process. The reasons for using the channels may be reflected in the responses from both academic engineers and scientists in the survey. Respondents from the survey stressed on using channels which had the ability to keep academics aware of current developments, and the likelihood of the channels containing authoritative, accurate and objective information needed for research.

6.12.3. Methods Used to Disseminate Research Results

From the survey results, articles in refereed journals were ranked first by 67.5% of engineers and 60.7% of scientists as the method used to disseminate research results. Another printed source "articles in refereed local journals" were ranked third by 61.1% of engineers and second by 49.8% of scientists. Published conference proceedings were ranked second by 57.8% of engineers and third by 41.1% of academic scientists. The responses from the exploratory study echoed the survey findings (Table 6.33) where journal articles and published proceedings were still the preferred channel mentioned by 96.8% (31) of engineers and 50.0% (12) of scientists. Oral presentations which were rated as important (first) by only 9.6% of academic engineers and scientists in the survey, were given greater importance in the exploratory study. In the survey, the use of e-mail to disseminate research results was placed first by only 2 (0.8%) academic engineers and second by 2 (2.4%) academic scientists. The exploratory study found that the use of electronic channels shifted somewhat in importance, where 28.1% (9) of academic engineers and 20.7% (5) of academic scientists included publishing their own web-sites and corresponding through e-mail as a popular method used to disseminate research results. The use of electronic channels is expected to increase in future as more scholars accept electronically published sources.

Table 6.33: Methods of Disseminating Research Results

Methods	Engineers		Scientists	
	Count	Row %	Count	Row %
Printed sources (journal articles, reports & published proceedings)	31	96.8	12	50.0
Oral presentations	7	21.8	13	54.1
Electronically (publishing web pages)	8	25.0	1	4.1
Correspondence or e-mail	1	3.1	4	16.6

6.12.4. Methods Used to Keep Abreast

The survey results indicated attending conferences and meetings as the most useful method to keep abreast by 72 (86.7%) academic engineers and 203 (85.0%) academic scientists. In the exploratory study, this channel was mentioned by only 9 (28.1%) and 4 (16.6%) academic engineers and scientists respectively (Table 6.34), while the highest number of mentions were given to printed sources (journals and reports) by both academic scientist and engineers as a means to keep abreast.

In the survey, the use of electronic sources was mentioned as useful by only 14 (16.9%) and 156 (65.3%) academic engineers and scientists respectively. In the exploratory study, this source ranked third as the method used to keep abreast. The use of electronic sources is expected to increase in the future with ready access currently available from the academic staffs' own desk

Table 6.34: Methods Used to Keep Abreast with Research Information

Methods	Engineers		Scientists	
	Count	Row %	Count	Row %
Printed sources (journals, reports)	15	46.8	13	54.1
Seminars	9	28.1	4	16.6
Electronically (Internet, e-mail)	6	18.7	3	12.5
Literature searching	1	3.1	2	8.3
Contacts	1	3.1	1	4.1
Sabbatical	1	3.1	-	-

Other methods used to keep abreast mentioned by those in the exploratory study include: searching the literature every 6 months, checking for information provided in the Internet, maintaining contacts with research laboratories and utilising the time provided by sabbatical leave (every three years) to keep current.

6.12.5. Description of Problems Faced

The respondents in the exploratory study indicated the kind of problems they frequently face when undertaking research. The opinions given are categorised into 8 groups (Table 6.35).

Table 6.35: Problem Faced when Undertaking Research

Problems	Engineers		Scientists	
	Count	Row %	Count	Row %
Funds	8	25.0	8	33.3
Good research students	6	18.7	3	12.5
Sources	5	20.8	4	12.5
Maintenance of equipment	4	12.5	7	29.1
Generating new ideas	2	6.2	2	8.3
Sufficient time	3	9.3	1	4.1
Colleges	1	3.1	2	8.3
Personal	2	2.6	1	4.1

A common problem mentioned by both groups of academics was lack of funding. Comments relating to this include: "It is a problem getting research fund", "lack of adequate funds to buy expensive equipment (not less than RM200,000)", "slow pace in awarding research grants and the reimbursement of expenses" and the "slow pace in ordering supplies and paying suppliers".

Both groups of academics also indicated that maintaining and sourcing equipment was problematic. Equipment costs are also constantly increasing and the need to allocate sufficient space to house the equipment has to be considered. Furthermore, chemicals ordered often took some time to arrive and this slowed down the research process.

A moderate number of academics from both disciplines complained about difficulties in obtaining printed sources. These difficulties include problems in getting needed journals and papers, in getting up-to-date journals, and the high cost of articles obtained from inter-library loans (the British Library charges an average of RM$45 per article).

Academics also faced difficulties formulating fresh ideas for research, getting good research and post graduate students, finding sufficient time for research, getting colleagues with similar interests, and facing red tape when purchasing necessary equipment or chemicals.

Because of the forced responses in the survey questions which focused on library related problems in obtaining information needed for research, it was not possible to identify other possible problems which might be directly related to the research process itself. The exploratory study has helped to identify some of these problems.

6.13. SUMMARY

The exploratory study has contributed two things to this research study. Firstly, it explained some of the findings from the survey, with regard to types of publications preferred, the relations of academic, personal, departmental and institutional factors to publication productivity, the channels used to obtain or communicate research results and the problems faced during the research process. Secondly, the study helps to explain similarities and differences found from the survey findings. The respondents interviewed were forthcoming with their views even though, in general, most were willing to allocate only between 30 to 45 minutes of their free time for the interviews. The opinions volunteered helped to explain the environment which respondents found conducive or desirable for research, the type of leadership needed to promote vibrant research, and the personal traits of a productive researcher. The following paragraphs summarise the findings of the exploratory study.

(1) It is accepted that academic staff should publish at least one publication per year, preferably a journal article.

(2) Publication in conference proceedings is acceptable, but journal articles in refereed journals are preferred.

(3) If an article focuses on results that have local applications, dissemination in local refereed journals is preferred.

(4) Joint publication is acceptable in multi-disciplinary research and is expected to improve the acceptability and quality of publications.

(5) The majority of academics are confident of their technical writing skills, but are still not satisfied with their publication achievements.

(6) Generally, academics feel that personal factors do not interfere with their research activities, but certain personality traits are associated with the productive academics. These include self-motivation, commitment to research, and a meticulous method of documenting data and reporting results.

(7) Collaboration, in terms of working in teams with colleagues within the same department, other universities or researchers abroad is generally accepted as a means to be more productive in research and this is connected to the general acceptance of publications in the form of joint-authored works.

(8) Factors such as adequate funding, adequate computer and laboratory support, are evidently important for the research process to succeed. However, personal factors (attitude, motivation, perseverance, hard work, etc.) are equally important in ensuring that the results of the research are successfully written and published.

(9) Academics from both disciplines want more from their library than just borrowing facilities. As budgets are cut and serial subscriptions are either frozen or discontinued, the majority of comments focus on the library's role in making speedier, less costly inter-library loan services and the need for ready access to the CD-ROM and online bibliographic databases via the campus-wide network.

(10) The frequent use of electronic channels such as the Internet and e-mail to establish contacts, and obtain and disseminate research information, is becoming more common. The more enterprising academics are creating personal web sites to "advertise' themselves and communicate their research interests and achievements to the world.

Chapter 7

SUMMARY, DISCUSSION AND CONCLUSION

This chapter gives a summary of the research study, discusses the results in accordance with the research questions posed, and concludes with a discussion of the implications and recommendation for future studies.

7.1. SUMMARY OF THE STUDY

The purpose of this study was to explore the factors, which might be related to academic publication productivity of selected Malaysian academic engineers and scientists from the National University of Malaysia (UKM) and University of Malaya (UM). The faculties from both universities were chosen because of their "likeness" in offering similar courses in engineering and science. This study aimed to identify differences and variations in the total and types of academic publications produced by both academic groups. It also investigated the types of endogenous and exogenous factors, which relate to academic publication productivity; the channels preferred by the academics to obtain and disseminate research results, the problems associated with publishing research results and in obtaining library related materials and services to support research. Publication productivity refers to total number of publications achieved by an academic between 1990 and 1995. The types of publication considered are articles in refereed journals, conference papers, research or consultation reports, books, as well as book chapters authored or translated, and patents or standards obtained.

The study was undertaken in two stages. The first stage involved the gathering of the main data using a fifteen-page questionnaire. The questionnaire consisted of 9 sections, which provided data such as the total number and type of publications, which form the dependent variable. Information was gathered on the personal, academic, professional, and attitudinal characteristics of the respondents; the channels used to obtain research information and to communicate research results; the problems faced when publishing works and when using the library-related sources and services. All these factors formed the independent endogenous variables. The departmental, institutional and collaboration factors constituted the independent exogenous variables. Data on the total number of publications were also obtained from each university's annual academic research report published between 1990 and 1996. The total sample comprised 83 academic engineers and 239 academic scientists.

The second stage of the study involved the analyses of interviews and e-mail dialogue sessions with 56 productive academic engineers and scientists from both universities under study, and from seven other universities in Malaysia. More than 50% of those interviewed were associate professors or full professors. The objectives were to explore further the results of the survey findings, determine possible reasons for such findings and ascertain general agreements or disagreements among academic staff with the results obtained.

7.2. SUMMARY OF FINDINGS AND DISCUSSIONS

Responses to the questionnaire were analysed using the Statistical Package for Social Science (SPSS) version 7.5. Descriptive analysis was used to report the findings. The Chi-square test was used for nominal data and the Spearman correlation was used for ordinal data. All tests were reported at the 0.05 level basing on the two tailed tests and indicated as significant if results reaches the 0.01 level. The summary and discussion follow the research questions posed in Chapter 1.

(1) What are the number and types of research publications published by academic staff between 1990 to 1995?

The 83 academic engineers altogether produced 1,344 publications and the 239 scientists accounted for 5,323 publications. Similar forms of publication were indicated by both groups and these comprised 31% -32% single-authored and 68%-69% joint-authored works. Both groups published similar proportions of different types of works. The most common type of work produced were conference papers (61.6% – engineers; 41.7% - scientists), followed by journal articles (21.0% - engineers; 38.7% scientists), and research reports (11.2% - engineers; 7.8% - scientists). Other types of publications produced were book chapters, books (authored, edited, and translated), and standards or patents obtained. When both groups were categorised into publication groups, 35 out of 83 (42.2%) academic engineers were in the low/minimum publication group compared to 49 out of 239 (20.5%) academic scientists. A higher percentage of scientists were placed in the high/very high publication group (110, 46.1% - scientists; 24, 28.9% - engineers). The analysis showed that the academic scientists were more active as publishers of scholarly works as almost half were placed in the high/very high publication group, publishing at least one or more works per year. For both groups, most of the works were jointly written. The higher number of joint-works indirectly indicates that both groups collaborated actively. This finding supports previous studies which indicate that collaboration is widely practiced in data disciplines such as in the sciences and engineering (Over and Smallman, 1973; Smart and Bayer, 1986; Bayer and Smart, 1988).

The results of the interviews indicate the types of published works produced by both academic groups. Even though both groups preferred to publish in the form of journal articles, followed by conference papers and research reports, this preference was not indicated by their actual publishing behaviour, which shows more conference contributions. This publication behaviour may reflect the general pattern adopted by most Malaysian S & T academics. Among the factors that contribute to this situation are the problems of getting works published abroad as well as the poor and infrequent support provided by local S & T journals (this will be discussed further under the next question). The conference contributions may be the increasingly accepted trend among academics and should perhaps be accepted as a legitimate finished output in the scholarly communication process. Future studies should therefore focus on whether this publication behaviour is true for S & T academics nationally. Also, further investigation is needed to ascertain the degree of completeness of the research reported in conference contributions and the justification (if any) for further communication in journals.

(2) Which are the journals chosen by the academic staff to publish their research results and their geographical distribution?

A total of 282 journal articles were published by the academic engineers, out of which, UM contributed 152 and UKM 130 articles. The academic scientists were responsible for 2,058 journal articles out of which 1,286 were contributed by UM and 772 by UKM.

The academics from UM published more journal articles. The academic engineers and scientists, published in 91 and 418 unique journal titles respectively. Of the 282 articles produced by academic engineers, 131 were published in journals from Malaysia, 60 from the UK, 42 from the USA, 34 from Asia/Pacific countries and 15 from the European countries. For the academic scientists, of the 2,058 articles, 907 were published in journals from Malaysia, 409 from UK, 329 from the USA, 236 from Europe and 177 from the Asia /Pacific countries. Academic staff from UM published more in foreign journals while those from UKM published more in journals from Malaysia. Those from the departments of chemistry, physics and genetics, constituted the top three publishers of journal articles among the science sample, while the electrical and chemical engineers were the top two contributors among the engineers. Forty-five journals published more than 10 articles for the academic scientists and of this 22 titles are published in Malaysia. The Malaysian journals which published the highest number of academic scientists' articles were: *Sains Malaysiana, Warta Geologi, Malaysian Journal of Science, Malaysian Applied Biotechnology, Pertanika, Journal of Physical Science, Jurnal Fizik Malaysia* and *Transaction of the Malaysian Society for Plant Physiology*. The other foreign journals which figured highly as a channel to communicate Malaysian scientific articles were *Journal of Organometallic. Chemistry* (Eur), *Phytochemistry* (UK) and *Tetrahedron Letters* (UK).

Malaysian journals also figured highly among the top journals that published articles written by academic engineers. These included *Jurnal Kejuruteraan UKM, AEESEAP Journal, Bulletin of the Institution of Engineers Malaysia, Journal of the Institution of Engineers*

Malaysia, Plastic News, Building Technologists, Pertanika, Journal of Physical Sciences, and *Bulletin of the Science and Technology Malaysia.* The foreign journals which figured highly were *IEEE Proceedings: Part C and Part J, Microelectronic Journal* and *Journal of the American Oil Chemists' Society.* The results indicate that Malaysian journals were used frequently to publish articles by both groups of academics.

The exploratory interviews indicate that local journals were rated poorly by both groups of academics, even though this rating did not reflect their actual publishing behaviour. During the interviews the academics gave reasons for choosing a journal to publish their work. The reasons provided included: prestige of the journal, relevance to the subject area of research, frequency, the total circulation of the journal, costs and past successes in accepting their submissions. These reasons provide some evidence for the low rating on Malaysian S & T journals by those interviewed. Others reasons were too few titles available to publish in, poor refereeing system, lack of quality and impact, and lower ratings given to these publications in promotion exercises.

Dissatisfaction with the poor frequency of local journals was indicated by the highly productive academic scientists ($p=.210$, sig.<0.01). The survey, as well as the interviews, revealed that journals are still the preferred mode of communicating results. This finding supports previous studies, which regarded the journal article as the most important bibliographic unit (Lofthouse, 1974; Subramaniam, 1981). Nederhof, et al. (1993) found that the academic scientists tend to orientate their publications to an international audience. This may be the reason why the productive Malaysian scientists, especially those from UM, publish more in foreign journals, especially those from the UK and USA. Ashoor and Chaudhry (1993) also found similar behaviour among the scientists in their sample, who preferred to publish in the English-language foreign journals.

(3) Is publication productivity related to the length of time that elapsed after the respondent wrote his first research report?

The research report refers to academic thesis, preliminary research report and consultation report. For the academic engineers, 6.1% wrote their first research report within the last five years, 68.3% between 5 to 10 years and 25.3% more than 10 years ago. Their total publication productivity, however, was not related to the number of years that had elapsed since their first report was written. The majority of the academic scientists, (102, 42.7%) wrote their first report between 11- to 15 years ago, followed by 83 (34.7%) who published between 6-10 years ago. Both academic groups indicate that their first publication was based on their thesis. The results for the scientists showed that the majority were experienced writers; more than half of them began publishing 11 or more years ago. The more experienced academics achieved a higher number of total (p=.408, sig.<0.01), solo (p=.163, sig.<0.01) and jointly authored publications (p=.312, sig.<0.01).This finding for the scientists corroborates the findings of previous studies which indicated that early publishers are likely to be high publishers (Meltzer, 1949, Manis, 1951, Kidwai, 1969, Lightfield, 1971, Clement, 1973, Blackburn, Behyer and Hall, 1978, Cole, 1979).

(4) Are respondents' demographic, academic, institutional and professional factors related to higher total publication productivity?

Demographic factors – The results of the survey indicated that the size of the respondent's family were not related to the publication productivity of both academic groups.

Age - Age is significantly correlated to total publication productivity (p=.227, sig.<0.01 – engineers; p=.367, sig.<0.01 – scientists). Those above 40 years of age, and especially those above 51 years were placed in the high/very high publication group.

The findings regarding the effect of age support the results from previous studies. As early as 1954, Davies found that age and publication productivity was related. Cole (1979) also found that age was curve-linearly related to productivity. Productivity peaked in academics who were in their late thirties and forties. A Norwegian study of academics by Kyvik (1990a), found that productivity was highest in the 45 –49 age group. Pelz and Andrews (1966) found two productivity peaks – between the ages of 35-44 and 50 to 54. The situation might be different for the Malaysian academics. Malaysian academics retire at the age of 55, and usually gain their highest academic qualifications in their late twenties or early thirties. The normal school leaving age is 17 and university enrolment is at the age of 20. It is likely that publication productivity peaks at an older age for Malaysian academics. Hence, if 45-59 years is taken as the peak productivity age, the corresponding age in the Malaysian context may be around 51 years. This effect of age cannot be ascertained in the present study as no longitudinal data were collected. The relationship between age and publication productivity peaks is therefore recommended for future investigation.

Race - Race is correlated to total publication productivity for the academic scientists. The academics who belonged to the "other racial group" tended to be placed in the high/very high publication group.

Academic factors – A higher number of academic correlates tested significantly to the publication productivity of academic scientists (6 out of 7 correlates) than academic engineers (3 out of 7) (Figures 4.1 and 5.1). This indicates that academic variables are good determinants of publication productivity.

Affiliation - Publication productivity was related to respondents' affiliations only in the case of the academic scientists (x^2 =8.008, sig.<0.01). When total counts were considered a higher percentage of UKM scientists were placed in the high/very high publication group and they also authored more conference papers. A higher percentage of academic scientists from UM were placed in the high/very high publishing group for total journal articles published. Malaysian universities have not been ranked nationally and it cannot be ascertained whether institutional prestige play a part in making UKM scientists achieve higher total publication. As indicated earlier, UM scientists focused on publishing in journals and the difficulty in getting published in this format may have affected their total publication output.

Department - Academics' departments was significantly related to the publication productivity of only the academic scientists (x^2 = 61.680, sig.<0.01). The departments that achieved a higher number of placements in the high/very high publishing category were the chemistry and the physics departments. A higher percentage of mathematicians were placed in the low/minimum publishing group. Previous studies have also found that faculty research differs between disciplines or departments. Wanner, Lewis and Gregorio (1981) compared the publication productivity among academics in the natural sciences, social sciences and humanities, and found that the natural scientists produced the most journal articles but the social scientists wrote the most books. Biglan (1973) who distinguished between those in hard discipline (e.g. chemistry) and soft discipline (accounting) further confirmed these results. He found that those in the latter group produced more books. Other studies have found that the publication rate was higher in chemistry than in physics (Hagstrom, 1965: Cole, 1979; Thagaard, 1986) and this was also found in the present study.

Academic qualification and years elapsed since the highest qualification was obtained – Publication productivity was related to the respondent's highest qualification in the case of both the academic engineers (p=.250, sig.<0.05) and especially the academic scientists (p=.314, sig.<0.01). A higher percentage of the engineers with a Masters degree (17 out of 29, 58%) were placed in the low/minimum publication group compared to those with Ph.Ds (18 out of 54, 33.3%). A higher percentage of the scientists with Ph.Ds were placed in the high/very high publication group (103 out of 204, 50.5%) than those with Masters (7 out of 35, 20.0%). The academic scientists who had qualified 15 or more years ago achieved higher total publications (p=.608, sig.<0.01). This situation does not apply to the academic engineers. A number of previous studies have found that academic correlates are significant determinants of research productivity. Prpic (1996b) found that, among the Croatian scientists studied, early acquisition of Ph.D. is related to a respondent's productivity. Similar results were obtained by Long, Allison and McGinnis (1979) and Chubin, Porter and Boeckman (1981).

For the scientists, early acquisition of Ph.D. may be equated with the length of years that had elapsed since the Ph.D. was obtained.

<u>Country where the highest qualification was obtained</u> - The country where academics obtained their highest qualification was not a significant correlate for both groups of academics. This may be due to the fact that the majority was qualified either in the United Kingdom or the United States, and the small number who qualified in Malaysia or other countries gives insignificant cross-tabulated results. This finding is verified by the academics interviewed where about 71% (both groups) disagreed with the view that academics trained at foreign universities are more productive.

<u>Academic rank</u> - Academic rank was a significant correlate for both the academic engineers ($p=.424$, sig.<0.01) and scientists ($p=.533$, sig.<0.01). In both situations, the professors were more likely to be placed in the high/very high publishing group compared to those in the other two ranks. The majority of both groups of academics interviewed, felt strongly about rank as a determinant of research productivity and the strength of agreement was greater among the engineers. Academics felt that promotional requirements helped to increase productivity as academics would have to prove themselves publication-wise first before getting promoted. Institutions gauged a person's productivity based on the amount of published works achieved, especially those in refereed channels. There was general agreement that those who obtained promotion are those who are experienced and are active authors of scholarly works. A number of respondents viewed a professor as one who has more years of research experience, is more likely to supervise Ph.D. students, gets bigger fund allocations, and has established a reputation that attracts research students. All these attributes contribute to the professors being more productive. Blackburn, Behymer and Hall (1978) found rank to be a good predictor of productivity Wanner, Lewis and Gregorio (1981), Kyvik (1990) and Tien and Blackburn (1996) also obtained similar findings

Experience - Another significant variable was "years of working experience" which correlates significantly for both the academic engineers (p=.386, sig.<0.01) and scientists (p=.408, sig.<0.01). Those with over 15 years of working experience were more productive publication-wise. Longer work experience was found to be related to increased publication by Rushton, Murray and Paunonen (1987) and Babu and Singh (1998).

Departmental factors – None of the departmental correlates can be applied to explain the publication productivity of academic engineers. For the scientists 5 situations were found to be correlated to their publication performance.

Percentage of time for research - The academic scientists, on average, allocated a mean percentage of 39.92 of their time to research compared to 30.84 for academic engineers. In both instances, the time spent on research was correlated inversely to the time spent on teaching. The cross-tabulated data indicated that the percentage of time allocated to research, administration and teaching was not related to the publication productivity of academic engineers. A higher percentage of academic scientists who allocated 31% or more of their time to research, were placed in the high/very high publication group (p=.131, sig.<0.05). For the academic scientists, teaching and administration was negatively correlated to publication productivity (p= -.260, sig.<0.01; p=-.190, sig.<0.01 respectively). Those who allocated 51% or more of their time to teaching made up the highest number placed in the minimum publication group, while those who spent 30% or less of their time to teaching, were in the high/very high publishing group. A similar situation applies to those who allocated more time to administration. The results obtained for the scientists corroborate the findings from previous studies. Allison and Steward (1974) proposed that time spent on research is an important predictor of research productivity. Bowden and Anwyl (1983) revealed that productive scientists often spent their evenings and weekends on their research. Moses (1986) investigated reward and incentives among academic staff and found that the university promotion policy influenced the amount of time academics allocate to research and writing.

Wood (1990) explained that experimental research such as the one undertaken by scientists and engineers, needs a continuous time commitment over a long period to achieve publishable results. This is indicated by the academics interviewed in the present study. Over 50% of academics felt that the amount of time put into research determine the extent of its success. The engineers felt that time is needed in experimental research, where data must be tested in laboratories or on-site. The scientists indicated that time for research is important especially in situations where no research assistants are available. Those who considered time allocation as irrelevant to the success of research put forward personal factors, such as motivation, and efficient time management as important in ensuring publication productivity.

Publication requirements set by departments – Perceived publication requirements were not correlated to publication productivity for the academic engineers. The productive scientists however were more likely to indicate that their department required them to publish 1 or more publications per year ($p=.150$, $sig.<0.05$). Although tenure is not a problem in Malaysia, 56.3% of academic engineers and 66.7% of scientists agreed that one publication per year is a realistic figure with the scientists preferring it to be a journal article. The interviews revealed two types of reasons for this opinion. The first is position dependent which stresses the belief that those higher in academic rank should publish more. The second is format based which stresses the difficulty of getting a journal article published, making it realistic to consider just one contribution per year. Both groups of academics, however, felt that this should be supplemented with a conference paper, whenever possible. The need to attain publication in journals was frequently mentioned by academics from the newer universities where journal publication was accorded top priority for promotion purposes.

Number of faculty members and the number of students enrolled – These two variables cannot be cross-tabulated with total publication scores for the academic engineers as over 90% of respondents reported that their department had less than 20 faculty members, and the student enrolment was between 10-20. The results for the academic scientists indicated a negative correlation between total publication scores and number of faculty members (p=-207, sig.<0.01). A larger number of academics whose departments have 40 or more faculty members were placed in the low or minimum publication group, while those with 31-39 or below 21 faculty members were well represented in the high publication group.

The number of students enrolled was not correlated to total publication scores for the academic scientists. The findings from this study support previous research by Fitschi, et al (1980) who observed that publication productivity peaks when the department has between 9 - 22 researchers and assistants. The truth of this situation needs further investigation since other studies have suggested a different optimum group size. Blackburn, Behymer and Hall (1978), Gallant and Prothero (1972) suggested 11 to 15, while Etzkowitz (1992) proposed 5-7 members to be the optimum group size. The results of these studies imply that the optimum size that affects productivity is discipline-dependent and that a large group size does not necessarily guarantee higher publication productivity. The subject of group size and age and their relationship to research productivity could be explored further in future studies.

This study has failed to support previous findings that quality research students help to promote research productivity (Berelson, 1960; Fonseca, et al. 1997). The presence of research students was less effective may be because the quality of the students did not match their supervisor's expectation. The survey results indicated that scientists view the quality of their research students as only "fair". Only 46 of the 239 scientists rated the quality of research students as good or excellent.

Organisational factors – Very few institutional correlates presented can be applied to explain the publication performance of engineers. More related results were indicated for the academic scientists.

<u>The number and amount of grants obtained</u> – The number and amount of grants obtained were significantly correlated to the publication productivity of the academic engineers (p=.375, sig.<0.01; p=.499, sig.<0.01) and scientists (p=.469, sig.<0.01; p=.408, sig.<0.01). The

results indicate that the larger the amount of grants received, the higher the likelihood of being placed in the high/very high publication group. Those academic engineers who obtained RM100,000 or more in grants achieved higher publication productivity. The scientists who received RM501,000 or more were the highly productive researchers. A closer analysis indicates that those academic engineers who received larger grants were from UKM (61.5% received more than RM100,000 of grant money), have more years of working experience and attained a higher academic rank. The highly productive scientists were the ones who perceived the disbursement of funds as efficient. The amount and number of grants received were significant determinants of research productivity.

A previous study by Wanner, Lewis and Gregario (1981) compared the research productivity of academics in the sciences, social sciences and humanities, and found the effect of the number of grants received was stronger among the natural scientists than the social scientists and those in the humanities. The receipt of grants apparently resulted in higher productivity of articles produced by natural scientists. Adequate funding is especially important for scientific research that need funds to obtain costly equipment, chemicals, and to finance travelling costs (Lowe, 1987; Wood, 1990). These findings verify the opinion volunteered by the academics interviewed, who felt strongly that the number and amount of grants received greatly helped to improve research productivity. Larger amounts are essential to employ research officers and buy equipment. The interviews revealed ways, in which the academics felt grants can be obtained such as proposing projects that have potential economic returns, delving into new areas of research, working within the priority areas determined by the government, and collaborative research.

<u>The library facilities available</u> – The majority of academics from both groups rated the library resources available to them as "fairly sufficient" (70.7%-scientists; 55.4% -engineers). However, this rating is not correlated to the publication scores of both academic groups. The ratings on seven types of library services revealed that the top four services which academics

found useful/very useful were book loans, photocopying services, inter-library loans and book reservations. The least used or not useful were borrowing periodicals (both libraries disallow this facility), library staff's help in locating sources and library staffs' help in searching online databases. When the ratings were cross-tabulated to the respondent's total publication scores, very few variables were correlated. The highly productive engineers only rated positively on "inter-library loans" (p=.224, sig.<0.05). The highly productive scientists indicated these services to be useful: "inter-library loans" (p=.140, sig.<0.05), "library staffs' help in searching online databases" (p=.140, sig.<0.05) and "library staffs' help in searching for information" (p=.197, sig.<0.01). The productive scientists who rated positively on the three services above were also above 41 years of age, with more than 11 years of working experience and were higher in academic rank.

The results indicate that even though academic staff rated their library services as fairly useful, the productive researchers found inter-library loan services, and help in bibliographic searches by professional staff to be helpful. However, the less experienced lecturers did not seek professional advice. Perhaps libraries should focus on this group of academics when marketing their services. The library's role in providing bibliographic information for research was highlighted by Vieira and Faraino (1997). As library professionals are equipped with the skills of bibliographic searching, it is natural that these skills be included when advertising the library service be it for free or fee-based. Most research projects receive funding and thus, allocation for bibliographic searches and the acquisition of needed materials could be worked into the proposed budgets. Such services are not aggressively marketed in academic libraries in Malaysia where academics are expected to visit the library to perform their own searches.

Respondents who were interviewed, as well as responses from the open-ended sections of the questionnaire indicated the types of services that academics would like improved. Those interviewed mentioned the following services: better access to electronic databases, continued subscription of mainstream journals and speedier inter-library loan services. One hundred and sixty-six scientists gave comments in the open-ended questions of the survey. The comments are categorized as follows: (a) acquisitions – concerned with the acquisition of new books and periodical titles; (b) access to databases – concerned with making CD-ROM databases available on the campus network or linkage with online services, such as BIDS at Bath University; (c) administrative policy – concerned with improved and speedier inter-library loan services and (d) improved periodical services such as speedier processing, shelving and re-shelving of new titles and the binding of loose journals. Fifty academic engineers added "other services" that needed improvement, such as: (a) better online access to other libraries; (b) acquisition of reprints from other libraries; (c) acquisition of more full-text databases; and (d) better photocopying facilities.

Laboratory facilities – Both academic groups rated their laboratory facilities as either fairly sufficient or sufficient. For the academic engineers, no correlation was obtained between the ratings and publication productivity. Those scientists who rated positively on their laboratories showed high publication productivity ($p=.378$, sig.<0.01), were older in age, more experienced and were higher in academic rank. The academics interviewed, generally agreed that adequate laboratory facilities were important to their research. The results indicate that, although the majority of respondents from both groups rated their laboratory as sufficient, this view was not related to the publication productivity of academic engineers, but was significantly related in the case of the scientists. This may be due to the experimental nature of research undertaken by the engineers, which needs a longer period of time to show productivity. Perhaps, future studies should investigate how laboratories actually support research productivity.

Computer support – The academics used stand-alone personal computers, but the majority used the net-worked computers which were available on their desk. Computers were mainly used for word processing, creating graphics, sending or receiving e-mails, searching for information via the Internet, statistical analysis and creating databases. The types of computer use were not correlated with higher total number of publication productivity of academic engineers because the low, average and high publishers rated positively to all types of computer use listed. As a result, no clear differentiation can be ascertained. The publication scores achieved by the academic scientists, however, are correlated to seven out of eleven types of computer uses listed. The productive scientists rated significantly higher (<0.01) use of computers for creating databases (p=.286), creating personal bibliographical index (p=.244), word processing (p=.210), creating slide shows (p=.194), sending or receiving e-mails (p=.176), searching for information from the Internet (p=.176) and statistical analysis (p=.139). Although the total publication score does not correlate with any of the types of computer uses for the engineers, further demographic analyses indicate that those older in age rated frequent use of the computers for creating databases (p=.267, sig.<0.05), but the younger engineers rated frequent use of e-mails for research (p=-.270, sig.0.01).

The use of computer to retrieve and disseminate information is expected to increase in future for the Malaysian sample as such facilities are being made more available. Previous studies in the West have indicated the increased in use among their sample groups (Chu, 1994; Lazinger, Barllan and Peretz, 1997; Applebee, Clayton and Pascoe, 1997). The present study focused on the types of use made of the computers, while recent studies in the West explored the types of use made of the Internet or computer network facilities. This can be the focus of future Malaysian-based studies. Respondents interviewed, agreed that computers have become indispensable to their research activity. The activities affected ranged from the preparation of manuscripts for publication, dissemination of preprints to peers, submission of finished work to publishers, cutting short information search time, and making it easier for them to access information available online. In this light, libraries may have to re-engineer their work processes by making more services available online such as special bibliographical listings, information to free full-text databases, establishing linkages to fee-based services, and facilitating the ordering of reprints through an online inter-library loan system.

Professional factors – The professional correlates indicated significant relationships to publication productive for both engineers and scientists.

Number of professional memberships - The number of professional memberships was correlated to higher total publication productivity for academic engineers (p=.270, sig.<0.01) and scientists (p=.292, sig.<0.01). For both groups, the results indicated that a higher number of those who were involved in two or more professional associations were placed in the high/very high publication group. The respondents who were interviewed felt that active professional membership did not make academics more productive, but the highly productive academics tend to be those active in their professional associations because of their established reputation. It is the productive researcher who are approached to be editors or reviewers for professional journals.

The number of consultation work - The survey findings indicated that the number of consultation activities undertaken was a good determinant of higher publication productivity for both the academic engineers (p=.297, sig.<0.05) and scientists (p.=374, sig.<0.05). Those who undertook two or more consultation works were more productive. However, the academics who were interviewed (68.8% of academic engineers and 58.3% of scientists) disagreed with this finding. The academic engineers indicated that most results of consultation works are confidential and, therefore, cannot be published, even though it helps to increase income. Similarly, when a consultation work involves testing or commissioning of projects, nothing of substance can be published. One academic scientists pointed out that the correlated results of the survey might be due to a reverse situation where those who published more are usually the experts who gets the consultation jobs. Lanning and Blackburn (1978) indicated such reversed situations in their study, where consultation, article productivity, and departmental influence increased together initially, until a maximum number of consultation activities is reached, after which departmental influence decreases as the consultants tend to move to other careers.

(5) Is publication productivity related to respondents' views on their role in research and the support provided by their department and institution?

Views on research –There was agreement among the highly productive academics, that research helps to improve academic reputation (p=.242, sig.<0.05--engineers; p=.237, sig.<0.01-- scientists), advance knowledge (p=.233, sig.<0.05-- engineers; p=.192, sig.<0.01 --scientists), gives self-respect and prestige (p=.221, sig.<0.05-- engineers; p=. 160, sig.<0.05 --scientists), and gives department and university prestige (p=.222, sig.<0.05--engineers; p=.185, sig.<0.01--scientists). The productive academic engineers agreed that research enhances career prospects (p= .334, sig.<0.01) and gives them the opportunity to present papers (p=.292, sig.<0.01). The productive academic scientists, however, agreed that research provided them with the opportunity to develop products (p=.193, sig.<0.01). This indicates that the highly productive academics recognised the potential of research in achieving the various outcomes implied in the research-view statements listed. The academics who were interviewed unanimously agreed with this finding. The general feelings was that a positive attitude such as the willingness to work hard, and to continue to undertake research even in the event of heavy teaching loads helps to spur positive activities. The findings also support the results of previous studies. Blackburn, Behymer and Hall (1978) found that preference for research was a strong predictor of higher total journal productivity. Fulton and Trow's (1974b) study also suggested that research interest was highly correlated to research performance. Allison and Stewart (1974) observed that the biologists, mathematicians, physicists and chemists who spent more time on research perform highly in research. Blackburn, Behymer, and Hall (1978) studied the correlates of faculty publications and found that when the effects of rank and academic division are controlled, interest in research emerged as the strongest predictor of higher total productivity of articles and total rate of productivity. Wood (1990) studied factors influencing the research performance of university academic staff and found that heavy teaching loads were considered a distraction from research but did not necessarily reduce research output. However, heavy teaching and administrative duties did prevent the continuity needed in experimental research.

Views on departmental support – The seven department-view statements were rated "fairly" by the majority of both engineers and scientists. The ratings on the "true/very true" scales ranged between 16% to 31% for academic engineers, and between 18% to 42% for the scientists. The total productivity score of academic engineers was not correlated to the ratings on all seven departmental-view statements. The ratings by the highly productive academic scientists were only correlated to two department-view statements, namely, "department arranges useful seminars" (p=.160, sig.<0.01) and "read colleagues publications" (p=.145, ig.<0.05). These findings indicate, in general, that the academic's higher total publication productivity is not related to most departmental-view statements posed. Among the academic scientists, all professors and 90% of associate professors rated either "quite true" or "true" to discussing research with colleagues (p=.305, sig.<0.01). The scientists' ratings on the departmental-view statements significantly differed between the departments. A higher percentage of scientists with Ph.D. indicates reading their colleagues' publications (p=.168, sig.<0.01), those higher in academic rank tended to rate positively on "department arranges useful seminars" (p=.163, sig.<0.01); and those who allocated a higher percentage of their time to research, felt that their teaching or administration load did not deter their research activities (p=.132, sig.<0.05). About 43% of engineers and 50% of scientists interviewed, agreed that publication productivity was not related to collegial support. One respondent stressed the importance of motivation while another spoke of the disciplined researcher who "fervently reports his research findings", to explain why some academics are more productive than their colleagues who put equal number of hours to teaching and administration work. The respondents who felt that collegial support was important stressed that the less motivated colleague can have a demoralising effect and an active colleague does act as a source of strength in research. Most of those who disagreed were lecturers with less years of working experience, who often felt "bullied" into undertaking more teaching and administration responsibility and "have little time to think about research". Finkelsten (1984) found that American academics rate their colleagues as important in enhancing their productivity. Crane (1965), Long (1978) and Reskin (1979) indicated that the effect of the department on research productivity tends to decline after a certain number of years. This may explain why academics in this sample rated their department less positively since the majority were fairly experienced (over 60% of scientists have more than 11 years of working experience and 80% of engineers have between 6-15 years) and may have established their own support group in research, and as such are less affected by their departmental environment.

Views on institutional support – The highly productive academics from both groups did not feel strongly that their institutions were supportive enough of their research needs. No correlated results were indicated to all nine views on institutional support. In general, both groups had no complaints about the computing facilities provided (about 70% rated this as good/excellent) and are fairly satisfied with their institution's support for presenting papers at local conferences (about 40%). There was dissatisfaction with the quality of research students (only 7% to 19% only rated this as good or excellent), laboratory assistants (5%-6% rated positively) and the lack of support for the presentation of papers at foreign conferences (13%-14% only rated positively). In Malaysia, the funds allocated for staff to present papers abroad are limited. The economic down-turn in 1996 allowed no financing of trips abroad. Even in better times (between 1990 and 1995), the number of trips abroad financed was limited (once every three years). This may be insufficient for the productive researcher, who needs to present their findings at international avenues annually. Synder, McLaughlin and Montegomery (1991) point out that the management style which helps to locate and communicate sources of funding and the allocation of seed money for new academic staff, provides the right environment to stimulate research productivity. The exploratory study revealed the kinds of institutional support needed by the productive respondents. These included getting quality researcher support; providing incentives for excellent research;

providing sufficient and fair funding support; instituting a balance between teaching and research; providing adequate technical support; recognising job preference (not penalising those who prefer to teach); and the establishment of a research resource repository where published research results can be obtained easily.

(6) Is publication productivity related to the degree of collaboration undertaken?

The results of the survey revealed that frequency of collaboration was a good determinant of publication productivity and significantly so for the academic scientists. Two types of collaborative behaviour were correlated to publication productivity for both groups, and these were collaboration with colleagues from other universities (engineers -- $p=.223$, sig.<0.05; scientists – $p=.327$, sig.<0.01) and collaboration with researchers outside the country (engineers – $p=.249$, sig.<0.05), scientists – $p=.372$, sig.<0.01). The highly productive academic scientist also collaborated with colleagues within their department and university ($p=.194$, sig.<0.01) and with local industries ($p=.631$, sig.<0.05). The results obtained were definitely significant in the case of the academic scientists. The academics who undertook research on their own were more likely to be placed in the average publication group. The academics interviewed agreed with this findings. They helped to explain why this situation is so, such as, the effect on funds, enrichment of ideas, commitment of team members to complete projects, the production of quality publications, the possibility of sharing expensive equipment and laboratories, and the sharing of new knowledge and experience. Collaboration provides more confidence for researchers to venture into new fields of research due to the presence of experts in the team. One scientist felt that international journals prefer collaborative work. Austin and Baldwin (1992) also observed that collaboration is instrumental to scholarly productivity.

(7) Is publication productivity related to the use of formal and informal channels to locate, communicate and disseminate their research findings?

Formal channels – The ratings on the thirteen formal channels used by both academic groups indicated that journals (ranked first by both groups), conference proceedings (ranked second by scientists and third by the engineers), and research reports (ranked second by the engineers and third by the scientists) are the top three channels rated most useful. However, the use of these channels were not related in most instances to the academics' total publication productivity. The productive engineers rated research reports (p=.253, sig.<0.05), and conference papers as useful/very useful (p=.271, sig.<0.01)and the academic scientists rated the library's accession list (p=.289, sig.<0.01) as useful. The academic scientists who were high-publisher of joint works also found library catalogues (p=.139, sig.<0.05), conference papers (p=.193, sig.<0.01) and the library's accessions list useful (p=.280, sig.<0.01). For the academic engineers, those who published more joint works found conference papers useful (p=.247, sig.<0.05), and those who produced more conference papers also rated conference papers more useful. The results generally indicate that the scientists prefer the more formal library and literature-based channels than the engineers. The interviews revealed that formal channels such as journals, conferences, research reports and libraries still figure largely among academics. The academics use of formal channels, especially journals, is indicated by previous studies (Styvendale, 1977). Crawford, Halbrook and Igielnik (1986), Clark and Gomez (1990) and Hurd, Weller and Curtis (1992) reported the use of databases such as *Current Contents* and the citation databases by scientists. Allen (1977) indicated that academic scientists tend to make greater use of formal literature than the engineers. Future studies should focus on the channels, which actually service Malaysian academic engineers information needs for research.

Informal channels - The ratings on the eight informal channels indicated that "e-mailing colleagues" (ranked first by the engineers and second by the scientists), "discussion at conferences" (ranked first by the scientists and second by the engineers), "dialogues with colleagues within the department" (ranked third by the engineers and fourth by the scientists) and "correspondence/letters" (ranked fourth by the engineers and third by the scientists) were the top four channels rated useful/very useful by both academic groups.

Cross-tabulated variables indicated that the types of informal channels preferred by both academic groups are different. The productive academic engineers preferred the oral kind of communication channels such as "dialogues with colleagues in other departments" (p=.247, sig.<0.05), "dialogues with colleagues outside the universities" (p=.269, sig.<0.05), "discussion at conferences " (p=.241, sig.<0.05) and "faxing colleagues" (p=.222, sig.<0.01). The productive academic scientists preferred the more traditional informal channels such as, "correspondence / letters" (p=.241, sig.<0.01) and faxing colleagues (p=.228, sig.<0.01). The more experienced academic engineers with Ph.D. and higher in academic rank tended to rate more positively on most of the eight informal channels of information listed. Although the use of e-mail was rated highly as a communication channel, it did not correlate with total publication productivity. On the other hand, corresponding, faxing, discussion at conferences and dialogues were related to research productivity. The majority of academics interviewed (56.2% - engineers, 54.1% - scientists) indicated that the Internet is used frequently. It is probable that the increased importance of this channel is due to the availability of campus-wide networks in both UKM and UM from 1997 onwards. The Internet was also used by both groups to seek information from their colleagues or collaborators, or to contact experts in their field of research. The interviews emphasised the use of colleagues and collaborators during the research process. Academics approached team members, friends and professors in the field, colleagues from abroad or from other institutions and research students assisting with their research to discuss researchable ideas.

The reasons given for choosing the above channels are they: contain information needed (ranked first by the scientists and second by the engineers); keep them aware of new developments (ranked second by the scientists and first by the engineers); authoritative; accurate and objective (ranked fourth by the scientists and third by the engineers); and nearest at hand (ranked third by the scientists and fourth by the engineers).

(8) Is publication productivity related by the methods respondents' used to keep abreast of research information?

The ratings on methods used to keep abreast of research information indicate that both groups commonly placed four methods as useful or very useful. These were: "browse current periodical shelves" (ranked first by the scientists, and second by the engineers), "attend conferences or proceedings" (ranked second by the scientists but first by the engineers), "contact those in the same field" (ranked third by the scientists and fifth by the engineers), and "browse abstracts / indexes in the field" (ranked fourth by both academic groups). Academic scientists rank "browse the Internet" fifth as a useful/very useful method (ranked eighth by the engineers).

Cross-tabulating publication productivity scores with the eleven methods used to keep abreast of research information indicated no correlated results for the academic engineers. The highly productive scientists rated very positively on seven methods. These were: subscribing to journals ($p=.157$, sig.<0.01), browsing the library's accessions list ($p=.167$, sig.<0.01), browsing special bibliographies ($p=.173$, sig.<0.01), searching the library's online catalogues ($p=.156$, sig.<0.01), browsing the publisher's catalogues ($p=.156$, sig.<0.05), contacting those in the same field ($p=.136$, sig.<0.05) and talking to colleagues in the department ($p=.158$, sig.<0.01).

Both groups in the survey rated "attending conferences and meetings" very positively, and this method is also mentioned by the academics interviewed (mentioned by 28.1% engineers and 16.6% scientists). Similar to the survey findings, "printed" formal sources still figured prominently for those interviewed. Fifteen out of 32 engineers (46.8%) and 13 out of 24 scientists (54.1%) mentioned printed sources, such as journals and reports as useful for keeping them abreast of research information. Lofthouse (1974) pointed out that journals provide a major outlet for academic publishing since more academics would produce an article rather than a book. Academics see journals as important sources of information to keep them in touch with current and recent works (Halsey and Trow, 1971). Future studies could ascertain whether this is still true in the event of the current ease in disseminating and communicating electronically. The other methods frequently mentioned by both groups of academics were electronic sources, Internet, e-mail, attending seminars, searching the literature, personal contacts and making use of sabbatical leave to keep abreast of research information.

In summary, the productive scientists prefer to keep abreast by using a variety of channels ranging, from library-related sources (Crawford, Halbrook and Igielnik, 1986; Hurd, Weller and Curtis, 1992) to informal sources, such as, personal contacts, discussion with colleagues and gatekeepers (Rosenbloom and Wolek, 1970).

(9) Is publication productivity affected by the problems faced when communicating research results and the problems encountered when locating or obtaining research information provided by the libraries?

Problems in communicating research results – Academics' ratings of the eight statements relating to possible problems in publishing research results indicate similarities in the types of problems faced. Based on the frequency of ratings of "serious problems" and "very serious problems", the academic scientists indicated the following five top problems for them: difficult to publish abroad; poor frequency of local journals; home environment; few local scholarly journals; and technical writing skills. The academic engineers indicated similar problems; poor frequency of local journals; difficult to publish abroad; few local scholarly journals; home environment and courage to write. These problems might be closely related to their actual publishing behaviour that indicates that both academic groups published the majority of their work in local S & T journals. Therefore, the small number and poor frequency of local S & T journals may slow down their publication activity.

More than 50% of the academic scientists and engineers rated these situations as not a problem for them, indicating that they know which channel to send articles for publication to (74.1% - scientists; 60.2% - engineers), are confident in writing in the English language (71.1% - scientists; 72.3% - engineers); have the necessary technical writing skills (62.8% - scientists; 78.3% - engineers), have unproblematic home environment (60.3% - scientists; 78.0% - engineers), and have the courage to write (59.0% - scientists; 65.1% - engineers).

When the scores on publication productivity were cross-tabulated with the ratings on the eight statements on research publication problems, more significant correlated results were indicated for the academic engineers. The highly productive academic engineers indicated no problem with: technical writing skills (p=.306, sig.<0.01); courage to write (p=.346, sig.<0.01), confidence in writing in English (p=.362, sig.<0.01); knowing which channel to submit articles to (p=.279, sig.<0.01); and a conducive home environment (p=.245, sig.<0.05). The productive academic scientists rated the poor frequency of local scholarly journals as a serious problem (p=-.210, sig.<0.01).

In general, the results indicate that even though the productive academic engineers had no problems in publishing their research results since most used local channels to publish, the academic scientists were less satisfied with the support given by local scholarly journals. The academics interviewed were also confident of their technical writing skills and in writing in the English language. The interviews explained the ways in which research writing skills were achieved. Writing skills developed with experience and not acquired and the thesis writing experience or guidance from supervisors helped to improve this skill. Other means mentioned were learning by themselves "till they get it right", learning through trial and error and possessing a good command of the English language.

Problems in obtaining information needed for research – The ratings of fifteen problem-situations in obtaining information for research revealed that both academic groups rated these 5 top situations as problematic "most of the time": (a) delay in journal arrivals (133 out of 239 scientists, 57 out of 83 engineers); (b) insufficient funds to order articles from abroad (122 scientists, 53 engineers); (c) cannot find wanted items from the shelves (93 scientists, 54 engineers); (d) no time to look for information (70 scientists, 47 engineers), and (e) library books are outdated (66 scientists and 37 engineers).

The five situations regarded as rarely or never a problem by the academic scientists were: (i) did not know how to search CD-ROM or online databases (101 scientists, 46 engineers); (ii) did not know how to choose relevant databases (87 scientists, 41 engineers); (iii) inadequate photocopying services (52 scientists, 18 engineers),); (iv) professional librarians were not willing to perform searches (59 scientists; 10 engineers); and (v) did not know where to look for information (46 scientists, 42 engineers).

When total publication scores were cross-tabulated with the fifteen problem situations, the results indicated that ratings on fourteen of the situations was independent of academic engineer's publication productivity. A negative correlation was indicated by the statement "colleagues are not helpful in providing materials needed" ($p=-.242$, sig.<0.05). The highly productive academic scientists rated these situations as problematic: (i) no help in finding information ($p=-.189$, sig.<0.01), do not know where to look for information ($p=-.222$, sig.<0.01); cannot find relevant information ($p=-.132$, sig.<0.05), receive information too late ($p=-.204$, sig.<0.01) and do not know how to choose relevant databases ($p=-.141$, sig.<0.05). The productive scientists rated positively (not a problem) on "library books are outdated" ($p=.124$, sig.<0.05) and "librarians are not willing to perform searchers" ($p=.144$, sig.<0.05).

The results indicated that the productive scientists still found problems in obtaining and using library-related resources. Libraries can be supportive by helping academics to search for relevant literature at the initial stages of their research and making them aware through the campus networks of currently available free or fee-based bibliographic databases which can be accessed through the Internet or from within the library. This effort should be aimed at the younger and less experienced academics who have problem in seeking the librarian's help in performing searches. Access to literature is crucial to the research performance and lack of access may hamper successes (Srichandra, 1970; Babu and Singh, 1998).

In summary, the results from this study indicated a number of agreements with the findings from previous studies. Variables such as chronological age, professional experience, academic rank, the number and amount of grants received, active professional membership, positive views on research, the number of consultation work awarded and the types of collaborative undertakings are good determinants of publication productivity for both the academic engineers and scientists. However, some variables are more applicable to the academic scientists only and these include gender, early publication activity, the percentage of time allocated to research, the department or discipline, perceived departmental publication standard, an optimum number of staff members, and adequate laboratory support. Other variables that have not been included but were mentioned by respondents interviewed are the role of research leadership, an effective institutional reward and support system, personal, psychological and motivational variables. This should be the focus of future studies.

7.3. IMPLICATIONS AND CONCLUSIONS

One of the fundamental processes in science is the communication and exchange of research results. The main channel used to communicate is publications. These take on several formats, with higher preference for journal articles. Publications allow researchers to verify proposed findings, and derive professional recognition and esteem. This study has focused on the output measures derived from counts of total work produced between the years 1990 and 1995. This "knowledge-related output indicators" (coined from Chan, 1978) include articles published in refereed journals, research reports, dissertations, invited papers, seminar papers, and patents obtained. Other types of publications considered in the total count are books, chapters in a book, works edited and translated. This focus on quantity is felt to be the most suitable measure in the Malaysian context. Academics in Malaysia are currently assessed yearly by a common national assessment system used for all civil servants. The assessment for academics (based on the assessment form, Universiti Malaya, Borang UM (Prestasi)1/93) is basically based on three criteria. The first criterion comprises the awards, prizes and recognition obtained. The second constitutes total administrative commitments at university, national and international level. The third criterion focuses on an academic's workloads which are sub-categorised into four types and these are: (a) total hours committed to teaching; (b) total hours spent on the supervision of undergraduates and postgraduates; (c) the number of research activities, the amount of funding obtained, and consultation work undertaken; and (d) publication activities spelt out in the form of books, book chapters, journal articles, works edited/translated, compiled and patents obtained. This type of quantitative measure has been used in a number of studies (Blackburn, Behymer and Hall, 1978; Braun, Glanzel and Schubert, 1990). The use of the questionnaire to gather such data has been indicated as reliable (Allison and Stewart, 1974). This study has further compared information obtained from the respondents and from the official reports of their publications, published annually by both universities. The publication counts, not only indicate total and average productivity of academic engineers and scientists between the years 1990 and 1995, but also indicate the publishing behaviour of the academics in terms of the journal titles preferred and the country which published the journals.

To date there has been no Malaysian study on academics' publishing behaviour, or one that investigates the relationship between endogenous as well as exogenous factors and publication productivity. This is the main contribution of this study even though it is confined to only a selected sample of academic engineers and scientists. The monitoring and reporting of research by the Ministry of Science, Technology and Environment, have been confined to providing information on "which research institutions have received allocations and how much". The survey conducted by the Ministry has been confined to finding out about the problems faced in the management and disbursement of research funds (National surveys, 1994, 1996). No national attempt has been made to investigate the output or outcome of the research funded. This study approaches academic research from a different perspective. It investigates the published output of research and ascertains whether the achieved output is related to certain environmental and personal circumstances. The findings from this study may be useful for the university management to understand the possible correlates to research productivity. Future studies can extend this investigation to include the other academic disciplines in the social sciences and humanities, to ascertain similarities and variations in findings. Output measures can be extended to include citations or awards received. The inclusion of citations is still a problem when using Malaysian sample since a high number of academics are either not publishing in journals indexed by *Science Citation Index,* or are publishing in low impact journals and works published are rarely cited (Arunachalam and Garg, 1986). Cole and Cole (1967) have suggested that where citation counts are not readily available for countries which are not adequately represented in the *SCI*, publication counts are roughly adequate as indicators of academics' publication performance.

The information provided by the present study may be useful to the university management in Malaysia, in general, and to the two universities sampled, in particular. Firstly academics are generally aware of their research and publication responsibilities, and for those in UKM and UM, at least, the imposition of a number requirement is perhaps unnecessary. However, academics do need to be made aware that articles in refereed journals are preferred by management to contributions to proceedings of conferences. Those who are already publishing in high impact journals must be recognised with acceptable incentives. The library can play a useful role in this context by making sure that high impact journals are subscribed to cooperatively by any of the nine local universities, and are made known to the academics from their own institutions. Informing those who have received citations to their work would be an incentive enough for further contributions since such information is not readily available to the academics themselves.

Secondly the state of local S & T journals makes it quite difficult for the academics to meet the journal article requirement, especially when publishing abroad proves to be difficult. Both groups of academics, especially the scientists feel that local S & T journals are not only small in number but also poor in frequency. Further investigation is needed to ascertain the reasons for the poor frequency. Editorial function is undertaken on a voluntary basis among Malaysian academics. Editors often handle both the professional and clerical functions related to journal publication. As such, to improve editorial functions, academic's active involvement in editorial activity must be encouraged and given proper incentives. This support would not only improve the quantity but also the quality of Malaysian S & T journals. Institutions of higher learning can help in terms of ensuring continued finance for journals with good potential and giving incentives to titles which keep to their publication schedules. To increase visibility, universities can encourage the faculties concerned with journal publications to go fully electronic. The Malaysian S & T academics must be encouraged, therefore, to publish their research in foreign channels and actively support S & T titles published locally.

Thirdly this study provides useful information to the libraries by highlighting the groups of staff who are finding problems with which types of library services or facilities, and what improvements academics feel that libraries can make to add quality to their research environment. The study reveals that those academics higher in rank and experience have fewer problems in using and seeking professional help. This is especially so among the scientists who depend more on published formal sources such as periodicals, special bibliographies and accessions lists produced or kept by the library. Two courses of action are, therefore, opened to the library. Firstly, the marketing of services and facilities must be aimed towards satisfying the needs of the less experienced lecturers who may lack the confidence to seek professional help or advice, and who may not be aware of the facilities available to them, such as, getting articles from abroad through the inter-library loan services, and help in identifying relevant databases. Secondly the needs of the productive academics are different. From the interviews and responses to the open-ended questions in the questionnaire, it was revealed that academics are active users but wanted facilities to be better managed. This includes providing a more efficient and cheap inter-library loan services (such as subsidising the cost of articles obtained from abroad), making available CD-ROM or online databases via the campus network, so that searches can be conducted from their desks, and managing the periodicals collection more efficiently (shelving of used periodicals, processing of new titles for the shelves, binding of loose periodicals and allowing the borrowing of bound journals). Poland (1993) pointed out that librarians are in the business of providing information and need to change strategies in dealing with academics. She suggested that libraries should identify the information gatekeepers in faculties and supply current relevant information to the keepers, hoping that the sources are disseminated.

Fourthly this study reveals the variety of options which faculties and universities should consider in improving publication productivity. The knowledge of factors related to publication productivity could be employed to promote higher productivity among academic staff at all levels. The need to incorporate the research leadership role among the departmental or faculty heads, is clearly indicated. The active researcher wants a head who is sympathetic towards the research activities of the staff under his care and is an exemplary researcher in his own right. Perhaps it is good strategy to entice a few "stars" or "superstars" in priority areas to boost research performance (Zhu, Meadows and Mason, 1991). Departmental level activities such as presentations of seminars and mutual exchanges of published results, can easily be instituted at departmental level. University management could help by giving priority of funding to the younger or new lecturers and providing special allocations for the more established researcher to present their results at international forums. Inter-departmental, institutional and international collaboration should be encouraged, as this seems to be associated with high productivity. The success of academic goals depends on several factors that include congruent departmental goals and faculty's expectation, and the goals should be operable and guided by a strong mission-oriented leadership strategy (Tuckman and Chang, 1988).

Johnston (1994) suggested a number of policy implications which might help promote research productivity such as: (a) favouring research proposals from teams of researchers rather than individuals (this would encourage linkages with the national or international research community); (b) supporting research which has the possibility of achieving international recognition, as there is no indication that increasing resource concentration would increase unit research productivity; (c) evaluating the performance of recipients based on comparable centres elsewhere (usually overseas); (d) undertaking a detailed assessment of the precise advantages of resource concentration in a particular context before deciding on the proportion of fund allocations. Baldwin (1990) had some useful suggestions to university management on how to maintain the productivity of the professors, such as: (a) encouraging professors to continue developing and expanding their professional interest; (b) asking them to assess their careers periodically and developing concrete goals that can energise and direct their career activities; (c) allowing them to collaborate and undertake risky projects; (d) recognizing and rewarding achievements; and (e) providing management training for those who have assumed an administrative role to enable them grow and perform effectively throughout their career. These strategies would minimise the "plateauing trap" which a number of academics fall into and never get out of.

In summary, factors that affect the academic staff's research output can be likened to Paisley's (1968) "concentric circles" of information use system. While Paisley identified a ten-layered system that affects the information user, this study has applied only eight of the layers to explain the environment that affects academic staffs' roles. The academic staff stands at the center of an eight-layer system that touched on every aspects of their work (which includes research). The outermost circle is the cultural system that affects their research activities and comprises for example the reward system, the emphasis on priority of discovery, and the assimilating the work ethics of the university lecturer and researcher. The second layer is the political system, that is the national R & D research policy and fund allocation system and the university research priorities that affect funding allocation for research within each university. The third layer is the membership group, which is the professional group they locate themselves in. An academic staff can be a biologist or physicists or a civil engineer and this membership system, controls the way he conducts research, the information channels he uses to locate and disseminate information for research. The fourth layer is the reference group that includes others with similar specialisation, similar training, and similar work focus. The members in this group may come from various disciplines and are researching in the same area but from various perspectives. The fifth layer is the invisible college, where members know each other, share information directly, share the same status level and may be geographically dispersed. The members in this layer appear to be more productive and better trained. The invisible college selects its own members. Papers and reprints received from each member were saved. The sixth layer is the formal system. This layer emphasizes the roles, lines of responsibility, and products. It provides the facility and policy of the formal organisation, which either opens or blocks research information available to scientists. The seventh layer is the scientist's work teams. This layer provides scientists with rich information through informal channels and is instrumental in nurturing a conducive and dynamic environment necessary for high research performance. The last system is the academic staff "within his own head". This constitute the personal system comprising the motivation, intelligence, creativity, attitude, interests, awareness, judgments, feelings, preferences, perceived relevance and perceived utility, that is essential to sustain high research performance. The systems approach indicates the endogenous and exogenous factors that may be related to academic staff's research performance. This study considers only one type of output, that is, total research publications by selected groups of academic engineers and scientists for the years 1990 to 1995 and investigations is focused on the possible endogenous / exogenous factors, which may explain high publication performance.

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APPENDIX 1

THE LETTER ACCOMPANYING THE QUESTIONNAIRE USED IN THE SURVEY

FAKULTI SAINS KOMPUTER & TEKNOLOGI MAKLUMAT
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15 August 1996

Dear

Survey: Academic Research Publication Behaviour and Indentifying Correlates of Academic Publication Productivity

I am a lecturer, attached to the Masters Program in Library & Information Science offered at the Faculty of Computer Science & Information Technology, University of Malaya. I am a registered Ph.D. part-time candidate at Loughborough University, United Kingdom. My research area is tentatively entitled:

> **The academic research communication behaviour and possible correlates of publication productivity**

As part of this research, I am conducting a survey. The main objective is to identify the academic's publication behaviour and ascertain correlates related to publication productivity. As such I beg for your cooperation. PLEASE HELP by filling this questionnaire. If you prefer to be interviewed please indicate so at the bottom of this letter in the box provided.

I appreciate and welcome any comments. Thank you.

Yours sincerely

(Zainab Awang Ngah)
Faculty of Computer Science and Information Technology
University of Malaya
50603 Kuala Lumpur
MALAYSIA

I PREFER TO BE INTERVIEWED ☐

APPENDIX 2: THE QUESTIONNAIRE USED IN THE SURVEY

ACADEMIC RESEARCH PUBLICATION BEHAVIOUR AND CORRELATES OF ACADEMIC PUBLICATION PRODUCTIVITY

This questionnaire aims to identify the publication behaviour and productivity of academic staff. Please answer all the questions and use the self-stamped envelope to return the questionnaire. The confidentiality of your answer is assured and no personal names will be disclosed. The results of this survey will be used to write a Ph.D. thesis. I thank you in anticipation of your response.

Please tick, or circle as appropriate.

A. PERSONAL BACKGROUND

1. Gender

   Male ☐ 1 Female ☐ 2

2. Age

   30 years or under ☐ 1 41-50 years ☐ 3

   31-40 years ☐ 2 51 years or over ☐ 4

3. Race

   Malay ☐ 1 Indian ☐ 3

   Chinese ☐ 2 Others ☐ 4

4. If you are married, please indicate your spouse's occupation

   Housewife ☐ 1 Self-employed ☐ 3 Other ☐ 5

   Civil servant ☐ 2 Private employee ☐ 4

5. Number of children ....

B. ACADEMIC BACKGROUND

1. The University you are affiliated to:

   UKM ☐ 1 UM ☐ 2

2. Your Faculty:

   Science ☐ 1 Engineering ☐ 2

3. Your Department ☐

4. Highest qualification / year / country received

   Masters ☐ 1 Year .... Country ....

   Ph.D. ☐ 2 Year .... Country ....

5. Your current position

Lecturer ☐ 1 Assoc. Prof. ☐ 2 Prof. ☐ 3

6. The number of years as a faculty member in the present university

Under 5 years ☐ 1 11-15 years ☐ 3

6-10 years ☐ 2 Over 15 years ☐ 4

C. DEPARTMENTAL BACKGROUND

1. Indicate roughly the per cent of your time devoted to each of the following:

Research ☐ %

Teaching ☐ %

Administration ☐ %

Research ☐ %

Total ----------------
100 %

2. Please indicate the publication requirements of your Department.

(a) No minimum number set ☐ 1

(b) At least 1 publication per year ☐ 2

(c) At most 3 publications per year ☐ 3

(d) Others (please specify) ☐ 4

3. Indicate the size of your department.

More than 50 faculty members ☐ 1

40-49 faculty members ☐ 2

31-39 faculty members ☐ 3

21-30 faculty members ☐ 4

Under 21 faculty members ☐ 5

4. Indicate the number of postgraduate research students enrolled in your department (Master and Ph.D.)

Over 20 ☐ 1 10-14 ☐ 3 Under 5 ☐ 5

15-19 ☐ 2 5-9 ☐ 4

D. PROFESSIONAL BACKGROUND

1(a). Are you a member of any learned societies or professional associations?

yes ☐ 1 no ☐ 2

(b). If "yes" please name the associations you are a member of.

In Malaysia
1. ....
2. ....
3. ....

Outside Malaysia
1. ....
2. ....
3. ....

2. Are you an editor / member of an editorial board of any journal publications?

yes ☐ 1 no ☐ 2

3. If "yes" please indicate the titles of the journals.

Journal titles	Country
....	....
....	....
....	....

4. Have you ever been a consultant / adviser to an external body?

yes ☐ 1 no ☐ 2

5. If "yes" please indicate and specify the consultancy / advisory work you have undertaken.

(a) Central government
....
(b) State government
....
(c) Local/Municipal government
....
(d) Private agency
....
(e) Foreign agency
....
(f) Professional organisation
....
(g) Others (please specify)
....

E. INSTITUTIONAL SUPPORT

1. Sponsor(s) of your research

University's own research vote ☐ 1

R & D allocations from central Government ☐ 2

Grant from government agencies (not under R & D)	☐	3
Grant from local industry	☐	4
Foreign financial aid	☐	5
Other (please specify)	☐	6

2.Please indicate the grants you have received for your research between the years 1990 and 1995.

Name of awarding body	Year	Duration	Amount
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

3. Have your research activities been limited by the lack of funding?

yes ☐ 1   no ☐ 2

4. If your answer is "yes" please indicate the reasons.

....
....
....
....

5. How did you find the disbursement of research funds at the university?

Very inefficient	☐	1	Fairly efficient	☐	3	Very efficient	☐	5
Inefficient	☐	2	Efficient	☐	4			

6. If you choose "4 or 5" from question 5 above please indicate your reasons.

....
....
....
....

F. LIBRARY SUPPORT

1. How adequate are the materials in your library in terms of your research needs?

Don't know / never used the library	☐	1
Sufficient for none of me requirements	☐	2
Sufficient for few of my requirements	☐	3
Fairly sufficient for my requirements	☐	4
Sufficient for most of my requirements	☐	5
Sufficient for all my requirements	☐	6

2. Are there any ways in which the library services could be improved to fulfill your research needs.

yes ☐ 1 no ☐ 2

If your answer is "yes" please indicate in what ways:

....
....
....
....

G. LABORATORY SUPPORT

1. How adequate are the laboratories at your university in terms of meeting your research needs?

Don't know / never used the laboratory	☐	1
Sufficient for none of me requirements	☐	2
Sufficient for few of my requirements	☐	3
Fairly sufficient for my requirements	☐	4
Sufficient for most of my requirements	☐	5
Sufficient for all my requirements	☐	6

2. If you ticked "5 or 6" in the boxes above, please give your reasons.

....
....
....
....

H. ELECTRONIC SUPPORT

1. Do you use a personal computer?

yes ☐ 1 no ☐ 2

(a) If "yes", please indicate the type of computers used.

A stand-alone personal computer	☐	1
A networked microcomputer	☐	2
Both types above	☐	3
Others, please specify	☐	4

(b) If your answer is "yes", please indicate the location of the computer which you use regularly (you may tick more than one box)

On your desk	☐	1
At your department	☐	2
At the Computer Centre	☐	3
At the library	☐	4
Others, please specify	☐	5

2. Indicate the frequency in which you use computers for research.

Never	☐	1
Seldom	☐	2
Frequent	☐	3
Very frequent	☐	4

3. For each type of computer use below please <u>circle</u> the number that describes your usage for research.

	Never	Seldom	Sometimes	Freq.	V. freq.
(a) To create databases	1	2	3	4	5
(b) Statistical analysis of data	1	2	3	4	5
(c) Graphical representation of data	1	2	3	4	5
(d) Word processing	1	2	3	4	5
(e) Preparing presentation slide shows	1	2	3	4	5
(f) Searching databases on CD-ROMS	1	2	3	4	5
(g) Sending & receiving e-mail	1	2	3	4	5
(h) File transfer	1	2	3	4	5
(i) Accessing information via the Internet	1	2	3	4	5
(j) Hold personal bibliographical index	1	2	3	4	5
(k) Programming	1	2	3	4	5
(l) Games playing	1	2	3	4	5
(m) Others	1	2	3	4	5

I. RESEARCH OUTPUT

1. In which year did you write your first research report? Year ....

2. Was the research report your thesis/dissertation?

yes ☐ 1 no ☐ 2

3. In the last 6 years (1990-1995), have you published any research publications?

yes ☐ 1 no ☐ 2

4. If "yes", please indicate the number of research publications that you have published between 1990-1995 in the boxes below.

Types of publication	Number of publications Alone	As Co-author
(a) Scholarly books	☐	☐
(c) Research reports	☐	☐
(d) Articles in refereed journals	☐	☐
(e) Articles in non-refereed journals	☐	☐
(f) Chapters / sections of a book	☐	☐

(g) Conference papers	☐	☐
(h) Books edited	☐	☐
(i) Books translated	☐	☐
(j) Standards and technical publications	☐	☐
(k) Patents	☐	☐
(l) Others (please specify)	☐	☐

3. Please provide details about your publications for 4 (c) & (d) above. (You may include a list)

Title of journals	Country of publication	Year	Language
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

J. COLLABORATION

1. Please indicate the nature of collaboration that you often adopted in research?

(Please circle)

Type of collaborations	Never 1	Hardly ever 2	Sometimes 3	Often 4	Always 5
(a) Did research by myself	1	2	3	4	5
(b) Collaborate with colleagues within the department	1	2	3	4	5
(c) Collaborate with colleagues from other universities	1	2	3	4	5
(d) Collaborate with researchers outside the country	1	2	3	4	5
(e) Others (please specify)	1	2	3	4	5

....

2. Explain your role in the collaborative research

Head of the team ☐ 1 Consultant ☐ 3 Others ☐ 5 (please specify)

Equal team partner ☐ 2 Research assistants ☐ 4 ....

3. Please indicate the extent of your agreement with these statements concerning factors which pose as problems to research publications.

Factors	V. serious Problem	Serious problem	Quite a problem	Unproblem-atic	Not a problem
(a) Skills in writing technical papers	1	2	3	4	5
(b) Courage to write	1	2	3	4	5
(c) Confidence in writing in English	1	2	3	4	5
(d) Few local scholarly journals	1	2	3	4	5
(e) Poor frequency of local scholarly journals	1	2	3	4	5
(f) Do not know where to send articles for publication	1	2	3	4	5
(g) Home environment	1	2	3	4	5
(h) Difficulty of getting articles published abroad	1	2	3	4	5

K. PERSONAL VIEWS

Please check the numbers in the scales that represent your agreement to the following statements.

1. Views on Research	Not true 1	2	3	4	Very true 5
(a) Adds to my reputation as a scientists/technologists	1	2	3	4	5
(b) Enables me to contribute to the advancement of knowledge	1	2	3	4	5
(c) Gives me prestige and respect	1	2	3	4	5
(d) Gives prestige to my Department/University	1	2	3	4	5
(e) Enhances my career prospects	1	2	3	4	5
(f) Gives me an opportunity to develop products	1	2	3	4	5
(g) Gives me an opportunity to present papers	1	2	3	4	5

2. Views on Department	Not true 1	2	3	4	Very true 5
(a) My department is highly research oriented	1	2	3	4	5
(b) Faculty members in my department are prolific writers	1	2	3	4	5
(c) I regularly discuss research with my colleagues	1	2	3	4	5
(d) The department arranges useful research seminars	1	2	3	4	5
(e) Colleagues encourage scholarly endeavours	1	2	3	4	5
(f) Department's teaching/administration load does not prevent me from undertaking research	1	2	3	4	5
(g) I read research articles / reports written by my colleagues	1	2	3	4	5

3. Views on Institution	Bad 1	Not good 2	Fair 3	Good 4	Excellent 5
(a) Provision of startup financial support for research	1	2	3	4	5
(b) Provision of sufficient support for presenting papers at local conferences	1	2	3	4	5
(c) Financial support for presenting papers at international conferences	1	2	3	4	5
(d) Quality of laboratories and working space	1	2	3	4	5
(e) Quality of assistants and technical research staff	1	2	3	4	5
(f) Quality of library resources	1	2	3	4	5
(g) Quality of computing facilities	1	2	3	4	5

L. INFORMATION SEARCHING & DISSEMINATION PRACTICES

1. Please check each of the following channels according to their usefulness in providing information needed for your research

Formal channels	Not used 1	Not useful 2	Fairly useful 3	Useful 4	Very useful 5
(a) Journals	1	2	3	4	5
(b) Books	1	2	3	4	5
(c) Research reports	1	2	3	4	5
(d) Conference proceedings	1	2	3	4	5
(e) Library catalogues	1	2	3	4	5
(f) Reference librarian	1	2	3	4	5
(g) Online /CD-ROM databases	1	2	3	4	5
(h) Indexes/Abstracts/Bibliographies	1	2	3	4	5
(i) Library's accessions list	1	2	3	4	5
(j) Standards / specifications	1	2	3	4	5
(k) Internet	1	2	3	4	5
(l) Bookstores	1	2	3	4	5
(m) Patents	1	2	3	4	5
(n) Others (please specify)	1	2	3	4	5

Informal channels	Not used 1	Not useful 2	Fairly useful 3	Useful 4	Very useful 5
(a) Correspondence / letters	1	2	3	4	5
(b) Telephone conversation	1	2	3	4	5
(c) E-mail colleagues	1	2	3	4	5
(d) Face to face dialogue with colleagues within the department	1	2	3	4	5
(e) Face to face dialogue with colleagues from other departments within the university	1	2	3	4	5

(f) Face to face dialogues with colleagues from other universities	1	2	3	4	5
(g) Discussion at conferences	1	2	3	4	5
(h) Fax to colleagues outside the university	1	2	3	4	5
(i) Others (please specif)	1	2	3	4	5
(j) Standards / specifications	1	2	3	4	5
(k) Internet	1	2	3	4	5
(l) Bookstores	1	2	3	4	5
(m) Patents	1	2	3	4	5
(n) Others (please specify)	1	2	3	4	5

....

2. For the channels that you have chosen as "very useful" or "useful" above, please indicate your reasons for doing so.

Tick in the appropriate boxes

(a) Sources are authoritative, accurate, objective ☐

(b) Sources would likely contain information needed ☐

(c) Easy to use ☐

(d) Free or inexpensive ☐

(e) Nearest at hand / accessible ☐

(f) Keep me aware of new developments ☐

(g) Others (please specify) ☐

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3. How do you keep abreast with research in your discipline? Please rate the methods you have chosen
Ratings: 1=not used; 2 = Not useful; 3 = Fairly useful; 2 = Useful; 1 = very useful

(a) Subscribe to journals ☐

(b) Browse library's accession's list ☐

(c) Browse current periodicals shelves ☐

(d) Browse through abstracts & indexes in relevant fields ☐

(e) Browse through special bibliographies ☐

(f) Browse library's online catalogues periodically ☐

(g) Look at publishers', booksellers' catalogues ☐

(h) Browse through information sources in the Internet ☐

(i) Maintain contacts with others working in the same field ☐

(j) Attend conferences / professional meetings ☐

(k) Talk to my colleagues in my department ☐

Please use the space below to indicate other ways in which you keep abreast.

4. Please rate each of the following library services which you may have used in connection to your research.

Services	Not used 1	Not useful 2	Fairly useful 3	Useful 4	Very useful 5
(a) Book loan services	1	2	3	4	5
(b) Reservation for books	1	2	3	4	5
(c) Photocopying services	1	2	3	4	5
(d) Borrowing periodicals	1	2	3	4	5
(e) Inter-library loans	1	2	3	4	5
(f) Professional library staff's help in locating resources	1	2	3	4	5
(g) Searching of online databases by professional library staff	1	2	3	4	5
(h) Others (please specify)	1	2	3	4	5

5. Indicate the frequent problems that you face in obtaining required information for your research.

Problems	Not applicable 1	Most of the time 2	Occasionally 3	Rarely or never 4
(a) Library books are outdated	1	2	3	4
(b) Delay in journal's arrival	1	2	3	4
(c) Lack of help to find information	1	2	3	4
(d) Do not know where to look for information	1	2	3	4
(e) Cannot find apprpriate information	1	2	3	4
(f) Receive information too late to be of much use	1	2	3	4
(g) Inadequate photocopying services	1	2	3	4
(h) Have no time to look for information	1	2	3	4
(i)Do not know how to choose relevant databases for information	1	2	3	4
(j) Do not know how to search CD-ROM, online databases	1	2	3	4
(k) Obtain too much irrelevant information from the librarians	1	2	3	4
(l) The professional librarian are not willing to perform the search for me	1	2	3	4
(m) I cannot find books I want on the shelf	1	2	3	4
(n) Colleagues are not helpful in providing materials needed	1	2	3	4
(o) Insufficient funds to order unavailable articles from abroad	1	2	3	4
(p) Others (please specify)	1	2	3	4

----

6. How do you usually disseminate results of your research? Tick and rank the three most important methods used.

	Tick & Rank
(a) Letters / correspondence to colleagues	☐
(b) E-mail to colleagues	☐
(c) Preprints	☐
(d) Oral presentation (conferences)	☐
(e) Published proceedings	☐
(f) Articles in local journals	☐
(g) Articles in foreign journals	☐
(h) Deposit a copy to the library	☐
(i) Reprints	☐
(j) Books	☐
(k) Others (please specify) --	☐

Be free indicate other reasons or comments below:

....

....

....

....

THANK YOU FOR YOUR COOPERATION

Please use the stamped envelope to return the questionnaire to:

Zainab Awang Ngah
Faculty of Computer Science & Information Technology
University of Malaya
50603 Kuala Lumpur

APPENDIX 3: THE LIST OF QUESTIONS USED DURING THE INTERVIEW AND E-MAIL CORRESPONDENCES

OPEN-ENDED QUESTIONS

A. PUBLICATIONS

1. Do you agree that academic staff should publish at least one publication per year?

2. Academic scientists seem to prefer to publish more conference papers instead of journal articles. Do you agree? Why do you think this so?

3. In terms of preference (ranking 1 to 3) which form of publication do you as an academic staff use to publish frequently

	Rank
(a) Research reports	___
(b) Conference papers	___
(c) Journal articles	___

4. Why do you think academic staff publishes more joint works?

5. How do you rate local journals in your field as a channel to publish your research results on a point of 1 to 10? (1-low & 10 = very high). Explain why you have given such a rating.

6. If local science and technology journals are refereed and indexed by international agencies such as ***Biological Abstracts***; ***Chemical Abstracts***; ***Georef***; ***CAB Abstracts***; ***MathSci***; ***Biotechnology Abstract***; ***Biotechnology citation index***, ***INSPEC*** etc., would you consider contributing more to locally published journals?

7. What are the criteria you usually use when choosing a journal to submit your articles?

8. The results of the survey indicate that academic scientists tend to resubmit articles to journals that have previously accepted their article for publication. Why do you think they behave in this way?

B. PERSONAL BACKGROUND

9. Do you agree that gender, race, age, spouse's occupation or the number of children respondent's have influences their publication productivity. Please explain

C. ACADEMIC BACKGROUND

10. Academic rank (lecturers, associate professors, professors) and work experience has a strong influence on publication productivity. Do you agree? Can you please elaborate on this?

11. Do you think that the thesis you wrote (for Masters or Ph.D.) has provided you with the skills in scholarly writings? Has it helped to boost your confidence in writing research publication?

12. Academic staff who has obtained their highest academic qualifications abroad will be more productive than those who are trained locally. Do you agree?

D. DEPARTMENTAL BACKGROUND

13. The per cent of time you allocate for research usually have no effect on your publication productivity. Do you agree. Can you explain why this is so.

14. You agree that departments must clearly spell out the publication requirements of their academic staff so that they can work out a realistic plan of action. Do you agree? Please explain.

15. Does the number and quality of higher degree research student influences publication productivity of an academic staff?

E. PROFESSIONAL BACKGROUND

16. An academic staffs who is active in professional associations tend to be more productive, publication-wise. Do you agree?

17. An academic staff who undertakes a number of consultation work will publish more. Do you agree?

F. FINANCIAL SUPPORT

18. Those who receives a higher number of financial support will achieve a higher level of research publication productivity. Do you agree?

19. Those who receive a larger amount of grant allocation will achieve a higher level of research publication productivity. Do you agree?

G. LIBRARY SUPPORT

20. Do you agree that the quality of research resources and services provided by your library affects your publication productivity?

21. Can you indicate how the library can help to improve your research quality?

H. LABORATORY SUPPORT

22. The quality of your laboratory equipment will not affect your publication productivity. Do you agree?

I. ELECTRONIC SUPPORT

23. The computer support provided by my university is adequate but this will not directly influence my publication productivity. Do you agree?

J. COLLABORATION

24. The more you collaborate the higher would be your research publication output. Do you agree?

25. Do you agree that collaboration with researchers outside the university or outside the country would increase your research publication output?

K. VIEWS

26. Do you agree that an academic staff who has a positive attitude towards research tend to achieve a higher level of research publication productivity?

27. Colleague's departmental duties do not affect your publication productivity. Do you agree?

28. Are you satisfied with your research publication performance? Please elaborate.

29. What sort of research environment would you like to see in your department?

What sort of institutional support would you like to see made available to help promote a more vibrant research publication environment.

30. What kind of research leadership would you like to see in your head of department or you should be (if you are a head of department)?

L. CHANNELS OF INFORMATION

31. How do you obtain information you need if you want to find out who else are doing research in your area of interest?

32. Whom do you usually contact to get information in the process of doing your research? Indicate why.

33. How do you usually let other people know that you are now undertaking a piece of research?

34. How do you let people know of the results of your research?

35. How do you keep yourself current in the area of your research?

M. RESEARCH PROBLEMS

36. Can you describe the sort of problems you recently or often face when undertaking research?

37. Do you feel that you have received sufficient training in research publication writing?

38. To round up – How have you achieved the present rate of publication productivity thoughout your academic career?

Department/Faculty:
Academic Rank:
Highest qualification: Country Year
Number of years working as a lecturer:

I thank you for cooperating in this study.

Please return to: zainab@fsktm.um.edu.my
Zainab Awang Ngah
MLIS Program
Faculty of Computer Science & Information Technology
University of Malaya
50603 Kuala Lumpur.

APPENDIX 4: LIST OF RANKED JOURNALS WHICH ACADEMIC ENGINEERS AND SCIENTISTS USED TO PUBLISH THEIR ARTCLES

Journal Titles which Published Five or More Articles by Academic Engineers

ACI Materials Journal (American Concrete Institute)
AEESEA Journal of Engineering Education (Association of Engineering Education in Southeast Asia)
Asean Journal of Science & Technology for Development
Building Technology & Management
Bulletin MSSST (Malaysian Solid State Science & Technology)
Bulletin of the Institute of Engineers Malaysia
Bulletin Science and Technology Malaysia.
Cement and Concrete Research : an International Journal
Chemical Engineering Science
Computing and Control Engineering Journal
Control & Instrumentation
Desalination
Drying technology
Electronics Letters
Geotechnical Engineering
IEE Proceedings: Part C
IEE Proceedings: Part J
IEEE Transactions
Industrial Engineering (IIE Solutions)
International Journal of Control
International Journal of Electrical Power Energy Systems
Journal Molecular Catalysis
Journal of Chemical Technology & Biotechnology
Journal of Computing in Civil Engineering
Journal of Electronics and Control
Journal of Industrial Technology
Journal of Mechanical Engineering Science
Journal of Physical Science
Journal of the American Oil Chemists' Society
Journal of the Institute of Chemical Engineers Malaysia
Journal of the Institution of Mechanical Engineers
Jurnal Fizik Malaysia
Jurnal Kejuruteraan (Universiti Kebangsaan Malaysia)
Majalah Persatuan Kejuruteraan Kebangsaan Malaysia
Mechanical Engineering
Microelectronics Journal
Newsletter of the Malaysian Institute of Chemical Engineering
Pertanika
Photogrammetric Engineering & Remote Sensing
Plastic News
Plastics Industry News
Remote Sensing of Environment
Sains Malaysiana
Soils and Foundation
Solid Waste Management Research
Technology

Journal Titles Used which Published 5 or More Articles by Academic Scientists

Acta Crystallographica
Acta Horticulture
Asia Pacific Journal of Molecular Biology & Biotechnology
Bryologist
Bulletin of Environmental Contamination & Toxicology
Bulletin of Solid State Science & Technology
Bulletin of the Geological Society of Malaysia
Bulletin of the Mathematical Society of Malaysia
Bulletin of the Singapore National Institute of Chemistry
Elaeis
Hydrobiologia
Journal Chemical & Crystallography
Journal Crystallographic & Spectroscopic Research
Journal Molecular Catalysis
Journal of Applied Polymer Science
Journal of Colloid and Interface Science
Journal of Natural Products
Journal of Organometallic Chemistry
Journal of Physical Science
Journal of Physics B
Journal of Solid State Science & Technology
Journal of Southeast Asian Earth Science
Jurnal Fizik Malaysia
Jurnal Matematik UTM
Malaysian Applied Biology
Malaysian Journal of Science
Malaysian Naturalist
Malaysian Nature Journal
Menemui Matematik
Microbiology & Immunology
Mycological Research
Mycotaxon
Natural Product Letters
Nature Malaysiana
Pertanika
Phyochemistry
Physics Letters
Physics Review
Sabah Museum Journal
Sains Malaysiana
Singapore Journal of Physics
SEA Journal of Tropical Medicine
Tetrahedron Letters
Transactions of the Malaysian Society of Plant Physiology
Tropical Biomedicine
Wallaceana
Warta Geologi

APPENDIX 5: Abstracts of Articles Published

Malaysian Journal of Library & Information Science, Vol.4, No.1 July 1999: 73-110

ELECTRONIC SUPPORT AND RESEARCH PRODUCTIVITY: THE CASE OF ACADEMIC ENGINEERS AND SCIENTISTS

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ABSTRACTS:
Compares the frequency of eleven types of computer use with the publication productivity of 83 academic engineers and 239 academic scientists from University of Malaya and National University of Malaysia. The data was collected from two sources. A self-administered ques-tionnaire was used to obtain demographic data, their opinion on the adequacy of the com-puter facilities made available for them and the types of use they made of the computers for research purposes. Data on the total number and type of publications authored was obtained from the questionnaire, and the annual reports of academic staff publications for the years 1990 to1995. The results revealed that the majority of both academic engineers and scientists made frequent use of computers for research. However, the scientists indicated a more varied use than the engineers. Both groups reported frequent use of computers for word processing (83% to 90%), sending or receiving e-mails (66% to 71%) and searching for information in the Internet (41% to 51%). Computers are least used for keeping personal bibliographical indexes (8% to 11%). For the academic scientists, the total publication productivity is correlated (≤0.01) to using computers for creating databases, word processing, slide presentations, sending or receiving emails, obtaining information from the Internet and maintaining personal bibliographical indexes. For the academic engineers the total publication output is not correlated with frequent use of computers for research, although the mean score for each type of computer use is high. The frequency of computer use is also related to such factors as respondent's department, age, work experience and academic rank.

Keywords: Publication productivity; Academic scientists; Academic engineers, University of Malaya, National University of Malaysia; Computer use; Electronic support in research.

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PERSONAL, ACADEMIC AND DEPARTMENTAL CORRELATES OF RESEARCH PRODUCTIVITY : A REVIEW OF LITERATURE

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ABSTRACT:
Reviews published sources on research productivity under two broad categories, general measures of research productivity and correlates of publication productivity. The latter cover studies on three broad determinants comprising (1) personal, (2) academic, (3) and departmental correlates considered to be related to academic publication productivity.

Keywords: Research productivity; publication productivity; correlates of productivity, scientometrics.