THE MANAGEMENT OF TECHNOLOGICAL INNOVATION IN SMALL AND MEDIUM SIZE FIRMS IN CYPRUS

A thesis submitted for the degree of Doctor of Philosophy

by

ATHANASIOS HADJIMANOLIS

Department of Management Studies, Brunel University

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ABSTRACT

The factors affecting innovation have been largely investigated in the context of industrialized or large developing countries. Innovation is, however, equally important for small developing countries also. It is argued in this thesis that the context of innovation in such small economies is sufficiently different to justify research into the relative potency of factors influencing innovation and the practice of innovation management. These differentiated innovation practices will also have repercussions for the national innovation policy of a small developing country.

The present research was conducted in Cyprus, a small developing country. A large number of manufacturing small and medium sized firms (n =140), were surveyed, during 1995, via a questionnaire administered during personal interviews with the firms' owners or managers. The survey was complemented with more extensive case studies of a subset (n = 25) of the survey sample of firms. A research model based on the antecedents approach was used in the survey research and the data were subjected to various statistical analyses including multivariate techniques.

The results indicate that the SME owner/manager plays a central role in innovation, influencing directly and indirectly the main variables affecting innovation. From the multivariate analysis these factors include: strategy, expenditure on R&D, cooperation with external technology providers, use of technological information sources and overall performance of the firm. The case material supports in general these findings and also emphasizes the importance of government policies for innovation. The importance of networking for innovation was partially confirmed, in terms of the cooperation with technology and information providers. However contrary to expectations and literature claims, horizontal networking (cooperation within the sector) was not found important for innovation.

Based on these results a number of practical suggestions are offered to both industrial managers and policy makers. It is believed that these suggestions are relevant, not only for Cyprus, but also for other small developing countries.

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ABBREVIATIONS

AMT	Advanced Manufacturing Technology
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CDB	Cyprus Development Bank
CNC	Computer Numerically Controlled
GDP	Gross Domestic Product
ITA	Industrial Training Authority
MIRP	Minnesota Innovation Research Programme
MOT	Management of Technology
NIP	National Innovation Policy
NIS	National Innovation System
NTBSF	New Technology Based Small Firm
O/M	Owner/Manager
R&D	Research and Development
SME	Small and Medium Size Enterprise
SDC	Small Developing Countries
SMTI	Strategic Management of Technological Innovation
SNIS	Strategic National Innovation System
TS	Technology Strategy

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The study of innovation is a fascinating subject. It is even more interesting in the context of a small developing country such as Cyprus, where the environment for innovation is less than friendly. During the long period of the research for this thesis, I had the opportunity to learn about the experiences of many people regarding innovation and its management through interviews and informal exchange of views. Small and medium enterprise owners and managers, government and trade association officials and many others, too numerous to be mentioned by name, have contributed to this study. I thank them all for their time and courtesy.

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CHAPTER 1

1. Introduction

1. 1 Innovation and the Techno-Economic Trends of the 1990s

Each period in human history is characterized by a number of *trends* in business and the economy that influence the development of new theories and explanations which try to account for them. The trends themselves are also, however, shaped to some extent by the new concepts of the theorists. Such trends in the last few years include fast technological change, globalization of markets, growth in the cooperative behaviour among firms, and the 're-discovery' of the importance of small firms (Freeman and Hagedoorn, 1994). New technologies such as advanced manufacturing techniques have changed the production capabilities of firms, especially small ones (Leicht and Stockman, 1993). At the same time communication and transportation technologies together with new socioeconomic institutions (e.g. international trade agreements) have reduced the barriers in the movement of goods, information and people (Freeman, 1995). The global dimension of competition is having more effect on developing countries, and especially small ones with a predominance of small firms (Kaplinsky, 1994).

Technology has today assumed a much more important role, than in the past, in business, economy and our everyday life (Steele,1989). Modern technology is characterized by rapid change (i.e. shorter life-cycles of specific technologies) and increases in its complexity and specialization (Patel and Pavitt, 1994). There is also much debate about the increasing mobility of scientific and technological activities, and of finance and production as well, and the repercussions and causes of this mobility (Fransman, 1995).

Freeman and Perez (1988) discuss the emergence of a 'new techno-economic paradigm' based on microelectronics that has revolutionized the world economic scene. By 'techno-economic paradigm' they mean a bunch of related technologies (microelectronics, but also computers and telecommunications) which are both enabling and pervasive. The latter term suggests that they have penetrated almost all economic sectors (not only the various branches of manufacturing, but also services). The term 'enabling' refers to their significant impact on production costs, economies of scale and labour requirements which enable firms to enter new markets, introduce new products or improve product quality. The new techno-economic paradigm is slowly diffusing throughout the globe and is one of the causes of the above mentioned trends.

New technologies based on microelectronics, but also on other disciplines (e.g., biotechnology) require increasingly larger scales of investment, which are beyond the means even of the largest multinationals (Twiss and Goodridge, 1989). This trend has led to increasing inter-firm collaboration on a global scale in order to share the high costs of research and development (Freeman and Hagedoorn, 1994). At the same time the new techno-economic paradigm has facilitated the decentralization of large firms and the emergence and cooperation of small firms by making production flexible i.e. possible at a smaller scale without much sacrifice in terms of scale economies.

Notwithstanding the trend towards interfirm cooperation, global competition is becoming more and more fierce and is increasingly based on product differentiation rather than cost (Rothwell, 1992). Technological innovation i.e. the commercialization of new products and processes which originate from new technology, but also from the successful exploitation, through creative recombination, of established technology (Coombs et al, 1987) has a central place in the efforts of business firms to compete against global competitors. This is recognized by Porter (1985) who considers innovation as an essential drive of competition in industry and a powerful competitive weapon of the firm. Similarly Manu and Sriram (1996, p.79) argue that "the contribution of innovation to corporate survival and growth is an accepted notion in much of management." The classical attention to productivity and cost control is simply no longer enough to ensure competitive success.

Innovation (especially its technological variant) has a direct impact not only on the competitive advantage of a business firm, but also on its flexibility to adapt to external threats and eventually its performance and success in the market place (Killick, 1995). Innovation is therefore a very important issue for the managers of business firms. For Drucker (1973) it is, along with marketing, one of the two most important issues. Innovation is also recognized as a major determinant of national economic growth, an 'engine' of growth as it has been called (Freeman, 1982). The success of a nation's firms in domestic and especially international markets leads to the successful performance of the national economy as well (Porter, 1990). According to Steele (1989) the desirability of innovation is universally accepted. Innovation is however a cause for concern (in the sense of not doing enough or the need to be more effective in innovation) even in industrialized countries like the USA and the UK. Technological change and innovation are also a major challenge for developing countries (Pirella et al., 1993) as they try to improve their position in the international division of economic activities.

Having briefly introduced the importance of innovation (in particular its technological component) and many of the trends associated with it, the research problem of the present thesis, which focuses on technological innovation in small firms, is introduced in the next section.

1. 2 The Research Problem

In very broad terms the research problem is two-pronged and can be stated as follows:

'An investigation of:

a): the factors affecting innovation and the methods and means used by the owners managers of manufacturing small and medium size enterprises (SME) to address technological innovation issues in the context of a small developing country (Cyprus) and,

b): the effectiveness of a resource-based strategic innovation management perspective in the research of these issues.'

It is essentially argued in the thesis that owners/managers can increase their firm's technological innovativeness and eventually its performance by concentrating on a number of important factors which have emerged from the research. Several of these factors are largely under their control, at least partially, such as external technological linkages, the proper place of innovation in their strategies (i.e. as a priority issue) and investment in innovation inputs (research and development expenditure and employment of scientists and engineers).

Since these factors cannot change overnight and they take preparation, time and investment to gradually build-up, the SME owner/manager has a central place (through his/her vision, commitment and leadership) in innovation performance. The case study research has identified <u>three</u> different types of innovation behaviour (i.e. proactive innovators, reactive innovators and non-innovators) and has examined the relationships between each type and the factors mentioned above as well as some less easily quantifiable (i.e. qualitative) ones.

Innovation at the micro-level (i.e. the level of the firm) can not, however, be isolated from the meso-level i.e. the position of the firm in relation to other firms and institutions and the interactions with them (i.e. the firm in a network approach) and eventually the macro-level i.e the economy at the national level and beyond (that is the supranational aspects). It will therefore be argued that in a small developing country like Cyprus, the effect of National Innovation Policy on local firms is more important than the corresponding effect in large countries.

The theoretical perspective in this thesis combines these micro-, meso-, and macro-, approaches, in that it incorporates:

i) the management of innovation at the level of the firm including strategic management and incorporating innovation theory and models,

ii) networking theory

iii) small and medium size enterprises (SME) and innovation, and

iv) the National Innovation Policy (NIP).

The research therefore adopts an integrative and managerialist outlook. Such an approach is recommended by other researchers e.g. Miller and Blais (1992, p.365), who suggest a "holistic and integrative approach that transcends disciplines and issues" as more appropriate for this type of research.

A list of the broad research propositions is presented below. They are established in more detail in Chapter 2 through the literature survey. These propositions are further developed analytically and tested against the survey data and case study material in Chapter 5.

Research Propositions

1. *The peculiar nature of a small developing economy influences the technological capabilities and innovation practices of its predominantly small firms.*
2. *The national innovation policy influences the innovativeness of firms.*
3. *Innovativeness of firms varies in the various sectors.*
4. *Innovativeness is influenced by the characteristics of the SME owner manager.*
5. *Innovativeness is influenced by the characteristics of the firm (SME) .*
6. *Innovativeness is influenced by environmental factors external to the SME.*
7. *Innovativeness is affected by the entrepreneur's perception of external barriers to innovation.*
8. *Innovativeness affects positively the performance of firms.*
9. *Different innovation 'strategic postures' imply different innovation practices.*
10. *Innovativeness is influenced by the level of the networking of the firm.*

1. 3. Justification for the Research.

Innovation as a subject of study has received a lot of attention from theorists. An enormous empirical research base has also accumulated, especially since the nineteen sixties. Innovation has been studied not only within the context of economics and strategic management, but also within sociology, anthropology and a number of other disciplines (e.g. economic geography and psychology).

Despite this vast research effort within individual discipline research traditions, and some multi-disciplinary efforts, innovation is still a controversial topic. Several theories have been proposed illuminating some limited aspects of innovation, but the many attempts to make a synthesis of the existing theories or propose a new one, have not led to a widely accepted general theory or model. Nelson and Winter (1982) have come close to such a theory. Their 'evolutionary theory' of the innovation behaviour of the firm has several worthy features and it is briefly presented in Chapter 2 as a framework for discussion. It offers however limited guidance at the practical management level. It seems that innovation is context-specific and context-sensitive (idiosyncratic) to a considerable extent (Wolfe, 1994). The innovation observer has to combine the insights from different disciplines and methodologies to get close to the understanding of the phenomenon in its specific context (Dodgson, 1993a).

The present research concentrates, as already mentioned above on the strategic management of technological innovation in the context of <u>small</u> manufacturing firms in a small developing country (Cyprus). The <u>type</u> of firm (small/large) has been suggested as an effective moderator of the predictor - innovation relationships, where predictors are sets of variables related to the firm and its environment, (Damanpour, 1991). Innovation has been initially studied in the context of large firms. Major innovations were traditionally associated with the large multinationals. Although the role of the small and medium enterprise (SME) in innovation was already recognized by Schumpeter (1943), the 'revival' of interest in SME is relatively recent. SME have been identified as important innovators in such high technology fields as computers and biotechnology (Rothwell, 1991) but also instruments and other sectors.

Most studies of innovation for large or small firms have been made in the context of industrialized countries, such as USA, UK, France or Germany. More recently some studies were carried out on technological innovation and its role in the rapid economic growth of the newly industrialized countries e.g. Korea (Enos and Park, 1988), Taiwan (Fransman, 1985). Other studies of technological innovation were made in the context of large developing countries e.g. India (Lall, 1985) or Brazil (Katz, 1984). There is still however a considerable *gap* in our knowledge of innovation, especially at the level of the firm, in developing countries ; as also Bell and Pavitt (1992, p. 271) have noticed, "we know far less about what factors affect a firm's strategies for technological accumulation or about the management of technology in developing countries". Kim et al (1993) suggest further research on SME innovation in developing countries.

The gap in the literature is even larger for small developing countries (SDC) where the existing studies are sparse. What Bell and Pavitt stated for developing countries as a group is also valid, *a fortiriori*, for the subgroup of SDC. The latter although they have a relatively small contribution to the world trade, and especially that of technologically intensive goods, in absolute terms, they have however a significant presence in the world scene, just by their sheer number. Detailed statistics on some SDC are presented in Chapter 3. For SDC even small improvements in their achievements in the adoption of technological innovation can have significant contributions to the upgrading of their overall poor economic performance.

In SDC small firms are not just important as complementary to large ones e.g. by supplying inputs to them as subcontractors or in other roles of coexistence. SME are the dominant force in the industrial fabric of SDC. Although SME in developing countries are very rarely, if ever, the pioneers in new technological fields as e.g. small biotechnology firms in USA, technological innovation is still important for their survival and growth. In this case technological innovation implies adoption of new production methods or development of improved products rather than first-to-the world innovations. Admittedly the term technological innovation has to be used more liberally i.e. extended to less novel forms in this case.

It is hypothesized in this thesis that smallness (of firms and countries) has a number of significant implications for the process of innovation and technological development. Furthermore it is argued that the success factors for innovation have a different potency in the specific context of small developing countries.

The empirical test-ground for the research, i.e. Cyprus is a small developing country. The economy of Cyprus, as explained in more detail in Section 3.1, is now at a critical juncture due, not only to the Customs Union with the European Union and the preparations to become a full member, but also the open trade environment of the 1990's. Under these conditions technological innovation undertakes a particular significance for the upgrading of the manufacturing sector. The successful management of technological innovation at the firm level is currently a lively topic among Cyprus industrialists.

1.4 Methodology

The methodology which is used to test the research propositions is presented briefly here. This is only an introductory overview since the research methodology is presented in detail in Chapter 4. Reference to methodologies used in innovation research is also made in the Literature Review in Chapter 2.

Innovation is a very complex subject without a single generally accepted theory, as already discussed above, therefore no single method is adequate for the study of innovation at the level of the firm. Previous research has identified various sets of variables which affect the innovation behaviour of the firm and has tried to operationalize these variables in a number of ways in order to evaluate their effect in each specific case. Therefore a quantitative survey method based on an extended questionnaire has been used in order to measure sets of relevant variables.

The pilot-tested questionnaire was used in face-to-face interviews with a sample of 140 firms in five manufacturing sectors (the firms were mainly SMEs, but 20 large firms were included for comparison purposes). The relative and combined explanatory power of the main sets of variables has been evaluated by application of multiple regression analysis. Contingency analysis, analysis of variance and correlation analysis have also been used for testing of particular hypotheses. Factor analysis is used to identify underlying constructs and provide parsimonious categories of behavioural responses for the SME owners/managers regarding particular aspects of innovation. Finally, discriminant analysis classifies the firms into innovative and non-innovative categories identifying the main discriminating variables and their relevant discriminatory power in predicting innovativeness.

Although the above multivariate statistical analyses provide some illumination of the complex interactions of the many variables involved in innovative behaviour they are inadequate to give a full account of the complexity of the innovation behaviour in the particular context. Innovation, being a social process with complex human interactions, demands also a qualitative research approach in order to get a rich picture of the situation.

A conscious attempt was made to combine various methods for research of management issues as recommended by many authors (e.g. Bryman,1989 - Easterby and Smith,1991). Qualitative multiple case analysis is therefore used in order to illuminate the research findings of the survey and provide richer explanations for the correlations found and to account for any unexpected findings. Twenty five (n = 25) cases are used which are actually a subset of the 140 firms which have been investigated with the survey method. As explained in Chapter 4 other researchers have used a similar combination of methods for triangulation of data and better explanation of the phenomena under study (e.g. Lall et al., 1994).

The subjects own meanings and interpretations of innovation related behaviour are presented in the case studies and the perceptions and attitudes of managers are recorded and analyzed. Based on case study data a taxonomy is developed of the case firms into three categories (proactive, reactive innovators and non-innovators). This taxonomy illustrates better the characteristics and practices related to innovative behaviour.

1. 5 Outline of the Thesis.

The structure of the thesis can be briefly described as follows:

CHAPTER 2	provides a comprehensive survey of the relevant research literature.
Section 2. 1.	defines innovation and proposes a classification scheme of innovation research traditions.
Section 2.2	deals with the macro-view of technological innovation theory concentrating on the economics of technological innovation and special topics like national innovation systems and national innovation policy. Innovation in developing countries and the special case of Small Developing Countries is discussed at some depth.
Section 2. 3	introduces and evaluates the main models of innovation.
Section 2. 4	provides the micro-view of innovation theory concentrating on the innovating firm. The research on the innovative behaviour of the firm is discussed with emphasis on the antecedents approach. The strategic management of innovation is treated separately as an important topic followed by, discussion on innovation in small firms.
Section 2 5	introduces various aspects of network theory and particularly looks to strategic innovation networks as related to small firms.
CHAPTER 3	concentrates on Cyprus which provides the context for this thesis as a case study for small developing countries.
Section 3. 1	discusses briefly the socioeconomic characteristics and the place of Cyprus in World Economy.
Section 3 2	concentrates on the manufacturing industry of Cyprus and provides brief profiles of the sectors which were the objects of study of the survey research.
Section 3. 3	deals with industrial development, science and technology activities in Cyprus and the National Innovation Policy.

Structure of the Thesis (continued)

CHAPTER 4	presents the research methodology.
Section 4. 1	outlines the survey research methodology.
Section 4. 2	describes the case study methodology.
Section 4. 3	presents the methodology used for interviews with officials.
Section 4. 4	outlines the ethical considerations in the research.
CHAPTER 5	This chapter presents the analysis of data.
Section 5. 1	gives the descriptive analysis of the survey research data and the testing of hypotheses.
Section 5. 2	presents the qualitative research (case studies)
Section 5 3	deals with interviews with government and other officials.
CHAPTER 6	Summarizes the conclusions and implications.
Section 6 1	provides a link to previous chapters
Section 6. 2	presents an extensive discussion of the research results in comparison to results from the literature
Section 6 3	highlights some limitations of the research of this thesis.
Section 6 4	provides the main conclusions about the research problem.
Section 6 5	discusses the implications for theory and methodology and offers some practical implications and recommendations for managers of SME and public policy makers.
Section 6. 6	makes suggestions for further research.

1. 6 Definitions of the Main Concepts.

Some of the main concepts are defined in this section in order to clarify the research problem. Although these concepts are also examined in the literature survey where alternative definitions from various authors are presented and evaluated, the definitions presented here are meant to serve as guidelines to reduce the ambiguity which accompanies some of the concepts.

Technology "refers to the theoretical and practical knowledge, skills and artifacts that can be used to develop products and services as well as their production and delivery systems" (Burgelman et al, 1996, p. 2).

Technological Innovation is defined as the "transformation of an idea into a new or improved saleable product or operational process in industry or commerce ..." (OECD,1981, cited in Roy, 1986, p.2).

Innovativeness is defined, for the purposes of this study, as the development or adoption of technological innovations (i.e. both new products and process innovations) by the SME over a specified period of time (three years prior to the year of the survey). The concept of innovativeness and its operationalization is discussed in Chapter 2 (Literature Survey) and Chapter 4 (Methodology) in detail.

Strategic Innovation Management is the "process by which organizations formulate and implement strategic technological change" (Clarke and Thomas, 1989, p. 275).

Small and medium sized enterprises (SME) for the purposes of this study are firms with up to 100 employees. Firms with up to 50 employees are small, while those with 51-100 employees are medium. Firms with over 100 employees are considered large. Detailed justification for the selection of this definition of SME for the Cyprus context is supplied in Section 3.1 (about Cyprus), while various definitions of SME and their implications are discussed in Section 2. 4.

Small Developing Countries (SDC) are those developing countries [as defined by the U. N. publications with GDP (Gross Domestic Product) per capita as criterion] which have less than 10 million inhabitants (Streeten, 1993, p.197). This definition is discussed and justified in Section 2.2.5.

1. 7 Conclusion

This introductory chapter serves as a plan for the thesis. It has introduced the research problem and identifies the major research propositions. The research was justified in terms of theory and practical significance and an outline of methodology was presented. The definition of the main concepts clarified their use in the research context.

CHAPTER 2

2. Theory of Technological Innovation

Chapter 1 (Introduction) has set out the research problem and the main research propositions. In Chapter 2 the relevant literature is reviewed and evaluated, while the research propositions are developed in connection to gaps in the literature or controversial issues. This review is structured in a perspective ranging from macro to micro (including the individual) and finally the meso-level which is linked to the previous ones

2. 1 Innovation Studies

2. 1. 1 What is Innovation ?

Innovation has been defined in many different ways by the various scholars who have studied this phenomenon according to their discipline (Economics, Sociology, Management) and their theoretical viewpoint. Innovation is defined either in terms of the innovation process or in terms of its output. Three examples of the innovation process type, which is the most usual, are quoted here:

> "Innovation is defined as the development and implementation of new ideas by people who over time engage in transactions with others within an institutional order."(Van de Ven , 1986 p.590).
>
> "Innovation is the search for and the discovery, development, improvement, adoption and commercialization of new processes, new products and new organizational structures and procedures." (Jorde and Teece, 1990, p. 76).

"Innovation is defined as the adoption of an idea or behaviour, whether a system, policy, program, device, process, product or service, that is new to organization" (Daft, 1982 ; Damanpour and Evan , 1984 as cited in Damanpour, 1992, p. 376).

In the second meaning of output the new product or production technique itself is defined as the innovation. Nelson and Winter (1982) for example define innovation as "the new products or services, new processes, and new organizational structures that firms use to compete with one another and meet customer demand."

The present study concentrates on a particular type of innovation i.e. the technological innovation. A commonly accepted definition is the OECD,1981 one already quoted in introduction (Ch.1). There are many other definitions, but most emphasize the following facts: a) that technological innovation is something different from invention, although it may be based on invention b) that it incorporates the feature of novelty, and c) introduction to market (and the profit motive) is an essential element of it.

Technological innovation is to be distinguished from administrative or organizational innovation which refers to the introduction of new procedures, policies and organizational forms As, however, Van de Ven (1986) rightly notes making a distinction between the two types of innovation often results in a fragmented classification of the innovation process since most innovations involve both new technical and administrative components and frequently a technological innovation can not succeed without simultaneous organizational innovations.

Classification of Technological Innovation

Technological innovation has been classified in a number of ways. The most common is the classification into product and process innovations. Product innovations refer to new products introduced commercially to meet a user or a market need, while process innovations "involve the equipment, methods and systems employed to produce the products" (Biemans, 1992, p.10). Another important typology is the distinction among incremental (or routine) and radical (breakthrough, fundamental or basic) innovations.

The later refer to innovations with a major economic impact which frequently create new industries destroying at the same time old ones. Such basic innovations according to Mensch (1975) are for example: steam engines, penicilline, gasoline motors, rockets and semiconductor technology. Incremental innovations according to Burgelman et al (1996, p 2) involve: "the adaptation, refinement, and enhancement of existing products and services and/or production systems". The above separations may not be complete and may depend on the sector considered (Coombs et al, 1987).

The Process of Innovation

Most writers refer to the process of innovation. Actually the definition of Van de Ven (1986), which has been quoted above, introduces the time scale (i.e. evolution of innovation over time) The innovation process can be defined as "the combined activities leading to new marketable products and services and /or new production and delivery systems" (Burgelman et al, 1996, p. 2). Innovation is considered to take place in a number of stages or phases which are more or less clearly discernible and in a specified time sequence

The classification by stages is a controversial issue and there are many models which depict various stages Some of these models and their merits and problems are discussed in more detail in Section 2.3. They are nice conceptually but have a number of limitations. As an example of classification that proposed by Damanpour (1991) is mentioned at this point. He distinguishes three stages i.e. Initiation, Development and Implementation. Each stage can be further subdivided to substages.

The innovation process is described as uncertain, complex, frequently unpredictable and difficult to model or explain. The uncertainty is caused by the fact that both technology and market are changing over time. The process is also iterative and concurrent rather than unidirectional and sequential. The features of innovation process are further discussed in the following.

2. 1. 2 Innovation Research Traditions

Innovation research splits into two areas of inquiry according to Adler (1989) i.e. the Economics oriented tradition which examines differences in the patterns of innovation across countries and industrial sectors, the evolution of particular technologies over time and intra-sectoral differences in the propensity of firms to innovate. The second is the organizations -oriented tradition focusing at the enterprise level (micro-level).

There is however considerable work in the economics tradition concentrating on the innovation at the enterprise level. The above classification is therefore less than perfect, unless one includes the latter in the 'organizations -oriented' work. This is what will be done here. For the purposes of this thesis the organizations-oriented tradition is the most relevant one The economics-oriented tradition (macro-research) provides however a useful background, a number of necessary concepts and viewpoints and the broader picture of which the organizations oriented research is a hard to separate piece.

According to *Guerrieri and Tylecote (1994, p. 50) the performance of firms in general* and therefore innovation performance by deduction, depends "not only on successful management practices by entrepreneurs but, to a large extent, also on the structural features of the sector and countries in which they operate".

Based on the above discussion a simple analytical schema is developed (Fig. 2.1) which will serve as a guide in the Literature Review. This is not meant as a definitive model, but rather an illustration of the structure of this work and an orientation aid in the compex structure of the macro- to micro- spectrum.

Innovation Research

The Economics-based Research Tradition	The Organizations-based Research Tradition
History and Development of Innovation	The Innovating Firm
Diffusion of Innovation	Antecedents Research
Technology Transfer	Innovation Determinants
Innovation and Competitiveness	Process Research
National Innovation Systems	Strategic Management of Innovation
National Innovation Policy	The Innovating Small Firm
Innovation in Developing Countries	Research on Innovation in Small Firms in Developed Countries
The Special case of Small Developing Countries	Research on Innovation in Small Firms in Developing Countries
Innovation Models	Strategic Innovation Networks

Fig. 2.1 Classification Model for Innovation Research

Source. Adapted from Adler (1989)

2.2 The Economics Based (Macro) Research Tradition

2.2.1 Development of Innovation Studies

The history and development of Innovation Studies is closely related to the economics - oriented tradition and is briefly summarized in the following. The classical economic theory, although considering technology as an important force in economic growth, views it as largely *exogenous* to the economic system. It also makes a number of unrealistic assumptions (Coombs et al, 1987) about technology. It assumes for example perfect information and equal technology available to all firms. The economic system is assumed to be in equilibrium adjusting to small disturbances. Any case study analysis (e.g. Allen et al,1983) shows that firms have different combinations of resources and information sources

It was Schumpeter (1942) who proposed the idea that innovation induces major changes in the economy. He referred to the 'creative destruction', caused by basic innovations, as shaking and redefining an existing equilibrium. For Schumpeter technological change is a very important component of economic development. In his early work (Schumpeter, 1934) he concentrated on the role of the entrepreneur who introduces an innovation undertaking the risk and expecting the large profits of a temporary monopoly position. The entrepreneur establishes a small firm which takes on the role of transferring to market new ideas and inventions largely exogenous to the firm. (Molero, 1996).

In his latter work Schumpeter concentrated on the role of institutionalized research and development effort of large firms in innovation. This corresponds to the endogenization of innovation with reference to the firm (Capitalism, Socialism and Democracy -Schumpeter, 1942). The two sets of ideas of Schumpeter are sometimes called Mark I and Mark II. Mark II is close to the 'technology push' hypothesis of the origin of innovations i.e. innovations originate from the Research and Development (R&D) effort within firms and research institutions (i.e mainly corporate activity).

The ideas of Schumpeter lead to questions about the ideal market structure for innovation (i.e. many entrepreneurs-small firms or a few large oligopolists), and the related one of the optimal size of firms for innovation (i.e. small size entrepreneurial firms or large, resource rich firms). These two questions are central problems of innovation and points of controversy. While the former is beyond the scope of this thesis, the latter is further discussed in Section 2.4.

Schmookler (1966) concentrated on the importance of demand forces as determinants of inventive and innovative activity. His historical time series studies provided support for the importance of demand. His work is usually associated to the 'demand pull' hypothesis of the origin of innovation. The relative importance of the technology push versus demand pull as the origin of innovation is another major controversial matter in the theory of innovation. It is not further considered here as it is not of immediate relevance for this research.

The neo-Schumpeterians have followed an evolutionary approach to economic growth and the role of technical change and innovation in it. Nelson and Winter (1977) for example have proposed a theory based on Schumpeter's ideas and the behavioural theory of the firm which is in the broad tradition of the evolutionary economics. They view the firm as operating in a dynamic selection environment and being not a profit maximizer but a satisficer Firms follow some decision rules and if these rules fail to meet their targets they try to change them through a local search i.e. by exploring techniques similar to those they or other firms in their industry are using.

Technical change and innovation, unlike other produced commodities, contain or require a significant degree of tacit knowledge (i.e. knowledge which cannot be simply codified and transferred through formal channels, but must in part, consist of accumulated experience and skills acquired through practical experience). The process of searching of firms leads to a gradual change in the state of industry and eventually the economy. The implications of the theory of Nelson and Winter for the firm itself are further discussed in Section 2. 4 which concentrates on innovation at the firm level (micro-level).

Industries (or sectors) also vary regarding the degree of the rate of technical change. Technological opportunities and demand growth differ then among industries. The potential of each industrial sector depends therefore on the interaction of the technological opportunities and demand. Technical change leads to structural change within the sector. The sectoral dimension of innovation has been discussed by many authors e.g Pavitt, 1991 for manufacturing and Dickson et al, 1993 for services. The importance of sectoral differentiation in the case of small countries is questioned in Section 2.4.1

The view that technical change is not uniform across sectors and it acts through structural change rather than directly has led to studies trying to identify patterns in the interaction of industries, technologies and markets and eventually patterns of growth. For example Abernathy and Utterback (1978) and Tushman and Anderson (1986).

It has been suggested that the world capitalist economy has gone through a series of alternating phases of accelerated and decelerated growth, in other words, through cycles or long term waves lasting 20-30 years. This is the Kondratiev's long wave theory (Hall, 1981) Neo-Schumpeterians as Mensch (1975) and Freeman (1982) have attributed the emergence of the accelerated growth phase of the cycle to 'clusters of innovation'. Freeman (1988) has introduced the related concept of 'New Technology Systems' i.e. technologies widely applicable to many products and processes in many industries (generic or enabling technologies as mentioned in Section 1.1) which generate a range of related innovations. He argues that the clustering of the diffusion processes for these innovations is the most important stimulus to the long wave upswing. New technologies can form a paradigm which pulls together technology and related institutional structures (training programmes, labour market structures, government policies towards industry).

The current long wave (fifth Kontratiev) is associated with information technology. The latter which is a broad term including microelectronics, telecommunications and advanced manufacturing technology has permeated several industrial sectors and revolutionized even mature industries such as textiles and paper. The long wave theory is controversial especially regarding the exact beginnings of a new long wave. It may provide a conceptual scheme for the historical review of innovation, but has limitations in the discussion of present and especially future trends. The discussion now turns to the process of permeation or diffusion of innovation throughout an economy.

Diffusion of Innovations

Rogers(1983, p.5) defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system". The four fundamental elements of diffusion are then:

- I) The innovation which diffuses.
- II) The population of potential adopters (and their process of decision making) .
- III) The flows of information about the innovation between manufacturers and adopters.
- IV) Time

Diffusion was initially studied among populations of individuals i.e. how farmers or doctors adopt particular innovations. Later diffusion of innovations among organizations was being addressed. Organizations were, however personified in most of these studies (i e they were treated as similar to a single individual). Diffusion can be considered as a stage in the innovation process. It is further a process by itself. Several models have been proposed for the diffusion process. The classical one is the epidemic model (S- curve).

More recent theories see diffusion as part of the socioeconomic development in particular social systems Freeman (1994) emphasizes the systems aspect of diffusion. Innovations are usually not isolated, but as already discussed above form part of a new technology system i e there is complementarity among related innovations e.g. computers, peripherals and software systems. Diffusion research has shown that rates of diffusion vary by product, system and country. Some aspects of the country effect are considered in Section 2.2.4.

Diffusion through its association with epidemics is sometimes considered as a more or less automatic process, implying a passive attitude on behalf of the adopters. Both the supplier and the recipient (adopter) can, however, have an active involvement and then we speak about technology transfer. Organizational adoption includes a learning process, and in many cases adaptation of the innovation.

Technology Transfer

Technology transfer can be considered as the active spread of technology. More formally it can be defined as "the set of activities and processes whereby technology is passed from supplier to user or from one user to another" (Bessant and Rush, 1993, p.79). Technology transfer can be considered as a more narrow concept than diffusion. The latter includes both the planned and the spontaneous spread of innovation. The term transfer may be somewhat misleading since it may be interpreted as meaning that technology is something concrete like a physical object that can be passed from the supplier to the recipient, while in most cases it involves a long process of cooperation and mutual learning and possibly adaptation for the eventual utilization of technology. It is therefore a two-way adaptation process (Bessant and Rush, 1993).

Technology transfer has received a lot of attention in both economics (mainly in development economics) as an essential factor in the economic development of nations (North-South technology transfer, Stewart, 1992) and in management which concentrates on the transfer of specialized know-how from an enterprise to the other (both on domestic and on international scale.)

Mechanisms, institutions and policies for technology transfer can be better investigated with the aid of a model for technology transfer such as the relationship model. This model distinguishes between phases of technology transfer with transfer of embodied technology, disembodied technology and eventually capacity transfer as evolutionary phases or stages of the process. Embodied technology is that taking the form of machines and tools or materials i.e. essentially the hardware. Disembodied technology can be defined as the programme or set of rules and decisions that drives a firm's processes i.e. the software. The latter is more difficult to transfer due to possible differences of language, culture, hierarchical patterns and reward structures between the supplier and the user of the technology. Capacity transfer can be defined as "the transfer of all the knowledge of how to reproduce from scratch similar plants and facilities" (Dollinger, 1995, p.137). Capacity transfer as the highest stage in technology transfer involves a lot of learning, investment in technology inputs and mutual adaptation of supplier and user.

Robinson (1988 p.17) provides a similar but more detailed classification of technologies in technology transfer. These are: user technology, productive/adaptive technology, manufacturing technology, design modification transfer and design transfer. Technology transfer, if successful, leads to the increase of productivity and the potential to innovate and eventually of competitiveness of individual firms and of national economies as aggregates of firms. The discussion continues with the issue of the link between innovation and competitiveness.

Innovation and Competitiveness

International competitiveness depends on a nation's capacity for technical innovation in anticipation of (or in response to) changing market requirements and technological trends (Pavitt, 1980). Competitiveness, in the sense used here, refers to the ability to successfully offer products or services in an open trading system, in exchange for income, despite others who offer similar products or services (Davis, 1994). The openness of the trading system places particular importance to the international dimension of competitiveness

While the classical economic theory emphasized the importance of factor endowments and fixed national comparative advantage the newer growth theories emphasize the dynamic comparative advantage. Technology (and technological innovation in particular) is an important determinant of this advantage. The empirical examples of Japan and the newly industrialized countries of East Asia e.g. Korea and Taiwan provide support to these theories.

New growth theories (Romer, 1990 - Grossman and Helpmann 1992) relax the assumption of considering technological progress as a pure externality and model innovation as the outcome of deliberate efforts by firms (Fagerberg, 1995). Competition is also no longer assumed 'perfect' and the market power due to the imperfect competition secures that the fixed costs necessary to develop new products and processes can be covered. New technology although viewed as a private good has also a public good component (externality) that provides a feedback to the capability to continue to innovate in the future. The latter ensures the continuity of innovation and growth.

The theories that have just been discussed draw on the ideas of Schumpeter (1934, 1942) . Some of his main arguments can be summarized as follows:

- Innovations originate in firms. Succesful innovating firms get economic rents due to the temporary monopoly that innovation brings to them.
- Innovation and diffusion of new technology drive economic growth.
- Economic growth drives input growth.

The central importance of the firm and its efforts in innovation is a key point. It implies that economic policies can only have an effect on innovation if they succeed to induce private firms to innovate. This issue is further dealt with in Section 2.2.3.

The above theories suggest that national differences in technological capability and innovation are determinants of structural and international competitiveness at least within the technology-intensive sector of production (Daniels, 1992), but probably in the other sectors as well Governments concerned with the international competitiveness of their countries have therefore to interfere at a strategic level to correct market failures and provide guidance. Innovation at the national level is examined in the next section, while the policy implications of the new theories of growth and innovation are discussed after that

2. 2.2 National Innovation Systems

The Nature of the National Innovation System

A national innovation system can be defined as "the network of agents and set of policies and institutions that affect the introduction of technology that is new to the economy". (Dahlman and Frishtack, 1993 p. 414). Nelson (1993) notes that all three terms (i.e. national, innovation and system) can be interpreted in a variety of ways. Innovation for example can be defined narrowly or broadly i.e. the introduction of a new product or process which is new to the world or just new to the firms that develop or adopt them. Similarly the term system may imply something that is consciously designed and built (a strategic system as defined in the following) or simply something that has emerged to the current state For Nelson (1993, p. 4) the system concept refers to "a set of institutions whose interactions determine the innovative performance of national firm". Finally the concept of a 'national' system may be too broad in the sense that the system of institutions supporting technical innovation in one field e.g. chemicals may have very little overlap with the system of institutions supporting innovation in electronics. On the other hand it may be too narrow in the sense that institutions in many technological fields are transnational in scope

From the above one could conclude that the National Innovation System (NIS) is a somewhat 'fuzzy' notion. There is a question where to place the system boundary. One way to try to determine the limits of NIS, according to Edquist and Lundvall (1993) would be to try to causally explain the invention, innovation and diffusion of technologies and let the explanatory factors define the limits of the system. Another way is to adopt a definition of NIS contributing to analytic insight.

A useful definition in this sense is that proposed by Patel and Pavitt (1994, p.79). NIS is defined as "the national institutions, their incentive structures and their competencies that determine the rate and direction of technological learning or the volume and composition of change generating activities) in a country". Although Patel and Pavitt admit that the above definition is very broad, they suggest four sets of institutions i.e: a). Business

Firms (especially innovative ones) b). Universities c). Public and private education institutions. d). Government. One should probably add to this list the institutional setup of the financial sector.

Apart of the constitutive elements of the system, the links among its components and the flows of information, finance and people are important. Edquist and Lundvall (1993) note that individual agents and organizations within NIS increase their knowledge in technical matters, not in isolation from each other, but in a process of interaction, involving learning from each other as well as developing innovations in cooperation.

Strategic NIS

NIS can be considered as a subsystem of the national political economy. At the same time it consists of a set of vertically structured and sometimes compartmentalized sectoral subsystems The basic question is however whether in an age of globalized markets the concept of NIS is obsolete and should be replaced with that of a Global Innovation System (GIS) There is indeed a global innovation system, but with distinct although interrelated national and international levels. The main reasons that GIS remains a two-tiered system and national systems maintain their importance are according to Spencer (1995) a) Inefficiencies in the markets for global innovation. b) The importance of national boundaries c) The tacitness of knowledge transfer.

In the context of a global innovation system national systems can be viewed as strategic systems in the sense that countries make conscious efforts to put in place a system that will help mainly native firms to increase their competitive advantage against foreign competitors. Spencer(1995) defines Strategic National Innovation Systems (SNIS) as: "Innovations systems comprised of institutional arrangements and resource endowments, created by institutional actors in a country and appropriable only by domestic actors".

Some of the reasons for the emergence and the continuing importance of SNIS can be summarized as follows: a) the diffusion of organizational innovations is easier within rather than across countries mainly due to sociocultural reasons (Kogut, 1991) b) the diffusion of tacit knowledge is easier within national networks of scientists, engineers and managers, and c) specialized government policies in each country aim at the creation of 'inimitable resources' for local firms. Such policies known under the collective name of 'National Innovation Policy' include discriminatory trade policies, public procurement and product standards.

There are differences among countries in the way they organize their innovative activities and they may have a strong or weak SNIS a fact which has consequences for their innovating firms. Where institutional arrangements provide incentive structures and remove barriers to innovation there is a direct effect on the innovative performance of domestic firms The divergence among national innovation systems suggests the need for a comparative approach in their study. Such an approach was followed in a research project which culminated with publication of a book on national innovation systems edited by Nelson (1993) Most studies of the project refer to industrialized countries with a couple of newly industrialized countries e.g. Korea included. These studies include some small countries like Denmark and Israel. The special problems of small NIS are discussed later in Section 2 2 5

Comparison of National Innovation Systems

Comparative studies imply that measures and indicators will be used for the comparison of NIS on a more objective quantitative basis in addition to qualitative comparisons. Such measures include technology intensive trade figures, scientific publications and patents in the innovation output size and various indicators of innovation input e.g. R&D expenditures, research scientists employed etc. The relative contribution of the public and private sectors in the latter, as well as, their distribution in the various sectors of the economy are frequently compared. Other relevant measures for NIS comparison concern general and technical education statistics, specific incentives for R&D and innovation and several others. These measures suffer from various deficiencies as objective criteria for the evaluation of specific NIS aspects and there are also problems of availability, recency and accuracy of the statistical figures. These problems are more acute for NIS measurement in small developing countries. They are further discussed for the case of Cyprus in Ch. 3.

The comparative approach to the study of NIS has led to a number of suggestions for 'best practice' national innovation systems. The recommendations of Bell and Pavitt (1992) are presented in summary form, although it should be noted that each country faces a unique set of circumstances and 'recipes of success' are of limited transferability.

I) *Importance of firms.* Most technological learning takes place in firms (due to the partly tacit nature of technological knowledge). Since firms are the main actors in innovation the NIS should be geared to the encouragement and facilitation of innovation within firms.

II) *Market structure and competitive pressures.* The firms must feel both local and international competition pressure in order to keep trying to innovate to remain competitive.

III) *Overcoming Government and market failure.* While market failure e.g. in R&D is recognized and measures are taken to alleviate its effects Government failure e.g. in 'picking winners' in innovation or in sectoral policies is less easily admitted and counteracted Government policies are further discussed in the next Section.

IV) *Government and dynamic efficiency.* Government should provide financial incentives for innovation (in view of market failure) and guarantee the intellectual property rights protection.

Other System Approaches

The national innovation system is not the only systems approach to innovation. Other 'systems' approaches or types of lens (Dodgson and Bessant, 1996) can be used, for example *technology systems* and *chains*, *clusters and complexes*. They are not further considered, apart from a brief presentation of the complexes approach, due to space limitations and because they are partly overlapping with the network approach discussed in Section 2.5.

The *complex* is analyzed as a network of relationships not only among firms of an industry (e.g. construction or food industry) but also with public sector research organizations, users and regulators (Government departments). The 'complex' approach which has been developed within the context of *small* industrialized countries (e.g. Denmark and Netherlands) is particularly relevant for the present study of small developing countries, since it gives the proper recognition to the very considerable importance of the public sector versus the private one in terms of R&D, but also technology diffusion, regulations, and public relations (Dodgson and Bessant, 1996).

2.2.3 National Innovation Policy

National Innovation policy, a key component of a National Innovation System as discussed above, is an important determinant of innovation. In this study it is argued that NIP is of even more importance in the context of small developing countries, despite the fact that it is a new concept for many of them and has not received so far due attention. The role of National Innovation Policy (NIP) is discussed in this section and a specific example of such a policy, NIP for Cyprus as a case study, is considered in Ch.3.

The Concept of NIP

National Innovation Policy (NIP) can be considered as a conscious effort by Government to coordinate the components of a National Innovation System, and promote their links. Thus NIP has both theoretical and practical significance.

National Innovation Policy is according to Rothwell and Zegveld (1985, p.83) "a fusion of science and technology policy (STP) and industrial policy (I.P)". STP includes policies on the patent system, technical education and the promotion of basic and applied research, while I. P. includes the taxation policy (in relation to manufacturing), investment grants, industrial restructuring etc

Rothwell (1986) defines both components of NIP by listing some of the main aspects of each policy In reality, while for STP there is more or less a consensus on its content, this is not the case with Industrial Policy. The latter according to Weiss (1988) can be approached from a variety of perspectives and economists, according to their intellectual leanings (Neoclassical, Radical etc), have focused on different areas of policy (e.g. treatment of foreign trade, use of direct controls etc.)

According to the above definition NIP is a horizontal i.e. an integrative concept. A policy much broader than STP cutting through economic sectors and government departments, while being itself aligned with development planning and the general economic policy. Ideally NIP should include all factors and policies which contribute to the national innovation capacity.

The Need for NIP

There are many arguments for and against government intervention in the economy in general and in the innovation process in particular. The 'non-interventionist' approach (laissez faire/laissez innover) is identified with the neoclassical economic philosophy with its emphasis on 'free market' forces (Joseph, 1984). The other extreme would be a command economy with detailed prescriptions for output (Bessant and Kaplinsky,1995). The intermediate position is some kind of intervention. Without getting into detail in such a complicated issue, it seems that the majority of experts are in favour of an active NIP (Cowling and Sugden, 1993 - Enos and Park, 1988 - Lall, 1992 - Sharp and Pavitt, 1993) and in practice, even in countries e.g. UK and USA with a 'free market' economic policy, some type of NIP is used (Rothwell, 1986)

The main arguments for intervention can be summarized as follows:

- Market Failure refers to the fact that private rates of return due to high risk, uncertainty or 'externalities' may be sufficiently low to deter private investment in areas of crucial long-term national interest (while the social rates of return would be much higher (Rath, 1990). This argument gets even more force in the context of a small developing country (e.g. Cyprus) where the constraints in the innovation process (due to the small size of the market, the small size of firms etc.) can not be overcome by private firms without the intervention of the government.
- Institutional Failure - The necessary institutions (e.g. R&D facilities etc.) may be missing, malfunctioning or not adequately linked with private firms, especially in small developing countries.
- International Competitiveness - Concern for the state of international competitiveness of the national economy (or particular industrial sectors) point to the need for a positive role

of Government in its increase through productivity improvement, innovation etc. (Francis, 1992 - Lall, 1992).

- Empirical Evidence - Empirical studies have documented the remarkable progress of Japan, South Korea etc. and cited government policy as a major factor in that success (Kraemer et al, 1992).

Why a National Innovation Policy ?

It is frequently argued that the globalisation of markets, products, capital, technology etc. is increasing with a simultaneous decline in the role of national borders (Nelson and Wright, 1992). This globalisation trend is attributed to various factors and especially the international activities of transnational companies (TNCs) which may have only a small portion of their business in their home country. In addition to globalisation, the integration of economic regions e g the European Union, NAFTA, ASEAN etc. leads to redistribution of decision power from national to supra-national bodies (Sengenberger, 1993 - Sharp and Pavitt, 1993).

Despite, however, the above trends, National Innovation Policies are still important and relevant especially for developing economies within the general frame of their adjustment to international economic and technological changes and improvement of their economic situation (Pack, 1992) Several authors (Andersen and Lundvall, 1988 - Francis, 1992 - Nelson and Wright, 1992 - Nelson, 1993) refer to 'National Systems of Innovation' emphasizing the fact that national firms are not isolated islands, but members of networks. The network within the boundaries of a nation-state seems to have a particular importance to innovation (Gregersen, 1988) This view does not deny the importance of networks that transcend national boundaries and their role in technology transfer, but emphasizes that innovation is facilitated by a whole set of relationships and linkages whose 'local part' is on the whole the most important as several studies of innovation have suggested (Bianchi and Bellini, 1991).

Formulation and Instruments of NIP - The Comparative Approach.

Both the concept of a National Innovation Policy (NIP) and the tools for applying such a policy have been understood and applied in various ways across different countries and time periods. It is widely suggested in the literature (Rothwell and Dodgson, 1992 - Sagasti, 1989) that a comparative analysis of NIP practices among various countries can provide some guidelines for the formulation and implementation of NIP especially in the case of small developing countries, such as Cyprus, which are latecomers in this field.

The usual comparative analysis in the literature (Rothwell and Zegveld, 1985) compares the policy objectives, the tools and the institutions of NIP and the phases of innovation process where intervention is made. Comparisons are also made on NIP evaluation procedures. Several of these studies refer mainly to industrialized countries (Braun, 1986 - Ergas, 1987 - Rothwell, 1986). The case of Japan is usually discussed as a model system not only for other advanced countries, but for newly industrialized ones (NICS). It is assumed that some of the successful NICS (Taiwan, Korea etc.) have followed the Japanese way (Weiss, 1988). Cyprus and other small developing countries (e.g. Malta, Jamaica etc.) could usefully apply lessons from small NICs (such as Hong Kong and Singapore).

C Freeman (1987) has summarized the most characteristic features of the Japanese system as follows

I) The role of Government through MITI (Ministry of International Trade and Industry).

II) The role of company R&D strategy in relation to imported technology.

III) The role of the educational system

IV) The conglomerate structure of industry.

The Japanese Government has followed an integrated technology, industrial and trade policy establishing through MITI strategic priorities and intervening in the innovation process, but without interfering too much in the operations of the market. On the other hand the Anglo-Saxon innovation policy approach (UK, USA) is closer to the laissez-faire model (Mosley and Schmid, 1993)

The new trends in the comparative approach focus on the comparison of National Innovation Systems (Freeman, 1991) and their evolution over time. In other words the traditional approach i.e. the 'rational-economic' one which assumes that formulation of the 'proper' mix of tools is all that is needed and this mix can then be applied in other countries as well (possibly with some adaptation), can be usefully expanded to include the context and process of innovation policy. These are examined in more detail in the following, starting with context and then discussing process and content.

Context of NIP

Inner Context (within the country) includes the following:

- The overall country objectives for example, equitable economic growth, protection of the environment, increased domestic technological capability and the priorities given to these objectives. The objectives are shaped within the national political/economic philosophies for particular time periods, which favour a more or less interventionist approach.
- The history and current structure of the National Innovation System with emphasis on the main components (The current role of Government, the educational system, the institutions of finance etc.)
- The effect of social institutions, culture and tradition.

Outer Context includes international trends in technology, the place of the country in major geopolitical, supranational formations and the place of the country in the international division of labour

<u>The Process of NIP Formulation</u>

The idealized process of needs/capabilities assessment and development of long-term goals which are then translated into a strategy with a timetable for implementation and built-in monitoring and evaluation mechanisms may appear as a linear and neat sequence on the documentation of NIP, but in practice NIP is to a considerable extent 'emergent' as Mintzberg (1987) has described the development of strategy at the enterprise level. Emergent in the sense that it is transformed during the process of its conception, formulation and implementation under the influence of vested interests, individual goals, power games etc. Much depends on the management and coordination skills of the bureaucrats, apart from their initial good intentions.

A realistic comparative approach in the study of NIP should examine the following:

- The Public Consultation Process and the Policy Environment (lobbying practices etc.) in Cyprus versus that in other countries. For instance in a small state like Cyprus where people know each other, powerful individuals and groups have more opportunities to use their influence than in a much larger state e.g. Korea, India etc.

- The cultural and political aspects of implementation (e.g. a top-down approach to government policy may be more acceptable in Korea or Singapore than in Cyprus or the UK (Whang, 1992).

- How change has been managed so far in practice and what is the experience of the change agents.

The NIP Content

i) *Classification of NIP tools.* NIP tools are classified into categories for easier comparison between countries and a better evaluation of their impact on innovation. One of the most well-known classification schemes is that by Rothwell and Zegveld (1985). Tools are classified under three main headings:

- Supply side measures e.g. financial subsidies, public R&D etc.
- Demand side measures e.g. government purchasing policy for innovative products and services
- Environmental measures e.g. the legal and fiscal framework in which industry operates like the patent system, antitrust regulations, health and safety legislation etc.

The proper mix of instruments can not be decided on the experience of other countries only (i e how effective a tool has been in practice in country X or Y), equally or more important is research on the actual practice of innovation in the country for which a NIP is formulated. The SME network model, which will be described in Section 2.3, is a useful framework for that type of research.

It is also useful in reminding to planners that all measures are directed to individual firms and it is the action of these firms that leads to success or failure of the innovation effort i.e. the effect of tools can only be measured by the response of firms to them (the alignment of innovation policies of firms to NIP (Hall, 1986). The network approach focuses on the need for interaction of instruments and the cumulative nature of technological knowledge much more than a market-based approach, as implied in market-based (supply demand) models.

ii) . *The Institutional Framework.* Many of the above mentioned tools interact with institutions and may need institutional change for effective implementation. Institutions relevant to NIP can be classified into *basic* e.g. the Intellectual Property Rights System, Science and Technology Infrastructure etc. and *secondary* e.g. banking, telecommunications etc.

Innovation encounters several institutional obstacles e.g. the barriers in the flow of knowledge from the academic to the industrial sector. Institutional change (by design or organic processes) is usually a necessary precondition for the introduction of a new NIP (or modification of an existing one). Institutional 'drag' or 'failure' i.e. delay in technical change due to institutional rigidities and a slow adaptation rate of social structures is well documented in the literature (Johnson, 1988 -Rothwell and Zegveld, 1985).

Sharp and Pavitt (1993) discuss the question of institutional 'failure' in 'myopic' national innovation systems (with the UK system characterized as such). Britain's short-termism and low innovation record is contrasted to that of Germany's, Japan's etc. and it is proposed to be rectified by seeking change in the institutional relations between finance and industry. This example shows that not only institutions themselves matter, but also the inter-institutional linkages (Dodgson, 1993b). Argenti et al (1990) consider as a major weakness of the S&T system in a small developing country (Uruguay) the weak interlinkages of the R&D system which hinder exchange flows, knowledge supply and demand, and joint activities and programmes The role of institutions in Cyprus is discussed in Ch.3.

The discussion in this section has shown that NIP has important ramifications for innovation at various levels Some examples of such ramifications have only briefly been presented above, some others are considered in the specific case of Cyprus in Ch.3.

2. 2.4 Innovation in Developing Countries

Technology and Innovation in Development Studies

The study of innovation as already mentioned in Section 1.3, has started in the industrialized countries (e.g. USA, UK) and focused at least initially on major innovations and the process through which such innovations are generated. Innovation in developing countries was initially studied not by the innovation theorists, but by development economists who realized that science and technology play as well a major role in the economic growth of the so called Third World, as for the industrialized countries. The emphasis has been on technology transfer from the developed to the developing economies It is no coincidence that most of these studies refer to the newly industrialized countries e g Korea (Enos and Park, 1988) and Taiwan (Fransman, 1987) or large developing countries like India and Brazil (Lall, 1985 - Katz, 1984) which are the most interesting cases in terms of technology transfer.

The ability to innovate is represented in Porter's (1990) 'development chain' as the highest degree of development of a particular society. This does not mean however that indigenous technological innovation is not desirable for, or beyond the capacity of, even the least developed countries. The specific mechanisms of innovation and enterpreneurship are less explicitly treated in the body of development literature, although they have been extensively reported in literature dealing with developed countries (Tiffin et al,1987). The development literature has, however, proposed and investigated some useful concepts closely related to innovation. The most important of them is that of technological capability.

Technological Capabilities

Najmabadi and Lall (1995, p. 43) define technological capabilities in industry as "the skills - technical, managerial, and organizational - that are necessary for enterprises to set up a plant, utilize it efficiently, improve and expand it over time, and develop new products and processes". Technological Capabilities (TC) are firm-specific, a form of institutional knowledge that is made up of the combined skills and experience of its members.

Dahlman et al (1987) give particular emphasis to the development of technological capabilities in developing countries. In their words (ibid, p. 759): "inventing products and processes is not in the center of the technological development needed for successful industrialization, but at the fringe; what is at the center is the acquisition of (technological) capabilities for efficient production and investment". The usual sequence in developing technological capabilities with entirely new technologies is from innovation to investment to production. Since for developing countries existing technologies are transferred from the industrialized countries the sequence is reversed and production capability serves as the foundation for development of capabilities in investment and innovation

Production capability involves production management and production engineering, while investment capability involves project management and project engineering (i.e. appraisal, design, construction and start-up of projects. Innovation capability according to Dahlman et al (1987, p. 766) "consists of creating and carrying new technical possibilities through to economic practice." The term is broadly used to cover everything from improvements in existing technology (minor innovations) to invention and major innovation

Lall (1995a) suggests that the process of successful industrial development involves the deepening of technological capabilities over time. Lall et al (1994) propose a useful functional categorization of the technological tasks facing a manufacturing firm by devising a *matrix* of technological capabilities. The latter are distinguished in *investment, production* and *linkages* capabilities. Within each functional category there is a progressive sequence of tasks arranged according to the degree of complexity from basic simple (routine) which are experience based through intermediate, adaptive and duplicative (search-based) to advanced, innovative and risky (research-based).

Lall et al (1994) however, consider linkages within the economy only. This seems restrictive in view of the fact that the most important linkages, at least technological ones, for developing countries cross the national borders. Perhaps the intention of Lall et al was to emphasize the importance of local linkages where they exist.

It is important to note that the development of innovation capabilities is seen as an evolutionary process starting from simpler elements and culminating in innovation. Furthermore it is not an automatic process, but it depends on the conscious and purposive efforts undertaken by the firm. These efforts include learning, searching and experimentation. The learning process means that firms even in the same sector can experience quite different rates of technological development and end up with different levels of efficiency and effectiveness in the use of the same technologies. Another important point made by Lall (1995a) is that in most developing countries the learning process itself has to be learned and that this process is long, risky, uncertain and demands considerable investment of time and funds and commitment by the firm's managers. The important issue of learning is further discussed in Section 2.4.3.

The concept of technological capabilities is a useful one in the study of innovation. Firms, for example, need to reach a basic level in them in order to benefit from technology transfer or at a later stage develop their own technological innovations. The problem is how to measure corporate technological capabilities. There is yet no complete set of universal indicators capable to be applied across sectors and countries.

The efforts of firms are a necessary but not an adequate element in the development of technological capabilities. Hillebrand et al (1994, p.3) suggest that the four pillars of technological capabilities are: a) capabilities of the firms for imitation and innovation b) framework conditions c) technology-oriented institutions d) effective system of education and training This list is based in a *systems view* of innovation and is a useful summary of some important elements. It omits however the interaction of firms among themselves. The question is also which parts of these general elements are the most relevant in specific cases and how to identify them. The effect of such elements on technological capability for the case of Cyprus are discussed in Ch.3. Firms develop capabilities interacting not only with technology institutions, but also with suppliers, customers, consultants, even competitors. They operate therefore in networks of formal and informal relationships. The contribution of networks to innovation is important enough to deserve a separate Section (2.5) later in this thesis.

Non-economic Innovation Determinants

Economists usually stress structural economic features, institutions and individual firm characteristics as determinants of innovation in developing countries, but social and cultural characteristics are also important. Albach (1994) classifies the cultural success factors for technical innovations into three categories: a) Individual (for example personality formation) b) Collective (for example social norms, behaviour, expressions, values) c) Institutional (for example social and political institutions).

The above classification does not refer exclusively to developing countries, although socio-cultural barriers to innovation are probably of particular importance for this group of countries Cultural factors and their possible effects on innovation are discussed in the context of Cyprus in the next chapter (Ch. 3). According to Albach Japan's culture with its emphasis on group work, commitment and loyalty of employees provides the comparatively most favourable conditions for technically innovative performance of the economy than e g USA or UK.

Peculiarities of Innovation in Developing Countries

The above discussion suggests that there is a need for adaptation of the innovation theory for the developing countries (DC). Their main differences with the industrialized countries, regarding technological innovation, that determine the need for a modified innovation theory can be summarized as follows:

- The development of incremental (minor) innovations is more important for DC rather than major innovations.
- Diffusion and adoption are more important than development of technological innovations. The main technological activities focus on learning and adapting foreign technologies (Kim, 1988).
- The Learning Process itself has to be learned (Lall, 1995).
- Socio-cultural factors play a major role in innovation

This is an indicative, rather than a definitive list, and these differences and their implications for innovation are further discussed below in the context of small developing countries and in Ch.3 for the case study of Cyprus.

2.2.5 The Case of Small Developing Countries

How small is small?

Various groups of developing countries have specific interests and problems in terms of technological capabilities accumulation and innovation. Among them small developing countries, defined as those with less than ten million people (Streeten, 1993, p.197) face particular and more acute problems than their larger brethren. It should be noted that the population criterion for the classification of small developing countries (SDC) is somewhat arbitrary and it should be combined with other criteria e.g. geographical area, national income etc, but for the purposes of this study it is considered as adequate.

Walsh (1986) notes that students of small countries have based their definitions of small countries on as diverse criteria as size of population, Gross Domestic Product (GDP) and/or international relations. On the basis of these criteria they have defined small states as e g those that have population of less than ten millions or those with under 20 billion US Dollars GDP Walsh herself (ibid, p.5) has chosen GDP as criterion justifying its use as follows "GDP captures some measure of the resources available to a country for future innovation, and the size of its domestic market. GDP reflects in particular the level of resources of relatively poor populated countries in a way which population size alone does not capture". Population figures are however more widely available and a more widely used criterion in the literature.

Characteristics of small developing countries

There are 83 countries with fewer than five million people (and another 90 with fewer than 15 million) (Todaro, 1993) and most of them are developing countries. Some characteristics which set the small developing countries apart from their larger counterparts are briefly summarized below. The specific problems facing small National Innovation Systems are discussed next.

- Small developing countries typically have limited markets, scarce physical resources, shortages of skills and a weak bargaining power for interstate agreements (Todaro, 1993).
- There is a lack of competitive markets as a result of the small country size (Jonsson, 1993). The Government and the public sector play a 'central role' in the economy in general and the scientific /technological affairs in particular, while the private sector a much less important one. The 'bulk' of R&D, for example, is carried out in the public sector.
- The 'high tech' sector is under-developed or non-existent and the main issue is the application of high technology in existing sectors, as well as, the gradual development of new ones with relatively higher technology (Lall, 1992).
- Institutions essential for the promotion of technological innovation are weak or underdeveloped
- Small and medium size firms are not just the majority in the population of the firms, but the predominant force in the economy (Segenberger, 1993). Even 'large' firms in SDC are small by international standards.
- The predominance of SME affects industry structures and interfirm linkages. The complex subcontracting systems around large firms as in industrialized countries e.g. Japan are largely absent. (There are, however, exceptions e.g. Singapore). There are formal and informal relations among more or less equal partners.

These characteristics are important since they affect the practices of innovation in private firms This is one of the basic arguments in this study which is tested through the development of specific hypotheses in Ch. 5. The discussion on this issue in the light of the results is presented in Ch. 6. The characteristics are also connected to the problems of small innovation systems as discussed below. The peculiarities of innovation in small firms, which is the predominant type of firms in SDC, are further discussed in detail in Section 2.4 4

Small National Innovation Systems

According to Endquist and Lundvall (1993) small national systems of innovation face special problems. They refer to small *industrialized* countries like Denmark, Norway and Sweden, but their comments are also valid for small developing countries which face similar problems because of their size and additional ones due to underdevelopment. The problems in the case of small developing countries are closely related to their characteristics as discussed above.

In small economies the development of generic technologies and radical innovations is a rare phenomenon and the most important activity is often diffusion i.e. the absorption and adaptation of technologies developed abroad. Therefore the system of technology diffusion is much more important than the R&D system. The former includes absorption, assimilation and incremental change. The above imply that in studying small NIS emphasis should be placed on analyzing the mechanisms, institutions and policies for acquiring foreign technology and disseminating it domestically (Endquist and Lundvall, 1993).

The discussion about the national innovation policy above and that on SDC (Small Developing Countries) leads to the following two hypotheses:

H1: The nature of SDC (i.e. its structural elements like political and economic ones, and cultural elements such as social norms and customs) influences innovation practices and performance at the firm level, through its effect on managerial practices, networking behaviour and the economic context.

H2: NIP in an SDC influences the innovativeness of firms.

These hypotheses (especially the first one) serve only as a broad frame for the other more specific and empirically testable hypotheses. Actually the hypothesis on the nature of Small Developing Countries and its effect on innovation can not, strictly speaking, be tested without comparative research based on a representative sample of SDC. The issue is further discussed in Section 6.2.4.

2. 3 Models of Innovation

2. 3. 1 Developments in Model Construction

Several models have been developed proposing the stages or events comprising the innovation process. Models can serve as useful simplifications of reality and guides to analysis and action (Nadler and Tushman, 1980). On the other hand they may distort reality through over-simplification. One of the aims of specifying stages (sequences of events) is to identify and understand the influences on the innovation process throughout its development This section refers selectively to some models related to the present research

Rothwell (1994) has described the chronological development after the second World War of the visualization of the innovation process. The models corresponding to the first and second generation innovation process are respectively the technology (or supply) push and the market (or need) pull models.

The above models are examples of the linear model of innovation which has received a lot of criticism. According to Howells (1994, p.11) the linear model "is guilty of gross over-simplification of the complexity of the innovation process". Jord and Teece (1990, p.77) express a similar view: "The serial (linear) model of innovation is an analytic convenience which no longer adequately characterizes the innovation process, except in special circumstances" The 'special' circumstances sometimes occur in major innovations. The linear model is therefore less than adequate particularly for incremental innovations.

The inadequacy of the linear model was gradually realized in the 1970's as a result of accumulating empirical studies. In Rothwell's words (1994, p.9) "it was indicated that the technology- push and need-pull models of innovation were extreme and atypical examples of a more general process of interaction between on the one hand, technological capabilities and on the other, market needs."

More sophisticated models were developed since. Due to lack of space the various generations of models are not considered here. The latest Rothwellian model which incorporates many of the features of previous models and adds some new ones is discussed below.

2. 3. 2 Rothwell's Fifth Generation Model

The emerging fifth generation model (Fig. 2.2) is depicting innovation as a process of know-how accumulation or learning process (involving elements of internal and external learning) The model also emphasizes links within the firm and links between firms or firms and other organizations e g. universities and contract research organizations. The innovation process is seen as operating within complex networks of backward, forward, horizontal and lateral linkages

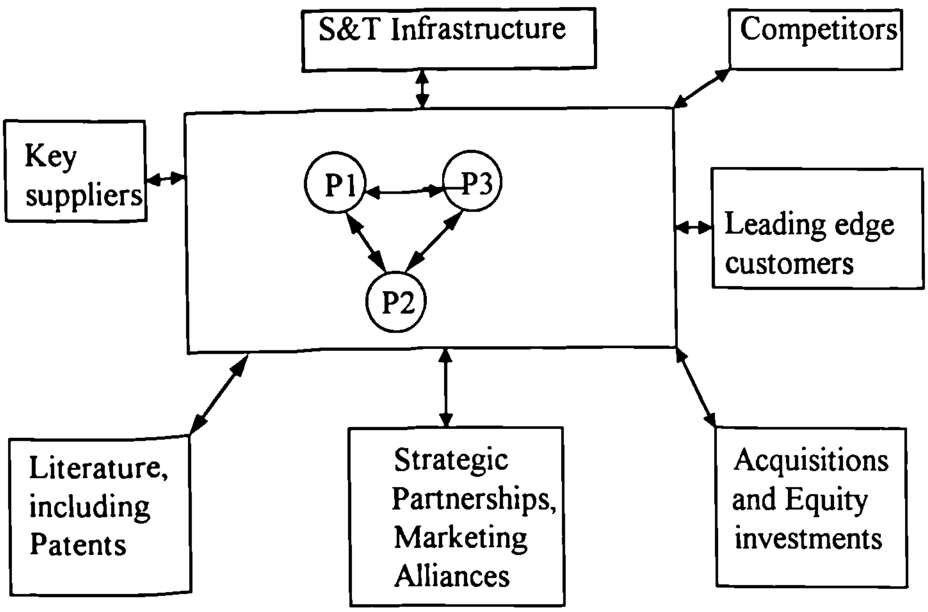
The features of the new model can be summarized as follows:

i) Feedback e g between research, development and production.

ii) Simultaneousness of research, development and possibly commercial activities

iii) Interactive nature of innovation processes and interdependence of actors.

The new model incorporates many features from previous generation models and adds some new ones centering mainly around the network concept which is treated in depth in Section 2 5 This model, while it illustrates the activities and the actors in the innovation process, it does not explain, however, the process of innovation as an unfolding sequence of events over time, and does not deal with the stages of this process. A representative process model is presented below.



Code P1, P2, P3 (Innovation Projects 1, 2, 3)

Figure 2. 2 The Fifth Generation Model (Innovation as a Process of Know-how Accumulation).

Source Rothwell (1994)

2. 3. 3 Van De Ven's Process Model

A well-known and widely accepted model is that proposed by Rogers (1983). It is actually a version of the linear model of innovation, portraying the process of innovation as a linear sequence of three basic stages (invention, development, and adoption/diffusion) over a time continuum. Rogers recognizes a number of factors as affecting innovation adoption. These include: factors affecting rate of adoption, innovation characteristics, administrative characteristics and the social system context.

Roger's model was developed for the development and marketing of innovations by organizations and adoption of these innovations mainly by individuals. While it is supported by extensive empirical studies among individual adopters (farmers or doctors etc.), it appears oversimplified for the case of innovation adoption by organizations. It is still a sequential model, while innovation in most cases is not a simple sequential process.

Van de Ven (1993) drawing on the results of MIRP (Minessota Innovation Research Program) has proposed a modified version of the classical model of Rogers. Van de Ven's model is presented below in a simplified form in Fig. 2.3. The MIRP project and its research results are further discussed in more detail in Section 2.4.2, where the 'process approach' to innovation is presented.

According to Van de Ven his model 'enriches' the model of Rogers in the following three ways.

- Innovation stages are viewed as activities or events occurring throughout the process over time Invention activities include need or problem assessment and research and idea development. Development activities involve design and evaluation and then commercialization. Finally adoption and diffusion acts include marketing and distribution and promotion/persuasion.

- Administrative and context factors are seen not as constants, but as emerging and changing through events and activities over time. The administrative activities include the organizational norms and rules, the personnel rewards and support and communication/coordination.

- The model adds a third axis tracking the occurrence of six process elements of organizational innovations which were identified in the MIRP project. These elements are: gestating events, shocking events, proliferating events, setback events, learning events and shifting innovation characteristics. They are further analyzed in Section 2.4.2.

Process models emphasize the time dimension of innovation, the continuity in activities and their cumulative nature and give a more realistic view of the reality. They may, however prove more complex and difficult to be used as guides in innovation research. The time dimension implies that longitudinal case study research is more appropriate for validation of such models. This type of research demands close follow-up of particular innovations over their initiation, development and commercialization stages. Process research is further considered in Section 2 4 2 in the context of research approaches to innovation at the level of the firm.

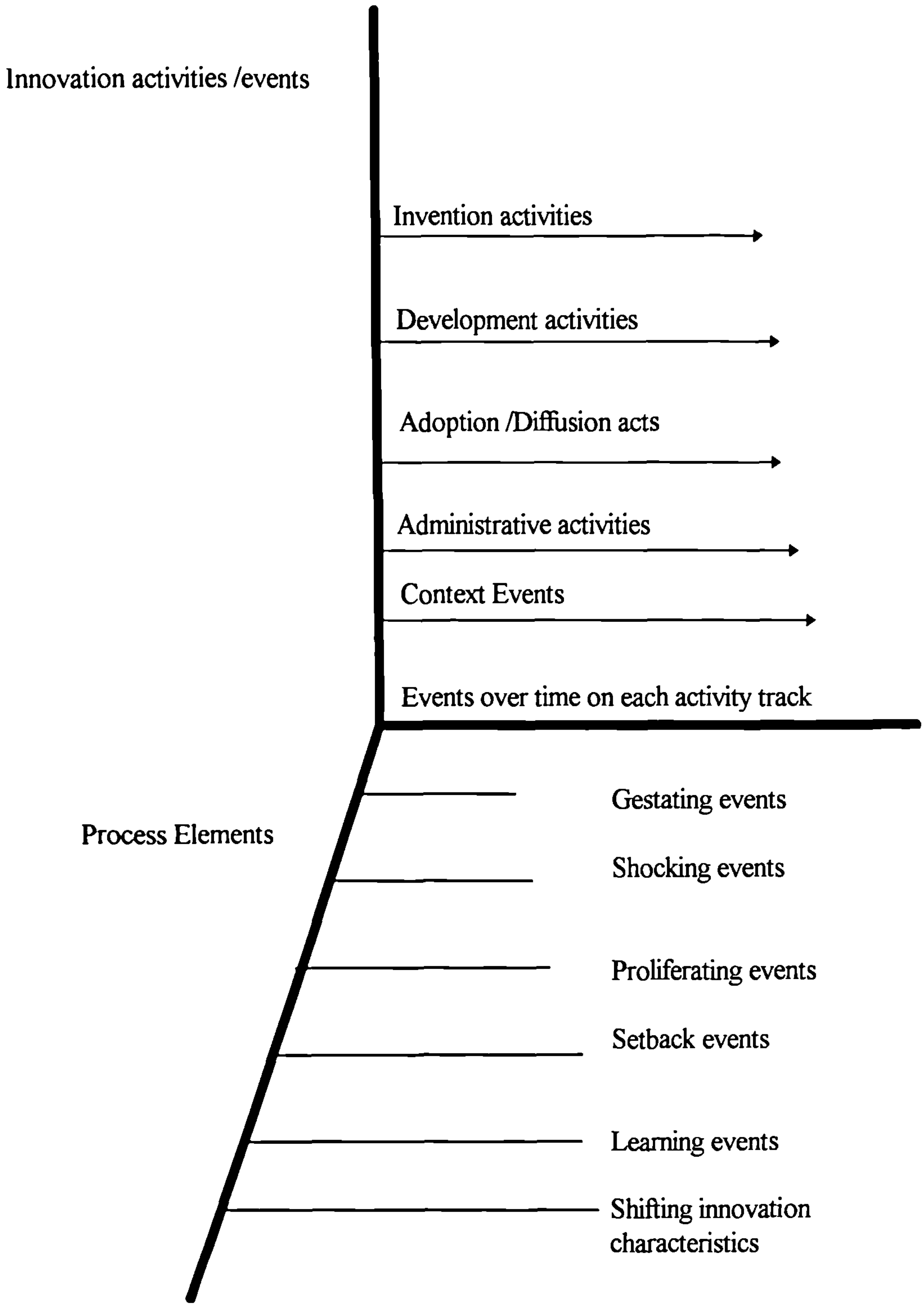


Fig. 2. 3 Van de Ven's Process Model

Source: Van de Ven (1993)

2. 3. 4 Models for Innovation in Small Developing Countries

For the development of a suitable National Innovation Policy for a country like Cyprus a model focusing on the innovation process within the context of small developing countries would be more useful than the above models which were developed within the context of industrialized countries Such a model is proposed in the next section.

The model should accommodate a number of features, due to the two conditions of 'underdevelopment' and 'small size' such as:

- The centrality of Government and the public sector in the economy in general and the scientific/technological affairs in particular (Argenti et al, 1990).
- The predominant role of small and medium size enterprises (SME) in industrial development
- The small firm's dependency on external resources.
- Interlinkages among firms and institutions in a small country (Argenti et al, 1990).
- The effect of cultural and social attributes on innovation management and practice.

The Network Model

The proposed model (Fig 2.4) for the study of Innovation in Small Developing Countries adopts a 'network' perspective The small and medium size firm (SME) is viewed as the representative actor in the innovation process and is depicted at the centre of a network including other firms (in the same or other industrial sectors) and organizations of various types (e g government departments, research institutes etc.). This is a different type of model that does not attempt to depict the innovation process, but merely to show the connections of the firm which enable the innovation process to take place. It will serve to set the scene for the hypotheses As further argued in Ch. 6 it is actually a more comprehensive version of the antecedents 'model' which is used as the research blueprint and is discussed in Section 2.4.2.

The central idea behind the model is that National Innovation Policy (NIP) should be directed not to individual firms (or even sectors) but to the national technoeconomic network as a whole or in certain cases local parts of it. It should aim to strengthen links, encourage replacement of missing ones whenever possible i.e. 'weave' the network (Bianchi and Bellini, 1991) and speed the information flow within it. The main parts of the network model which is only a convenient way of conceptualization are briefly summarized and explained below:

I. The Government plays a basic role both directly through general and specific (e.g. NIP) economic policies and indirectly through the External Technology Intermediators.

II. Supranational Organizations. In the case of Cyprus the European Union and for other developing countries various regional economic associations, play nowadays a vital part by setting standards, providing technological and financial assistance, promoting cooperation among firms etc. Other organizations e.g. various United Nations bodies such as UNIDO play also a role in technology transfer and innovation.

III The SME The model in contrast to other ones, e.g. the chain linked model of Kline and Rosenberg (1986) which shows the complex interactions feedbacks and interrelationships between functions (marketing, R&D etc.) in the innovation process, concentrates mainly on the external rather than the internal interactions (within the SME). The latter despite their obvious importance in the innovation process are mainly 'informal' in the case of SME and on an individual level, with the entrepreneur / SME owner at the hub of all activities .

IV External Technology Intermediators. They are mainly state controlled and especially important for SME in the context of small developing countries (Johnson, 1988).

V Input Providers/Output Users. The users and the suppliers of resources (goods, capital, information etc) form the forward, backward and horizontal linkages of the SME network and have a vital role in the accumulation and use of technological knowledge Kogut (1991) and the commercialization of innovations. Although the primary emphasis of the network model is on the interactions with suppliers/users etc. within the boundaries of the national economy i e. a "geographically circumscribed network" according to Freeman (1991), the vital links to foreign suppliers (for technology transfer etc.) and export market users (for feedback on design, quality characteristics etc.) are not overlooked. Implied, but not shown, are the 'informal' linkages e. g. personal relationships among entrepreneurs, social bonds etc. which are equally important to formal ones, especially in a small society and are affected by cultural and social values.

VI. Economic/Social Environment. The SME operates within an environment (social, political, economic) which affects the task environment (linkages to other firms) and the management of the innovation process.

Comparison of The 'Network-Model' with Other Models of Innovation in Developing Countries.

The proposed model is compared briefly with two models from the literature i.e. Rath (1990) and Roessner et al (1992). These are both input/output models. Rath's model is reproduced in a simplified form in Fig 2.5 (page 55), while that of Roessner in Fig 2.6 (p.56).

Rath's emphasis is on the macroeconomic level, covers the economy as a whole and uses an input/output approach. The model considers the 'macro-systems' (i.e. R&D system, production system, socioeconomic system). It makes no reference to specific actors within the system/subsystems This model emphasizes the interaction of the national innovation system with the international context which according to Rath (1990, p.1430) "provides a very powerful set of enabling opportunities and constraints, that must be taken into account for most decisions at the national level".

Roessner's model focuses at the individual 'technological enterprise' and its inputs (scientific and technological resources etc.) and outputs (e.g. high technology production etc.). The technological enterprise operates within a 'cultural and policy infrastructure' on the one hand and an 'economic infrastructure' on the other, which affect both its inputs and outputs. Roessner's model although paying due attention to the general environment of the firm and process/behavioural factors within the firm makes no specific reference to the firm's network relations (vertical, horizontal etc.) and the crucial role of the government.

In conclusion both above models do not adequately cover the other (apart from the required resources) determinants of innovation, such as network relationships, managerial factors etc. The 'network model' views innovation as 'multi-institutional networking process' and has much in common with the 'fifth generation model of innovation' of Rothwell (1992). The main differences with the latter lie to the fact that Rothwell's model concentrates mainly on high technology firms in industrialized countries, where science and technology, patents etc. are the key elements, and R&D partnerships are among the main network forms. The 'network model' owes a lot to the ideas of the Scandinavian 'network school' of Andersen and Lundvall (1988) and Johnson (1988) about national innovation systems and industrial networks and their role in innovation.

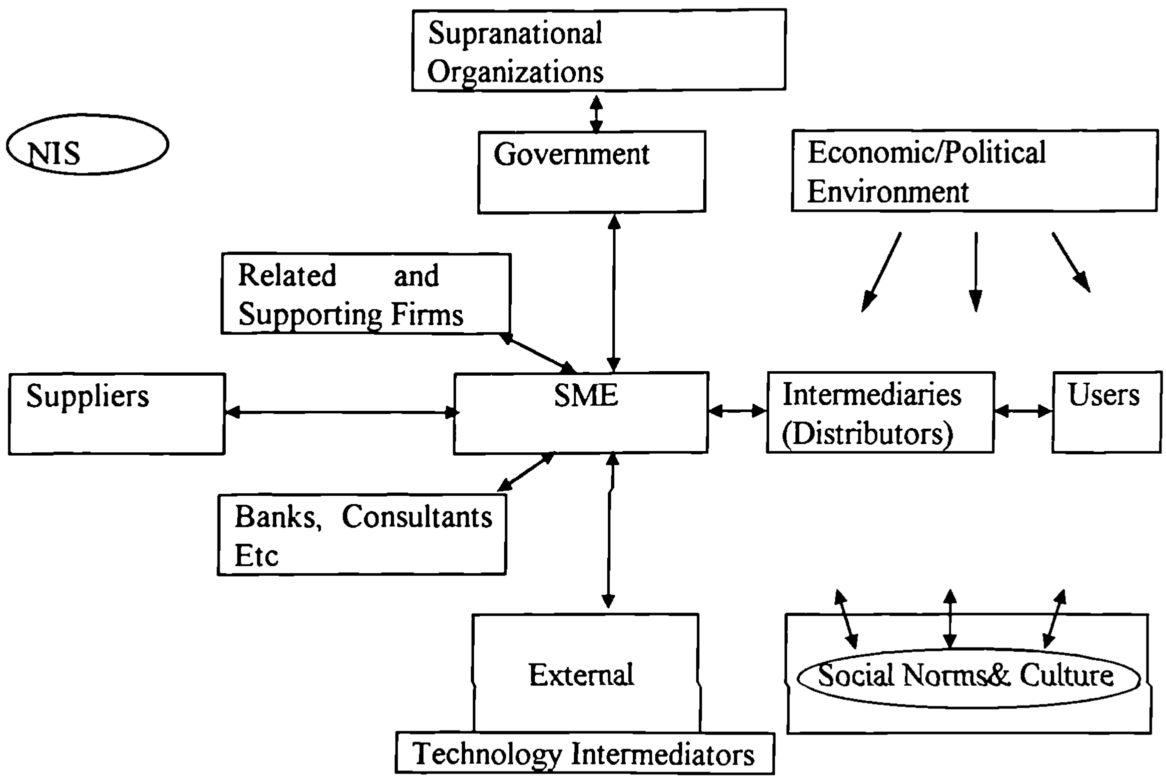


Fig. 2. 4 The Network Model

Source Adapted from Andersen and Lundvall (1988)

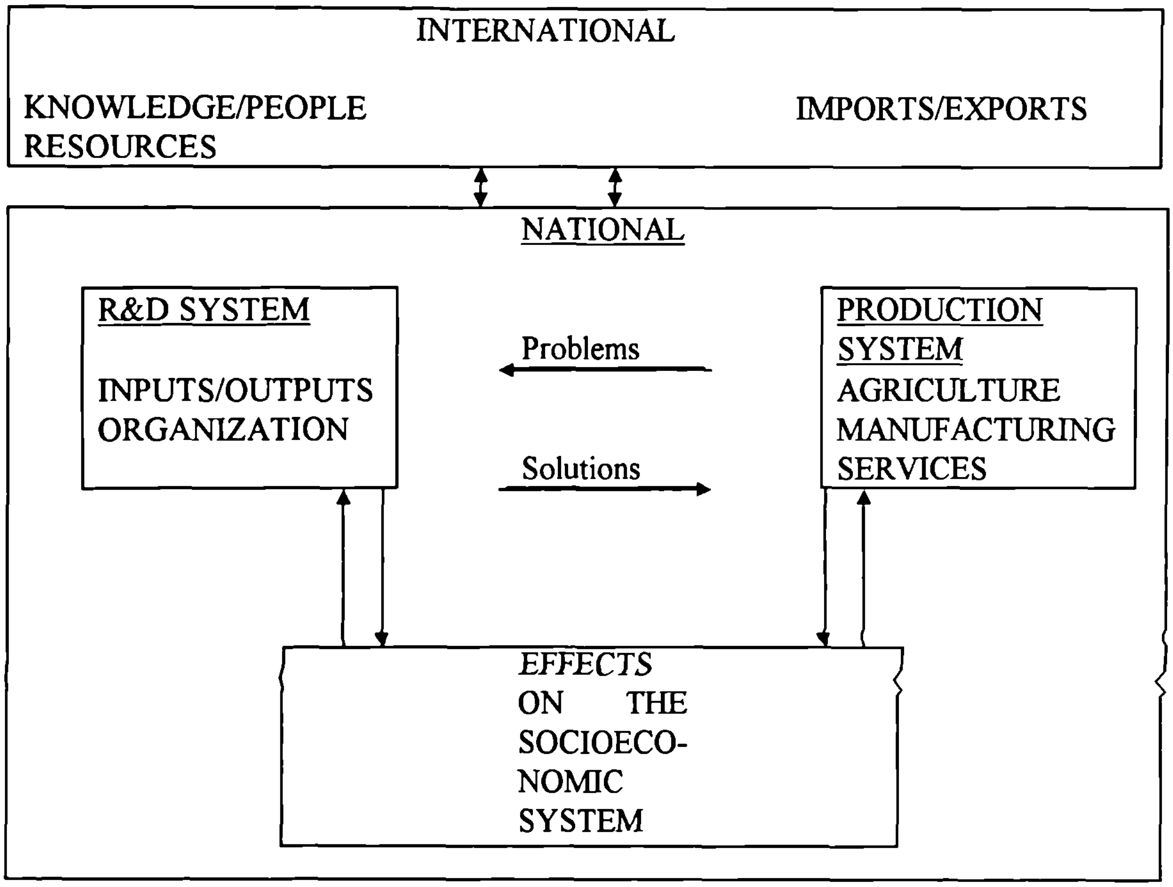


Fig. No. 2. 5 Rath's Model

Source: Rath (1990)

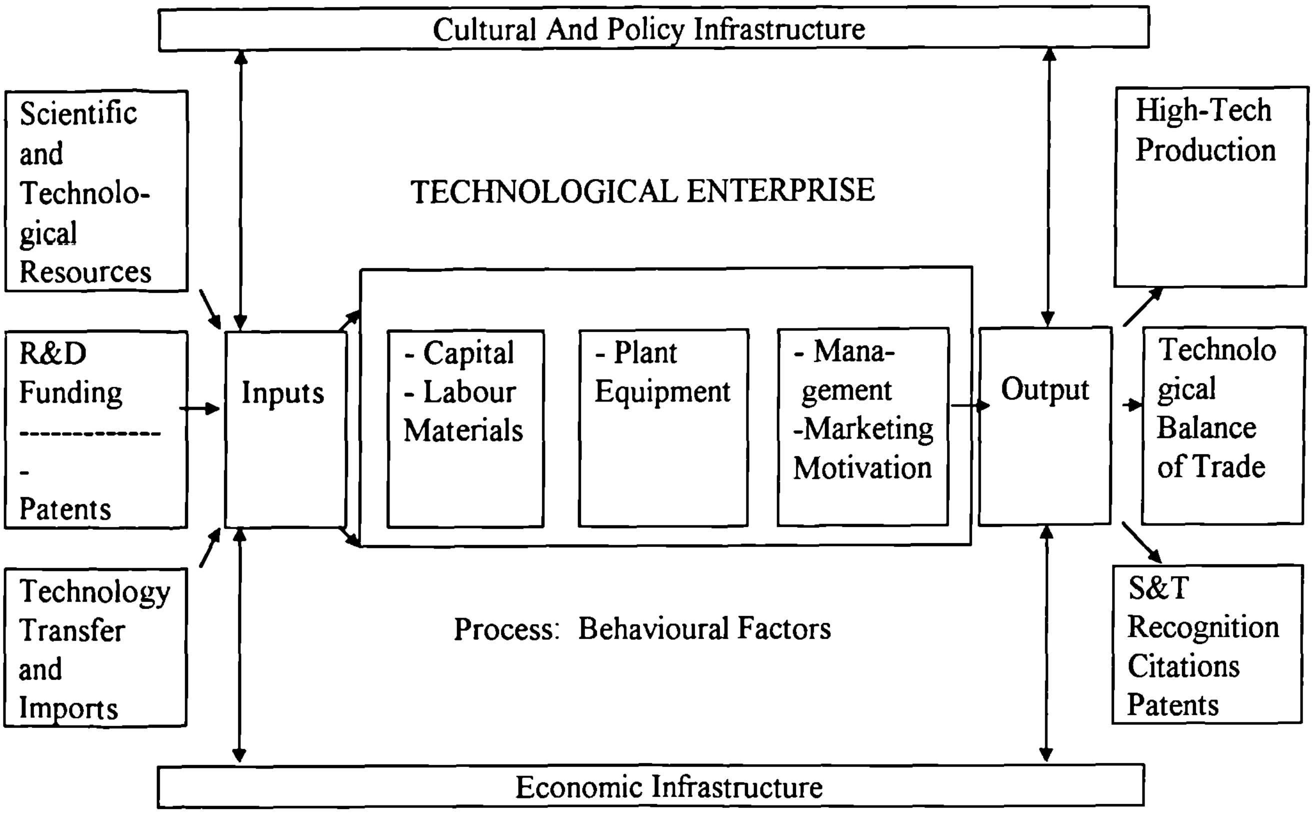


Fig. No: 2. 6 Roessner's Model

Source: Roessner et al (1992)

2. 3. 5 Summary

This section has briefly discussed the place of models in innovation theory and research, and has selectively presented some models related to the present research. It has proposed the network model for small developing countries. This model is meant as a visual context and a framework for the hypotheses which will be developed in the next sections rather than a model to be empirically validated.

2. 4 Innovation Theory/ The Micro-View

2. 4. 1 The Innovating Firm

a) A General Theory

The innovative behaviour of firms (or organizations in general) has received a lot of attention both in theory and in empirical studies since the firm has a central place in innovation activities. Although the ideas and knowledge for innovation may originate outside the firm and individuals and groups play a significant role in innovation development, it is the firm that comes out as the main actor in innovation. Due to the sheer size of the literature on the innovating firm the review here is highly selective, concentrating on theories and models most relevant to the research project of this thesis, and wherever possible applicable to small firms and countries.

It is possible to classify firms to types regarding their innovativeness (i. e. the proclivity to innovate) from the simple taxonomy of innovative and less innovative firms to more sophisticated ones Typologies of innovation strategies are further discussed in Section 2 4 3 It seems that some firms have the ability to perform better than others in developing and or adopting technological innovations. Research has focused on the assessment of the characteristics of the 'innovative' or technologically progressive firms. Some of these research traditions are dealt with below.

A general theory or model of the firm should take into account the characteristics of the technological opportunities presented to the firm, the intrinsic characteristics of the firm, the structural features of the industry and the market in which it operates. Apart from the above according to Coombs et al (1987, p. 115) "there is still the possibility of a 'residual' degree of indeterminacy in innovative behaviour which is captured in Freeman's notion of innovation strategies". Management scholars would certainly object to the reduction of strategy into a 'residuals' place. Innovation strategy and its importance is discussed at length in a latter section (2.4.3).

As mentioned in Section 2.2 Nelson and Winter (1977) have come closest than many others to a general model or theory of the innovating firm. According to them firms have certain decision rules or search routines which are more or less stable at least in the short run. They use for example the same production technology for years. At the same time they carry out 'goal oriented search processes' such as research and development. Innovation is then seen as a change in decision rules stimulated mainly by external (environmental) threats. Some of these rules concern the technical characteristics of the firm's products and processes. Firms follow therefore 'technological trajectories' (Dosi, 1982) i.e. more or less predetermined paths. Other theorists proposed more or less similar concepts to the 'technological trajectories' e.g. 'technological guide-posts' (Sahal, 1981) The above imply that technological decision making of firms is constrained and firms have a limited range of technological options at most times.

Firms also operate within a certain 'selection environment'. Each type of selection environment is characterized by a different combination of motivations, rewards and criteria for success Therefore firms face different incentives and disincentives for innovation Nelson and Winter's theory combines microeconomic inducement mechanisms, managerial models of the firm behaviour and sets of technological possibilities common to groups of firms but not leading to identical responses by firms due to the complexity of the selection environments uncertainty and strategy. Strategic management theories such as the resource based theory which are discussed in Section 2 4 3 share some common characteristics with the above theory but are less deterministic. The issue will be revisited in the just mentioned section.

b) Key Elements in Innovation Research

In this section a number of key elements in innovation research are considered. They include origination of innovation and modes of transfer of innovative ideas, sector or industry effect and size of the firm.

The origins of technological innovation have been investigated even in the early studies on innovation Initially the attention was focused on external sources (i.e. external to the innovating firm) Particular emphasis was given to research on the role of the *inventor* and the contribution of *basic science* to technological innovation (Stewart and Conway, 1993)

External sources were proved in the early studies to represent a high proportion of innovation ideas e g 67%, Carter and Williams (1957). The dimensions of external sources which were mostly investigated were the *organizational type* (academic, public R&D etc), the *cognitive category* (basic science developments, or recombination of pre-existing knowledge) and the *geographical location* (domestic or overseas) (Stewart and Conway, 1993)

The relationship of the organization which serves as the source of the innovation idea to the focal firm (the innovator) has received increasing attention since the mid 1970's. In the early studies the manufacturing active paradigm (MAP) was the main model i.e. the manufacturer initiates the innovation which then promotes to a 'passive' user. (Biemans, 1992) Then the role of the user was gradually recognized as essential, even as the primary source of innovation in certain sectors e.g. scientific instruments and semiconductors (Von Hippel, 1977). A customer active paradigm (CAP) began to emerge

The supplier was also appreciated as a significant source of innovative ideas in several cases and in particular in certain sectors e.g. thermoplastic materials, industrial gases etc.

(von Hippel, 1988). Finally the role of competitors in certain cases was recognized. Allen et al (1983) for example have found in a study of innovation in small firms that 23% of all 'messages' used in the idea generation stage of product development originated from firms in the same industry i.e. apparent rivals.

The realization of the importance of the external sources to innovation led to the investigation of the *modes of transfer* of innovative ideas and innovation-related information from the source to the innovator. It was found that there are several ways of transfer such as individuals moving from one firm to the other or from academia to an industrial firm (Langrish et al, 1972) and informal channels e.g. personal contacts of scientists and engineers (Allen et al, 1983). In the 1980's the role of formal and informal networking systems among organizations and individuals gained increasing attention (Freeman, 1991) The features of networks and their role as a channel of innovation ideas and information together with their other influences on innovation are further discussed in Section 2 5

Sector has an important effect on innovation, since opportunities for innovation are sector dependent Regarding the technological possibilities common to groups of firms in a sector (or industry), Pavitt (1991) has proposed a technology-based classification of business firms as follows·

- Supplier dominated (Traditional manufacturers)
- Scale intensive
- Science based
- Specialized suppliers

The last two categories are supposed to have the highest technological opportunities (and motivation) for innovation.

Large innovative firms are according to Pavitt (1991, p.41) "a major source of the world's technology". They make particularly big contributions in certain sectors such as the chemical, aerospace and automobile sectors. The range of choices about innovative product and process technologies available to firms depend on their accumulated competence. Pavitt describes four key characteristics of the large innovating firm. These are:

- *Firm specific competences.* As Pavitt (1991, p.43) has stated "Large innovating firms are typically broad-front in their technological activities". This is in contrast to small firms which are typically specialized in their technological strategies concentrating on product innovations, largely in the last two categories i.e. 'science-based' and 'specialized suppliers' of the above list. The competitive advantage of large firms lies in the ability to develop firm-specific skills which lead to innovative product or process technologies related to these skills and tacit knowledge obtained through experience, even if this knowledge is complemented with some bought-in technology. The relative self-sufficiency of large firms can be contrasted to the dependence of small firms on external sources of knowledge, resources, and what Teece (1986) has called "co-specialized assets" to take full advantage of the innovation.

- *Differentiated innovation activities.* Firms specialize in certain technologies and can innovate only in closely related fields.
- *Internal collaboration.* In large firms innovative activities involve continuous and intensive collaboration amongst professionally and functionally specialized groups.
- *Specific systems and methods.* Allocation of resources in innovative projects with highly uncertain outcomes demands appropriate systems and methods.

The characteristics of the large innovating firms serve as a yardstick against which the characteristics of small innovating firms can be contrasted and the relevant differences highlighted Some of these differences have received a passing reference above, but they are further developed in the Section (2.4.4) on the small innovating firm which is here the main object of study

The above technology-based classification of firms needs further empirical validation. Its relevance for firms in industrialized countries seems to be justified at least as a first approximation on a theoretical basis. In small developing countries, however, most, if not all, firms fall within the first category (supplier dominated, technologically mature sectors) therefore the above classification is not very relevant. The sectoral effect is tested in the empirical research (see Ch.5).

2. 4. 2 Research Approaches to Innovation at Firm-Level

Much of the empirical research is based on contingency theories of innovation. Different writers have proposed alternative taxonomies of the key research streams (or research traditions), for instance King (1990) proposes a classification in three categories i.e.:

A) The antecedents approach.

B) The process approach

C) 'Types of innovation' approach.

Wolfe (1994) has suggested also three categories as follows:

1) Organizational Innovativeness Research

2) Process Theory Research

3) Diffusion of Innovation Research

The antecedents approach is almost identical to the organizational innovativeness research, while the process approach is the same as the process theory research. These two approaches are discussed in detail, while the remaining two non-overlapping approaches i e the 'types of innovation' and 'diffusion of innovation' plus other approaches in the literature are only briefly touched upon, being of peripheral importance for the purposes of this thesis Therefore this section deals with A (antecedents), B (process), C (other) as above, followed by innovation effect on performance and the hypotheses developed from the review of the above research.

A) The Antecedents Approach

According to Wolfe (1994) the unit of analysis in this approach is the organization and a variance research model is used usually based on survey data collection. The dependent variable is the organizational *innovativeness*. The influence of a host of independent variables including individual, organizational and environmental, as mentioned above, on the dependent variable is examined. Particular emphasis in this approach has been given to structural organizational variables as primary determinants of innovativeness. The survey part of this thesis follows more or less this approach (antecedents). First the dependent variable (innovativeness) and then the antecedents in the sequence shown below and their single and whether possible their combined effects as they are described in the extant literature are examined in the following in detail.

The antecedents are distinguished in the following categories:

A1) Organizational members i.e. those controlling innovation such as leaders, managers and change agents.

A2) The organization itself (e.g. size, structure)

A3) Extra-organizational (environmental) factors

A model illustrating the effects of antecedents on innovativeness and eventually performance is depicted in Fig. 2.7. The classical antecedents model, as described by King (1990), is extended here to show the link of innovativeness and performance and emphasize the influence of national innovation policy (NIP) and interfirm linkages which are certainly environmental factors, but too important to be lumped together with the other extra-organizational factors. This model can be criticized, in common with many other models of innovation for its sequentiality. The single direction of arrows was only used for a simplified presentation. It is expected that in reality influence acts in both directions and there are feedback loops among the variables. The model and its relationship to the network model of Section 2.3 is further discussed in Ch.6.

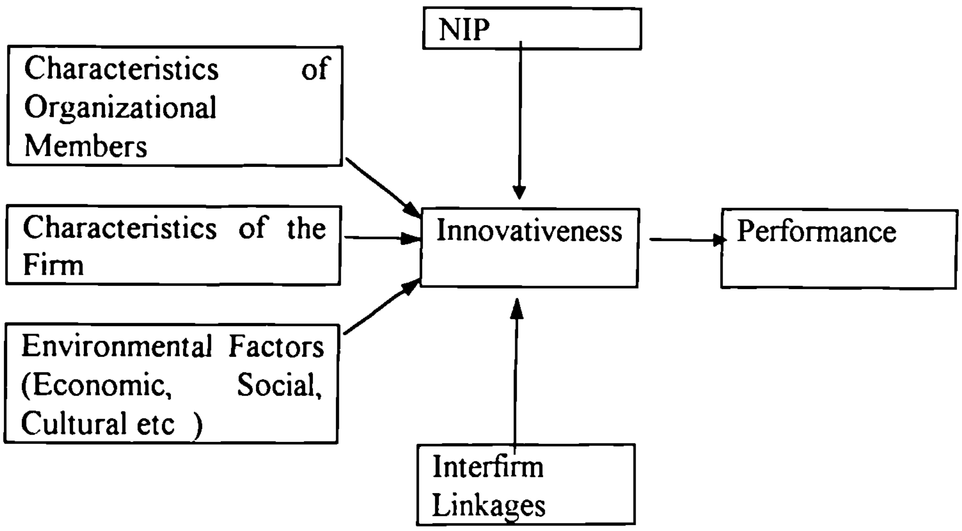


Fig. No: 2. 7 The 'Antecedents' Model of Innovation

Source. Adapted from King (1990) / Wolfe (1994) /Avlonitis et al (1994)

Innovativeness

Innovativeness can be defined in various ways. Rogers (1983, p.22) defines it as follows: "Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system". Some measures of innovativeness based on this definition are the elapsed time of adoption, the subjective opinion of 'expert' judges and the number of innovations adopted by the firm out of a list of innovations Alternatively a simple dichotomous measure of adoption or not of an innovation in a specified time period can be used.

There are however problems when a single innovation is used as the criterion in that it may prove to be a biased measure favouring certain types of firm. Experts prefer multiple innovations as providing a more reliable criterion. For example Damanpour (1991, p.556) states "Organizational innovativeness is more accurately represented when multiple rather than single innovations are considered". Avlonites et al (1994) considers innovativeness as a multidimensional concept with both technical and behavioural components

An ideal measure of innovativeness would therefore include several dimensions (e.g. number of innovations, importance of innovations i.e. radical or incremental) and both subjective and objective measures. Each dimension would itself be a composite measure. For innovation novelty as an example and referring to product innovation only Mc Grath et al (1995) use several indicators (newness of product, of market, customer need, technology, distribution channel etc.).

Since ideal measures are difficult to be applied in practical research a compromise is usually arrived at, adapted to the needs of the specific study. For our purposes the broad innovation activities of the firm are considered. Innovativeness is indicated by both subjective measures based on perceptions of managers and objective innovation output measures. These refer to changes in products and production processes and the overall performance of the innovation efforts. The exact measures and indicators are discussed in the methodology Section (4.1). They broadly refer to the number of new products developed, the degree of technical change in the production process and the overall performance in technological innovation relative to competitors.

A1. Characteristics and Behaviour of Organizational Members

Particular attention has been given to leaders and decision makers. As leaders can be considered the innovation project managers, but more frequently the chief executive of the firm or the appropriate organizational unit (division etc.). Biographical characteristics, personality and attitudes are the three main groups of variables which have received attention

Biographical (demographic) characteristics of the chief executive include age, sex, family background, education, job experience, tenure in the company, cosmopolitanism, even race It is not possible to consider here in detail all these characteristics, but only two as examples Education of owner/manager has been identified as an important factor in small firm success (including success in innovation), although it appears that the type of education rather than the level is *important (Gudgin et al, 1979 - Lloyd and Dicken,* 1982) Educational experience can make managers more receptive to change (Romano, 1990) Job experience (training) in business has been suggested as important in providing the manager with knowledge helpful to the current operations (Dickenson and Kawaja, 1987)

Personality related characteristics include need for achievement, locus of control, tolerance for ambiguity, and risk taking propensity. In small firms Miller and Toulouse (1986) have found that *need for achievement* is not correlated with innovative success. The concept of the *'locus of control'* can be explained as follows: "a person with an internal locus of control believes that the consequences of his/her behaviour are the results of his efforts, while an 'external' person perceives the events of life as beyond his/her control" (Rotter, 1966 as cited in Kim et al ,1993, p.218). Internal chief executive officers were found to favour innovation strategies and thus introduce more new products and processes (Miller and Friesen, 1982 - Miller and Toulouse, 1986).

Tolerance for ambiguity is the tendency to perceive an ambiguous situation as desirable rather than as threatening (Budler, 1962). It is regarded as an entrepreneurial quality and is believed to be a positive factor promoting innovation activities in small and medium size firms, because the outcome of the innovation process is unpredictable. Regarding the *risk taking propensity (RTP)*, given the risk inherent in the innovation process, the top manager's RTP is indispensable for the successful initiation and implementation of innovation projects (Kim et al, 1993). Khan et al, (1989) found a positive relationship between an entrepreneur's propensity to accept risk and product -service innovations in 50 small firms in USA.

Managerial attitudes to innovation and management style are included under the 'attitudes' label, although clearly both are also related to personality as well. Managerial attitudes toward innovation are recognized as the most critical factor determining technological innovation in SME in Korea (Kim et al, 1993). Top management's support is considered important to initiate innovation and coordinate subunits in the implementation process In the context of SME where decision making power tends to be concentrated in top management, managerial characteristics including attitudes would have a greater impact on the adoption of innovation than in larger firms (Miller and Toulouse, 1986) Regarding management style, successful innovation is associated with open management style (Burns and Stalker, 1961). Management style must allow space for imaginative and creative activity to stimulate effectively successful innovation (Romano, 1990)

Other organizational members apart from leaders and top managers usually considered are idea champions and change agents (insiders and occasionally outsiders). Their importance is higher in larger firms and for this reason are not further considered here. Employees are less frequently considered in the literature; and when they are considered it is usually in the context of their resistance to innovational change.

A2) Characteristics of the Organization

These include: size, structure, resources, knowledge, age, strategy, culture and climate.

Organizational size has received a lot of attention as a determinant of innovativeness. The results of the research are however controversial. One of the reasons is the variation in the operationalization in size measurement. Measures can be either personnel based (i.e. the number of employees) or non-personnel (capacity, volume, or financial) e.g. the sales turnover and the assets of firms. Occasionally a combination of both is used. Different measures of size would probably be appropriate for different types of organization e.g. a personnel measure for labour intensive organizations, a volume measure for chemical companies etc (Damanpour, 1992). Damanpour (1992) has found a slightly stronger size-innovation correlation when a log transformation rather than a raw measure of size was used which suggests a curvilinear relationship between size and innovation rather than a linear one This means that innovation increases with size at a declining rate.

Another concern is that size may actually be a surrogate measure of several dimensions that lead to innovation. According to Swann and Newell, 1995, p.852 "the relation between size and innovation probably emerges due to other dimensions associated to innovation e g total resources, proportion of scientists and engineers and organizational structure which are themselves associated to size". Damanpour (1992, p.395) states something similar "size is a broad organizational variable that not only affects innovation directly, but also indirectly through its effects on other properties (variables) of the organization". Due to its importance for the purposes of this study the question of size and innovation is further discussed in Section 2.4.4.

Structure has been operationalized in a number of dimensions including *centralization* i.e. the extent of concentration of the authority and decision making at the top of the organizational hierarchy, *formalization*, i.e the emphasis on rules and procedures and *complexity*, i.e occupational specialization and task differentiation.

The effects of structure on innovation have been examined extensively starting with Burns and Stalker (1961) who found a strong positive relationship between organic (that is flexible) structure and technological innovation of firms in the U.K. The relationship between centralization and innovation is ambivalent. Decentralization and a participatory work environment lead to an increase in team members' awareness, commitment and involvement in innovation. On the contrary, the implementation of innovation requires strong leadership to overcome resistance and difficulties (Damanpour, 1991-Zaltman et al, 1973) In the context of small firms Khan et al (1989) found a negative relationship between centralization and innovation.

Formalization is considered as an inhibitor to innovation because "rigid rules and procedures may prohibit organizational decision makers from seeking new sources of information" (Zaltman et al, 1973, p.138). Organizational complexity is held by Zaltman et al, 1973 to be positively related to innovation initiation and negatively related to its implementation *Professionalization* a concept related to occupational specialization reflects the professional knowledge of organizational members (Hage and Aiken, 1967). Professional staff (and in the case of technological innovation especially scientists and engineers) through experience and external contacts provide inputs which facilitate innovation *Administrative intensity* a possible measure of task differentiation indicates the ratio of managers to the total number of employees in the firm. The higher the proportion of managers, the higher the adoption of innovations since this adoption depends on the leadership, support and coordination managers provide (Damanpour, 1987)

Organizational Resources measures are found to be positively related to innovation (King, 1990) Attention has also been given to slack resources i.e. the degree to which uncommitted resources are available to the organization (Rogers, 1983). There are problems with the operationalization of 'slack resources'. The concept of slack according to Rogers and al (1976) is as much psychological as financial i.e. whether the organization leaders *believe* resources to be available specifically for innovation. Resources in the form of 'sunk costs' can be *negatively* associated to innovation in the sense that the organization may fail to 'exnovate' from a failed innovation. In the case of technological innovation technical resources e.g. technical experience and investment in R&D are of particular importance.

Organizational knowledge of innovations indicates the organization's ability to identify potentially useful innovations in the environment (King, 1990). It is affected by both the characteristics of key people (professionalism, cosmopolitanism etc.) and the extent of encouragement and engagement in active innovation-seeking behaviour within the particular organization.

Organizational age is a controversial variable. Different researchers suggest conflicting relationships between organizational age and innovativeness e.g. Aiken and Alford (1970, p 32) suggest a *negative* relationship since in their words "the older the organization, the more bureaucratic the system and the less receptive the system is to policy innovations." In contrast to the above Kimberly and Evanisko (1981) have found positive relationships between age and both technological and administrative innovation. The operationalization of age is also problematic either referring to the absolute age of the organization or the length of tenure of the leader (or other strategic organizational members).

Organizational strategy, climate and culture are also important determinants of innovativeness A common approach to strategy is to identify strategic typologies with reference to innovation This approach is further discussed in Section 2.4.3. Due to its importance for this research, innovation strategy is allocated a whole section (2.4.3). Brooks et al (1987) have found that strategy is an important determinant of the level and type of innovation Similarly Cooper (1984) found strategy to be a significant predictor of a firm's product innovation Strategy can be considered at an aggregate level or specific components of strategy deemed important for innovation can be analyzed. Such components include R&D intensity, external technological linkages, internal controls etc. Khan et al (1989) consider as components of strategy: Planning, analysis, explicitness and integration They consider functional factors like controls, communication, integration of decision making and environmental scanning as a separate group. Their findings are analyzed in Section 2 4 4

Other specific aspects of strategy can also be analyzed in relation to innovation. For example Molero (1996) has found that firms with the greatest regularity of innovation are the ones most inclined to internationalization (export propensity, investment abroad etc). Organizational climate and culture are identified as important antecedents of innovation by many writers e g Fischer and Farr (1985), Kanter (1983). They are similarly further treated in Section 2.4.3

A3) Extra-Organizational (Environmental) Factors

The factors outside the organization are generally called environmental. The term may refer to the market or sector within which the organization operates or may include political, cultural, geographical etc. variables. For our purposes environmental variables are divided in two groups, the first refers to specific aspects of the environment (e.g. country, region, sector, financial or political environment etc.) The second group refers to the nature of the environment (environmental dynamism, complexity and hostility).

Country and sectoral effects are discussed in Ch. 3 in the context of Cyprus. The discussion there includes aspects of the financial environment, cultural influences and the important effects on innovation of Government policies. The effect of networks on innovation can also be considered as an environmental influence and is analyzed in detail in Section 2.5

Environmental dynamism indicates how frequently elements in the environment are changing (Duncan, 1972) Sudden changes in customer demand, product technology or market competition, are more likely to force the firm to make product or production technology changes in order to cope with environmental change (Kim et al, 1993). Dynamism can be considered as a similar concept to *environmental turbulence*. Aiken and Alford (1970) state that a high degree of turbulence in the environment (i.e. instability and unpredictability) will stimulate innovation by making organization more aware of 'cues' to innovate

Environmental complexity, also called environmental heterogeneity, refers to the number of external elements that are relevant to the firm's operation (Jurkovich, 1974 - Kim et al 1993) It has been found to have a positive impact on organizational innovation (Baldridge and Burnham 1975-Kimberly and Evanisko 1981).

Environmental hostility indicates the degree of competition the firm faces in the market (Miller and Friesen, 1982). The more hostile the environment, the greater the need to obtain a competitive advantage in production cost and/or market differentiation and therefore the more likely the firm to be innovative.

Criticism of the Antecedents Approach

The antecedents approach to innovation research has received a lot of criticism. The main points can be summarized as follows:

I) Variables are frequently difficult to operationalize e.g. organizational size and age, environmental complexity. The use of inadequate or inappropriate measures adds to confusion and is a barrier to the cumulativeness of innovation research.

II) Variables may have different effects according to the stage of the organization's life -cycle (Miller and Friesen, 1984).

III) Wolfe (1994) criticizes the antecedents approach for a *static* orientation since changes of innovation during the innovation process are ignored. The *static model* of discrete innovation development or adoption can be contrasted to the *evolutionary* model where the firm has the technological knowledge to develop a particular innovation and adapt it later (post-innovation) to the changing constraints and opportunities of a dynamic environment. The issue of technology evolution is further discussed in Section 2 4 3.

IV) The antecedents approach focuses mainly on the adoption (or the development) decision rather the implementation of innovation.

V) The determinants of innovation may interact and the exact way of interaction is not (or partly) revealed in antecedent studies.

VI) Wolfe (1994) also notes that meaningful antecedents research necessitates degrees of variable variance and sample sizes that may be impractical.

VII) The antecedents approach tries to identify common features among innovators. If, however, firms do not necessarily share the same *motives* in innovating as it is quite reasonable, then the pursuit of a homogenous set of variables as innovation determinants may turn out to be unrealistic. This may explain some of the contradictions certain authors have found in past research (Lefebvre et al, 1991).

VIII) The antecedents model, as also indicated above, appears sequential and this is a deficiency, since feedback loops are ignored for the sake of simplicity.

B) The Process Approach

This approach addresses the process of innovation within organizations i.e. how and why innovation emerges, develops, grows and (perhaps) terminates (Wolfe, 1994). The unit of analysis is the innovation process. Process research, in general, is aimed at "developing descriptive accounts and explanations through looking at patterns and sequences of events over time " (Pettigrew, 1992).

There are numerous models proposing the stages of events comprising the innovation process A representative example i.e. Van de Ven's model has already been considered in Section 2 3 Similarities and differences among models can be examined according to King (1990) in their initiation-implementation balance i.e. their relative emphasis on pre- and post-adoption stages and the depiction of the start and the end of the process.

Wolfe (1994) differentiates between two generations of process research. The earlier is the *stage model* research which conceptualizes innovation as a series of stages unfolding over time It tries to find out if identifiable stages do exist and which they are and their order Few empirical stage model studies have been conducted. The existing evidence indicates that identifiable innovation stages do occur. The degree of occurrence in a predictable order depends on the nature of innovation and its source (Ettlie, 1980).

The stage model research can be criticized in that innovation may be not simple, but complicated with a complex iterative process having many feedback and feed-forward cycles They are not therefore accurately represented by simple sequential stage models. Schroeder et al (1989) have criticized all the conventional stage-based models for their lack of grounding in observations of actual innovations, and questioned whether discrete stages in the process can in fact be identified. They have proposed an alternative more fluid model, which was depicted in Fig. 2.3 in Section 2.3, and is further considered below in the discussion of the MIRP project.

The second generation is simply called *process research* and it involves in-depth longitudinal research trying to describe the sequences of innovation processes and the conditions affecting them. The second generation research focuses on the 'precursors' i.e. the organizational context (strategy, structure, resources, technological strength), but also organizational policies and their outcomes i.e. the innovation process and its divergent and parallel paths. The precursors is of course another name for antecedents.

An example of the second generation process is the MIRP (Minnesota Innovation Research Program) The results of this multi-year, multi-researcher, multi-disciplinary project were collected in a book (Van de Ven et al, 1989). MIRP researchers adopted a common framework and methodology to compare findings across the innovations studied. This framework defines the process of innovation development with *five* core concepts which were used to observe how innovative *ideas* are developed and implemented by *people*, who engage in *transactions* (or relationships) with others and make the *adaptations* needed to achieve desired *outcomes* within changing institutional and organizational contexts

Based on the results of MIRP work a model was constructed [Fig. 2.3, Section 2.3 - Van de Ven, 1993] viewing innovation stages as *activities* or *events* occurring throughout the process over time The administrative and context factors are considered not as constants, but as emergent and changing through events and activities over time. Six process elements affect the multiple activities over time. These are according to Van de Ven (1993, p 275) the following:

Gestating events Innovations studied by MIRP occurred after an extended gestation period frequently lasting for years. A variety of coincidental events may occur during this period setting the stage for launching the innovation process.

Shocking events: Concrete actions to allocate resources and initiate innovation development appear to be triggered by 'shocks' from sources internal or external to the organization.

Proliferating events: After the initial innovation decision the process does not follow a simple linear sequence of stages, but it proliferates into divergent paths of activities by different organizational units (functions) developing their own innovation agendas. Instead of a single process there is a proliferation of multiple, parallel, and interdependent activity sequences.

Setback events: There are frequently mistakes, setbacks and change of the initial plans during the innovation process. They may lead to innovation failure, but also to 'reinvention' and eventual success with valuable learning experiences for future innovation activities in the way.

Learning events: Learning and adoption speed are facilitated when innovation is developed within the user organization. Innovations adopted from external sources need the involvement of organizational participants in the adoption process and their modification for the local circumstances which imply learning and gradual development of commitment.

Shifting innovation characteristics (novelty, size, duration): The effect of these contingent factors on the innovation outcome has been established in the MIRP project. The chances of success increase with experience and learning from past innovation trials and decrease with the novelty, size and temporal duration of an innovation project While proper management cannot ensure innovation success it can improve its chances of occurrence.

Pavitt (1989) criticizes the Minnesota Innovation Research Program on processes of technological innovation in that their analytical framework, consisting of five elements as mentioned above i e. people, ideas, transactions, context and outcomes, is far too broad (encompassing change in general) and is therefore not *specific* enough for change specific to technological innovation. While it is true that the same concepts could be used for studying any process of change, whether involving technological innovation or not, they are essential in the study of innovation. More work on their exact specification for innovation and perhaps their complementation with some technology concepts is needed.

C. Other Approaches to Innovation Research

'Types of innovation' research is a stream of research comparing different types of innovation e.g. the technical and administrative distinction. Zaltman et al (1973) has proposed a typology categorized on three dimensions: a) programmed-non programmed (i.e. scheduled or not) b) instrumental-ultimate (instrumental are those introduced in order to facilitate the subsequent introduction of ultimate innovations and c) radical-not radical (radicalness can be seen as a combination of an innovation's novelty and riskiness. The radical type is novel and risky). The above dimensions can be used in real life cases. Product versus (production) process innovation is another well-known differentiation.

Differentiation of innovations into technical/administrative or product/process is important since the different types of innovation may not have the same determinants and may involve distinct innovation processes. Separate research would then be needed within each class of innovation. Damanpour (1991) has, however, found in his meta-analysis of the effects of determinants on innovation that the types of organization adopting innovations are more significant moderators of focal relationships than the types of innovation. This means that innovation determinants are more likely to differ among different types of organization such as large versus small firms or manufacturing versus service organizations.

Diffusion of innovation approach has as its objective to explain or predict rates and patterns of innovation adoption over time and/or space by a population of potential adopters A limitation of the diffusion of innovation research stream is according to Wolfe (1994) the stringent set of assumptions of the classical S-shaped diffusion model i.e. that of an invariant unit of innovation and a definable population of potential similar adopters which frequently are not valid.

The traditional diffusion research dealt with the adoption behaviour of individuals (farmers etc) the diffusion research among organizations followed that tradition, but the simplistic and inappropriate 'anthropomorphizing' of organizational characteristics (Yin, 1978) led to disappointing results.

The 'Barriers to innovation approach' concentrates on the main barriers i.e. obstacles to innovation usually as perceived by the managers of the firm. It may also include factors motivating innovation i.e. facilitators. The aim of the research is usually not only to locate and list the barriers but also to observe and attempt to measure their consequences which is the really difficult part. The research results of a comparative study in the European

Community which focused mainly on SME (Piatier, 1984) are summarized in the Section 2.4.4 on small firms.

The economists' approach as defined here i.e. a supply/demand approach and emphasis mainly on objective /quantitative factors rather than organizational concepts is followed in a number of studies on innovation, or closely related topics as e.g. technological capability (some of them of immediate interest to the present research since they refer to developing countries).This is a vast area and only one example of such an approach, the study of Lall et al (1994) on Ghana, is considered as it refers to a developing country.

The study of Lall et al (1994) examines the technological capabilities of firms through a combination of survey and case studies by measuring such variables as investment in plant and equipment, human capital and technology level (with capital labour ratio and productivity of labour). Reference to the results of this study is made later in the appropriate Section 2 4 4.

Innovation and Performance

All the above approaches to organizational research, and especially the economist's approach, have something to say about performance. Performance is a complex and multidimensional concept. Two important dimensions of performance are:

I) The time-frame of assessment (long or short term)

II) The type of performance outcome (financial or non-financial).

Performance is closely related to concepts like organizational effectiveness and competitiveness (e.g. international competitiveness, which is the ability to compete in world markets). The multiplicity of the criteria of performance assessment reflects the difficulty to measure it. Usually they are *financial* like return on assets, return to capital employed and profitability complemented with *market performance* criteria like sales growth and market share growth and sometimes *employment* criteria e.g. employment growth. Each firm attaches different importance to different criteria and this relative importance should preferably be reflected in the performance assessment.

The criteria of performance may be contradictory to some extent among themselves, as an example the well known dilemma is mentioned between short term costs versus the long term benefits for pioneers (first movers/ innovators). Instead of the objective criteria mentioned above for which exact data are frequently difficult, if not impossible, to obtain in organizational research, subjective criteria are frequently used in performance assessment e.g. the relative ranking of the firm by the firm's managers against the largest competitor or against some average of the sector. The criteria used for performance measurement in the present study and the justification of their selection are presented in Ch. 4 on Methodology.

Although some studies support a high innovation - high performance linkage (Rumelt, 1987) the relationship appears tenuous (Parnell et al, 1996). Studies of Miller (1988) have not confirmed the link between innovation and performance. Even if such a relationship exists however, there are further questions regarding the direction of causation which is not possible to establish in survey research and the duration of the lag between the innovation and its impact on the performance of the firm.

Summary

The antecedents approach has been selected in this research as the most suitable model for the formulation and testing of empirical hypotheses. Some of these hypotheses based on the above discussion are presented in the next page. The process approach, despite its importance is not used due to time and resource constraints as explained in Ch.4.

Hypotheses
3. *Innovativeness of firms varies in the various sectors.*
4. *Innovativeness is influenced by the characteristics of the SME owner/manager (e.g. Education Level, Age, Prior business experience, Cosmopolitanism.*
5. *Innovativeness is influenced by the characteristics of SME (e.g. Size, Age, Sales Turnover, Degree of Internationalization, R&D expenditure, Number of scientists and engineers, Environmental Scanning and Strategy).*
6. *Innovativeness is influenced by environmental factors (e.g. Intensity of competition, Environmental change etc.).*
7. *Innovativeness is influenced by entrepreneur's perception of external barriers.*
8. *Innovation affects positively the performance of firms.*

2. 4. 3 Strategic Management of Technological Innovation

A) Innovation and Strategy

A multitude of terms is used in the literature for the management of technology and of technological change. Terms like technology strategy, technology policy, technology management, (and alternatively management of technology-MOT), strategic management of innovation etc. are sometimes used interchangeably or may have subtle differences in their use.

Strategic management of technological innovation and technology strategy are used as broadly equivalent in the rest of this section, although it is recognized that they are not always considered as equivalent in the literature. Another viewpoint would treat technology strategy as the broader concept which includes the subset of the strategic management of innovation.

Clark and Thomas (1990, p.275) define strategic management of technological innovation as "the process by which organizations formulate and implement strategic technological change" Pavitt (1989, p.79) offers a more detailed definition which includes all technological activities "The management of technology-related activities, central to the long-term survival of the firm, ranging from the continuous improvement of existing products, processes and services through the introduction of new ones to activities designed to enter new fields".

A 1987 National Research Council (NRC) study in USA defines management of technological innovation as linking "engineering, science and management disciplines to plan, develop and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization" (Mogee, 1992, p.413). In my view technology, technological change and innovation are so closely intertwined, that the broad definitions of Pavitt and NRC are to be preferred.

The technological dimension of competitive strategy or put differently the links between technology and business strategy have received a lot of attention especially after 1980 in the strategic management literature. Similarly Pavitt (1986) notes that there is a shift in innovation research in the 1980's from the tactical problems of innovation to strategic ones.

Porter (1985) suggested that technology as a strategic variable can change the competitive 'rules of the game' by impacting on all the five forces of competition. It is or may become a source of competitive advantage. The latter is built through the effect of technology on cost drivers or on differentiation (or possibly on both of them). The firm can be seen as a collection of technologies throughout its value chain. For some of the technologies there is interdependence and connections to the value chains of suppliers and customers.

Strategic decisions in general, and therefore technology strategy decisions as well, conform to several characteristics (Langlois, 1995) i.e. they affect the entire firm, are made by top managers, are long-term in nature and are based on perceptions of the future rather than on hard knowledge. The strategic paradigm in the case of technology and innovation relies on the argument that technology is an essential element of strategy and therefore must be integrated into the strategic thinking and planning processes of the firm.

In this section the resource-based view of the firm is discussed first as a unifying theory of strategy (Maijoor et al, 1996) which is closely related to the evolutionary approach to technological innovation adopted by Nelson and Winter (1982). It is linked with the complementary configurational approach of Miller (1996) as the theoretical base for the discussion of the Strategic Management of Technological Innovation (SMTI). Then the role of organizational learning as the integrative concept in SMTI formulation and implementation, is presented, followed by a summary of the types of innovation strategy, and finally SMTI itself is considered in more detail. It is acknowledged that all these parts are major topics in their own right and only the most relevant aspects to the present study are touched upon.

B. The Resource -Based Theory

According to Maijoor et al (1996, p.549) "the resource based view of the firm seeks to bridge the gap between theories of internal organizational capabilities on the one hand and external competitive strategy theories on the other hand". It complements and integrates contributions from many perspectives especially industrial organization and transaction cost theory. This theory focuses on the firm's resources and capabilities to understand business strategy and to provide direction to strategy formulation (Andreu and Ciborra, 1996).

Resources are defined as those tangible and intangible assets that are tied semi-permanently to the firm. (Maijoor et al, 1996, p.550). They are physical, human, technological or reputational. They include in-house technology and employment of skilled personnel (Dollinger,1995). Innovation related resources are further discussed below

Miller and Shamsie (1996) distinguish between property-based and knowledge-based resources, the latter are of greater utility in uncertain i.e. changing and unpredictable environments. *Knowledge -based* resources often take the form of particular skills for example technical and collaborative. They allow the organization to respond and adapt to challenges and are closely connected to the ability to innovate. Miller and Shamsie (1996) further subdivide them to *discrete* and *systemic* knowledge-based resources. Technical skills fall within the first category, while integrative skills required for multi-disciplinary teamwork in the second. Collaborative skills are most subject to uncertain imitability. They can be extended to include those required to reach outside the firm and seek complementary sources of know-how from other firms and institutions (inter-organizational networking).

The resource dependence theory is actually based on the premise that few organizations are self-sufficient with respect to critical resources. The lack of self -sufficiency leads to dependence on other firms and introduces uncertainty into the firm's decision making environment. Collaboration with other firms e.g. formation of strategic alliances is one way of creating governance mechanisms to reduce uncertainty and manage dependence (Varadarajan et al, 1995).

The resource based view of strategy is concerned primarily with how the firm can secure the factors needed to create the core competencies and capabilities that form the basis for establishing and sustaining competitive advantage or competitive effectiveness. Competitive advantage is a function of the firm's ability to create idiosyncratic, relatively inimitable resource endowments which then become *strategic assets* (Amit and Shoemaker, 1993). Strategic assets derive not only from a firm's factor endowments, but also from the ways of their combination and utilization.

These 'ways of combining' become routinized over time (Nelson and Winter, 1982), where *routines* are defined as repetitive patterns within an organization. Routines often possess a tacit dimension making them difficult to identify or copy. Resources and routine accumulation are path dependent i.e. their current state is affected by past history.

Resources are therefore combined in routinized, but idiosyncratic ways which imply heterogeneity in the strategic position of firms. Innovation may bring considerable benefit to the firm when superior resource combinations are discovered, since the new combinations may incorporate difficult-to-imitate routines. It takes time before a combination is matched by competitors (Mc Grath et al, 1996). Innovation can then be seen as a mechanism of generating valuable new resource combinations specific to the firm and appropriable mainly by it.

Innovation capabilities can be considered as a subset of organizational capabilities. They are defined by Burgelman et al (1996, p. 8) as "the comprehensive set of characteristics of an organization that facilitate and support innovation strategies". By way of example some innovation capabilities are mentioned here, such as the capacity to understand competitors' strategies, industry evolution and the firm's technological environment (Burgelman et al, 1996).

Mc Grath et al (1992, p. 138) criticize the resource-based theory for inadequate *practical* strategic management guidance. In their words "as yet it offers little theory which would help a strategist make a particular deployment decision, let alone establish a sufficiently consistent stream of such decisions as to be termed strategic". According to Miller (1996) the literature based on the resource theory is quite focused and usually concerns *parts of strategies* rather than wholes. Therefore understanding of how a company can effectively develop and implement a comprehensive strategy is far from perfect. There are many missing links between the capacities to produce sustainable superior 'rents' or core competencies and the vision of the firm which inspires and 'orchestrates' its strategy, structure and process. This is why the configuration view is brought in as a complementary theory.

C) The Configurational View

Miller (1996) proposes the *configurational view* as a way to develop deeper understanding of these links or relationships between resources, competitive strategies, learning mechanisms and market conditions. *Configurations* are defined as types or categories representing common alignments of elements (Miller and Shamsie, 1996). Initially they were proposed as alignments of strategy and structure, but as recently extended by Miller (1996, p. 508) they may include: "organizational co-requisites of different generic strategies or resources e.g. organizational skills, decision support systems and coordinative mechanisms". A small number of organizational configurations or types can be used to describe the vast majority of organizations.

The configurations approach incorporates the theory-based typologies (from the simple typology of Burns and Stalker, 1961 into organic and mechanistic firm structures to the innovation strategies typologies of Freeman, 1982). The latter are discussed in the following. Configurations are, however, preferably based on the taxonomy approach i.e. *empirically* derived types such as strategic groups or the configurations of Miller and Friesen (1984) which are presented later in this section.

Miller (1996, p.509) adds a third approach to studying configuration shifting the focus from typologies and taxonomies to configuration as a quality or property that varies among organizations. Configuration in this sense is defined by Miller (1996, p.509) as "the degree to which an organization's elements are orchestrated and connected by a single theme". For example in an innovative firm strategies may emphasize R&D and innovation, control systems reward innovative activities and information systems focus on technological data to support innovation. A powerful unifying theme may offer synergy, clarity of direction and coordination, difficulty of imitation, distinctive competence and speed. As usually, however, too much of a good thing could lead to the opposite effects, in this case rigidity and lack of balance.

The value of the configurations approach is the emphasis on interdependencies of elements and the networks of relationships. It can serve as a paradigm for the multivariate analyses of quantitative survey approaches, as well as, for qualitative research on innovation. The classification of firms by innovation strategy in the case study research of the present thesis (Section 5.2) is based on the configurations approach.

D) Organizational Learning and Innovation

Di) The Nature of learning. Learning has been defined as "the ways firms build, supplement and organize knowledge and routines around their activities and within their cultures, and adapt and develop organizational efficiencies by improving the use of the broad skills of their work-forces" (Dodgson, 1993d, p.377). This definition implies that learning occurs throughout all the activities of the firm and that organizational learning is somehow something more than the parts of learning by individual employees. According to Mezias (1995) the whole management of technology can be modelled as an experiential learning system (routine based, target oriented and history dependent). Similarly Burgelman et al (1996) state that technological strategy can be conceptualized as an evolutionary learning process.

Firms which pay particular attention to learning and design structures and strategies to facilitate it are called 'learning organizations'. Pedler (1989 as cited in Dodgson, 1993d p.377) defines the learning company as "an organization which facilitates the learning of all its members and continually transforms itself". Such firms emphasize training and human resource development strategy.

Writers on learning distinguish separate types of learning and they actually describe a hierarchy of learning activities with the implication that higher forms of learning have higher management requirements. For instance Argyris and Schon (1978) distinguish between:

Single loop learning aims at achieving present objectives and provides feedback on their achievement.

Double loop learning aims to the detection and correction of errors through the modification of the norms, policies and objectives of the organization.

Deutero-learning occurs when organizational members reflect about previous learning experiences and invent and evaluate new strategies for learning.

An alternative view connects learning to the concept of 'organizational routines' (Nelson and Winter, 1982). Routines refer to business practices and are the organizational analogue of individual skills (Hendry et al, 1995). Single loop learning corresponds to the maintenance of the existing routines and double loop to their incremental improvement. Deutero-learning would then correspond to changing of routines or importing new ones. Innovation especially of the radical type frequently requires change of routines.

Technological learning can be considered as a subset of organizational learning. It is defined by Hillebrand (1994, p.17) as "The process of mastering and then continuously improving production processes in firms". This definition, in the development economics tradition, places emphasis on production as a central technological activity in developing countries, but it seems rather restrictive since technology permeates all activities of the firm. The focus here is mainly on technological learning as a major factor in innovation.

Why do firms learn? In other words what motivates learning? Learning is viewed by management theory as a purposeful activity i.e. it aims to certain positive outcomes. It is interesting to note that even if an activity fails it may have positive results from a learning point of view (learning from failures). Fast technological changes e.g. the pervasive effect of information technology and market/environmental turbulence are considered as the main inducements for firms to learn and adapt their practices (routines) to the new conditions.

Innovation, and especially its technological variant, as a phenomenon representing change is at the same time a strong motive for learning and an outcome of learning. The relationship of learning and innovation can be examined at two levels (Dodgson, 1993d). Firstly at a strategic management level and then at a tactical management level (e.g. in the new product development process). The two levels are obviously interdependent and complementary. We are more concerned with the first here.

Dii)The Processes of Learning. Learning is a complex, multilevel phenomenon starting at the individual level and escalating to the collective level (Dodgson, 1993d). It takes place in many functions of the firm and its various types are probably complementary to each other. Learning has a multitude of sources, involves several activities and has a number of outcomes Organization theory has studied the processes and outcomes of learning.

The firm has many potential *sources* of learning and the literature suggests that use should be made of a variety of them. The sources of technological learning can be distinguished into internal and external. Internal sources include R&D and production. Research and development is a major source of technological learning for the firm. Cohen and Levinthal (1989, p.569) argue that learning occurs not only in the focal area of R&D, but also in the process itself. In their own words: "while R&D obviously generates innovations, it also develops the firm's ability to identify, assimilate and exploit knowledge from the environment". They call the latter ability *learning* or *absorptive* capacity of the firm

Learning from manufacturing or production is also well recognized in the literature and the factory can serve in certain cases as a 'learning laboratory' (Leonard-Barton, 1991). Manufacturing as an internal source of learning is of particular importance for SME in developing countries which usually have little or no R&D capacity of their own. This is an important issue which is investigated in the case studies (Ch. 5).

External sources of learning include training, joint ventures, purchase of capital equipment, hiring key individuals, reverse engineering etc. This list, adapted from Hobday(1990), refers in particular to firms in developing countries which are of the main interest here. Suppliers and users have also been recognized as important sources of learning (Von Hippel, 1988). The centrality of interfirm links in technological innovation has been established through a number of studies particularly in the last decade (e.g. Rothwell, 1992).

There are several ways of classifying learning into separate *activities* or steps. These may include: search for specialized information on technological alternatives, technological negotiation, new product development and machinery and equipment adjustments and alterations.

The outcomes of learning can be improved skills and knowledge or even new skills for a changed situation. Eventually the new skills lead to higher innovativeness and performance. The problem is that the results of learning take time to appear and frequently there is no clear link between the learning investment and its outcomes leading firms to under-invest in training for false short-term economies.

Learning by doing was assumed by some economists to be automatic, passive and costless (Bell and Scott-Kemmis, 1990). This is not however the case for this or for any other type of learning. Learning requires initiative, effort, resources, commitment and management. The management of learning can be seen as a sequence of steps. The following provide an example.

- Setting goals for learning and designing suitable strategies and an accommodating structure. This implies that learning is recognized as an important activity. Organizations close to this ideal have above been called *learning organizations.*
- Allocation of resources to learning (internal and external training costs etc.)
- Human resource development: The role of individuals in learning and the importance of some key individuals is well recognized in the literature. Among them technology-gatekeepers (Allen, 1977) which act as intermediaries in bringing external technological information in the firm have received a lot of attention. Individuals often form teams and learning occurs at a team level. The role of an organizational culture with shared norms and values in individual, team and eventually collective learning has been underlined by many authors e.g. Hendry et al, 1995.

- Managing 'learning facilitators' (incentives, resources) and inhibitors (structural rigidity, control systems).

Dodgson (1993c) refers to the exemplary Japanese practices to promote collective learning. Hendry et al (1995) consider redundancy as an underlying principle of these practices. *Redundancy* involves "the conscious overlapping of company information, business activities and managerial responsibility" (Nonaka, 1991, p.102). Redundancy facilitates transfer of tacit knowledge and spreading of new one and promotes innovation and improvement.

Small firms have some obvious disadvantages in learning e.g. lack of resources for internal and external training and limited or no redundancy. They may have advantages as well, such as more effective internal communication and more closely-knit work teams. The important issue, for the present study, of learning in the context of small firms is further dealt with in Section 2.4.4.

E Typologies of Innovation Strategies

Innovation strategies differ among different firms. Many typologies of innovation strategy have been proposed in the literature. One of the most well-known is that of Freeman (1982) Freeman proposes the following six-fold classification: offensive innovation strategy, defensive, imitative, dependent, traditional, and opportunist strategy. Freeman has based his typology on the speed and timing of entry of firms into new technology.

Firms with an *offensive* innovation strategy are the leaders in introduction of new technologically based products, while those with a defensive strategy are fast followers in innovation. The other categories include less effective innovators and non-innovators. This classical typology is not further considered here, since it was based, especially for the first two categories, on the activities of large firms in industrially advanced countries. A typology more relevant to innovation in small firms is considered in Section 2.4.4.

Many other writers on innovation have proposed alternative typology schemes, usually contrasting two polarized strategies variously described as proactive/reactive, leader/

follower etc. or considering intermediate situations as well. Others use alternative typology dimensions. Some characteristic typologies that are further used in the classification of cases are briefly summarized in the following.

Urban and Hauser (1980) distinguish between *proactive* strategies, where firms try to forecast and anticipate environmental changes and *reactive* ones, where firms respond to customer demands and competitor activities. The first-mover advantages (building market share, reputation for innovation, etc.) and disadvantages (high development costs, costs of market education, risk of investing in the wrong technology or design) are associated with the proactive strategists. Reactive strategists or defenders on the other hand tend to adopt process rather than product innovations. The positive bias of the pro-innovation literature has led to underestimation of the "power of imitation strategy"(Kremen-Bolton, 1993).

Miller and Friesen (1984) distinguish between *entrepreneurial* innovators and *conservative* innovators. According to them entrepreneurial innovators "innovate boldly and regularly while taking considerable risks in their product-market strategies" (ibid., p.160). Their types are comparable to the proactive/reactive innovator dichotomy. Pavitt (1986) on the other hand distinguishes between innovators (investors) and non-innovators (traders).

All the above typologies have to be used with caution. Freeman (1982, p.173) notes that: "any classification of strategies by 'types' is necessarily somewhat arbitrary and does violence to the infinite variety of circumstances in the real world." The categories of Freeman for example, especially those apart from the first (offensive strategy), are also not pure forms, but overlap with each other. Despite these reservations, typologies are still considered useful for purposes of conceptualization. An important point concerns the implications of the type of strategy for the resources and organization of the firm. Freeman (1982), but also Maidique (1978), emphasize the different functional requirements of the alternative innovation strategies in terms of R&D, manufacturing, marketing, finance, organization and timing.

F. Technology Strategy / Strategic Management of Technological Innovation

Most scholars and researchers concentrate on the *content* of technology strategy. The *context* within which it is developed and the *processes* of generation, selection, and implementation of technological strategies are relatively neglected (Pavitt, 1986). The content, process and context of technology strategy are discussed in turn, in the following, in more detail. It has to be emphasized that all three are interdependent (and especially content and process) and they are only considered separately for the expedience of their analysis.

The Content of Technology Strategy can be described by listing its components. The description of components is different according to the literature source. Only two of the many examples are given. Rieck and Dickson (1993) propose the following six:

- Setting horizons
- Industry forecasting
- Technology positioning
- Determining technology availability
- Appropriating technology
- Managing technology

These components or tasks have different time frames starting from the very long (10-20 years according to the industry) and getting shorter down the list. The ordering of these components is also related to the process of strategy, since they start from broad strategy formation activities and end up with implementation activities e.g appropriating and managing technology.

Burgelman et al (1996) propose a different list of components or dimensions of technology strategy as they call them:

- Deployment of technology to the firm's product -market strategy.
- Broad use of technology in the value chain.
- Resource allocation to various technological areas.
- Managing the technology function.

Despite the terminology differences and the different emphasis on individual aspects of strategy of the above lists it is obvious that they have much in common. It could thus be said that the main components of technology strategy have to do with the selection and acquisition or development of technology, the type of innovation strategy (first-mover or follower) and the management of technology.

The Process of Technology Strategy. The dynamic view of technology strategy perceives it as the product of a complicated process (or processes) involving several actors and activities taking place in a temporal sequence i.e. in stages. This sequence is possibly fluid and not well defined as also mentioned in Section 2.4.2. The processes involve more than the technical function i.e. also production, marketing, finance and organization. This implies that the actors are top managers as well as middle managers and groups in the just mentioned functions, but possibly also external ones like outside consultants, clients and suppliers

The development of technology strategy (TS) is not, however, a pure exercise in the objective analysis of data and the selection of optimal solutions. Since TS involves many functions and professions and it is accompanied by major uncertainties, its formation (and implementation) is a matter of power struggles and compromise. It seems, as also mentioned above, that successful firms manage to develop *routines* or rules of thumb for TS formation including innovation development and implementation. Learning from past experience of 'doing' (using of technology, etc.), but also failing and reverse engineering (Pavitt, 1989) is a vital element in the development and continuous improvement of routines.

The processes of learning about the context (technological, etc. as described below) define the content of strategy and the implementation of the content then directs subsequent learning (Dodgson, 1989). In Pavitt's (1989) view the learning concept helps thus to resolve the sharp distinctions between content, context and process of technology and innovation strategy. The process view of innovation has been discussed in some detail in the Section 2.4.2 on theories about the innovating firm.

Regarding the steps of the technology strategy they can be considered as some sequence of the components mentioned above in the 'content' section or simply separated in two sets occuring within the formation and implementation phases respectively. Whatever steps (or stages) we accept, there is certainly overlapping among them and feedback or feed-forward loops. Another important point is that the activities are based on the perceptions of the actors (e.g. managers) and their interpretations of events in the environment and the internal situation in the firm.

The main decisions in TS *formation* can be seen as influenced by uncertainty and determined by fit and capabilities as explained below. *Uncertainty* refers not only to technological performance and the possibility of technology obsolescence but also to market demand and environmental changes affecting it, the potential product characteristics and the economics of manufacturing processes. Managers should find ways to cope with all these uncertainties.

The concept of *fit* is essential in strategic management and it has several dimensions. There is first a need for fit of the overall strategy of the firm with its environment and the firm's structure. Technology may affect this fit. The evolution of technology and the emergence of a dominant design and product standards change both the environment and the current strategy fit. Then there is the need of fit of the technology strategy with the overall corporate strategy. A prerequisite for the latter is the fit of the technology strategy with the capabilities of the firm.

Innovation *capabilities* were mentioned above. They include both innovation strategy formation and implementation capabilities. Brown and al (1989) discuss the idea of fit between decision and implementation inputs given some innovation goals. Decision inputs include corporate strategy, technology policy and the values of the top managers, while implementation inputs include structure and other factors necessary for the successful implementation of innovation. Implementation inputs are connected with capabilities as much as with resources. They are further considered below.

The separation of strategy formation from *implementation* is probably only an analytical convenience for the text-book presentation since in practice they are intertwined. The following factors are usually associated with technology strategy implementation: a) structure b) the human system c) the organizational culture and climate d) Specific tasks. Brown et al (1989) include structure, information flows, manpower flows, and key roles in the implementation inputs. The last two can be included in the human system of the previous classification, while information flow is actually a structural feature.

Structure has been considered in the section on the determinants of innovativeness. Research seems to suggest that the appropriate structure depends on the stage of the innovation process. While an organic (flexible) structure is needed in the idea stage for the facilitation of idea development and selection a mechanistic structure is better for the implementation stage (Damanpour, 1991). Teams and special task forces may be needed for innovation projects and the integration of the efforts of the various functions of the firm without much interference is a widely discussed problem. Innovation according to Van de Ven (1986) is not an individual, but a collective activity.

The human system is formed by individuals and inspite of the above statement of Van de Ven, innovation is also a matter of the individual. Firms have therefore to recruit innovative people and harness their individual innovation. One important aspect of promotion and encouragement of individual innovation is to find ways of rewarding innovation and helping people to work on new ideas. Such ways include the provision of incentives to technical people and innovation project teams and bringing technologists into the technological strategy formulation processes of the company. There is a lot of research on specific roles in innovation of e.g. 'innovation champions' and 'technological gatekeepers'. Since this literature has mainly focused on large firms it is not further explored.

Culture and climate are important intervening variables affecting the outcome of innovation strategies (Nystrom,1990). They refer to common values and norms which promote and support innovation. Informal relations and open communication across hierarchy levels and functions are considered important elements of implementing successfully innovation strategies. Leadership could also be considered under this heading. Van de Ven(1986) claims that innovation requires a special kind of supportive leadership.

Specific tasks are involved in the implementation of technology and innovation strategy. They include product and process development, internal and external technology sourcing and many others. Some of them demand the use of special 'tools'. The use of financial analysis methods, such as the net present value analysis (NPV) in new product development can serve as an example of such tools. Project management techniques, technology audits and technology forecasting are some other examples.

The context of TS can be considered under two main categories i.e. environmental (or outer) and organizational (or inner) context. There are several aspects of context within each category. *Environmental* context includes the technology, industry and national aspects These are briefly discussed in turn:

A firm's technology strategy is based on the evolution of its technological capabilities over time. These capabilities are not, however, entirely endogenous since they are affected by the evolution of the technology itself. Some aspects of this evolution are according to Burgelman et al (1996): a) the evolution of technologies along S-curve trajectories. b) The interaction between product and process development (e.g. emergence of a dominant design produced by a particular production process) over the course of a particular technological trajectory and c) the emergence of new technologies and their competence-enhancing or destroying consequences.

Important aspects of the industry context of TS are:

- The industry structure as captured in the five forces model of Porter (1980).
- The appropriability regime associated with a particular technological innovation (or a bunch of related innovations -Teece, 1986).
- The emergence of dominant designs and industry standards with their repercussions for industry structure, conduct and profitability (Abernathy and Utterback, 1978).
- The social systems aspects of industry development and their interaction with technological aspects.

The *organizational context* category can also be seen as determined in an evolutionary process i.e. it is dynamic and past-dependent. Some of its aspects include:

a) The dominant technology culture within the firm which is partially determined by its current competencies in science and engineering. The latter include design and manufacturing technology b) the organization culture e.g. the cooperation climate within the firm and the degree of external orientation towards customers c) the organization structure, especially aspects of information gathering and communication and d) the background and managerial style of the chief executive.The latter is especially important for implementation of innovation in small firms as also argued later in the next Section (2.4.4).

G) Summary

Section 2.4 3 has briefly considered the important topic of the strategic management of innovation. It has first introduced the resource-based theory of strategy and the complementary configurational view as the theoretical framework. Organizational learning was then considered since innovation strategy is essentially a learning process, while building knowledge resources through learning is a key component of innovation. Typologies of innovation strategies, as part of the configuration view, serve as a useful description of innovation activities of firms and are utilized in the case study research as further discussed in Ch.4 Finally the technology strategy of firms was analyzed in terms of content, process and context using the concepts of the resource-based theory.

Strategy, as an organizational determinant of innovation, is included in the antecedents model and its effect is tested by the hypothesis H3g (Ch.5). The discussion, however, on technology strategy and especially the types of innovation strategy leads to the following *supplementary* broad hypothesis which is tested through the qualitative case studies research:

9. Different innovation 'strategic postures' imply different innovation practices.

2. 4. 4 Innovation in Small Firms

A) The Small Firm

There is a lively debate in the literature on what constitutes a small firm. Various definitions and criteria have been used. The definition used by the Bolton Committee (1971) is widely cited and has been used in several studies. They actually used two complementary definitions an 'economic' and a 'statistical' one (Storey, 1994).

The economic definition used the following three criteria for the classification of firms as small.

- Small firms have a relatively small share of their market place.
- Small firms are managed by owners in a personalized way, not through a formalized management structure.
- Small firms are independent (they are not part of a large enterprise).

Based on the above definition, the Bolton Committee then devised a statistical definition for the identification and counting of small firms. For the manufacturing sector which is of the main interest here they used a 'personnel' criterion i.e. they defined as small firms those with 200 employees or less. For services they used a turnover criterion i.e. turnover of 50000 sterling pounds or less.

Since the time of the Bolton Committee there have been many attempts to define a small firm. According to You (1995) the number of full time employees is a usually applied criterion (for the classification of small firms), since data are normally available for classification. The European Commission follows such an approach based on a single criterion i.e that of employment. It considers micro-enterprises as those with between 0 and 9 employees and small enterprises as those having between 10 and 49 employees. (While the maximum was 99 in the past, it was revised in January 1995 to 49).

Curran, Blackburn and Woods (1991) use a multi-dimensional 'grounded' definition of small firms. Their selection of firms in each sector is based on consultations with firm owners, trade associations and other relevant to the sector people which lead to a consensus of what constitutes a small firm for the particular sector.

In this study a simple statistical definition is used based on employment as further discussed in Ch. 4. Although it lacks the specificity of grounded definitions it is a practical operational definition which allows comparison with other studies.

B) The Innovative Small Firm Typology

The firm size as a determinant of innovation has received a lot of attention in both the economics and the organizational research traditions of the innovation studies as already briefly mentioned above (Section 2.4.2). Actually Schumpeter in Mark I has assigned a 'glamorous' role to small firms with their initiation of the "gales of creative destruction" through the introduction of new products (Storey, 1994). It is frequently argued that technological discontinuities are associated with the emergence of new small firms to exploit them, given the conservatism, obsolescence and bureaucracy in established large firms

Pavitt (1989) disagrees with the above view and cites evidence showing the importance of large firms in introducing new technology. Scherer (1984) has investigated the association of size and innovation in various manufacturing sectors in USA. Using sales as a size measure he concluded that inventive inputs (R&D employment) and outputs (patents) increase less than proportionately with sales. He notes, however the methodological difficulties with measures of both innovation and size.

It has been suggested that the relative contributions of small and large firms to industrial innovations vary by industry (Damanpour, 1992). Rothwell and Zegveld (1982) state that the major contributions of small firms to industrial innovation are in low capital intensive industries where development costs for new products are low.

Rizzioni (1991) considers the examination of the relation between corporate size and innovation at an abstract level as misplaced and proposes concentration on the range of elements conditioning this relation. Such elements are the following:

- Sector characteristics
- Stage of the firm's life cycle
- Characteristics of the firm's technology
- External economies and interfirm relations
- Structures and processes of firms
- Diffusion of innovation

Rizzioni supports the thesis of the *dynamic complementarity* among small and large firms in innovative processes. In other words points to the existence of dynamic, complementary relations among firms of different sizes in innovation activities and the division of labour among small and large firms for both innovative activities and diffusion processes. Firms of different sizes play different roles according to the required resources and skills.

The small firm sector is highly heterogeneous (Rothwell, 1991). The idea therefore that different types of small firms play different roles in innovation seems plausible. There are various typologies in the literature, but that proposed by Rizzioni (1991) and based on a consideration of the above mentioned elements affecting the small firm's innovation role, appears to be among the most sophisticated ones.

This typology is described briefly below:

- *Static firms.* They are outside innovation processes, produce traditional products and have a marginal existence.
- *Traditional firms.* They are users of innovation developed elsewhere i.e. take part in innovation diffusion.
- *Dominated firms.* Produce on behalf of larger firms (i.e. they act as subcontractors). Their innovation is imitative or based on external suggestions by their suppliers or more frequently their large clients.
- *Imitative firms.* They follow a niche strategy and carry out innovative activities complementary to those of large firms in the same sector.
- *Technology-based firms.* They operate in rapid growth sectors with high technological opportunities e.g. the scientific instruments industry and industrial automation. They have high technical skills, but not necessarily managerial ones.

- *New-technology based small firms (NTBSF)*. They operate in the boundaries of new technologies (e.g. biotechnology, and semiconductor technology). These firms play an important role in the introduction of new technological paradigms. NTBSF have usually an offensive innovation strategy supported with high scientific, technical and managerial skills.

The above typology, although it has some similarities to the classical one of Freeman (1982) as described above in Section 2.4.3 is better adapted to the small firm innovation role. Rizzioni's typology has been developed again in an industrialized countries context. In developing countries small firms in the last two categories are rather few.

C) Peculiarities of Innovation in Small Firms

The literature on innovation in small firms is reviewed in the following and the various studies are classified under two headings i.e. studies carried out in developed countries and respectively in developing ones. It would be, however, useful at this point to summarize the peculiarities of innovation in small firms in order to examine then whether they are widely supported in the literature or not.

These peculiarities can also be seen as advantages and disadvantages in comparison to large firms, although some of them can turn either to advantage or disadvantage depending on the circumstances. Rothwell (1989) provides a detailed list of the advantages and disadvantages of small firms in relation to innovation. Here only some of the main ones which are more relevant for this study are briefly discussed.

Flexibility. The notion of flexibility has received particular attention among the advantages of small firms. Such firms can adapt faster to demand changes because they have an organizational flexibility and can change faster to new products and processes (Leicht et al, 1993). Because they are closer to customers they can faster detect market niches. They can thus through a planned niche strategy avoid the competition pressure of large firms. The flexibility gets additional importance through the argument that the demand structure of society has changed away from 'mass production' goods to high quality 'individualized' products. Piore and Sabel (1984) even claim that small firms offer the way out of the crisis of mass production because they can combine the flexibility of production organization with product specialization. The introduction of flexible advanced manufacturing technology is claimed to have reduced the importance of scale economies in favour of small firms, changing their conditions of growth. While this may be happening in some sectors, such universal claims seem rather exaggerated.

Informal processes. The innovation processes in SME are often informal and weakly structured. It was found that only a small minority of the sample firms in a study of Dutch SME made an innovation plan beforehand. None of the firms made efforts to assess the total cost of an innovation process (Kleiknecht and Reijnen, 1991). Informal communications may however promote and facilitate innovation.

Personality of owner manager. It is argued that the personality of CEO affects the innovation strategy of SME (Miller, 1986). The fact that the owner sometimes continues to be pre-occupied with operational tasks, as at the start of the firm, may lead to lack of strategic thinking.

Culture of SME Many SME are family firms working as extended families with the CEO acting as the paternalistic figure. This may imply higher motivation of the employees (due to the informal family atmosphere) and lower control problems and coordination costs. It could also mean lower bureaucracy and lower labour costs, due for example to employment of relatives.

Scarcity of resources. Many SME not only lack resources for innovation, but probably also lack the relevant specialized and co-specialized assets in order to appropriate the benefits of their innovations (Teece, 1986). They have therefore to make cooperative arrangements with large or other small firms in order to overcome these barriers. Resources include the human ones, that is small firms may not afford to hire the best people or specialized labour lacking therefore specialized knowledge.

Low bargaining advantages .The small size may lead to low market power, lower ability for lobbying, possibly higher bureaucratic barriers in their growth and limited access to capital markets.

D) Prior Research on Innovation in Small Firms in Developed Countries

Research on innovation in small firms has emphasized some of the peculiarities mentioned above and their repercussions for innovation. In the following a selection of studies, judged as the most relevant to my research, are reviewed.

D1) Khan et al (1989) have studied innovation in 50 small manufacturing firms in Texas (USA), through a mailed questionnaire survey. Small firms were defined as those with less than 500 employees. They have investigated the effect of 31 predictor variables on innovation as the dependent variable. The predictors are classified in the following categories: a) managerial performance (which includes strategic and functional variables) b) firm characteristics c) environment d) product differentiation e) risk taking and f) characteristics of the responding executive and his/her role in innovation.

With a step-wise regression procedure they ended-up with an eight variables model which still has a reasonable R square of 0.66 (against 0.77 of the full regression model with all 31 variables).These eight variables are: risk taking, technocracy, integrated decision making, environmental heterogeneity, percentage R&D to cost of goods sold, and three characteristics of the chief executive (founder status, reading of professional journals, role in technological development).

The findings support in general prior results in the literature. Some surprising findings include the following: i) a negative coefficient for technocratization in the regression model, although it appears as a significant predictor. This means that in small firms employing highly qualified scientists and engineers appears to be less necessary than e.g. risk-taking. ii) Similarly a negative coefficient was found for the level of participation of the responding executive in the technical development of innovations i.e. a hands-off approach is suggested as favourable to innovation. iii) Another unexpected result is the "surprising omission -given prior literature- from the models of locus of control, as well as structural variables like centralization and formalization" (ibid., p.195). The authors offer as an explanation the relative lack of variation for these variables in the sample.

An apparent contradiction in the above research is the negative coefficient for the participation level of the responding executive in the technical development of innovations given the positive coefficient of his/her efforts at 'technical interaction' through professional journals. The authors do not offer any comments or explanations on this issue.

D2) Rothwell (1989, 1991) and Dodgson and Rothwell (1991) have made influential contributions to the study of the management of innovation in small firms. Their papers present the results of several research projects which they had conducted in the late 1980's. A very brief summary of their work is presented in the following.

Small and medium size high technology firms have to develop advantages of flexibility and speed of response in order to compete with larger firms, therefore they need a strategic approach. Since technology is a major factor affecting competitiveness (and thus a major strategic issue) SME need a technology strategy (Dodgson and Rothwell, 1991). The authors concentrate on *five* key issues of the strategic management of technology in SME found to apply to many firms across a range of industrial sectors:

Accumulated technological competences. The SME in their studies obtained initially technical expertise from external sources (academic institutions, large firms etc.), but then started to build upon this base through internal R&D and by getting feedback from users and suppliers.

Internal strategic cohesion. It was found that in the most successful firms in innovation consideration was given to all aspects of the innovation process. The technological strategy was an integral part of the overall corporate strategy and had close links with the other functional strategies (finance, investment and marketing). There were also effective information and communication flows within the company.

Organizational specialisms. The importance of the flexibility in organizational structure was emphasized. Using the results of a case study (Celltech) as well as survey research the authors found that factors such as the architecture of the offices, the climate within the firm (ethos and morale) and the systems for internal collaboration and direction of effort are some of the mechanisms to achieve organizational flexibility.

External orientation. The authors claim that according to their results there is a trend among UK SME to become increasingly outward-looking. The firms in their studies have an awareness of their own and their competitors' strengths and weaknesses and consider external technological networking as a strategic issue. They have a high percentage of external linkages and seek various ways of collaboration with other firms both small and large.

Types of linkages The main ones mentioned are: a) subcontracted R&D b) collaborative R&D c) marketing relationships d) manufacturing relationships e) public sector linkages. The most significant type in terms of the frequency of occurrence was the subcontracting of manufacturing. Rothwell (1991) cites also Dutch research of Stockman and Docter (1987) and Beije (1987) which reached similar conclusions for the efficient external communication as a significant factor contributing to successful technological innovation. He also mentions the importance of employing qualified scientists and engineers as affecting the propensity and the ability of SME to forge external technical linkages.

Management skills. The role of management comes out as being of critical importance for technological innovation success. Managers in SME perform many tasks e.g. technological assessment, building and maintenance of external links, internal communication of strategic objectives and last but not least human resource development. Another related major finding is the importance of a high quality leadership and a 'vision for the future' of top management.

D3) Lefebvre et al (1991) have studied technology adoption decisions in a sample of 144 small manufacturing firms in Canada. *Four* broad categories of adoption factors are used: a) characteristics of the firm (size, financial performance, investment in R&D) b)competitive and manufacturing strategies pursued during the adoption decision processes. c) internal and external influences on the adoption decision process; internal influences include those of the chief executive officer, production and marketing groups and external ones include suppliers, clients and consultants d) characteristics of new technologies adopted (cost, reliability etc.).

They adopt a dynamic model hypothesizing that the relative importance of various adoption factors evolves as the company acquires more *experience* with new technology. Using factor analysis they identify the most important adoption factors separately for the two groups:

i) More innovative firms (which adopted two or more new process technologies).
ii) Less innovative firms (which adopted only one new process technology).

The most important factors for the *first* group (innovative) are: influence of clients and of the company image, internal influence of functional groups (production, engineering and marketing) and influence of outside groups (suppliers and consultants).

The most important factors for the *second* group (less innovative) are: influence of organizational characteristics, influence of cost savings (financial considerations) and internal influence (chief executive officer).

There is a marked contrast between the factors influencing the technology adoption decisions of innovative and less innovative firms. Innovative firms appear to be after longer term, less quantifiable gains in flexibility and quality of service and more outward-looking, while the less innovative firms are cautious, conservative and rather inwardly - oriented in their technological decisions. They also look for more short-term tangible gains. It seems therefore that the "pursuit of a homogenous set of adoption factors may turn out to be unrealistic, explaining some of the contradictions certain authors have noted in the literature." (ibid., p.242).

D 4) Raymond et al (1996) report about their recent research on 14 small and medium size Canadian firms. They have investigated, with a case study methodology, the approaches of these firms to managing technological change. The following *four* sets of factors were considered:

Strategic advantage (Firm's strategic positioning, competitive environment, impact of technology on the sector etc.)

Technological expertise (capacity for R&D, capabilities of owner manager, quality of technological scanning, information sources and networks, human resources etc.)

Decision process (extent of formalization of the decision process, risk management, characteristics of the firm, role of internal and external participants).

Organizational capabilities (flexibility, technological implementation, impact of technological acquisition on various functions of the firm, and implementation problems).

The research has highlighted the following variables as critical ones for technology management in SME: critical attitude of the entrepreneur against his/her firm's technological capabilities, very strong impact of technology on cost structure and product differentiation in the sector, systematic evaluation of R&D process and functioning, hostile competitive environment, and close integration of technological and corporate strategies.

Cluster analysis classified the firms in three groups (technology management profiles). The firms belonging to the first group are managing technological change in a strategic perspective with a matching level of technological expertise (proactive). Those of the third group are reactive towards technical change and their ad hoc environmental scanning and resource allocation behaviour reflects this perspective. The second group firms show an intermediate profile closer to the first group in terms of strategic advantage, but to the third in terms of technical expertise.

This research could be criticized especially for the cluster analysis in that there are too few data points (cases) i.e. 14 for the many variables (85) measured, which can lead to artificial results. The approach of quantitative research (measurement of variables) has been used in a relatively small number of cases.

D5) Piatier (1984) reports on a study carried out for the Commission of European Communities. This study under the title "Barriers to innovation in SME" includes work done by several researchers in eight countries of the European Economic Community. A consolidation of the individual national reports, despite its problems (due to differences among countries in industrial structure, complexity of innovation operations and the sheer variety of barriers and their perception) identifies some major barriers to innovation common among the countries involved. These include the effect of education and training upon employment in enterprises, the effect of action by banks upon the financing of the innovation, the effect of action by venture-capital companies upon the financing of innovation and norms and standards- product controls- effect upon the manufacturing of new products.

The report has also investigated the origin and impact of barriers. The origin of barriers is mainly attributed to: a) general legislation and bureaucracy b) norms and standards c) climate value attached to the role of the head of the enterprise d) information on science, technology and patents. Impacts are mainly on finance, manufacture and manpower. General government action, which is estimated to cause about half of the difficulties experienced, has its strongest negative impact upon the *downstream* end of the innovation process (i.e. distribution and exports). On the basis of these results the report recommends an innovation strategy and detailed measures for support of innovation in SME.

It is interesting to note the effect of problems caused by government action at the marketing end. Innovation policies usually concentrate upon the initial stages of the innovation process and fail to consider barriers during the commercialization stage which may prove the critical one.

The above studies have used a *'variance'* model approach in Mohr's (1982) terminology, that is they study the effect of a number of factors on innovation in a cross section of firms. Even the case study research of Raymond et al follows this approach. The next study is an example of a qualitative 'process' model study, while the research of Dickson et al. below, also follows a qualitative approach with emphasis on interfirm collaboration.

D6) Langley and Truax (1994) in an interesting research study based on qualitative methods (longitudinal case studies of new technology i.e. advanced manufacturing technology in five small Canadian firms) have developed an 'induction process model'.

This model depicts the technology adoption process as a "partially nested set of three parallel and interacting sub-processes that are different in nature: the strategic commitment process, the technology choice process and the financial justification process"(ibid. p.619). The three sub-processes are presented below in summary form.

The strategic commitment process is informal, with unclear boundaries, experienced by top managers and leading to a psychological commitment to new technology. It can be described as a 'process of incubation' during which the commitment of managers fluctuates with changes in information collected, contextual conditions and decisions in other strategic areas. The various types of contextual influences have been identified by the authors and labelled as sensitizing, inhibiting, and precipitating elements. The latter trigger the technology choice process.

The technology choice process is described as a purposeful and explicit process which is usually delegated (from the chief executive to internal managers) and leads to equipment selection. It is a more formal process (than the first one), involving the definition of priorities, specification of needs and selection of systems and suppliers. Contextual factors affect also this process. The information generated in the technology choice process affects the strategic commitment process.

The financial justification process is directed to outsiders (bankers, venture capitalists etc). This process includes the preparation of formal justifications emphasizing financial results and market potential. It is a formal and political process (requiring credibility and support from outsiders) leading to financing of technology investment. It is also influenced by contextual factors and interacts with the other two sub-processes in various ways.

The findings confirm the results of prior research e.g. Fredrickson (1986) and Shrivastava & Grant (1985) about the relatively informal nature of decision processes in small firms and the fact that they are centralized around the chief executive officer. Senior managers in small firms are influenced more by contextual factors rather than the political pressure (from power games within the firm) as in Dean's (1987) research which dealt with large firms.

Another important conclusion of the study is that new technology adoption is not a clear-cut, well defined 'decision' as frequently presented in the literature which overemphasizes the role of managerial deliberation, but rather "an evolving issue, influenced by on-going events and choices in other issue areas important for the firm"(ibid., p.645). The model puts due emphasis on the organizational and environmental context in the tradition of Pettigrew (1990, 1991). The connection of technological decisions to other strategic issues (e.g. plant expansion or market development) is also a noteworthy point i.e. that "technology adoption cannot be isolated clearly from the overall process of strategy formation within the firm" (ibid., p.642) .

D7) Dickson and coworkers (1991, 1993, 1996) and Lawton Smith et al (1991, 1995) have investigated the phenomenon of collaboration of small firms with large firms (or other small firms) as a significant factor in technological innovation. The motives towards collaboration and various strategic and operational issues are examined in interfirm collaboration (mainly on technological research) among 27 pairs (mostly small /large) of innovative firms in U. K. Advantages and problems of cooperation are highlighted.

The small firms of the sample employed fewer than 120 people. There were five collaborations between small firms, sixteen between small and large and five between large firms. The firms were in three manufacturing sectors (biotechnology, electronics and electromechanical engineering). Almost all firms operated in specialized niches within the above sectors. A case study approach was used with detailed interviews conducted with both partners about their motives, expectations and experiences of collaboration.

The advantages of interfirm collaboration (and therefore the motives to collaborate) differ among the sectors and for small versus large firms. In electronics for example in small firms include: to exploit new technology, build company resources, open new markets and obtain grants for research. For larger firms advantages include: access to people with the right combination of skills to develop new products, solutions to technical problems, entry to the U. K market etc. The positive outcomes for the collaborating firms in all sectors have been identified as: development of new products and processes, sharing costs of development and improved scientific standing of some small 'high tech' firms.

Several hazards of cooperation were also found e.g. delays, time of management spent on cooperation problems, loss of control, dilution of profit, and intellectual rights problems. The existence of informal, personal networks among the scientific and engineering elite was found to be the *key* factor in the establishment of collaborative links. Trust was an essential ingredient of these relationships. The authors argue that the adoption of the rules of a 'cooperative game' is vital for successful collaborative innovation.

In a follow-up study (Lawton-Smith, Dickson, and Coles, 1995) the learning process and adaptive behaviour of firms as a result of their experience of collaboration is researched. The initial firms in the sample were re-visited after a period of 5-6 years to assess the longer-term consequences of their original collaboration. Some firms had entered into collaboration with new partners and the same or other firms had interrupted previous partnerships. Among the causes of failure the following ones have been identified:

- Asymmetry in information and control of intellectual property and leakage of expertise.
- Asymmetry in the balance of resources and balance of power.
- Partner fails to deliver.
- Personnel changes in one or both firms of the pair.

While in the original sample most collaborations were within the U.K some firms have extended the scope of collaboration to include overseas partners. The authors have found that taking part in collaborations is a learning experience for firms. Empathy and development of trust build and maintain relations, while their absence plus instances of technical and marketing incompetence are the main causes of failure.

Lawton-Smith, Dickson and Coles (1995) conclude that:
"Innovation is more than just a process of technological advance, it incorporates the commercial evaluation of technology, while management learning plays a role in technological development ... The process of collaboration has become a part of an innovation strategy" (ibid., p.15).

The above study refers to high tech small firms in an industrialized country but some of the conclusions may have applicability to small firms in developing countries. For example that collaboration is a 'give and take' process, that it has to be gradually learned through practice and it should be part of an innovation strategy to bring the most benefit to the firm.

E) Prior Research on Innovation in Small Firms in Developing Countries

The above studies were made in the context of industrialized countries, studies in developing countries are less frequently found in the literature. The selection was again made to fit the purposes of the present research.

E1) The study of *Kim et al (1993)* attempts to identify the most important factors explaining why some small firms are technologically more innovative than others in Korea. Their definition of small firms, although not explicitly stated, is derived as firms with less than 1000 employees.

They use a matched sampling strategy with a sample of 49 firms in total (innovative and non-innovative) in the broad manufacturing sector. Four categories of variables i.e. environmental, strategic, structural and top management characteristics are used as predictors of the innovative behaviour. A composite index is used for technological innovation performance. The latter is derived from a principal component analysis of three variables i.e. 1) the number of new products developed 2) the degree of technical change in production 3) the overall performance in technological innovation in the past five years.

They have found that the following factors discriminate best the technologically innovative small firms in Korea from the non-innovative ones:

- *Top managerial characteristics* (risk-taking propensity and tolerance for ambiguity i.e. that innovative firms have top managers with a higher level of risk-taking, but a lower tolerance for ambiguity characteristics.) The "managerial attitudes towards innovation" is singled out as the most critical factor i.e. the best predictor of technological innovation.

- *Environmental Heterogeneity.* Innovative firms perceive their task environment as more dynamic, complex and hostile.
- *Environmental Scanning Strategy.* Innovative firms have a more aggressive strategy towards innovation both through internal efforts (R&D activities) and external efforts (scanning and building networks with various technical sources).
- *Professionalization of Organizational Structure.* Innovative firms have a less centralized and formalized, but more professionalized and administratively intensive structure.

The findings of Kim et al (1993) support the conclusion of Damanpour (1991) that the type of organization is an effective moderator of the predictor - innovation relationships. They also point out that managerial attitudes and strategic orientation are more important than structural attributes in explaining differences in innovation behaviour.

The result on the tolerance for ambiguity is interesting since this variable was not significant in the bivariate analysis (i.e. not significantly different between innovative and non-innovative firms) Then tolerance for ambiguity, as a discriminating variable, is not in the hypothesized direction i.e. not positive in the innovative group as expected and found e g in Quinn (1979), but on the contrary positive for the non-innovative group.

This unexpected result is explained by the authors (Kim et al, 1993, p.223) as follows: "technological innovation in small Korean firms is more likely incremental in nature and may not require a significant ambiguity-bearing role of top managers". But then the same is also probably true for the risk-taking propensity (which was found in the expected direction) since incremental innovation implies relatively low risk.

E2) Lall's et al study (1994) is of particular interest, since it concentrates on the technological capabilities of firms in Ghana, a country of Sub-saharan Africa and an example of the least industrialized countries. As the authors note there is practically no detailed research on the latter, while there are several examples of research on the industrialized developing countries of Asia and Latin America. Strictly speaking Lall's et al study is not research specifically on innovation, but it covers similar ground in the broader context of technological development for industrialization.

The study is not focusing exclusively on small and medium size firms, although of the 168 firms in the survey panel only 12% are large (over 100 employees), 19% medium (30-99) and the majority (69%) small (10-29), or micro (0-9). Similarly the firms in the complementary case study research are almost all SME. Firms were selected from four manufacturing sectors (textiles, wood, metal and food).

Lall et al have used structural cluster analysis to find out whether or not differences in groups of firm characteristics (mainly technological ones) are characterized by "distinct jumps" across the size spectrum of the sample firms. The main findings of cluster analysis can be briefly summarized as follows:

- All industrial sectors in the sample are characterized by clear clusters based on technological characteristics. Part of the reason of clustering in terms of physical and human capital is due to the fact that technological capabilities are firm and technology specific. This implies that the firm itself determines the level of capabilities through its decisions to invest in their acquisition and upgrading.
- Size and technology are *not* consistently correlated, although firms in top clusters are on average larger. For each sector the inferior technological cluster (lower capital and skill intensity) is always composed of micro-enterprises.
- There is as expected a positive and consistent relationship between size and human and physical capital intensity.
- The type of technology is different in each cluster. Firms therefore do *not* operate "over a continuum of alternative technological options" (Lall et al,1994, p.74).
- Segmentation in factor markets affects technological upgrading mainly at the *intermediate* technological levels.
- Upgrading across technological clusters is rare, especially where large changes in technology are necessary and market segmentation exists.

The above findings have some important policy implications. Addressing, for example, factor market deficiencies is helpful but inadequate. In order to use new technologies many firms, apart of financial constraints, would need to develop new sets of technological capabilities. This process (of developing new technological capabilities) faces many barriers e.g. lack of managerial skills, shortage of skilled technicians etc. Government policy measures to overcome these problems can improve the situation.

The case study research that complements the above survey research has highlighted some important issues of a more qualitative nature: the technological learning process is not a simple function of years of experience, but rather the outcome of investment in skill creation. Technologically competent firms have more educated top managers (similarly more educated production managers). Competent firms have a higher proportion of scientists, engineers and technicians. Foreign equipment suppliers are the most important source of technical information, but technological linkages with them are rather short term. There are few local linkages. Performance indicators like growth and capacity utilization are significantly better in the technologically capable firms. Technologically competent firms are larger than the other firms in the case studies. The latter finding of the researchers *contradicts* to some extent the conclusion of cluster analysis that size and technology are not consistently correlated.

E3) Khundker (1992) has conducted research on small firms in the informal sector in a less developed country (Bangladesh). The study focuses on the various dimensions of technological adaptation by small firms and on factors important for their growth and expansion. Small firms in this case are actually 90 *micro-enterprises* (employing up to ten full-time workers) in two manufacturing sectors (fabricated metal products and plastics) in Dhaka and its environs and non-registered (i.e. not covered by official statistics).
The findings can be summarized as follows:

- Informal sector firms are not technologically stagnant as sometimes suggested in the literature.
- Innovations include both product improvements/new products and process innovations embodied in self-constructed capital goods.
- Technical change in the context of small firms is a multi-dimensional phenomenon.

Khundker due to the last observation uses factor analysis of a set of observed variables (different types of adaptation) to identify the dimensions of innovativeness. Three factors are identified, the first associated with supply-side adaptability (e.g. self-constructed machines, making own spares or tools etc. The second (product innovation) and third (quality improvements, recent acquisitions of machinery) are associated with demand-side adaptability. Regarding the factors inducing innovation, especially innovation in capital goods, the main ones identified include: cost cutting, unavailability of machines in local market, making better use of the slack time and spreading the investment over a period of time i.e. alleviating the 'lumpiness' problem in investments.

The author uses then a probit (discrete choice) model to test the importance of the various demand- and supply-side variables in stimulating innovations. The results show that the key variables explaining the different types of adaptation are industry type and prevalence of import competition. It is interesting to note that entrepreneurial characteristics such as age, education or previous experience were not significant variables in explaining adaptation and only in the case of making own tools did the previous experience have a positive and significant effect.

Import competition is important not only as a demand side stimulus. The author regards it as also an important source of learning for both product and process innovations. Finally the author has investigated the relationship between innovation (adaptability) and performance. The latter is measured as the level of entrepreneurial profits accruing to firms (i.e. profit adjusted for rental on owned capital). The results show that innovativeness is not related to the firm's performance. The only significant variable explaining profits is the enterprise size (measured by the number of workers employed).

F. Summary

Innovation in small firms has a number of unique features, as discussed above and as research has shown. Most of the research was done in industrialized (developed countries) and frequently in high technology firms. The few studies done in developing countries confirm some of these features and point to others of particular importance in a resource-deficient context and in traditional manufacturing industries. The present study intents to illuminate through empirical research in Ch.5 some of the peculiarities of innovation in small firms in the context of a small developing country i.e. Cyprus.

2. 5 Networks and their Role in Innovation

2. 5. 1 Introduction to Networks

"No company is an island" (Hakansson, 1990, p.526). Firms are embedded in socioeconomic networks (Granovetter, 1985) consisting of enduring webs of relationships with customers, suppliers, financiers, trade associations etc. Their strategic action takes place within the framework of these relationships (Fletcher et al, 1995). Firms enter into relationships with other firms and organizations for many reasons. One important reason is to obtain information and resources needed in the process of adopting or developing innovation. The motivation for network participation is examined in more detail below. Innovation is frequently developed in cooperation with other firms e.g. suppliers and customers or organizations such as contract research organizations and technology institutes.

There is a *growing appreciation that industrial markets function through a* 'dynamic network' *of changing interfirm relationships rather than the 'perfect competition' among* independent economic agents as postulated by the classical economic theory (Mattson, 1987). The view of the 'markets -as- networks' (or sectors-as-networks) is complemented by the view of networks as intermediate organization forms between markets on the one hand and hierarchies on the other.This is the new 'synthesis' of competition and cooperation in the market place versus the neoclassical 'competitive' model.

A number of research traditions are directly or indirectly related to networks which are now a 'fashionable' topic of research and theorizing with an exponential growth of publications in the last 10-15 years (Jarrilo, 1988). It is also frequently claimed that during the 1980's networks appear to have increased in importance, incidence and variety (Hobday, 1994). The study of networks was started by sociologists and involved personal and, less frequently, inter-organizational networks. In management, economics and industrial geography more attention was given to the topic after empirical studies, in the so-called industrial districts (in 'Third Italy' and elsewhere) and in Japanese industrial organization practices, drew attention to the phenomenon of cooperation among firms.

Firms in industrial districts are collaborating among themselves and with other organizations and part of their successful performance has been attributed to the operation of networks (Bianchi and Bellini, 1991). The study of industrial districts as a new empirical reality revived interest in the early studies of Marshall (1890) on industrial districts. Some of the common features emphasized in both the classical industrial districts of Marshall and the modern industrial districts are the following:

i) The districts are composed of a large number of small firms.

ii) A skilled labour pool is formed.

iii) There is a wide availability of local suppliers of intermediate goods.

iv) There are several externalities which, apart from skilled labour and local suppliers, include sharing of technical information and tacit knowledge through mobility of personnel, informal networks etc. As Marshall put it "industrial secrets are on the air."

There are however some important differences between modern and classical industrial districts (Langlois, 1995). While price competition was the rule among the many small firms in classical industrial districts, it is product differentiation through design and product innovation which is the main mode of competition in the modern industrial district (I.D). Some firms in modern I.D tend to create networks of satellite firms i.e. have a stake of ownership in other smaller firms in various stages of the production chain which largely serve to protect the leakage of their design and innovation competencies.

Apart of the industrial districts in Third Italy and in certain areas of Denmark and Germany other variations of the modern industrial district are the *innovative networks* e.g. in Silicon Valley and in Route 128 in USA or in certain industrial parks in Europe. These networks are composed of many small *high technology* firms in such fields as biotechnology and computers. Competitiveness is based on tacit exchange of knowledge among these firms. According to Langlois (1995) networks of venture capitalists are 'superimposed' on the networks of producers in this type of networks. The role of such networks in innovation in small developing countries, where high technology firms, if at all existent are anyway few, is less important.

The study of the empirical reality of industrial districts has led to the formation of theories of a new mode of production the *'post-fordist'* or *flexible specialization* that has been proposed as a new techno-economic paradigm, mainly by Piore and Sabel (1984), which has supposedly taken the place of the 'mass production' paradigm. The new paradigm emphasizes the role of the small firms which apply the new technology in order to produce small quantities of high quality goods as required by the differing demands of the differentiated market sectors of the modern affluent consumer society. Similar positions are taken by other authors e.g. by Best (1990) in his theory of the "new competition".

The flexible specialization thesis is considered by some authorities as "highly empirically contestable" (Dodgson, 1993a). There is also the normative question of the possibility of replication of industrial districts, e.g. in developing countries under widely different cultural, socioeconomic and political conditions. Since flexible specialization was proposed some years ago as the core for a new industrial strategy for Cyprus (Murray, 1992) the whole issue is further discussed in Ch. 3.

Under conditions of large economies of scale or high transaction costs where industrial districts are not appropriate from an economics point of view, other types of network have appeared e.g. *core networks* organized around a single large firm where satellite firms supply intermediate inputs to the core (the main firm) which coordinates the network. An example of core networks are the Japanese decentralized networks where a large firm cooperates with a large number of small subcontractors. The large firm usually has a shareholding participation in the capital of some of these firms. The subcontractors are organized in a hierarchy where the first tier subcontractors assume primary responsibilities for design, quality and compatibility. This is an example of supplier-generated innovation, although again relatively less relevant for small developing countries.

Sako (1992) has noted the importance of *trust* in the relationships among the subcontractors themselves and between the subcontractors and the core firm. This type of relationship [called by Sako Obligational Contractual Relationship (OCR)] is contrasted to the usual type of Arms-length Contract Relationship (ACR) in western societies. The issue of trust is further discussed in the following.

The above types of network i.e. in industrial districts, high technology districts and core networks differ substantially in terms of structure, duration, aims and motivation (Hobday, 1994). Another important dimension is whether the firm intentionally enters into networks (strategic networks) or not. The discussion will concentrate on strategic networks and their role in innovation after a section which will briefly summarize the theory of networks and their features and another one covering the measurement of networks.

2. 5. 2 Networks Theory

A network can be defined as "the web of relationships of an organization with identifiable counterparts" (Hakansson, 1990, p.530). Network analysis is largely an analytical tool not a theoretical framework. It is grounded primarily in theories of exchange power and resource dependence. These theories have recently merged due to their overlaps (Auster, 1990).

The main assumptions behind the network approach according to Auster (1990) are:

I) Action is intentional.

II) Actors attempt to establish linkages in order to acquire resources or information, reduce uncertainty and increase their power.

III) Networks represent interconnected flows of resources.

IV) Networks are dynamic shifting over the time as actors power positions change.

The first assumption seems unduly restrictive for networks in general, while it is part of the definition of a strategic network.

The establishment of network boundaries is largely arbitrary, done by the researcher or those involved in the network. The selection criteria are based on the *attributes* of the organizations or the *characteristics* of their relations. Boundary specification is a major methodological problem in the study of networks (Biemans, 1992).

The inter-organizational linkages, the 'building blocks', of networks can be *vertical* (exchanges between firms at different stages of production), *horizontal* (between firms of the same sector producing similar products) or *lateral* (between production-wise unrelated firms). Apart from the direct relationships the indirect ones may also be important for innovation. They are defined by Mattson (1987, p.128) as "from focal firm A's point of view to be a relationship between two firms of which A is not one of the counterparts" for example between a supplier and his customer's customers. Networks can also be classified according a) to network's complexity (simple: one partner, complex: many partners) b) the nature of the major cooperation partners c) the environment of the interactive relationship.

The content of linkage refers to what is exchanged or transmitted. Common inter-organizational linkages are those including licensing, joint R&D etc. The linkages or interactive relationships may involve transfer of products/components or services, of information, financial resources or even social content. The latter is of particular significance since it leads to development of commitment, trust and openness which can be seen as 'vital ingredients' in relationship management (Biemans, 1992). The network relationships may be among the most valuable resources of the firm. Their development takes time and resources and can be seen as investments to increase productivity, create information channels and increase control (power).

The degree of dependence among two actors depends on the content of the linkage. Auster (1990) distinguishes among low and high resource investment linkages. The latter e.g. joint ventures require much longer-term commitment and trust and therefore the exit barriers are higher. Apart from the content other features such as, the purpose, the intensity, the duration and the extent of formalization of interaction are of relevance in the study of networks. Also the social and cultural basis of interaction which is further discussed in the following.

The network approaches fall into <u>two</u> major categories:

I) Those analyzing *characteristics* of the networks (where the networks themselves are the focus of analysis).

II) Those analyzing the *position* of an organization within a network (The latter are of the main interest here, but some appreciation of the former is necessary for better understanding of the role of networks in e.g. innovation development and diffusion).

There is a lot of controversy about the characteristics of networks e.g their exchange, communication and social content and if networks can be differentiated on the basis of them as Szarca (1990) claims or networks can exhibit all these characteristics simultaneously. This is a complex topic, not directly related to this study and is not further examined.

The position of the firm in the network is defined by the functions performed by the firm for other firms, the relative importance of the firm in the network, the strength of relationships with other firms and the identity of the firms with which the firm has direct relationships. The present network position can be regarded as the firm's strategic situation (Mattson, 1987).

According to Hakansson (1987) a network contains three basic elements:

- *Actors* i.e. organizations in interorganizational networks.
- *Activities* which are performed by the actors. These are distinguished in transformation activities (carried out within the control of one actor and characterized by one resource being improved by the use of other resources) and transaction activities which link transformation activities and create relationships with other actors.
- *Resources* that consist of physical, financial and human assets.

Our focus in the following will be mainly on the application of the network perspective to organization sets. Where an *organization set* is the set of linkages of one focal organization. The network perspective can be applied at four different levels of analysis. These are the individual, organizational, group, and community levels (Auster, 1990). They are briefly summarized as follows:

I) The *individual* level is defined as the study of how people affect inter-organizational relations and the effects of inter-organizational relations of individuals. As an example some key individuals (boundary spanners) play a significant role in the creation and evolution of linkages e.g. in technology transfer to the organization. It will be argued latter that this role is fulfilled by the owner/manager of an SME. The impact of inter-organizational relations e.g. on the attitudes of the SME owner, his work-time requirements etc. is also an interesting topic.

II) The *organizational* level. This level, which is the one of the primary interest here, focuses on the organizational characteristics and their impact on the creation, management and success or failure of inter-organizational relations. The strategic approach of what types of portfolios of linkages are most effective in particular environment types will be followed. Related questions refer to the motives in entering relations, and the selection criteria for partners. These issues are further discussed in the next section on strategic networks. The relations follow a pattern over time and the impact of the organizational and linkage characteristics may actually vary by the stage of the process of inter-organizational relations management. Only a longitudinal tracking can give an in-depth analysis of these changing patterns.

III) Organizational population Groupings level. Strategic groups, sectors or industries may form the research areas at this level of analysis. The dynamics of exchange relations in each particular sector of the Cyprus manufacturing industry and the differences among sectors are of particular interest in the present work i.e. the effect of the environmental and sector characteristics on network relations.

IV) Community Organizational field. The focus at this level is on phenomena such as consortia, chambers of commerce, etc. that cut across sectors. In our case the national level i e. Cyprus as a whole is the relevant 'reference community'. Issues that can be considered are for example the effect of social, cultural and economic structure factors on network relations. Also policy questions regarding the possibility of government intervention to create a positive cooperation climate among the local firms. The *international dimension* of networks is not specifically considered by Auster (1990), although it is of particular importance and interest in small open economies and is investigated in this study.

2. 5. 3 Measurement of Networks

The measurement i.e. investigation of networks, is a difficult task. It is based either on direct observation, analysis of archival records or on survey data. It is certainly hard to establish the membership, the level of participation and especially the content and importance of particular relationships. Past studies have concentrated more on the quantitative rather than the qualitative aspects of networks (Curran et al 1992) e.g. on the frequency of contact among members of the network, time spent for these contacts and the size of the network.

For example Birley et al (1990) have used the following indicators in comparative research for cross national differences in networking behaviour among entrepreneurs:
a) involvement in clubs or societies b) tendency to take positions of responsibility c) number of persons in entrepreneur's network d) amount of time spent on developing new contacts versus that spent on maintaining existing ones.

Relatively little attention has been given to the character or significance of relationships. Networks, however, are considered by Curran et al. (1992) to be primarily cultural phenomena that is, sets of meanings, norms and expectations which are usually linked with behavioural correlates of various kinds. As cultural phenomena they are more amenable to study by qualitative rather than quantitative methods.

The qualitative methods will be based on the actors' accounts of networks. The contents of network relations will then be studied in terms of the motivation, expectations, norms, world-views and desired outcomes of the participants as interpreted by them. Curran et al. (1992) have used a thematic approach selecting and examining particular *themes* as a means of exposing the character of network linkages. Such themes included family and kinship, co-directors and partners, customers and market, and investment and finance.

The *critical incident analysis* was then used for incidents related to each of the themes, for example events in the family life. The purpose was to throw light on the reasons why the network was used in specificic circumstances and the ways in which it was used. Tjosvold et al. (1993) have used the critical incident technique in a similar way to study the interaction behaviour of the incident and the responses of the interviewees to the interaction.

A mixture of qualitative and quantitative indicators is another approach. It may be particularly useful in cases where both a rich picture of the situation and a type of quantitative measure for comparison purposes are needed. Such an approach is used in the current study and described in Ch. 4.

2. 5. 4 Strategic Networks

Even the simple exchange relationships that firms enter without much thought about them may have some significance for innovation. Innovation ideas and tips for problem solving may come unexpectedly from obscure sources (Allen et al 1983). In contrast to unplanned relationships, strategic networks are, however, of much more importance. The neoclassical principles of strategic management can be contrasted with the strategic network management principles. The latter can be considered as an emerging new version of management (Borch and Arthur,1995).

Jarillo (1988, p.32) views strategic networks as "long-term, purposeful arrangements among distinct but related for-profit organizations that allow those firms in them to gain or sustain competitive advantage vis-à-vis their competitors outside the network". According to Bull et al. (1993) 'strategic' means aiming at long-run effectiveness as opposed to short run efficiency, although Jarillo stresses both effectiveness and efficiency as features of strategic networks. Borch and Arthur (1995, p.420) define strategic networks as "investments in cooperative relationships among firms in order to exchange or share information or resources".

The above definitions are not very helpful in the differentiation of strategic from other types of network. Probably a combination of criteria is needed which could include trust, duration of relationships, purpose of network development or use and gains (like effectiveness).

The strategic network theory according to Jarillo (1988) and also Bull et al. (1993) emphasizes the importance of the role of the leading or hub firm which is usually a large firm and undertakes the task of stimulating other firms to innovate and coordinating the member firms of the network. In this view it is actually the leading firm which takes the initiative and creates network links mainly to serve its own strategic plans, therefore the network is *strategic* mainly for the leading firm. The latter is also the main innovator while the other firms may play only a complementary role as subcontractors. It is implicitly assumed that they are subcontractors by specialism (linked to innovation and product diversification) rather than subcontractors by capacity linked to cost minimization.

A different view is adopted here which is more appropriate for a population of firms composed mainly of SME and considers strategic networks as purposeful relations between more or less equal partners. Competition is seen as a form of positioning the firm in the network rather than attacking the environment. The entrepreneurs of SME attempt to obtain competitive advantage through the network. Strategic networks in this case may be viewed as an evolution form of exchange networks among firms with connected value chains (production chains) or with a partial overlap of value activities which enables collaboration.

A network arrangement allows a firm to specialize in certain activities of the value chain where it has specific capabilities and are most important for its competitive advantage. It thus obtains specialization and focus and economies of scale. The status of each individual firm within the network depends on the ownership and availability of assets and perhaps the previous experience in network relationships.

Strategic networks can take the following forms:

i) Interfirm alliances (joint ventures, R&D partnerships, collaborative manufacturing, co-marketing arrangements)

ii) Broader networks involving for example suppliers, buyers and technology providers or a hierarchy of subcontractors.

There is some ambiguity, whether two-way relationships as in i) above can be described as networks or rather parts of them.

Whatever the form of the strategic network the rules and conventions which condition the behaviour of the firms in the network e.g. the rules of contact and control are of primary importance for the development and the maintenance of the network. These rules depend to some extent on the characteristics of the industry in which the network develops (e.g. the fast or slow knowledge development, the R&D intensity, and the barriers to effective collaboration.

2. 5. 5 Innovation Networks

The fast pace of technological development and the increasing complexity of new products and processes, as well as, the globalization of markets, force even large firms to develop innovations through cooperation with other organizations (Freeman and Hagedoorn,1994). Innovative activities require the utilization and integration of a wide range of capabilities and expertise. Firms can not rely only on their internal capabilities, they have to establish formal and informal strategic networks or expand the existing ones.

These networks can then be used to obtain knowledge and expertise not generated internally (Malerba, 1992). Alliance networks can also be used for sharing risk and reducing the cost of innovation or as a valuable source of learning as already mentioned. Complementarities tend to develop between internal capabilities and specific external network channels. Innovation networks can therefore be considered as a subset of strategic networks.

Interaction in a network for innovation may occur among the firm and its suppliers, customers or other organizations (technological intermediaries etc.). In the case of two parties' relationships e.g. producer and user the two parties can *learn* about each other's resources and find new and better ways to combine them i.e. the relationship can have an innovative effect (Lundvall, 1985).

What has been said above for private firms in general (i.e. large and small) is also valid, *a fortiriori*, for small firms. The latter, as explained in the relevant section on small firms, have a relative lack of innovation specific resources and expertise. They need, therefore, to obtain them from external sources through strategic networks and as a consequence the interactive character of innovation in their case is even more intense.

Developing innovation within networks involves not only advantages, but also potential disadvantages as well (Biemans, 1992). Some examples of the latter are the following:

- Increased dependency, especially for the weaker partner (and dominance for the stronger partner).
- Increased costs of coordination (versus those occurring within the firm).
- Changed (and more complicated) personnel management.
- Danger of leakage of confidential information and copying of proprietary skills.
- Relationships with specific partners can be perceived as a threat by other partners who may take sanctions against the focal firm (Anderson et al., 1994).

The potential disadvantages are probably of more concern for the less powerful small firms. Since small firms are of the major interest here, some empirical research on innovation networks among small and medium size firms is presented below including the highlighted disadvantages and advantages.

2.5.6 Research on Strategic Innovation Networks among SME

The cooperative behaviour of small firms has been studied in the manufacturing and (relatively less frequently) in other sectors e.g. services. In the limited available space only two examples of empirical research are briefly reviewed here. The examples were selected as related to the research reported in this thesis.

The first example of such research conducted in various sectors is the work of Dickson et al (1993, 1996). This research uses the network concepts, but concentrates on the cooperative behaviour of the firms rather than the network as a whole or the position of specific firms in it. The repercussions of such behaviour on technological innovation and the performance of firms is investigated through a mixture of quantitative and qualitative methods. A similar approach has been used in the present research.

Dickson et al (1993) identify certain specific types of cooperative behaviour and study the levels of trust and reciprocity in each case. They suggest a dichotomous taxonomy of firms in types A and B. Type A companies are "those which operate in a competitive, low-trust and isolated idiom", while Type B companies "operate in a cooperative, high trust and interactive idiom" (ibid., p.4). Various explanations are sought for these behaviour types including the personality of owner managers, sectoral influences and environmental uncertainty.

Small firms in manufacturing, service (farms, repair garages, advertising/design agencies etc.) and the horticulture sector in the U. K were studied. The findings of the research on manufacturing firms have already been summarized in Section 2.4.4 on small innovating firms. The interesting point for the discussion here is the effect of the existence of informal personal networks among scientists and engineers on the establishment of collaboration links.

In the service and horticultural sectors the authors have found highly significant correlations between type of sector and cooperativeness, but also confirmed a "distinct divide" between different groups of sectors. For example advertising/design agencies are mostly 'type A' firms with 'insular' attitudes. In contrast repair garages and horticultural firms appear to have 'type B' characteristics establishing informal cooperative networks with suppliers, but also with competitors. Informal relations require reciprocity and trust, are frequently centered around social events and may involve exchange of technical information and physical resources.

The authors had hypothesized that the personality and attitudes of the owner/managers (e.g. individualists versus collectivists) would affect the cooperation behaviour of firms, but the results suggest that "the sector imposes a form of behaviour on the individual" i.e. the sector effect is stronger and probably masks the personality effect. In one sector (horticultural) links were important for technological change forecasting.

The second example is the work of Biemans (1992). He has investigated the development of innovations and the role of networks among small and medium size manufacturing firms in the Dutch medical equipment industry. Biemans used the case study approach, as the most suitable research method for the issue under research, in two stages i.e. an exploratory one (six cases) and the follow-on study (13 cases).

He has found various types of interaction, both active and passive among partners of networks. Interactive relationships can operate at a single or multiple levels of intensity and are realized at different stages of new product development. Networks were simple e.g. between a manufacturer and a user or complex with many partners. Biemans has found both advantages and disadvantages to the parties involved in innovation development within complex networks which differ by the specific case. Some specific problems of the small firms (having 50 or less employees) were identified. These include the strong functional interdependence, limited cash funds, no real marketing experience and no realistic go/no go decisions.

Both above examples emphasize the importance of networks in the various activities of firms and in particular innovation related ones. Which are the most relevant networks in each case and the interaction strategies of the participants in them are issues which are difficult to investigate.

2.5.7 Summary of Networks Discussion

While there has been a lot of theorizing about the importance of networks, the substantive evidence is rather ambiguous. It seems, however, that despite the reservations, networks in a broad sense do matter for several aspects of business. Innovation is one of these aspects and the study of innovation can not be complete without the consideration of the role of networks in which the innovating firm participates. The notion of networking as such was relatively unknown in Cyprus till the end of 1980's, when it was emphasized by foreign experts who studied the Cyprus industry. Its practical relevance will be considered in Ch. 3 and investigated in Ch. 5. The above discussion leads to the following hypothesis:

10. The more efficiently integrated into networks, the better in innovativeness a small or medium size enterprise (SME) is.

2. 6 Conclusion

In Chapter 2 above the relevant literature on the determinants of technological innovation and its strategic management has been reviewed. The review covered the extant literature in the context of the industrialized countries. Then an effort was made to review the relatively sparse and scattered (outside the narrow innovation studies field) literature on the management of technological innovation in SME in the context of developing countries. The aim was to compare and contrast, wherever possible, the results of research in developing versus industrialized countries.

The literature review has revealed gaps and controversies in the existing literature and extracted a number of interesting hypotheses which are summarized in Table No. 2.1 below. The next Table No.2.2 summarizes the expected relationships between dependent and independent variables in hypotheses and the key supporting literature.

In Chapter 3 some aspects of the special context of the present research i.e. Cyprus as a small developing country, are presented and connected to the previous discussion of theory and the empirical research that follows.

Table No. 2.1 Hypotheses

No:	Hypothesis
1.	The nature of a small developing country (SDE) (i.e. its structural elements like political and economic ones and cultural elements such as social norms and customs) influences innovation practices and performance at the firm level, through its effect on managerial practices, networking behaviour and the economic context.
2.	NIP in an SDE influences the innovativeness of firms.
3.	Innovativeness of firms varies in the various sectors.
4.	Innovativeness is influenced by the characteristics of the SME owner/manager (Education Level, Age, Prior business experience, Cosmopolitanism).
5.	Innovativeness is influenced by the characteristics of SME (Size, Age, Sales Turnover, Degree of Internationalization, R&D expenditure, Number of scientists and engineers, Environmental Scanning and Strategy).
6.	Innovativeness is influenced by environmental factors (Intensity of competition, Environmental change etc.).
7.	Innovativeness is influenced by the entrepreneur's (owner/manager's) perception of external barriers.
8.	Innovation affects positively the performance of firms.
9.	Different innovation 'strategic postures' imply different innovation practices.
10.	The more efficiently integrated into networks, the better in innovativeness a small or medium size enterprise (SME) is.

Table 2.2 Hypotheses and Supporting Literature

H No	Dependent Variable	Independent Variable	Expected Relationship	Key Supporting Literature
1.	Innovativeness	Sector	Different	Bell &Pavitt (1992)
2a.	Innovativeness	Education Level	Positive	Miller &Toulouse (1986) Khan et al (1989)
2b.	Innovativeness	Age of Entrepreneur	Negative	Kim (1993)
2c.	Innovativeness	Prior Business Experience	Positive	Piatier (1984)
2d.	Innovativeness	Cosmopolitanism (No of Business Travels abroad)	Positive	Avlonitis et al (1994) King (1990)
3a.	Innovativeness	Size of Firm	Positive ?	Kimberly&Evanisco (1981) (positive) Mohr (1969) positive Rogers (1983) Negative
3b.	Innovativeness	Age of Firm	Positive ?	Kimberly&Evanisco (1981) (positive) Pierce &Delbecq (1977) Negative
3c.	Innovativeness	Sales Turnover	Positive	Kimberly&Evanisco (1981)
3d	Innovativeness	Degree of Internationalization	Positive	Molero (1996)
3e.	Innovativeness	R&D expenditure	Positive	Kamien &Schwarz (1982) Kim et al (1989)

Table 2. 2 Hypotheses and Supporting Literature (continued).

H No	Dependent Variable	Independent Variable	Expected Relation	Key Supporting Literature
3f.	Innovativeness	Number of Scientists & Engineers employed	Positive	Hage &Aiken (1970) Dewar & Dutton (1986)
3g.	Innovativeness	Written Strategy	Positive	Cooper (1984)
3h.	Innovativeness	Environmental Scanning (Diversity of Tech. Inf. Sources)	Positive	Miller & Friesen (1982) Khan & Manopichetwattana (1989)
3i.	Innovativeness	Cooperation Level (External Technolog. Linkages)	Positive	Rothwell & Dodgson (1991) Kim et al (1987)
4a.	Innovativeness	Intensity of Competition	Positive	Cooper (1984) Milo (1971)
4b.	Innovativeness	Environmental Change (Dynamism)	Positive	Burns & Stalker (1961) Miller & Friesen (1982)
5.	Innovativeness	Importance of Barriers	Negative	Piatier (1984)
6.	Performance	Innovativeness	Positive	Cooper (1989)
7a	Innovativeness	Networking Intensity	Positive	Pennings & Harianto (1992) Malerba (1992)
7b	Networking Intensity	Sector	Different	Dickson (1993)

CHAPTER 3

3. Cyprus: It's Economic and Technological Activities

Technological innovation is a context-specific phenomenon, as discussed *in Ch.2 (Literature* Review), and the policies for its promotion have to be adapted to the particular needs and features of the individual economy, especially in the case of small developing economies. The context of this research, the small island state of Cyprus, is examined in the present chapter. The first section (3.1) outlines the economy in broad terms, while the second (3.2) concentrates on manufacturing industry and the third (3.3) on industrial and technological development, in other words the technological state of the manufacturing industry and the policies which have been followed till now for its support and restructuring. Finally some conclusions are presented in section 3.4 drawn from the discussion about Cyprus and its industry.

3. 1 The Economy of Cyprus

3. 1. 1 A Brief Review of Economic History

Cyprus is an island in the eastern end of the Mediterranean Sea. It is the third largest and most populated Mediterranean island after Sicily and Sardinia. Its proximity to the Middle East is both an advantage (closeness to markets, a bridge between Europe and Asia) and a problem (proximity to a region with major political problems, strategic location). Cyprus maintains strong links with Europe both cultural and economic as further explained later in this section.

Cyprus has about 0.7 million people. The main ethnic groups are Greeks (80%) and Turks (18%) with various others (2%). The island has few physical resources (i.e. minerals and energy) apart from its sunny climate.

Cyprus achieved independence from Britain in 1960. At the time of independence it was mainly an agricultural country with a very small industrial base and underdeveloped infrastructure (Wilson, 1992). Its economy grew modestly in the 1960s with manufacturing accounting for little more than a tenth of GDP at the end of the 1960s, and only a fifth of commodity exports. From 1970 there were some signs of an industrial take-off. There was a rapid growth (50%) of manufacturing value between 1970 and 1973 (Murray, 1992).

Then in July 1974 the Turkish invasion divided the island and forced the Greek population from the North to move to the South. The economy received a nearly fatal blow. In 1975 manufacturing value added in the South was 45% down on the 1973 figure for the whole of the island, while unemployment reached 40%. The discussion and all data below refer to the part of the island which is controlled by the Cyprus Government.

Within the next few years the economy recovered and grew rapidly, especially between 1974 and 1980 in what was called the "Cyprus economic miracle" (Christodoulou, 1992). The recovery started with the development of the manufacturing industry, especially clothing, and continued with construction and then the rapid growth of the tourist sector. Growth slowed down between 1980 and 1985 with a gradual recovery and labour shortage after 1988. During 1976 and 1988 the economy grew at a compound rate of 5% per year in real terms which was quite high by European standards (Kaplinsky, 1994). By the late eighties Cyprus was considered as an upper-middle economy.

Then in 1987 Cyprus Government decided, mainly for political reasons, to seek a Customs Union with the European Economic Community. The implications of this decision for the manufacturing sector, which is of the main interest here, are considered in detail below. The signing of the agreement with the then E.E.C was the beginning of a period of liberalization of the economy with deregulation, gradual tariff reduction and removal of quantitative import barriers. These changes together with changes in the world political and economic scene brought turmoil in the Cyprus economy particularly the manufacturing activities.

3. 1. 2 Macroeconomic Characteristics

Cyprus is an open economy with a relatively high per capita income, low unemployment rate and a low level of inflation. The main economic indicators are summarized in Table 1 in Appendix C (similarly the other tables and figures mentioned below are in same appendix) and briefly considered below. Exports and imports of goods and services account for about 95% of the GDP compared to an average of 50-55% in the member-states of the European Union (Planning Bureau, 1994). This high degree of openness is connected to the small size of the Cyprus economy.

Cyprus ranks high among the developing countries regarding GDP per capita, although it lags behind the more prosperous industrialized countries e.g. most members of the European Union. Recently Cyprus was no longer considered by the United Nations (UN) as a developing country, and although in terms of GDP this may be true, by other measures of industrial development Cyprus is certainly still a developing country. It is classified anyway as a 'medium income' economy in the World Development Report 1996. During 1993 the Human Development Index compiled annually by the UNDP in the Human Development Report ranked Cyprus 27th (twenty seventh) out of a total of 173 countries. This ranking takes into account the purchasing power, life expectancy and infant mortality (Panayotopoulos, 1995).

The structure of production in Cyprus is typical of service-based economies. Table 2 gives the origin of GDP, while Fig. 1a shows the share of the primary, secondary and tertiary sectors in Gross Value Added. The tertiary sector (services) contribute close to 60% to Gross Value Added and its share is growing in recent years. From the point of view of size 'retail/gross trade, hotels and restaurants' is the most important sector in Cyprus economy. Manufacturing is an important activity contributing around 12% to Gross Value Added (Fig.1b) with a downward trend in recent years. Cyprus can thus be considered as a services economy with tourism having a central place in terms of employment and earning of foreign exchange. Total earnings from tourism account for 22% of GDP (the highest percentage in EU states is in Portugal with 7⁰ o) as mentioned in the Planning Bureau's report of 1995. Offshore business makes also a significant contribution.

Cyprus is a small firm economy. There are many micro-businesses (86% of firms have less than 10 staff), while only 2.3% of firms have more than 50. Since our main interest here is on manufacturing firms the size distribution of them is further considered in the next section.

The structure of exports reflects the strong connections of Cyprus with Europe. Table 3 shows the exports by broad economic sector. Industrial products of manufacturing origin form a significant percentage (57%) of domestic exports. European Union countries are the main trading partners representing the major export destination (48% of the total manufacturing exports - Table 7) and at the same time being the main suppliers of the Cyprus economy. Manufacturing depends on exports to a considerable extent (around 45%). The direct dependency is around 35% leaving a difference of 10% for indirect dependency (Planning Bureau, 1994).

3. 1. 3. Competitiveness of the Cyprus Economy

The competitiveness of the Cyprus economy has been eroded in the last few years (Planning Bureau, 1994). During the five year period (1989-1993) unit labour costs have risen annually 6% on average for the whole of Cyprus economy (and by 6. 8% for the manufacturing sector) against 4.5% and 4.0% respectively in the European Union. The erosion is attributed to endogenous and exogenous factors. The former include labour shortage, small size of production units and insufficient technological upgrading, long term protection of domestic production etc.). Another important endogenous factor is the low labour productivity against E.U countries. Exogenous factors include the globalization of markets and therefore the more intensive international competition, especially competition from the newly industrialized Asian countries and more recently China, exchange market changes and political developments e.g. in Eastern Europe.

The Planning Bureau (1994) estimates that labour productivity increased at a satisfactory level of almost 3% on average annually during the 1989-93 period. Its level is however low compared to EU countries particularly in the manufacturing sector. Some reasons for the low productivity are the already mentioned deficiencies in technology (including computerization) and the inadequate management techniques. The latter are not necessarily connected to the small size of the firms as the Planning Bureau's report implies.

There has been a major increase of the environmental complexity for business in Cyprus in the last few years. There is at the same time faster change and a more hostile environment. The main reasons are the exogenous and endogenous factors mentioned above. Two key events have also contributed to the changes. The first is the signing by Cyprus of the recent GATT agreement of the World Trade Organization, which has repercussions for the imports of goods. The second concerns the implementation of the association agreement with the European Union (EU), that is now close to completion (in 1998). Cyprus has also applied for the full membership of EU and is expected soon to start the relevant negotiations. It is therefore committed to harmonize its economy with the Maastricht indicators and the EU guidelines.

3. 1. 4. Cyprus as a small state.

Cyprus is a characteristic case of a small state. Some would even say a micro-state (micro-states or micro-economies can be considered those with less than 1 million inhabitants - Jonsson, 1993). It has all the characteristics of a small state as discussed in Section 2.2.5. The size of an economy affects the characteristics of its National Innovation System (NIS). It has both direct and indirect effects. The indirect effects are related to structural features of the economy such as the absolute number and size of firms, the size of home markets, the openness of the economy and the absolute size of the civil service (Jonsson, 1993). The direct effects refer to the constraints or barriers and inadequacies of NIS e.g a small public R&D base and limited demand for innovation services.

Some additional disadvantages of small state, apart from the ones that were discussed in Section 2.2.5, particularly relevant for the discussion here, include:

- Disproportionate dependence on exports due to the small local market.
- High specialization in these exports.
- Small and limited public sector (in comparison to larger states not as a proportion of GDP).

The dependence on exports can be both a positive influence on innovation, through competitive pressure for improvement, and a negative one in the case of unexpected changes in export markets. Some examples of such influences are discussed below for the case of Cyprus manufacturing industry. The specialization in exports is of limited applicability in the case of Cyprus since most exported manufactured products such as clothes or food products are traditional manufactures. The small administration implies lack of resources and specialization for development of long term policies for example a national innovation policy. The smaller the administration, the more difficult to function as a neutral body and resist pressures of interest groups (Jonsson, 1993).

As an island state Cyprus has also the disadvantages of small island economies which relate mainly to geographical factors. These disadvantages according to Briguglio (1995) include: remoteness, isolation, proneness to national disasters and a highly limited internal market. The list could be increased with the addition of lack of physical infrastructure, and deficiencies in technical, managerial and possibly entrepreneurial skills.

The first two disadvantages (i.e remoteness and isolation) are the result of long distances between island countries and their overseas markets and imply increased costs, but also barriers to information flow which are of particular relevance for technological innovation. The small internal market implies that international trade (imports and exports) is of particular importance. The economy is therefore vulnerable to exogenous shocks. The lack in infrastructure and skills implies that in some manufacturing sectors the 'critical mass' for innovation development is missing.

Briguglio (1995) ranks Cyprus 26th in his 'Vulnerability Index' which is a composite index based on the disadvantages of small island economies, as mentioned above, with one (1) as the most vulnerable (top of the scale). It is therefore in a better position than Singapore (8), Jamaica (12), Mauritius (14), Malta (16), but in a worse one than Ireland (63), New Zealand (68), and Iceland (99).

Despite the above mentioned disadvantages, emphasized by economists preoccupied with scale economies and diseconomies, the advantages of small scale (by analogy to those of SME) like flexibility, internal cohesion etc. should not be overlooked. Table No. 3.1 below shows some basic indicators for selected small economies. Cyprus appears to occupy an *intermediate* position between the lower income developing countries and the high income European small economies.

Table 3. 1 : Basic Indicators for Selected Small Economies.

Country	Population, 1993 in '000s	Area '000s Sq.Km	GNP/capita US$, 1993	Avg Growth % '80-'93
CYPRUS	726	9. 20	10, 380	4. 9
MALTA	361	0. 30	7, 970	3. 2
ICELAND	263	103. 00	24, 950	1. 2
LUXEMBOURG	396	3. 00	37, 320	1. 8
FIJI	762	18. 30	2, 130	0. 5
BAHRAIN	533	0. 70	8, 030	- 2. 9
QATAR	524	11. 00	15, 030	- 7. 2
BRUNEI	274	5. 80	-	12. 6

Source: [Research and Development Statistics 1991/1992]

3. 1. 5. Culture, Social Structure and Management *Practices in Cyprus*

Cyprus is a European country with a history of 3000 years and a rich cultural tradition. It has long-dating relations to Europe. The education levels of Cypriots are quite high especially among the younger generations. They are similar to European levels and higher than those of many other developing countries. Literacy rates in 1992 were 98% among males and 90% among females. Table 4 shows the educational attainments for recent years.

Family in its extended form had traditionally a high place in Cypriot society (Christodoulou, 1995). This is gradually changing with urbanization, changes in social structure and significant occupational mobility. It still plays however a significant role. Family business prevails; it is estimated that two thirds of the total are family businesses (ibid., p.25). The 'achievement - orientation' trait of Cypriots is related to the effort to maintain/enhance the position of their family in society.

In a small place like Cyprus, as in other small societies, people know each other well, then impartiality and efficiency of the civil service suffers (Brigguglio, 1995). Lobbying practices have also more chances to succeed. This should be kept in mind in the discussion below of the implementation of innovation policies. The public sector (including the public utilities) is the largest employer. There is a significant gap among the public and the private sector in terms of salaries and benefits. The public sector offering higher salaries, in addition to job security, attracts the most highly educated and skilled people. (CAST/CDB Report, 1995).

There are around 5500 managers in the basic sectors of the economy (1989). The percentage of managers at 3.1% is probably low compared to other countries. There is however a large number of working proprietors (25000) working in enterprises with under 5 employees. 60% of the managers are relatively young under 45 years old, while 55% have university level education (Labour Statistics 1989).

In a study of the Industrial Training Authority (ITA, 1992) on management in Cyprus some interesting facts were brought out. 44 % of the managers in the sample had no previous work experience. This is connected to the trend of the children of owners to undertake management positions in the family firm directly after their studies. Most managers in the sample were general managers (58%), followed by production managers (19%), while sales and marketing managers and especially personnel managers were represented with very low percentages (6% and 3% respectively). In other words in many firms the general manager handles also the sales /marketing and personnel functions.

Professional managers in the private sector, according to the same study, are not rewarded as high as in comparable positions in the public sector and feel job insecurity. There is no recognition of the need for delegation from owners to professional managers. Delegation takes only place among the members of the family or relatives. Regarding entrepreneurship the report notes that Cypriot owners/managers are conservative, reactive rather proactive, copying products and ideas for new ventures and being reluctant to undertake the risk of investment in new products or change the structure of their firms. Most managers were not aware of major changes in the world economy with long-term repercussions for their businesses.

3. 2 The Manufacturing Industry of Cyprus

3. 2. 1 History and Current State

The history of manufacturing is described very briefly in order to sketch the initial conditions as the base which the manufacturing activity had to build on and its subsequent evolution which has determined its position today.

Manufacturing in Cyprus has a relatively short history. This history can be divided in four periods: i.e. a) pre-1960 b) 1960-1974 c) 1975-1987 d) 1988-today.

a) In the period before the Independence (1960) there was little manufacturing activity and there was a predominance of agriculture and traditional crafts (Christodoulou, 1992).

b) The post-independence government launched an industrialization policy based on import substitution combined with high protection of the local industry through both high tariffs and quotas i.e. quantitative restrictions to imports (Wilson, 1992). Effective rates of protection varied from sector to sector and exceeded 100% in certain sectors. The state was not much directly involved in manufacturing activity apart from isolated cases e.g. the oil refinery. Cyprus started in manufacturing from a relatively low initial base of industrial skills. As mentioned in 3.1.1 the growth of manufacturing was modest till the end of sixties and started to improve from 1970. It was severely affected by the invasion of 1974, but started soon afterwards to recover.

c) The period of 1975 till the early eighties was the period of the rapid growth of the Cyprus Industry. There was a rapid expansion of investment, output and exports. Exports were mainly directed to the Middle East (the flourishing at that time, due to the high oil revenues, Arab markets). During the late 1970's manufacturing employment (including the cottage industry) overtook for the first time employment in agriculture. A key role played the light industry (textiles/clothing and footwear) which employed over one third of all manufacturing workers during the 1980s (Panayiotopoulos, 1995).

Growth during the first half of the period under consideration (1975-1987) was based on labour intensive industries and the availability of relatively cheap labour (refugees from the northern part of Cyprus). It was also based on exports to non-demanding quality-wise markets (Arab countries). When the labour market tightened in the 1980's manufacturers started to invest in new machinery to substitute for labour and productivity growth rate increased from 1.4% per annum in the latter 1970's to 2.6% in 1985 (Murray, 1992).

d) The year 1987 was a turning point for the Cyprus economy and therefore for manufacturing. There was a strategic re-orientation of economic development with the Cyprus -EEC customs union agreement. There was a shift from a protectionist to a liberal-outward oriented trade policy (Poutziouris, 1995). The effects of the change were not immediately felt by industry since the changes were gradual. At the same time some exogenous factors had adverse effects on industry (CGTM Report, 1992). These were:

i) The decline in the rate of growth of traditional markets in the Middle East (due to the fall of their oil revenues) which forced Cypriot exporters to turn to EU markets.
ii) The increased competition from low cost mass - producers in the Far East.
iii) The increased competitive pressure in both domestic and export markets from European high quality goods producers.

The above combined with the many problems and deficiencies of the Cypriot industry, which are considered below, decelerated its growth. There was then a downward course of the manufacturing's share to the GDP, a period of de-industrialization which continues till today. The only industries, which were not so much affected were those with a local resource base (e.g. beverages) or those enjoying natural protection from high transport costs.

The main manufacturing subsectors are illustrated in Fig.2. Manufacturing output is concentrated mainly in two subsectors i.e. 'Food, Beverages and Tobacco' accounting for 33% of the manufacturing value added and 'Textile, Clothing and Footwear' with 16%. Combined these two subsectors represent half of the total Manufacturing Sector. Other important subsectors include: 'Metal Products, Machinery and Equipment', 'Chemicals and Plastics', and 'Wood Products including Furniture'. Table 5 illustrates 'Gross Manufacturing Output by Major Industry.' All these sectors with the possible exception of chemicals (including pharmaceuticals) and plastics and perhaps some subsectors of metal products are generally considered as traditional (mature, low-tech or sun-set) industries. The usual criteria to identify high technology sectors are: The intensity of R&D, the proportion of scientists and engineers employed, the speed of obsolescence of products and processes, the number of patents, and the number of major innovations introduced (Daniels, 1993).

The study of the size distribution of manufacturing firms leads to some interesting insights. As illustrated in Table 6 the majority of firms (around 88 %) are micro-firms with less than 10 employees. Only 0.5% i.e. 41 firms have 100 or more employees and another 0.8% (67) have 50 - 99 employees. It is obvious that practically all firms in Cyprus are small in terms of employment. In the sense of low market power as used in the small firms literature, 'small firms' in Cyprus are the firms with less than 10 or even 5 employees. Ch.4 discusses in detail the definition of small, medium and large firms in the Cyprus context for the purposes of this study and justifies the choice of it.

Exports are important for the manufacturing sector, in view of the small size of the domestic market. Table 7 shows manufactured exports by area. The sector's contribution to GDP has been declining as mentioned above (1987: 16% , 1993: 13%, 1995: 13%) . There has been also a fall in the sector's share in total employment (1987: 20% 1995: 15.6%) and in numbers 1985: 48500 people while in 1995: 44000. At the same time manufacturing is losing competitiveness as shown by the falling export to output and export to import ratios (Table 3.2 below - CAST Report). The export performance towards EU is similarly deteriorating.

Table 3. 2 Manufacturing Performance

	1987	1992	1993
Export / Output Ratio	22%	16%	14%
Export/ Import Ratio	21%	15%	15%
EU Exports/EU Imports	16%	12%	13%

Source: CAST /CDB Report, 1995

3. 2. 2 Comparison and Relations of Manufacturing with the other Sectors of the Economy

For comparison purposes the service sector and the primary (agricultural -mining) sectors are briefly considered. Cyprus has a very developed tertiary (services) sector which in 1995 represented around 69% (including the Government Services) of the total GDP i.e. it is at similar levels with that of industrialized countries (approximately 55-65% of GDP).

The primary sector had a share of 5.8 % of GDP in 1995. Agriculture has followed a downward trend in recent years with its GDP share fluctuating at 5.5 - 6 % (5.5% in 1995) compared to 10% in 1980. The sector continues to employ a substantial number of people and earns considerable foreign exchange (through exports). It is also important for the balanced development of the economy to avoid overdependence on the volatile tourist sector.

Manufacturing depends mostly on agriculture followed by electricity, gas and water and then wholesale and retail trade according to data from input/output tables (Hadjimanolis,1991). Agriculture is therefore important as a purchaser of industrial goods (e.g. chemicals, pumps, pipes etc.) but also as a supplier of input (fruits for processing in the food industry etc.). The technological state of agriculture and services in comparison to that of manufacturing is considered below.

3. 2. 3 Main Problems of Manufacturing

The main problems of manufacturing can be summarized as follows:

- Small local market and isolation (*relative to foreign customers* and suppliers) and long supply lines for raw materials and intermediate goods are connected to the characteristics of Cyprus as a small island state.
- Undercapacity and low stock turnover are consequences of the small local market (Murray, 1992).
- Low labour productivity (against the main trading partners, especially EU countries) (Planning Bureau, 1994). This is probably due to the relatively short industrial history of Cyprus (only about 40 years).

- Labour shortage and scarcity of technicians due to the rapid growth of services especially tourism and the preference for employment there.
- High local costs e.g. labour cost and cost of electricity. The latter is higher than in Europe due to the maximum demand charge which increases the cost of production in energy-intensive industries, despite the special rate for them. (CAST/CDB Report, 1995).
- Lack of domestic suppliers and specialized service firms. Particularly important are the deficiencies of the local metal/mechanical industry as suppliers of equipment and machinery. (According to Porter, 1990 a key element in the development of competitive firms is the existence of local competent suppliers, especially of equipment).
- Lack of specialization between firms due to their insistence on production of full product ranges sometimes for their own shops (Murray, 1992). Also low degree of vertical and horizontal linkages of industrial activities and minimal production depth (imported raw materials undergo usually only one step of processing resulting in low value added) (Foerstner, 1991).
- Lack of cooperation among the local firms. Despite the efforts of Government to encourage cooperation, through supply of incentives for consortia formation, the results are rather disappointing so far. Active cooperation especially in production is very limited and in new product development or other innovation activities it is virtually absent [Interviews with Government officials (Section 5.2.7) and CAST/CDB Report, 1995].
- Overdependence on traditional export markets (U. K, Arab countries).
- Structural weaknesses of the manufacturing sector (too many micro-firms) and family character of businesses.
- Uncertainty for the future (due to the political problem). Foreign occupation and the fear for military action combined with the delay in a political settlement create a climate of uncertainty which affects investments in manufacturing with relatively long payback periods.

3. 2. 4. Manufacturing Subsectors

Brief profiles of the main subsectors of manufacturing are presented below with emphasis on the subsectors which were covered in the survey research.

A) Chemicals and Plastics

Chemicals and plastics are combined together in the reports of the Statistics Department, although the plastics subsector has distinct characteristics. They have been treated as separate subsectors in the survey research. Together they contribute 10% to the manufacturing value added (1995) [Fig.2].

i) Chemicals include the following 'industries' (Table 3.3 below). They also include petroleum refinery (153 employees and 61 million pounds gross output), that was excluded from the survey and is not further considered here. The largest group (industry) is cleaning and toilet preparations with drugs and medicines as second largest. The 1995 Economic Outlook of the Planning Bureau notes that the external demand for pharmaceutical products has been rising continuously in recent years, making them the second most important manufactured export product of Cyprus.

Table No. 3. 3 Chemical Industries

Industry	Employees	Gross output million Cyprus pounds
Basic Industrial Chemicals, Fertilizers and Pesticides	179	10
Paints Varnishes and Lacquers	229	10
Drugs and Medicines	359	20
Cleaning and Toilet Preparations	656	26
Other	317	12

Foerstner (1991) notes that by international standards all Cypriot companies of this sector are small. There is a lot of machinery working under capacity and in some subsectors e.g. paints the machinery is rather old, but probably adequate for the local needs. Most companies indicate that they carry out R&D work especially in the paint subsector. Foerstner's (1991) report notes the need for more up-to-date testing equipment in the paint sector and found the laboratories in the 'Cleaning and Toilet preparations' subsector as "sometimes rather poorly equipped". License agreements with foreign producers are common in the chemicals sector. In 1988 the cosmetics (toilet preparations) subsector had concluded 28 and the paint subsector 7 royalty agreements. The former cover almost exclusively the purchase of brand names (Table 10).

ii) Plastics

They include the following two main groups:

- Rubber Products with 159 employees and around 4 million Cyprus pounds gross output.
- Plastics Products with 1132 employees and 33 million gross output. The plastics products group is by far the most important one. It is relatively capital intensive and its machinery is on the whole at a good technological state. It includes modern computer-controlled production machines.

The combined subsectors of chemicals and plastics represent the most important manufacturing activity in terms of employment of R&D personnel (Table 8) and R&D expenditure (Table 9). The 1992 R&D Statistics report mentions as main research activities in the chemicals subsector the development of new pharmaceutical forms, pharmacokinetics and clinical trials for new substances, the modification and development of new active drug substances and the development of new pesticide formulations.

B) Metal Products, Machinery and Equipment

This subsector contributed 12% of added value in manufacturing industry in 1995. It includes a very wide spectrum of groups. i.e the following (the numbers within parentheses indicate the first the number of employees and the second the gross output in million Cyprus Pounds for 1995):

- Metal products except machinery (3553/82.5) including household utensils, tools and general hardware, metal furniture and fixtures, structural metal products and other metal products. The metal products group is by far the most important in terms of both employment and gross output. Structural metal products is the most important activity within it.

- Machinery except electrical (1337/28.6) including machine shops, turbines, refrigerators.
- Electrical machinery and apparatus (527/14.9)
- Transport equipment including motor vehicles and ship and boat building and repairing (444/11. 3)

Sales concentrate mainly on the domestic market, although imports are gradually gaining market share. Exports comprise around 5% of the total output. The industry had enjoyed growth around 11% annually till 1991 due to domestic demand, especially of hardware and construction-related items, but its growth is very low since 1992.

In research conducted in the metal subsector (Efstathiadis,1993) it was found that CAD technology was used by 22.4% of firms, NC/CNC machines used by 10.2% and CAD/CAM technology used by one company only. Robotics were used by 3 companies only. No company with under 10 employees was found to have any form of Advanced Manufacturing Technology (AMT), whereas all 3 large companies (over 100 employees) were using a form of AMT.

In a study of the Productivity Center (1995) of the Metal Industry it was found that the basic AMT type in use is NC/CNC machines. Computers are used mainly in stock control, production planning and control, and design. It is concluded that the use of advanced technology is at relatively low levels. In 43% of the firms in the sample the owner/managers considered the degree of use of the existing technological equipment as low. The CAST/CDB report (1995) mentions a low level of efficiency in the use of sheet-metal cutting and shaping equipment in most of the visited factories.

c) Food

Food, Beverages and Tobacco is traditionally the largest subsector in the manufacturing industry of Cyprus. In 1995 it contributed 33 % to the manufacturing value added, registering a 1.5% rise against the previous year at constant market prices. The rise was due to the increase in domestic demand, while exports remained at the same level. The main groups are food, beverages and tobacco manufactures (the latter are not further considered as they were not part of the survey).

Food includes: meat products, dairy products, canning and preserving of fruits and vegetables, oils and fats, grain mill products, bakery products, chocolate and sugar confectionery, other food products, and animal feed.
Beverages include: alcoholic beverages, soft drinks and carbonated water.

In a study of the Industrial Training Authority of the food subsector (1991) it was estimated that the total number of firms in the food industry were around 760. About half of them are in bakery and related products. The vast majority (85.4%) of firms employ 1-9 people, while only 56 enterprises employ more than 20 people. Production workers make-up 64.1% of employees, while managers and supervising personnel are 7.5%. Scientists and engineers comprise only the 2.5%. The canning industry and oils and fats account for over 50% of the total exports of food industry. There are some relatively large firms in these subsectors as well as in wine and soft drinks industries. Most of these firms have relatively modern machinery and equipment.

d) Textiles and Clothing

This subsector had traditionally an important position in manufacturing in terms of employment and exports. It follows a downward trend in recent years, especially after 1990. It contributed 16% to the manufacturing value added in 1995, while it had contributed 20% in 1993. It employed 10702 people in 1994 (23.6% of manufacturing employment) against 13650 in 1990 (29.6%) respectively (ITA study, 1996). The reduction in employment was particularly serious (24%) in the clothing group against a 3% reduction in knitting industry (part of textiles). There was also a reduction in the number of firms especially in micro-businesses (under 5 people). Some medium and large businesses transferred at least part of their operations to low labour cost countries abroad (e.g. Jordan). In 1994 exports were 44.6 millions Cyprus pounds representing 27% of the local production against 70.3 millions in 1990 (39.4%). At the same time import penetration is increasing. Investment in clothing in 1994 was 615.000 Cyprus pounds against 2.294.000 in 1990 (a 73. 2% reduction).

Regarding the technological state of this industry some (8-10) of the larger enterprises have introduced and operate computer aided design systems. There is only one integrated design and cutting system in Cyprus in one of the largest firms. Advanced type sewing machines (programmable) are in wide use. There is however a limited introduction and use of automatic presses for ironing and finishing. In the knitting industry automatic (computer-controlled) machines are in wide use. Recently (end of 1996) the long awaited fashion and technology resource center for the clothing industry was established.

Computers are mainly used in administration and accounting, while their use in production control, costing and in operation of management information systems has somewhat increased in recent years, especially among the larger firms, but much more has to be done. The ITA report, 1996 observes that the main way of productivity improvement especially in the clothing subsector is through improvement of production organization rather than more advanced mechanical equipment.

The Industrial Training authority reports a reduction in the participation in training programmes especially of new employees entering the clothing industry, while participation in management level seminars has been maintained at about the same levels. ITA subsidizes programmes for training in new technology abroad or locally with foreign consultants. These programmes appear also to be in decline after 1990. It is widely felt among the industrialists that the human factor has to be improved and labour productivity to increase, but the crisis in the industry is a barrier to the wide use of the available training programmes.

It is obvious from the above that the clothing industry in Cyprus is going through a restructuring process similar to that in the industrialized countries. Its technological state does not lag far behind the international standards, at least for the medium and large enterprises. There is however a problem of technological upgrading in the small and micro-businesses.

e) Other Subsectors

These include non-metallic mineral products with 10% of the value added in manufacturing industry, wood and wood products including furniture with another 10%, paper and paper products, printing and publishing with 7% and other manufacturing industries with 2%. Some comments are only made on the furniture industry, which has been extensively studied by foreign experts. The wood and furniture subsector, a growing industry in the past due to high demand in the protected local markets, is facing recently very low growth and increasing pressure from imports. Although investments were made in modern machinery, its rate of use is low. Exports are low and the industry has major design deficiencies (CAST/CDB Report, 1995). Some efforts have been made by Government and the Development Bank to promote cooperation in production and marketing among firms of the sector, but it is still early to evaluate the results. Due to space limitations the other subsectors, that were also not part of the survey, are not further considered.

3. 3 Industrial and Technological Development

After presenting the manufacturing sector of Cyprus, the National Innovation System is described with a major emphasis on its components which are directly related to the manufacturing sector. First the industrial development policies, which have shaped the evolution of the manufacturing sector, are briefly introduced, then the state of Science and Technology in Cyprus, the Cypriot technology indicators and the relevant institutions are described. Finally the National Innovation Policy (NIP) is discussed.

3. 3. 1 Industrial Development Policies in Cyprus

Cyprus has a Planning Bureau which prepares five-year development plans for the economy. These plans, which include industrial policies, serve as blueprints for government action. The industrial policy for the 1980s was based on the philosophy that big is beautiful. There was encouragement of mergers among local companies and the formation of public companies. The pre-1987 incentive schemes focused on fixed capital with investment allowances. This led to the acquisition of machinery sometimes in excess of that actually needed and therefore operation at a low capacity. There was also an attempt to attract foreign mass producers in a free trade zone in Larnaca. The above policies failed to a large extent (Murray, 1992).

In the late '80s the Cyprus Government, realizing that a major restructuring of industry would be necessary in view of the implementation of the 'Customs Union Agreement' with the European Union, initiated a series of studies by consultants for a new 'Industrial Strategy' and an integrated 'Science and Technology Policy'. An 'Industrial Restructuring Council' was formed in order to promote the suggestions of these studies and the indicative five-year development plans began to include the revised industrial policy. There was therefore a shift in industrial development strategy after 1987.

The philosophy of the proposed changes was based on the 'flexible specialization' approach for Cypriot industry. Thus, from around 1990, elements of a NIP started to emerge. An alternative vision based on the observed operation patterns of the industrial districts and inspired by the achievements mainly of the 'Third Italy' was proposed and adopted as the way forward for Cyprus. It was judged that Cyprus was well placed to embrace the principles of flexible specialization (Murray, 1992). The suggestions of the experts covered not only specific policies but also institutional changes including the formation of new institutions for innovation and technology promotion.

In parallel with the industrial strategy a complementary technology strategy was developed by foreign experts at about the same period. Technological upgrading was explicitly recognized as an important component of the industrial restructuring process. An innovation policy was also drafted (Bessant, 1988) suggesting change of emphasis from hardware to software. Technology related strategies are considered in more detail below.

The flexible specialization approach has come under severe criticism (in the case of Cyprus by O' Donnel and Nolan, 1989). They emphasize the dangers of production for market niches and question the capabilities of the very small Cypriot firms to compete in E.U without some growth of their size e.g. through mergers. Murray, himself, admits that flexible specialization was mainly developed by observing the organization of industrial districts. In his own words "Much less experience of trying to implement an explicit strategy of flexible specialization ab initio was available" (Murray, 1992 p. 256).

Despite the objections to the theoretical approach, there is no doubt that many of the suggestions were sound including the sectoral approach, the need for cooperation among firms, the need for technology upgrading, specialization, attention to quality and innovation. Valuable was also the original idea of applying the same principles of flexible specialization to public administrative practices. Christodoulou (1992, p.107) agrees that the diagnosis and recommendations of the above team of experts were sound, although he considers their recommendations "with extreme difficulty" feasible.

What actually happened in the following years was the implementation of some of the recommendations with substantial delay, while several others were just ignored. The strategy that was followed in practice was not coherent. The Government under political pressure made steps to the opposite direction e.g. by allowing imports of foreign labour and taking reactive measures in response to particular crises (CAST/CDB report, 1995).

3. 3. 2 Science and Technology in Cyprus

The Strategic Development Plan (1994-1998) observes that Cyprus is lagging behind most, as it puts it, EU countries in technology and research. This is rather an understatement of the problem and 'lags behind all EU countries' would probably be more correct. The low level of technology affects productivity and has led together with other factors to the gradual erosion of competitiveness in manufacturing.

In 1987 an excellent team of foreign experts (including N. Clark and others from Susssex University - SPRU Centre) after assessment of the technological capabilities in Cyprus recommended a technology strategy for Cyprus (Feb. 1988). Unfortunately the strategy was never actually implemented in its entirety and few of its recommendations were applied. The technological situation today, especially in manufacturing, although somewhat better is still problematic and the comments of experts after almost 10 years retain their validity. Some of their findings and recommendations (the most relevant to manufacturing) are briefly summarized here.

The industrial (manufacturing) sector was found in a poor technological state (compared to industrialized countries) except for its use of office automation technologies in contrast to the better technological state of agriculture. Professional engineering services were reported as poorly developed. The authors of the report criticized the assumption that foreign direct investment and technological licenses were the main mechanisms of technology transfer as wrong. In their opinion the purchase of capital goods and the interchange of people (including re-patriating Cypriots) are the main mechanisms.

They proposed an integrated technology strategy for all sectors of the economy and the relevant coordination mechanisms and institutional support. Their recommendations included the establishment of a technology culture, encouragement of greater technological intensity in the private sector, a policy on mechanisms for technology transfer and technology selection assistance to private firms.

Few of the recommendations were adopted and even today there is no coordinating body for science and technology and each ministry is responsible for research within its field. The importance, however, of science and technology is much better recognized today and among the objectives of the latest development plan is the promotion of research activity, within the capabilities of the economy, and especially the upgrading of technology (through imported technology). The prospects of science and technology appear now better through the participation of Cyprus in the relevant programmes of the European Union.

3. 3. 3 Cypriot Technology Indicators.

The first and only survey of the 'Science and Technology Potential' in Cyprus was made fairly recently (1992). The main R&D indicators for Cyprus as resulted from the above survey are summarized in Table 3.4 below. Cyprus has made considerable technological progress in fields such as construction, telecommunications, water development and agriculture (in the sense of the fast adoption of foreign technology). It is, however, acknowledged [Report CGTM, 1992 and in the technology strategy report that was mentioned above] that the manufacturing sector is in a relatively poor technological state without the support of local public research and relies to a great extent on imported technology in a 'packaged' form (purchase of machinery, licensing etc.).

Comparisons with other small countries on R&D expenditure and employment show that Cyprus has a very low level of R&D expenditure as a percentage of GNP [Research and Development Statistics 1991/1992]. In 1992 Cyprus's expenditure on R&D amounted to less than 0.2% of GNP, compared with Jordan at 0.3%, Ireland at 1.1% and Singapore at 0.9% (Table No. 3.5 below). The average is about 0.65 % in developing economies and 3% in developed countries (Planning Bureau, 1994). While Cyprus had only 366 full-time researchers, Jordan had 463, Ireland over 8500 and Singapore had 5800 (Table 3.5). Furthermore, from the figures in Table 3.4 it can be seen that agriculture has the lion's share of Cypriot research funds, while manufacturing has a very low research activity indeed.

Interestingly, Daniels, 1993 ranks Cyprus in a comparatively intermediate position in comparison to other small countries regarding their trade performance in ' technology-intensive' (TI) manufactures. These TI manufactures include chemicals, selected types of machinery, electronic equipment, instruments etc. According to his data Cyprus ranks far behind Ireland, Singapore, Hong-Kong or Israel as would be expected but ranks above New Zealand, Iceland, Mauritius etc.

Table 8 (Employment in Research and Development by Manufacturing Sector) and Table 9 (Expenditure in Research and Development by Manufacturing Sector) show that the little research and development that is done in the private manufacturing sector is mainly carried out in three subsectors i.e. 'Chemicals/Plastics and related products', 'Food /Beverages and Tobacco' and the 'Metal Fabricated Products'. The Chemicals/Plastics sector comes also on top in the statistics on 'numbers of scientific and technical personnel employed by industrial sector' (Hadjimanolis,1991), as well as R&D expenditure.

Table No. 3. 4 : R&D in Cyprus

Total Expenditure in R&D (1992) :	US$11. 2 millions
- of which Current Expenditure is	86. 2%
and Capital Investment is	13. 8%
- of which Public Sector Share in R&D is	84. 4%
of which Agriculture is	60. 5%
Health is	20. 3%
Manuf'g & other is	19. 2%
and Private Sector Share in R&D is	15. 6%
People employed in R&D (1992)	366 (Full time Equivalents)
equal to 0.13% of people in total employment of which Public Sector employed	85. 2%

Source: [Research and Development Statistics 1991/1992]

TABLE No: 3.5 Personnel Engaged in and Expenditure on Research and Development (Selected Countries)

Country	Year of Reference	Personnel Engaged in R&D	Expenditure on R&D as % of GNP
Cyprus	1992	366	0. 2
Ireland	1988	8590	1, 1
Denmark	1989	25448	1, 6
Greece	1986	. . .	0, 3
Iceland	1989	1177	. . .
Malta	1988	46	0, 0
Jordan	1986	463	0. 3
Israel	1985	. . .	3, 1
Singapore	1987	5876	0, 9

Source: [Research and Development Statistics 1991/1992]

3. 3. 4 Institutions

Innovation related institutions provide the infrastructure which enables private firms to develop innovations. Their importance has been discussed in Ch.2. They can be classified into technology, financial, labour and general infrastructure.

a) Technology-related

Intellectual Property Rights. In Cyprus till the beginning of the 1990's there was no Patent Office and inventors had to apply for a patent abroad (usually in the UK) at considerable cost. In 1991 legislation was introduced enabling Cypriots to apply through a local authority to the European Patent Office. Cyprus has also ratified the Convention on Protection of Industrial Property. Trade marks are registered with the department of the Registrar of Companies. Patent statistics in Cyprus is not a relevant innovation indicator, since almost all applications for the registration of patents are filed by foreign companies (mainly multinationals). The number of applications for patents by Cypriots in other countries (UK etc.) is not known but probably very small (Hadjimanolis, 1991). Table 10 illustrates the distribution by sector of the number of licenses received by Cypriot companies from foreign firms.

Public R&D in Cyprus is relatively limited as the data presented above show. The Agricultural Research Institute established in 1962, carries out applied agricultural research, finding solutions to problems of agriculture and animal husbandry and contributing to the technological upgrading of agriculture. It is an important regional research and training center employing 42 scientists. The Institute of Neurology and Genetics is a recently established research center in the health sector. A Cyprus Research Council to promote research in all fields and monitor the allocation of research funds is in the process of formation.

Higher Education. Cyprus has one university established fairly recently (in 1992) which includes a school of physical sciences, but not engineering. The establishment of a school of engineering in the next two to three years is currently under study. Research is carried out according to the scientific interests of the academic personnel. Several university researchers have tried from the start to arouse the interest of local industry in their research. Although it is rather early to evaluate the results of these efforts the first impressions, as expressed in interviews during the present research, were rather disappointing at least concerning the response of the manufacturing sector. University level engineers and scientists are in ample supply. They are graduates of foreign universities in Greece, UK, USA and many other countries. The Higher Technical Institute trains technician engineers in various fields of engineering at a relatively good standard. It also carries out some research of an applied nature mainly in the energy field.

The technical (vocational) education covers various occupations including some of manufacturing interest. Unfortunately the level of those attracted to technical schools is rather low i.e. mainly the less academically able pupils.

Technological services. The Technology Foundation (TF) was created in cooperation with industrial employers' associations. It acts as a broker for technology resources (information, etc.) and promotes a 'Funded Consultancy Scheme' which allows local manufacturing firms to use the services of foreign and local (accredited by the TF) consultants on a subsidized basis. The Technology Foundation in cooperation with the Development Bank has also helped in efforts to create consortia (networks of local firms) e.g. in the furniture industry [CAST/CDB Report, 1995]. The Ministry of Industry and Commerce has an Industrial Extension Service initially designed for the provision of help in technological problems of the industry but now acting more as a liaison with the major industrial sectors. The Cyprus Standards Institute is pursuing the introduction and monitoring of standards and quality management systems, while an Energy Unit in the same Ministry helps industry, as well as, other branches of the economy with the efficient use of energy.

Training providers include the long-established Productivity Centre and the Cyprus Training Authority. The latter carries out research for the training needs of industry and introduces suitable training programs for industrial workers and managers.

b) Financial

Cyprus has several commercial banks (both local and subsidiaries of foreign banks). A stock exchange has also been recently created. The Cyprus Development Bank provides loans to manufacturing among other sectors. It has schemes for support of SME including management advice and participation in their share capital.

c) Labour-related

Labour-related institutions merit a few words also. A tripartite agreement between Government, trade unions and industrial employers, formed in the mid-70s to provide a framework for the settlement of industrial disputes has served the economy well.

d) General Infrastructure

Telecommunication and transportation facilities are at a reasonably good level against those of industrialized countries and probably in a much better state than those of many developing countries (Cyprus Industrial Strategy Report). Energy, however, which is mainly derived from imported oil is expensive, although electricity generation and supply is at a good technical level. Water is relatively scarce, but the water storage and distribution system is very well organized.

3. 3. 5 National Innovation Policy in Cyprus

Many industrialists have questioned the viability of a NIP (even of an Industrial Strategy) for Cyprus as revealed in the case research (Ch. 5). They perceive 'Government failure' (in terms of red tape, inefficiency, vested interests of civil servants etc.) as a major constraint in the development of an effective Industrial Strategy. This view however should be interpreted with caution since many of these industrialists still consider state protection against imports as its most desired feature. Any discussion of NIP in Cyprus must extend beyond its content (i.e. the mix of tools used to promote innovation) and include the context and process of innovation policy formulation.

The Context of Cyprus NIP: The objective to join the European Union linked with the current, 'free market' economic approach of the Government is shaping the internal context for a NIP as well as the current government stance towards its development. The internal context interacts with the external setting which includes international trends in technology development (e.g. the expanded growth of microelectronics and information technology), the role of Cyprus in a major regional political/economic bloc (i.e. the expanding European Union) and the globalisation of industry.

The Process of NIP Formulation: The public consultation process and the policy environment in Cyprus has a number of peculiarities in comparison with larger states (e.g. Korea, India) which are probably shared with several other small developing countries. In a small state like Cyprus, powerful individuals and groups have more opportunities to use their influence during the process of policy formulation than in a larger state. Lobbying practices are therefore more informal, but no less effective.

To a greater extent than many of their counterparts in other developing countries, Cypriot state officials are well educated, competent and have the necessary management and coordination skills for effective policy formulation. The problem is, in the words of a disillusioned industrialist who participated in public/private committees for innovation promotion, that:

"most government officials bring their own 'hidden' agendas in meetings and try to promote, primarily their departments' and sometimes their own interests, rather than the stated objectives" (Case research Ch. 5).

The consequence is inefficiency and delay rather than fast action, despite the initial good intentions. Since Innovation Policy involves by its nature, many government departments it frequently falls victim of power games and vested interests.

The NIP content: NIP tools can be classified into supply-side, demand-side and environmental measures, [Section 2.2.3] according to Rothwell's classification scheme (Rothwell and Zegveld, 1985). In Cyprus, supply-side measures have been in place for several years now, e.g. incentives for new product development and investment in new high technology sectors. However, the tax-basis of these incentives makes them rather weak due to the extent of tax evasion in the manufacturing sector. Some recently provided funds from the EU have been used for restructuring and technological upgrading of the industry, but to a limited extent.

Regarding demand-side measures, e.g. government purchasing policy for products and services, encouragement has been directed at production at the lowest possible cost without even insisting on certain quality standards, let alone promote the production of innovative products and services. An example from the paint industry illustrates this point: tenders are requested for paint without stating in detail the required specifications and are evaluated on the lowest price criterion only. Similarly foreign consultants and specialist contractors are used without a requirement for close cooperation with local firms to induce transfer of know-how and a gradual development of local experts.

Environmental measures, i.e. the legal/fiscal framework within which industry operates (including for example, the patent system, health/safety legislation, anti-pollution measures) have been given more attention during the last few years, but in most cases the legislation has not yet been fully applied. The institutional framework can be considered as part of the environmental measures (although institutions are also frequently the channels of implementation of supply and demand side tools). It is certainly in a much better state than it was ten years ago. However it can, at best, be described as still being in a developmental phase. Some infrastructural initiatives, e.g. the proposed by the Industrial and Technology

Strategies of the foreign experts (Sussex Group) sectoral resource centres, have been in the drawing board for more than 5 years.

Evaluation of NIP: Evaluation of the effectiveness of the currently existing NIP tools and institutions has not yet been attempted, as it is probably too early to judge, since their effects take years to materialize. The main problem with NIP in Cyprus seems to be that the current crisis in some major export-based industrial sectors (e.g. clothing, footwear, etc.) leads to pressures by industrialists for short-term relief measures (e.g. low interest loans, and export guarantees.) which could put into jeopardy or postpone the necessary long-term changes (institutional development, etc.). It seems also that small firms (i.e in the case of Cyprus the micro-firms) are rather neglected. Kaplinsky (1994) noted a bias of policy towards medium and large firms, due to Government prejudice, but also perhaps the stronger political influence of the latter and their higher awareness of the incentive schemes.

3. 4. Conclusion

The above discussion has shown that there are significant gaps in the research on innovation in Cyprus and its management. Much of the existing research has been on the aggregate (national or sectoral level) rather than on the firm level. Significant topics as the interfirm relations, and the management of technological innovation at the level of the enterprise have received scant attention. It is the ambition of the present work to fill some of the gaps and point to the need for further research on promising directions.

The economic weaknesses of Cyprus and the various barriers to the development of the manufacturing sector due to the small country size, the present economic structure and the fact that practically all firms are small have been discussed in this chapter. The relatively recent first steps to the formation of a science and technology policy and the difficulties in developing an integrated National Innovation Policy have also been considered. The findings of the research about the innovation practices of Cypriot firms and their repercussions for NIP (as well as the effect of NIP on them) are discussed in the next chapters. The lessons from the experiences of Cyprus for other developing countries are considered in Ch.6.

CHAPTER 4

4. Methodology

This chapter describes the methodology which is used to test the research propositions (hypotheses) as they came out from the literature review in Chapter 2. Since innovation is a very complex subject without a single generally accepted theory or a universally applicable model, no single method is adequate for the study of innovation at the level of the firm. This is not an uncommon situation in management research and writers on methodology e.g. Easterby-Smith et al, 1991 suggest, as further explained below, mixing methods as a way out, leading usually to a combination of quantitative (such as a survey) and qualitative (e.g. case study) methods. Sometimes the qualitative method is used first in an exploratory stage, followed by a quantitative method based on the results of the first stage. Here the methods are used in parallel, in a complementary fashion. Lall et al (1994) among others have followed a similar approach. Section 4.1 sets out the survey research methodology, while section 4.2 the case studies methodology. Section 4.3 introduces the supplementary interviews with officials of government and others and finally section 4.4 the confidentiality arrangements.

4. 1 The Survey Research Methodology

4. 1. 1 The Research Model

The aim of the survey with the code name 'INNOCYP' is to investigate the way technological innovation is managed in Cypriot small and medium size enterprises (SME) and in particular the role of the owner/manager in innovation management. Apart from the central role of the owner/manager, the characteristics of the firm (size, age etc.), several environmental factors (intensity of competition, degree of environmental change etc.), the national innovation policy and the inter-organizational relationships in which the firm is involved, are expected to have an effect on the innovation efforts of the firm. An attempt is therefore made to evaluate these various influences.

Since the research is mainly based on a cross-sectional survey the adopted research model is following the 'antecedent' factors research tradition which was presented in Chapter 2 and uses the 'antecedents' model (Fig. 2.7). A process approach would imply a longitudinal research plan over an extended period of time which was beyond the means of the researcher. An effort however was made to introduce some kind of a longitudinal element through the case studies that complement the survey research (as explained in the following).

4. 1. 2 The sample

The INNOCYP project is based on a survey of a sample of manufacturing firms in Cyprus. A lot of thought and consideration was given to the selection of the size range of the firms to be included in the survey. Size, measured here in terms of employees number, is hypothesized to be one of the main influences on the innovativeness of firms and this hypothesis is well supported in the literature as discussed in 2.4.2.

In the small island economy of Cyprus small firms, strictly speaking, are those under 10 or even under 5 employees. Since the aim of the survey was to study firms with important innovation efforts the concentration on micro-businesses would not serve this purpose. Small and medium size firms were then defined as those with 10-100 employees. No strict distinction was made between small and medium size firms ; nevertheless for our purposes small are those with 10-50 employees and medium between 51-100. A number of micro-businesses (below 10 employees) and 'large' firms (over 100 employees) was also included for comparison purposes and in order to have a fuller picture of the Cyprus economy as a whole.

The above definition of SME size will permit comparisons with SME firms in other European countries, since similar definitions of SME have been frequently used in other research projects (e.g. The STRATOS group study) and is close (for small, but not for medium firms) to the definition adopted by the European Union (as of January 1995 small firms up to 50 employees and medium 51-250. The E.U specifies also maximum turnover and balance-sheet totals) as cited in PROMEESE Project report, 1995, p.28.

The sampling frame used in INNOCYP was a register of firms in the Directory of the Cyprus Chamber of Commerce and Industry (CCCI, 1992). Other publications of the CCCI e g. the Register of Exporters (1993) and information from industry experts was also used in the selection.

A random sample is the ideal for a research project, but in this case it was difficult (if not impossible) to be achieved for a number of reasons: a) access to firms was important for completion of a long and detailed questionnaire b) a balance was also aimed in terms of innovative/less innovative firms in the sample (or at least the inclusion of several truly innovative firms, which are a rather rare species in the Cypriot context). Information from industry experts (e.g. from the Industrial Extension Unit of the Ministry of Trade and Industry and other sources) was used for the inclusion of innovative firms. Kim et al (1993) give a similar argument, i.e. the low level of technological capability/innovation of small firms in Korea as a reason why a probability sampling plan would result in the inclusion of too few innovative firms.

A possibly useful research design, using matching of innovative and non-innovative firms, was used by Rothwell et al, 1974 in the SAPPHO project (and by Kim et al, 1993 among others). But this approach would have needed concrete information on innovation outputs, e.g. innovation awards, specific innovations details etc. However such information was not available for this project so this research design could not be adopted.

A large (140 firms), carefully balanced, judgmental (purposive) sample was then used. The use of purposive samples is not an unusual practice in organizational, management and related studies. On the contrary according to Bryman (1989) relatively few instances of survey research in organizational studies are based on random samples. Balance was aimed across a variety of features such as size, innovative record, performance, sector etc. and can be seen that it was achieved by figures presented in the next chapter (Ch.5 Table 5.1 - See also Chart No.2, p.363, App. B).

The size of the sample is such, that for some sectors e.g. plastics, chemicals, it is almost a census (at least for the small and medium size enterprises, without the micro-firms). In 1994 there were only 108 establishments with 50 and over employees in all manufacturing sectors (Table 6, App. C). The sample includes almost one half of them (45). It is important to note that the distribution of the sample firms reflects the structure of the Cyprus industrial enterprises in general and the sample is believed to be fairly representative of the population of manufacturing firms.

A cross sectoral approach was used to determine any variations in innovation performance and characteristics caused by industrial sector specific factors. The main industrial sectors were chosen in order to reflect a broad and representative range of business environments and technological innovation practices. The following five sectors were used for the survey:

Sector		Number of firms
1)	Chemicals (including pharmaceuticals)	30
2)	Plastics	30
3)	Food	25
4)	Clothing / Textiles	25
5)	Metal	30

The main selection criteria for the above sectors were:

a) R&D expenditure (as taken from the R&D survey of the Statistics Department).

b) The Number of Scientists and Engineers employed (from Labour Statistics).

c) The Technological Level (adoption of Advanced Manufacturing Technology as judged by outside experts).

d) Importance in the National Economy (percentage of the manufacturing sector value added from Industrial Statistics).

e) Export Performance (from Trade Statistics).

f) Number and quality of inter-sectoral linkages and position in the local innovation networks (as judged from interviews with industry experts).

g) Access of the researcher to firms of the sector.

No sector scores high in all of the above indicative criteria, it is however felt that the most important manufacturing sectors in terms of innovation importance were included in the survey. They represent together over 70% of the manufacturing value added (Fig.2, App.C).

4. 1. 3 The Questionnaire

A questionnaire of 20 pages was constructed after analyzing the existing innovation literature and exchanging views with managers in the Cyprus industry and academics. Subsequently it was pre-tested in June/July 1994 with 12 firms (as representative as possible of the population of firms under study and including some known innovative firms). It was then adjusted, corrected and re-worded according to the results of the pilot-testing. This procedure aimed to increase the content validity of the questionnaire. The results of pilot testing were not incorporated in the survey data.

The interviews for the questionnaire completion were face-to-face, since it was felt (rightly as was later realized) that the response rate with a postal questionnaire of such length and complexity would be unacceptably low. It should be added, by the way, that the face-to-face interview, and in most cases the tour of plants, was a valuable source of supplementary information and observations. The interviews were taken during ten months (due to the large number of them) between March and December of 1995. The interviewees were owners wherever possible (100) or senior managers (general managers or production/technical managers) of the firms (40).

The questionnaire a copy of which appears in Appendix A is divided in five sections:

1. Section 1 seeks to collect background information on the SME e.g. size, age, sector.
2. Section 2 asks questions about the firm's innovation activities and resources e.g. the number of new products introduced, and R&D expenses.
3. Section 3 investigates the network linkages of the firm for example, the forms and importance attached to collaboration with competitors, and suppliers.
4. Section 4 concentrates on the owner/manager of the SME and seeks information on his/her education level, previous business experience and personal attitude to a number of business and technology related issues.

5. Section 5 attempts to collect information on the perceptions of SME owners/managers regarding the Innovation Climate in Cyprus (i.e. the extent and type of Government interference as perceived by managers, the internal and external barriers to innovation etc.).

Several questions have been adapted from two other sources: Dickson et al (1993) and the STRATOS group survey (1990) because the opportunity arose to study similar issues.

Due to the method used to collect the data (personal interview) there were few missing values. Seven (7) questionnaires which had many missing values due to the fact that managers were not prepared to supply all the requested information were discarded and the initial target for 150 firms i.e. 30 in each sector was revised to 140 (two sectors Food and Textiles with 25 firms each). The few missing values were left as they were. In some isolated cases the mean value imputation was used (from data related to the same question) where some missing values could cause problems in the statistical analysis. This is one of the procedures recommended in the literature e.g. Bryman and Kramer, 1990.

4. 1. 4 Survey Hypotheses

The main, empirically testable, hypotheses are summarized in Table No.4.1 below. They follow from hypotheses developed in Theory Section (Ch. 2). Several of them contain a number of sub-hypotheses.

Table No 4. 1 Empirical Hypotheses

H1 :	Innovativeness of firms varies across sectors.	
H2 :	Innovativeness is influenced by the characteristics of the SME owner/manager.	
	H2a	Education level
	H2b	Age
	H2c	Prior business experience
	H2d	Cosmopolitanism
H3 :	Innovativeness is influenced by the characteristics of the SME.	
	H3a	Size
	H3b	Age of firm
	H3c	Sales Turnover
	H3d	Degree of internationalization
	H3e	R&D expenditure
	H3f	Employment of scientists and engineers
	H3g	Existence of written strategy .
	H3h	Environmental scanning
	H3i	Cooperation with technology providers
H4 :	Innovativeness is influenced by environmental factors	
	H4a	Intensity of competition.
	H4b	Extent of environmental change.
H5 :	Innovativeness is influenced by owner/manager's perception of external barriers.	
H6 :	Innovativeness affects positively the performance of firms.	
H7 :	The networking activities and attitudes vary across sectors of the economy.	
H8 :	Innovativeness is influenced by the level of networking.	

4. 1. 5 Main Variables and their Operationalization

a) Innovativeness

This is the key dependent variable. A scale is included in the questionnaire for measuring innovativeness in terms of the subjective evaluation of the owner/manager of the extent to which the firm is a pioneer in new product introduction. It has been adapted from Deshpande R., Farley J. and Webster F. (1993) who have themselves adapted the scale from Capon, Farley and Hulbert (1988). The scale (NPDINSU) measures indirectly the novelty of the firm's products and aspects of the innovation strategy of the firm (Table No. 4.2)

Table No. 4. 2 Innovativeness Scale

In a new product introduction how often is your company :

	Never				Always
a. First-to-market with new product	1	2	3	4	5
b. Later entrant in established, but still growing markets	1	2	3	4	5
*c. Entrant in mature, stable markets	1	2	3	4	5
d. At the cutting edge of technological innovation	1	2	3	4	5

*Scores for item three (c) are reversed.

Such summated multi-item Likert type scales as used for innovativeness and other variables below are treated as interval level variables in the statistical analyses because they have been found to communicate interval properties to the respondent. This is the usual practice in the management literature (Bryman and Kramer, 1990).

The reliability of the above scale and those for other variables are highlighted in Table No : 4.8 (page 178). The calculation of Cronbach's alpha is a good technique for assessing reliability of multi-item scales as recommended in the literature (Babbie, 1989/DeVaus, 1991/Secaran, 1992). Nunnaly (1978) as cited in Bryman and Kramer, 1990) suggests that a coefficient alpha greater than 0.7 indicates a scale of good reliability. Deshpande et al (1993) suggest 0.65 and above as a rule of thumb. The analysis of reliability of NPDINSU has shown that by dropping item 2, reliability is increasing to 0.68 (Items are deleted as necessary to purify scales as suggested in the literature e.g. De Vaus, 1991). Therefore the revised NPDIN variable is used as the measure of innovativeness. Innovativeness is, however, a multifaceted concept and one measuring scale can not adequately cover all these facts. Two additional measures were constructed for cross-checking purposes (convergent validation.)

The first refers to product innovativeness and is a composite measure constructed from three variables related to new product development (i.e. a variable measuring the number of new products introduced, a second one measuring the percentage of sales attributed to new products and a third one measuring the percentage of profits attributed to new products). These three variables were re-coded to dichotomous variables as illustrated in the following Table No. 4.3. The composite measure PRODINN (a = 0.83) is a simple additive index of the above three dichotomous variables. It reflects the number and the importance of new products (but not the novelty).

Table No. 4. 3 Product Innovativenes Index

Type of Firm	Code
Innovative (firms with more than three new products) :	1
Non innovative(with less than three) :	0
Innovative (with sales attributed to new products of over 5%) :	1
Non innovative (with less than 5%) :	0
Innovative (with profits attributed to new products of over 5%) :	1
Non innovative (with less than 5%) :	0

The second measure refers to process innovativeness. It was constructed from 7 variables related to AMT introduction, new process technology adoption, machinery adaptation, etc. All were converted into dichotomous variables as in Table No: 4.4. The composite measure PROCINR (a − 0.60) is a simple additive index of the above seven dichotomous variables. It reflects various aspects of process innovativeness.

<u>Table No: 4. 4 Process Innovativeness-Index PROCINR</u>

	VARIABLE	Value 1	Value 0
1.	Introduction of Advanced Manufacturing Technology (AMT)	Yes	No
2.	AMT Types	2 or more types	Less than 2
3.	New Process Technology (NPT)	Yes	No
4.	NPT Type	New for Industry and/or for Cyprus	New for firm only
5.	Intention to Introduce New Technology	Yes	No
6.	Modification/Adaptation of Machinery	Yes	No
7.	Modification of machinery by firm itself	Yes	No

The above three measures of innovativeness are significantly correlated at the <u>0.001</u> or better significance level.

NPDIN } $r = 0.29$
PRODINN } $p = 0.001$

NPDIN } $r = 0.30$
PROCINR } $p = 0.000$

PROCINR } $r = 0.31$
PRODINN } $p = 0.000$

b) <u>Network Activity</u>

The intensity of networking is measured by the importance attached to links with other businesses in the <u>same</u> sector. The relative variable is <u>LINKIMSU</u> (Table No 4.5 below) The extent of collaboration of firms in production, sales or product development, that would be a better measure, is too low to serve as a reliable measure.

Table No. 4. 5 Networking Intensity

How important are links with other businesses in the same sector?

	Not Import.	Slightly Import.	Neither Important nor Unimportant	Import.	Very Import.
a. Locally based firms (within 30 kilometres from your base)	1	2	3	4	5
b. Cypriot firms in other towns	1	2	3	4	5
c. Foreign firms	1	2	3	4	5

An alternative measure of networking (NETWR) was developed from factor analysis of the network related variables. Eight (8) variables forming one factor were selected: 5 dichotomous variables (0 = No, 1= Yes) referring to:

1. Discussion of state of industry with competitors (COCONT)
2. Lending of materials or equipment to other firms in the sector (COLEND)
3. Passing information about new technology to others in the sector (NTINEX) .
4. Having long-term relationships with local suppliers (LSREL)
5. Lending materials etc. to non-competitors (NCOLEND)

Three variables related to collaboration with competitors in production, sales/physical distribution and product development/technical research respectively (COLINT1, COLINT2, COLINT3) were also used.

NETWR (a = 0.62) a simple additive index of the above is correlated to LINKIMSU
r = 0. 26 p = 0.002 (statistically significant) .

c) Performance

A summated scale is used of the subjective evaluation of the owner/manager of the firm's position against the largest competitor in terms of profitability, size, market share and growth (BENCHSUM) (Table No.4.6 below).

Table No. 4. 6 Performance Scale (BENCHSUM)

Relative to our firm's largest competitor we have:

	Less	Same	Greater
Profitability	1	2	3
Size	1	2	3
Market Share	1	2	3
Growth	1	2	3

The scale was adapted from Deshpande et al (1993). Although self-assessment measures are prone to potential bias, they are the most commonly used form of performance assessment in organizational research. They may be less problematic than more 'objective' financial measures which are also biased because they are frequently prepared at least in the Cyprus environment, but perhaps elsewhere as well, with tax 'minimization' or other similar motives. The owners/managers of firms would not be prepared to provide such confidential data. Several studies have demonstrated the convergent validity of self - assessment scales with financial measures (Deshpande et al, 1993). For comparison purposes an alternative composite index of performance (PERFP Table No.4.7 below) was constructed as follows: Three variables i.e. trend in sales in the last 3 years, trend in employment in the last 3 years and export sales existence were re-coded into dichotomous variables:

Table No. 4. 7 Performance Index (PERFP)

Sales increasing	1	Sales not increasing	0
Employment increasing	1	Employment not increasing	0
Export Sales	1	No export sales	0

The composite measure (PERFPR) (a = 0.49) is a simple additive index of the above three dichotomous variables.

PERFPR is correlated to BENCHSUM   r = 0,20   (statistically
                                    p = 0,017   significant)

PERFP is measuring sales and employment growth and export performance rather than the relative position of the firm in the market as BENCHSUM.

d) Other Variables.

The intensity of competition, the importance of new technology for the sector, the environmental change as perceived by the owner manager, the cooperation with external technology providers and the external barriers perception were measured by summated scales (COMPINT, NTIMPSU, CHANGSU, COOPFSUM, EXBARSUM respectively) as they appear in the questionnaire.

A number of variables relate to the characteristics of the owner/manager e.g. education level, age etc. They are measured at nominal/ordinal level. Owner/manager personality and attitude measurement scales for e.g. locus of control, need for achievement and attitude to risk were not used since it was felt that such scales developed in a completely different social and cultural environment in industrialized countries (mainly in USA) and mainly for large firm executives would not be appropriate for our research. On top of that contradictory results in various research projects were obtained for most of these variables with the exception of the attitude to risk. The latter is however more relevant for radical rather than incremental innovations. Kitchell (1995, p. 204) notes that: "because technology adoption involves a broad range of risks that apparently are not correlated, it is difficult to capture the risk-taking construct with Likert-type instruments that have both content validity (i.e. adequately address all types of risk) and reliability". She has opted for a global measure of risk, but the use of such measures is not without problems. Due to the above considerations the personality and attitudes (including the attitude to risk) of O/M were investigated through factor analysis of their statements and especially through the qualitative case research.

There are several variables related to the characteristics of the firm (SME) e.g. number of employees, age of firm, sector, R&D intensity etc. which are measured at nominal/ordinal level. Some comments on the R&D intensity measure (expenditure on R&D as a percentage of sales) have to be made. Even in large industrialized countries it is difficult to distinguish between R&D and a set of related activities taking place in the various departments of a firm for example pre-production trials. In the small developing countries context firms frequently have no separate R&D departments and research (the R component) is, strictly speaking, very limited. Various types of development are, however, taking place extending from laboratory work to design engineering and trial production. They are connected with the aim to make new or technically improved products or processes. The present research includes all R&D activities in this broad sense and expenditure related to them.

Two variables relate to strategy existence and types (STRATEX) (STRAT 1,4). Structure and function related variables, frequently used in 'antecedents model' based studies in other countries (usually advanced ones) (Damanpour, 1991) were not included. In the context of a small developing country structures of family firms are usually informal and functions often not clearly differentiated (in practice or even on paper-organizational charts).

A summary of the reliability scores of the main operational variables which are used in the research is presented in the following Table No.4.8.The table confirms that reliabilities are within acceptable limits.

Table No. 4. 8 Reliability Measures

Scale	Variable	No: of Items	Cronbach's Alpha
1. Innovativeness	NPDINSU NPDIN	4 3	(0. 53*) 0. 68
2. Performance	BENCHSUM	4	0. 86
3. Network Intensity	LINKIMSU	3	0. 58
4. Collaboration Intensity	COLINTSU	3	0. 57
5. Cooperation Relations	CORELSUM	5	0. 89
6. External Barriers	EXBARSUM	25	0. 82
7. Change	CHANGSU	7	0. 65
8. Competition Intensity	COMPINTSU COMPINT	5 4	(0. 60**) 0. 72
9. Frequency of Technical Cooperation	COOPFSU	5	0. 70
10. Significance of Technological Information Sources	SITINFSU SITINF	7 4	(0. 46***) 0. 71

Notes:

* Scale reliability of NPDINSU is improved by dropping item 2 and using the new variable NPDIN.

** Scale reliability of COMPINTSU is improved by dropping item 1 and using the new variable COMPINT.

*** Scale reliability of SITINFSU is improved by dropping items 1, 3, 5 and using the new variable SITINF

Source: Survey data analysis

4. 1.6 Statistical methods

The analysis of the data of a quantitative survey through powerful statistical techniques is one of the important advantages of the quantitative approach. A variety of univariate and multivariate statistical methods were used in the analysis of the survey data. The assumptions of the proper use of each method were also tested. The main methods used are very briefly described below. The SPSS statistical package Version 6.1 for Windows was used for all statistical analyses.

a) Univariate and bivariate methods

Analysis of variance. One way analysis of variance (ANOVA) is used to test for differences. This technique compares the means of three or more unrelated samples. It is essentially an F test in which an estimate of the 'between groups' variance is compared with an estimate of the 'within groups' variance.
Contingency analysis (cross tabulation). This technique examines the association relationships. The statistical significance of the associations is tested with the chi-square test.
Correlation analysis measures the degree of association of variables. The Pearson's r correlation coefficient is calculated for interval level variables, while the Spearman's rank correlation coefficient ρ is used where one (or both) of the variables is of an ordinal level.

Due to space limitations only correlation (and ANOVA where appropriate) analysis was used for the testing of the hypotheses. The calculation of Spearman's coefficient ρ was used as an adequate alternative (to contingency analysis) for hypotheses testing, where ordinal level variables were involved. The issue is further discussed in Section 5.1.1

b) Multivariate methods

These are advanced statistical methods which permit the analysis of multiple variables in a single relationship or a set of relationships.

Multiple regression analysis is a statistical technique that can be used to analyze the relationship between a single dependent variable and several independent (predictor) variables (Hair et al, 1995).

Multiple discriminant analysis is used in situations where the total sample can be divided into groups based on a dependent variable e.g. Innovativeness (high/low). The primary objectives of the technique are to understand group differences and to predict the likelihood that an individual will belong to a particular group based on several metric independent variables.

Factor analysis is a technique particularly suitable for analyzing the patterns of complex, multidimensional relationships. In other words the underlying structure in a data matrix is explained by defining a set of common latent dimensions, known as factors. It is used here in an exploratory mode.

c) Statistical Assumptions

All the above statistical methods set certain assumptions for the data. Especially the multivariate analysis requires testing the assumptions not only for the separate variables but also for the multivariate model variate. The testing of the separate variables is discussed here, while the testing of assumptions for each multivariate procedure is dealt with together with the analysis in Chapter 5. Each individual metric variable was checked for:

Normality (correspondence of the data distribution for each variable with the normal distribution). It is tested with the derivation of the normal probability plot and calculation of a statistical test for normality i.e. the modified Kolmogorov-Smirnov (K-S Lilliefors) test.

Homoscedasticity is an assumption related primarily to dependence relationships between variables i.e. that dependent variables exhibit equal levels of variance across the range of predictor variables. The Levene test is used in ANOVA analysis and reported together with the results in Chapter 5.

Linearity i.e. absence of substantial non linear effects which may decrease correlation values is tested with examination of scatterplots.

While some variables, for example BENCHSUM, do not exactly meet the strict normality requirements they can still be accepted for multivariate analysis.

4. 2 THE CASE STUDY METHODOLOGY

4. 2. 1 The case approach

While the survey approach sheds some light on the most important factors involved in the management of technological innovation in SME, it brushes aside the complex and dynamic interaction of the many influencing factors and the subtleties of the process of managing innovation. Cross sectional survey data are unable to answer 'why' questions about innovation, for example correlational analysis does not explain why a particular independent variable co-varies with innovativeness. It may be a cause or an effect or both may be caused by a third factor not in the analysis.

In parallel therefore with the survey a number of cases (25) were studied in order to get some qualitative data not possible to be collected through the survey (e.g about the peculiarities of management and specifically of managing the innovation process in the context of a small developing country, feelings and perceptions of owners/managers, interpersonal relationships etc.). The case *studies represent an 'in-depth' approach to the* study of innovation and its management (Rogers, 1983).

The case studies focus on the emergence of innovation strategy and the influence of networks on innovation and try to further clarify the critical role of the owner/manager. Their emphasis is on the inner workings of the 'black box' of innovation, rather than its inputs and outputs where the survey is the most suitable approach. It was felt that the case studies would complement the information obtained through the survey and would be a useful way of data triangulation together with several interviews with Government officials and other knowledgeable people. The emphasis is on cross-case patterns rather than on each separate case.

There is of course the danger in this approach that data from the survey and the cases are not compatible i.e. pointing to different directions on some issues which could lead the researcher to dilemmas, but it was felt that this risk was set against worthwhile benefits.

The method of inquiry is presented in more detail in the following and then the five major themes that served as the frame for the cross case comparisons and the broad proposals/hypotheses that guided the research are considered. The actual cross case comparisons are presented in Chapter 5.

4. 2. 2 The Method of Inquiry

The unit of inquiry is again the small and medium size manufacturing firm (under 100 employees) in the above mentioned sectors. The owner/manager, as the main decision maker is the 'embedded unit' of the analysis (Yin, 1994).

The comparative approach across multiple cases was selected as the most suitable one for the task in hand. A sample of 10 'major' and 15 'minor' cases was used. The terms major and minor refer not so much to the research effort which was more or less similar across the cases (i.e. 2-3 sessions of about two hours each per case) but in the final case description. The ten most 'interesting' cases (i.e. C1, M4, C2, T5, P1, F2, C4, P4) were written up in five page comprehensive descriptions, while the 15 'minor' ones were only given a two page summary each, mainly for reasons of space economy. Three case descriptions are presented in Appendix E. For confidentiality reasons all cases are referred to by code names, with the initial letter denoting the sector e.g. C = Chemicals , M = Metal etc.

Theoretical sampling was used in the selection of cases (Strauss and Corbin, 1990). The aim was to have a balance between the three main groups under consideration i.e. proactive innovators, reactive innovators and non-innovators.The rationale of the consideration of these groups is explained below. Some spread across size ranges, sectors and networking activity was also intentionally pursued. The selection of firms was based on interviews with expert informants e.g. of the Industrial Extension Service of the Ministry of Commerce and Industry and other knowledgeable people, the initial results of the survey research and the prior knowledge of the writer about the Cyprus industry. The firms are actually a subset of the 140 firms that took part in the survey and are distributed equally among the sectors (5 from each sector). More details for the cases characteristics will be given in Chapter 5.

The main research instrument was the semi-structured interview with the owner/manager of the firm. However observation, casual conversations with scientists and engineers (or other employees) working in the case firms during plant tours etc. and secondary material from published interviews, company leaflets or other sources were also used.

Data on cases were collected during the period of May to September 1995. An effort was made to supplement the 'one time' data collection with some post-hoc longitudinal data. A second visit was therefore made to the case firms after six months i.e. during January/February of 1996 asking about any changes (technological, market etc.) which had taken place in the interim period and any developments in the innovation projects that had been discussed during the first interview. Process analysis is therefore mostly through retrospective analysis and limited real time longitudinal analysis.

Regarding the longitudinal element, which is important in gaining some idea about the process of managing innovation, it should be noted that the writer is familiar with most of the firms under study for a number of years (in some cases over 15) due to his employment as the sales manager for industrial raw materials in a local firm.

The case descriptions are based on field notes and were written immediately after the visits. Audio-tape recording was avoided, since in the Cyprus context it was felt that it would interfere with the open discussion atmosphere of the interview.

The interviews focused on five major themes as follows:

1. The firm and its competitive environment.
2. The owner/manager (his background, perspectives and cognitions, the meanings attached to innovation related issues, feelings and innovation related attitudes. Also his roles and tasks in the firm). It is noted here that all owners/managers of the case firms are male.
3. Networking activities of the firm, especially those related to technological innovation.
4. Innovation strategy of the firm.
5. Innovation climate in Cyprus as perceived by the owner/manager.

Wherever possible a variant of the 'critical incident technique' (Tjovold and Weicker, 1993) was used by asking the manager to concentrate on a recent example of a major new product development project or an advanced manufacturing technology adoption project. Details were obtained about the decision process, the participants in it within the firm and outside and the barriers associated with the selection and implementation of the project.

4. 2. 3 Case Study Hypotheses

The review of the literature in Chapter 2 and the examination of the case material led to the development of further more flexible (than those generated for the survey) proposals/hypotheses. These latter hypotheses defined below serve as guides for an orderly discussion of the inherently complicated, some would even say 'chaotic' phenomenon of technological innovation.

In the first instance it is hypothesized that firms can be broadly distinguished into three types, i.e. proactive innovators, reactive innovators and non-innovators. The first and last of these represent the two opposite ends of a continuum, while the third (reactive innovators) resides between the two extremes. The characteristics of these ideal patterns are briefly outlined below:

The proactive innovator is frequently the first mover in innovation and is driven by market and technology motives.

The non-innovator operates within short horizons and prefers low-risk standardized activities and quick, even if low returns. This behaviour reminds of traders.

The reactive innovator innovates reluctantly e.g. when seriously challenged by competitors and wherever possible with little risk taking.

The classification of the case firms in one of these three types is based on four criteria (Miller and Friesen, 1984), which are grounded to the statements of the owners/managers of the firms as well as on evidence presented in latter tables. This broad taxonomy of firms, based on the strategy and philosophy behind innovation, is widely supported in the literature as discussed in Section 2.4.3.

These criteria are:

1. The proactiveness in innovation defined as taking the initiative and shaping the environment by introducing new products or new process technologies.
2. Frequency and level of innovativeness.
3. Risk taking defined as making relatively large and risky resource commitments (which are indicative of the significance of innovation for the firm).
4. The type of innovation stimulants (market/technology opportunities versus mimetic, coercive or normative processes) (Chiesa et al, 1996).

The proactive innovator is hypothesized to have a clear innovation strategy linked to the corporate strategy. The latter is relatively well articulated, even if not written down. The proactive innovator is expected to use a great variety of technological information sources and be strong both in 'core' processes of innovation i.e. concept generation, product development, process innovation etc. and in the 'enabling' processes like networking, use of systems and tools, leadership etc. (Chiesa et al, 1996). The proactive innovator has a relatively high level of investment in innovation inputs. The owner/manager of such a firm is expected to have vision, commitment to innovation, an external locus of control (in the sense of feeling that his firm's destiny depends more on his/her actions rather than external forces) and a high need for achievement. Involvement in local and international networks, including links to Government institutions is high.

The reactive innovator is hypothesized to lack an innovation strategy and be weaker in corporate strategy formulation as well. There is a more limited variety of technological information sources and the firm is also relatively weak in core and enabling processes of innovation with a lower investment in innovation inputs. The owner/manager has a relatively more internal locus of control and a lower need for achievement than the O/M in proactive innovator type firms. The reactive innovator is less involved in strategic networks.

The non-innovator does not appreciate the importance of innovation and is hypothesized to have either no corporate strategy at all or a cost-based one. The variety of technological information sources is very limited and there are no signs of existence of the core and enabling processes for innovation. The O/M is conservative. The non-innovator is also a typical 'isolator' i.e. hypothesized to avoid active involvement in networks.

The cross comparison of case data in Chapter 5 will attempt to verify the possibility to classify the case firms in the above categories and to confirm or reject the hypothesized features (predictors) of each of the three patterns.

4. 3 Other Sources of Data

More than 25 interviews were conducted in order to get supplementary information about government policies, specific problems related to technological innovation, institutional factors and mechanisms of technology transfer. The purpose was data triangulation and collection of information not available through the survey or the case studies. These interviews are further dealt with in Chapter 5 and are broadly divided in two categories: a) interviews with government officials b) interviews with others (for example trade association officials).

4. 4 Ethical Considerations and Confidentiality

In both the survey and the case studies and other interviews, the nature and the purpose of the research was explained to the participants.They were assured for the confidentiality of any information supplied and an effort was made especially in the case studies to preserve the anonymity of the cases. The opinions, statements etc. of owners/managers in the case studies and government and other officials were recorded as closely as possible with their own words.

CHAPTER 5

5. Analysis of Data

This chapter presents the analysis of data of the empirical research. The survey data is analyzed first (5.1). In the survey analysis section (5.1.1), descriptive data about the firms, their innovation inputs and outputs and various other characteristics are presented. The testing of hypotheses and various other statistical analyses are then dealt with in section 5.1.2. Section 5.2 presents the qualitative analysis of the case studies, followed by 5.3 with the main issues of the other interview material. This current chapter is not discussing the implications of the research results or a comparison with the results of other researchers, which will be done in Chapter 6.

5. 1. ANALYSIS OF SURVEY DATA

5. 1. 1 Descriptive data

Basic data is presented below with additional descriptive comments where necessary. The presentation of data relates directly to the main sections of the questionnaire (App. A).
A more comprehensive set of data is presented in Appendix B.

A) Firm details

The size distribution of firms is illustrated in Table No. 5.1 below and in Chart No.2 p.363, App. B. Almost 70% of the firms have less than 50 employees.

Table No.: 5. 1 Size of firms (Number of employees)

Size	Less than 10	10-20	21-50	51-100	More than100
No. of firms	30	31	34	23	22
%	21. 4	22. 1	24. 3	16. 4	15. 7

Most firms are old (over 70% are older than 10 years) (Table 5.2, below and Chart No.1 p.363, App.B).

Table No.: 5. 2 Age distribution of firms

Age	Less than 3	3-5	6-10	11-20	More than 20
No. of firms	6	9	22	47	56
%	4. 3	6. 4	15. 7	33. 6	40

The sample is relatively balanced across the sectors (Table 5.3, below).

Table No.: 5. 3 Distribution of firms by sector

Sector	Chemicals	Plastics	Metal	Food	Textiles
No.of firms	30	30	30	25	25
%	21. 4	21. 4	21. 4	17. 9	17. 9

Over 65% of the firms in the sample have a turnover higher than 500.000 pounds (a relatively large turnover for the Cyprus business environment) (Table 5.4, below). This fact reflects the purposive bias of the sample away from the micro-businesses which form the large majority of firms in Cyprus but are not of immediate interest in a study of innovation.

Table No. : 5. 4 Distribution of firms by sales turnover (000s pounds)

Sales Turnover	Less than 100	100 - 500	500 - 1000	1001- 5000	Over 5000
No:	10	37	36	39	18
%	7. 1	26. 4	25. 7	27. 9	12. 9

Due to space limitations all the following tables appear in Appendix B.

Trend of sales.(Table1) Most firms (55.7%) had increasing sales in the last three years. Few (10%) had decreasing sales, while one third of them (34.3%) had stagnant sales.

Trend of Employment Level (Table 2). Most firms (47.9%) had the same number of employees in the last three years, a substantial number (20.7%) had a decreasing number an indication of the crisis in the Cyprus manufacturing industry.

Number of competitors (Table 3). Half of the firms (50%) have 5 or less competitors, while about 47% more than 5. A small minority 2.9% have no competitors in the Cyprus market.

Intensity of competition (Table 4). A large percentage (80.7%) of the firms believe that price competition in their sector is strong or very strong against 40% believing the same for product development competition, only 24.3% for advertising competition, 21.4% for product quality competition and 65.8% for competition in distribution. In other words Cypriot firms compete mainly on pricing and distribution rather than product development, product quality or advertising.

Existence of written strategy (Table 5). Only a minority of firms (30%) have a formal (written-down) long -term strategy. Even then it is in outline form and not a detailed strategic plan as revealed in the case study research.

Strategy components (Table 6). Most firms (77.1%) have a market development strategy, even if unwritten, and a technology development strategy (66.4%), but half of them (50.7°o) have no export strategy and only a minority (29.3%) have a human resources strategy.

Importance of New Technology (Table 7). 'Automated Machinery' is considered to be the most important type of new technology for firms in order to compete in their business sector. Most firms (77.1%) considered it important or very important, against 64.3% for new materials technology, 48.2% for new packaging technology, and 34.3% for computer aided design (CAD).

Extent of Change (Table 8). Firms have observed 'little' to 'some' change in distribution patterns, financial and credit markets, raw materials and energy, human resources and legislation. More change has been observed in technology, where 34.3% have observed major to critical change and competitors' behaviour, where 35.7% observed major to critical change.

Demand Forecast (Table 9). Few firms (7.9%) face very short (less than one month) demand horizons or very long ones (more than 12 months) (8.6%). Most are in the range of 3-6 months (40.7%).

Exports (Table 10 and 11). Most firms in the sample (67.9%) have some exports (Table 10), indicative of the open nature of the Cyprus economy and some bias in the sample towards export-oriented and presumably relatively innovative firms. Most firms (77.1%) export 30% or less of their production, but a substantial minority (15.7%) export over 50% of their production (Table 11).

Trend in export sales (Table 12) For a substantial number of firms (44.4%) export sales have been decreased in the last three years, while for another 31.1% they remained stagnant (the same) indicative again of the crisis in the manufacturing sector in the last few years.

Quality of exports (Table 13) For the majority of firms (88.9%) the quality of exported products is the same as that for the local market.

B) Innovation activities

Employment of qualified scientists and engineers (university graduates) (Table 14)
Most firms employ 3 or less scientists and engineers (75.7%), this includes 25.7% which employ none. Only a small minority employ more than 10.

Predominant type of innovation (Table 15) Few firms admit that they had no innovations introduced (11.7%), while the majority have introduced mainly product innovations (60.7%) and a much lower percentage (22.9%) mainly process innovation.

Research and development levels (Table 16). Most firms(63.6%) have some R&D activity, while a substantial number (36.4%) have no R&D. Only few firms(13. 6%) have R&D expenditure levels 2-5% and only 9.3% spend on R&D more than 5% of their sales turnover. R&D is meant here in a very broad sense (see also Section 4.1) and for Cyprus it is mainly development, not research.

Introduction of new products (Table 17). Only a small minority of firms (9.3%) have introduced no new product in the last three years, while 32.1% introduced 1-3 new products and 42.9% 4-10 new products. A small minority (15.7%) introduced more than 10 new products in the last three years.

New products as percentage of sales (Table 18). For a substantial proportion (47.3%) of the firms which introduced new products in the last three years these products accounted for more than 10% of their sales, while for 30.2% accounted for 5-10% and for 22.5% for less than 5%.

New products as percentage of profit (Table 19). New products account for slightly lower percentages of profit (against those for sales) for the first two categories and higher for the last. The respective to the above percentages are: 44.9% (for more than 10% of profits), 26% (5-10% of profits) and 29.1% (less than 5%).

New Product Introduction Behaviour (Table 20) A substantial proportion of managers (45.7%) feel that their firms are first to the market with new products frequently and always [(4) and (5) of the scale, p.318, App. A]. A much larger proportion (53.6%) think that they are later entrants in established, but still growing markets and (24.3%) are entrants in mature, stable markets i.e. laggards! Only 11.4% think that they are frequently or always at the cutting edge of technological innovation.

Decision maker in new product development (Table 21). In the question who decides the direction of the new product development in your company 2.9% answered nobody systematically, 7.1% a functional head i.e. marketing or production manager, 42.1% the managing director alone and 47.1% a management committee.

Feedback from customers in new product development. (Table 22). A substantial proportion of firms (33.6%) get no feedback from their customers during development and before launch of a new product.

Significance of technological information sources (Table 23). 'Suppliers' were mentioned as a significant, very significant or even crucial source of technological information by 90% of the firms followed by 'business contacts abroad' (87%) and 'visits to trade exhibitions' usually abroad (84%). 'Consultants' is the source least frequently used (20%), followed by licensers (37%).

Introduction of advanced manufacturing technology (AMT) (Table 24 and 25)
About one third (32.1%) of the firms in the sample have introduced some form of AMT (Table 24). The main types of AMT introduced are Computer Aided Manufacturing (CAM) by 57.1% of the firms which introduced AMT and then Computer Aided Design (CAD) by 35.7%. Only a small minority (7.1%) of the firms with AMT have a form of robotics (Table 25). It should be noted that by CAM in the Cyprus context is mainly meant computer controlled machinery rather than integrated computer based manufacturing systems which is the usual meaning of the term in the literature and in industrialized countries. The apparent discrepancy with the figures of AMT introduction

i.e. between Tables 24 and 25 is due to the fact that firms may have introduced more than one form of AMT.

Objectives for AMT introduction (Table 26) Improvement of product quality was mentioned as the most important objective (34% of firms), followed by the reduction of production costs (31.2%) and reduction of reliance on labour (27.8%). Tax incentives and subsidies were considered unimportant (only 1.4%) of firms mentioned them and similarly the objective to match similar competitors' moves was relatively unimportant (5.5%) .

Fulfillment of AMT initial objectives (Table 27). Most firms (52.6 %) report fulfillment of their objectives by much or very much, while only 2.5% state that their objectives have not been fulfilled at all.

Installation of new process technology (Table 28). Most firms (65%) have introduced new processing technology in the last three years in the form of new machinery or equipment.

New process technology types (Table 29). For 10.8% of firms the processing technology they introduced is new to industry, while for 41.3% is new for Cyprus. Therefore for half of the firms which introduced new processing technology this is 'state of the art' technology or close to it.

Effect of Government Policy on firm's technological decisions (Table 30). For most firms (67.9%) Government (Industrial) Policy did not affect their decision to adopt new technology.

Ways of Government Policy influence on decision to adopt new technology (Table 31). For the few who mentioned an influence it was mainly through taxation and subsidies considerations.

Technology Transfer Modes (Table 32) The main modes of technology transfer to the firms are information exchange (45. 4%) with suppliers etc., technology embodied in new machinery purchased (33%) and licensing (11.5%). Hiring of experienced personnel (7.3%) and joint ventures (1.5%) are relatively unimportant.

Modification/adaptation of imported machinery (Table 33 and Table 34). A significant proportion of firms(37.1%) modify or adapt imported machinery (Table 33). Most of these firms modify the machinery with their own personnel (54.8%), while 22.5% of the firms use the services of local specialized firms and 22.5% the services of the original machinery suppliers (Table 34). Use of a combination of these modes is also possible.

Local machinery /equipment purchasing (Table 35). A significant proportion of firms (38%) purchase locally at least some of the machinery/equipment they need.

Rating of local machinery/equipment supplier (Table 36). While 83.3% of firms consider good or very good the technical adequacy of the local machinery/equipment suppliers only 39.6% say the same about the prompt delivery, 60.4% for the after sales service and 43.7% for the technical advice they receive.

Designer of locally constructed machinery equipment (Table 37). The local supplier is most frequently (51.5%) the designer of the locally constructed machinery /equipment followed by own personnel (30.8%), and imitation of design (17.6%) from imported machinery by either the firm or its local supplier.

Cooperation with technology intermediaries (Table 38). Only 6.4% of the firms cooperate occasionally or frequently with foreign universities and technical institutes against 12.2% with foreign research and development institutes, 17.8% with foreign testing centers, 23.1% with local testing centers, and 10.7% with the local Higher Technical Institute or the University of Cyprus.

Types of technical services needed (Table 39) 'Testing' (27.8%) is the type of service mostly needed and not offered locally, followed closely by 'machinery and equipment repair' (27.4%) and 'supply of spare parts' (27%).

Financing of new product development (Table 40). Most firms (42.1%) use their own funds to finance their new product development, others use loans (29.1%) or bank overdraft (28.7%). The combination of some of the above methods is also possible.

Financing of the purchase of new machinery (Table 41). Most firms (63%) use bank loans to purchase new machinery, while 28.2% their own funds and 8.7% bank overdraft. The combination of methods e.g. of own funds and loans is probably usual.

Performance of firms (Table 42). A relatively high percentage (43.6%) of the firms estimate that they have the same profitability with their largest competitor, against 30.7% which think they have less and 25.7% greater. Regarding the size, 9.3% believe that they are of the same size, 54.3% of less and 36.4% of greater. For the market share 7.9% same, 50.7% less and 41.4% greater. For growth 25% same, 28. 6% less and 46.4% greater.

C) Networks

Main factors influencing business cooperation (Table 43). Past experience (36.1%) is the main factor influencing business cooperation with other firms in the same sector, followed by professional attitudes (27.1%) and social relationships (26.1%). Origin from same village etc. with 3.2% and family ties (7.5%) are relatively unimportant.

Importance of links with businesses in the same sector (Table 44). Links with foreign firms in the same sector are rated as important/very important by 52.9% of the firms against 42.8% for links with locally based Cypriot firms and 30.7% for links with Cypriot firms in other towns.

Government Policy effect on the relationships with other firms (Table 45). The vast majority of firms (88.6%) report no such effect.

Collaboration with firms in the same sector (Table 46). Collaboration in general is low.The lowest collaboration i.e. less than 20% overall (including 'slight' category) occcurs in product development. The corresponding figure for collaboration in production is around 30%.

Contacts with competitors (Table 47). Most firms (77.9%) discuss the state of their industry with competitors.

Frequency of contacts with competitors (Table 48). Contacts with competitors are every few months (47.2%), or every month (41.7%), and less frequently once a week (11.1%).

Topics of discussion with competitors (Table 49). Trade information (44.4%) is the main topic of discussion with competitors, followed by prices (40.8%), and technical information (13.4%).

Rating of relations among local businesses in the firm's sector (Table 50). Most firms (75.2%) think that relations are business-like, rather than friendly (8.8%) or missing altogether (16.1%).

Lending of materials /equipment to firms in same sector (Table 51) Most firms (58.6%) lend materials/equipment to firms in their sector.

Passing technological information to other people in the industry (Table 52). The majority of firms (70.7%) do not pass technological information to other people in the industry, although a significant proportion of almost 30% do it.

'Critical technological information' secrecy (Table 53) The overwhelming majority of firms keep technological information which would give them a business advantage secret, some firms (5%) say they share it.

Long-term relations with foreign suppliers (Table 54). The vast majority (95%) of firms have long-term relations with foreign suppliers.

Long-term relations with local suppliers (Table 55).The majority (90.7%) of firms have long-term relations with their local suppliers.

Rating of relationships with local firms in other sectors (Table 56). Most firms (67.9%) consider the relations with local firms in other sectors regarding price setting as good, very good or excellent against 70% for delivery, 80% for quality, 40,7% for technical advice and 60% for after sales service.

Lending materials/equipment to non-competitors (Table 57). Most firms (64.3%) lend materials/equipment to non-competitors.

Main factors influencing cooperation with main suppliers (Table 58). Price (93.6%) , quality (84.3%) and reliable delivery (64.3%) are the three main factors influencing cooperation with main suppliers. These are followed by credit facilities (43.2%), and supply of technological information (26.8%).

Importance of relations with main foreign suppliers (Table 59). Supply of formulations and technical information is the main service/facility provided by the main foreign suppliers as mentioned by 95.7% of the firms. This is followed by advice on future technological opportunities or threats (56.5%), training of firm's personnel in supplier's laboratories, technical centers or factories (55.2%), testing of samples (41.1%), free-of-charge trouble-shooting (31.5%), and supply of complementary materials not produced by the supplier (17.7%).

Closeness of relations with local versus foreign suppliers (Table 60). Relatively more firms (42.9%) rate their relationships with local suppliers as less close in comparison to relationships with foreign suppliers, against 32.9% more close, and 20.7% equally close.

Close relations with foreign firms (Table 61).The majority of the firms (64.3%) maintain close relations with foreign firms in their sector.

D. Characteristics of Owner /manager

Education level of owners/managers (Table 62). Only a tiny minority (2.9%) of owners/managers have a primary school education, while 14.3% have high school education and 6.4% trade qualifications. Another 11.4% of them have post-secondary college education, while a substantial proportion 65% have university education, with 41% of the latter having also postgraduate qualifications.

Age of owners/managers (Table 63). A small proportion (7.1%) of the managers are in the age group of 20-30, while 29.3% are in the age group 31-40 and 42.1% in the age group 41-50. Then 20% are between 51-60 and only 1.4% over 60. In other words the majority of managers (about 78%) are relatively young (under 50).

Previous business experience (Table 64). One third (34.3%) of owners/managers had not worked in any other business before joining the present one, while 60.7% had worked in 1-3 businesses ; only a small minority (5%) had worked in more than three.

Number of business trips of owner/manager abroad (Table 65). Around 52% of owners/managers make 1-3 trips abroad for business per year. Around 37% make 4-10 trips, while around 8% make more than 10 trips. The number of trips abroad is an indicator for cosmopolitanism. Only a small minority of around 3% do not travel abroad for business.

Membership of social and business associations (Table 66). Membership in business associations predominates with 71.4%, followed by membership in professional bodies (53.4%), membership in government committees (40.9%), in social clubs (28.6%), and political parties (27.3%).

Personal attitudes (Table 67). Managers have *strong* views on a number of issues, while they are almost equally divided on others. Some examples of the former are:

Managers *agree* (the percentages below indicate 'agree' and 'strongly agree' categories together) that:

Statement	Percentage
'The government should do more to encourage the introduction of new manufacturing technologies'.	96.4%
'Sector specific strategies are needed, rather than a universal governmental industrial strategy'.	91.4%
'Managers should plan rather than follow their intuition'.	86.5%
'Small businesses should cooperate more rather than practise cut-throat competition'.	85%
'Small business managers should be directly responsible for personnel management'.	83.5%

Managers *disagree* (the percentages indicate 'disagree' and 'strongly disagree' categories together) with :

Statement	Percentage
'A small business manager should concentrate more on management issues rather than technical issues'.	67.9%
'Small firms should use the same management methods as large firms'	66.5%
'Business should take preference over family life'.	62.1%

Importance attached to personal aims and objectives (Table 68). The three most important objectives of owners/managers (percentages indicate the categories high and very high importance combined) are:

92.9% 'financial independence'

89.3% 'self-fulfillment'

87.6% 'job satisfaction'

the least important (percentages indicate no importance and low importance categories combined) are : 43.6% 'high social status' and 42.8% 'attractive life style'.

E. Innovation Climate

Government policy measures to support industry (Table 69). Most firms (54.3%) do not feel any supportive government measures (no Government interference). The three most important policy measures mentioned by firms are:

1. Import or export policy
2. Standards (product, safety etc.)
3. Industrial policy (e.g. sectoral schemes)

Rating of innovation support measures (Table 70). The majority of firms consider the current innovation measures as inadequate especially research and development (new product) subsidies (82.9%) and technical guidance (74.3%).

Additional measures of innovation. Few firms had suggestions for additional measures. Among those mentioned are sectoral resource centers and technical information centers.

External barriers in the adoption /development of innovations (Table 71). The five most important external barriers to innovation as viewed by firms (percentages below show 'important' and 'very important categories' combined) are:

83.6%	'Innovation too easy to copy'
76.5%	'Government bureaucracy'
72.9%	'Lack of government assistance'
71.4%	'Shortage of skilled labour'
71.4%	'Bank policies on credit'

Internal barriers to innovation (Table 72). The three most important barriers to innovation are:

60% 'Lack of time (e.g. one man responsible for many tasks)'

51.4% 'Inadequate R&D, design, testing and other technical facilities within the firm'

44.6% 'Inadequate financial means'

Evaluation of prospects for own sector (Table 73). Most of the firms (66.4%) view the prospects for their sector in the next three years as good against 20% as excellent and 20% as bad.

Modes of response to future prospects (Table 74). Most of the firms (66.4%) plan mainly to expand or respectively restrict their product mix, in order to address the future prospects. This can be set against 61.4% of firms which plan to penetrate new markets, and 25.9% to employ more or respectively less staff. A combination of the modes is of course possible.

Intention to innovate in the next three years (Table 75). Most of the firms (74.3%) intent to develop or introduce technologically changed products or processes in the next three years.

Other Tables

Contingency tables were produced and Chi-square analysis was performed, with the SPSS statistical package, for many ordinal level variables (e.g. education level of owner/manager by size of the firm, predominant type of innovation by sector). They are not presented, however, here or in the appendices due to space restrictions, except from only two indicative examples, as discussed below.

Contingency tables can provide additional (to correlation analysis) information on the trends of increase or decrease of one variable across the various categories of the other variable. They have though two main problems. The first one is that in most cases the original categories have to be collapsed to much fewer ones in order to meet the statistical criteria of Chi-square analysis. The second problem is that the SPSS output is voluminous. The first example of a contingency table is Table 76 (App. C, p.361) which indicates that 'AMT Introduction' differs by sector and is clearly higher in Sector 3 (Metal), as expected. Reference to the second example (Table 77, p.362) is made in the next page (203).

5. 1. 2 Testing of Hypotheses

The following is the testing of hypotheses as presented in Table No. 4.1 in Chapter 4. For details of the variables (e.g. NPDIN) the reader is referred to Ch. 4.

H1 The first hypothesis was re-phrased as follows:

The Innovativeness (I) of firms is not the same in sectors (1. . 5) i.e. $I_1 \neq I_2 \neq I_3 \neq I_4 \neq I_5$.

One way ANOVA for more than two groups shows that the variance for NPDIN (measure of Innovativeness) is not significantly different among the sectors.

Group (Sector)	Mean
1	8.0667
2	7.7667
3	8.8000
4	9.3200
5	8.7200

F ratio = 1,7692 Fprob = 0.1387 (Not significant)

Levene test for Homogeneity of Variance: 0,21 (2-tail signif.) = not significant

Scheffee-test= No two groups are significantly different at the 0.050 level.

Hypothesis H1 is therefore *rejected* and innovativeness is the same (not significantly different) across sectors.

H2a: *Innovativeness is higher, the higher the education level of the owner/manager.*

For testing H2a hypothesis first the Spearman's ρ correlation coefficient between NPDIN and EDLEV is calculated (since EDLEV is an ordinal variable.)

NPDIN } $\rho = 0.29$

EDLEV } $p = 0.001$

There is correlation (at a low level)* and statistically significant at the 0.001 level therefore H2a is *accepted*. Cross tabulation also confirms the hypothesis H2a (NPDIN is converted first into an ordinal scale with 3 categories NPDINR and education level (EDLEV) is re-coded to three (3) categories to make cross-tabulation valid (Table 77, Appendix B).

* Note: Correlation is considered to be very low if it is less than 0.10, low between 0.10 and 0.29, moderate between 0.29 to 0.60, and high over 0.60 (Bryman and Cramer, 1990).

H2b: *Innovativeness is higher, the lower the age of the owner/manager.*

For testing H2b hypothesis the Spearman's ρ correlation coefficient between NPDIN and AGE is calculated (since AGE is an ordinal variable) .

NPDIN } $\rho = -0.17$

AGE } $p = 0.045$

The correlation coefficient is very low, but in the expected direction (negative) and statistically significant at the 0.05 level, H2b is therefore *accepted.*

H2c: *Innovativeness is higher, the higher the business experience of the owner/manager (work in other businesses before joining the present one.)*

NPDIN } $\rho = -0.03$

BASNOW } $p = 0.725$

The correlation coefficient is very low and not statistically significant, therefore H2c is *rejected.*

H2d: *Innovativeness is higher, the higher the number of business travels of the owner manager abroad.*

NPDIN } $\rho = 0.19$

TRAVNO } $p = 0.023$

There is a low but statistically significant correlation, therefore H2d is *accepted.*

H3a: Innovativeness is higher, the larger the size (number of employees) of the firm

NPDIN } $\rho = 0.17$

EMPLNO } $p = 0.042$

There is a low but statistically significant correlation at the 0.05 significance level therefore H3a is *accepted.*

H3b: Innovativeness is higher, the higher the age of the firm.

NPDIN } $\rho = 0.05$

AGE FIRM } $p = 0.556$ (Not statistically significant)

The correlation is very low and not statistically significant, therefore H3b is *rejected.*

H3c: *Innovativeness is higher, the higher the sales turnover of the firm.*

NPDIN } $\rho = 0.18$

SALETUR } $p = 0.03$

There is a low, but statistically significant relationship, therefore H3c is *accepted.*

H3d : *Innovativeness is higher, the higher the internationalization of the firm.*

Export sales is used as a substitute measure for internationalization.

NPDIN } $\rho = 0.18$

EXP } $p = 0.03$

There is a low, but statistically significant relationship therefore H3d is *accepted*

H3e: *Firms with higher R&D expenditure, are higher in innovativeness.*

NPDIN } $\rho = 0.45$

RDPRC } $p = 0.000$

There is a moderate and statistically significant correlation, therefore H3e is *accepted.*

H3f: *Firms which employ a higher number of scientists and engineers, are higher in innovativeness.*

NPDIN } $\rho = 0.28$

SENGNO } $p = 0.01$

There is a low and statistically significant correlation, therefore H3f is *accepted.*

H3g: *Firms with a written strategy are higher in innovativeness.*

NPDIN } $\rho = 0.32$

STRATEX } $p = 0.000$

There is a moderate and statistically significant relationship, therefore H3g is *accepted.*

H3h: *The higher the degree of environmental scanning (i.e diversity and significance of sources of technological information), the higher the innovativeness.*

The hypothesis was tested by calculating the correlation coefficient (Pearson's r) of the variables :

NPDIN} $r = 0.32$

SITINF} $p = 0.000$

r is in the medium range and statistically significant, therefore H3h is *accepted.*

H3i: *The higher the cooperation level of a firm with technology providers, the higher its innovativeness.*

NPDIN } r = 0.31

COOPFSU } p = 0.000

r is in the medium range and statistically significant, therefore H3i is *accepted.*

H4a: *The higher the intensity of competition, the higher the innovativeness of firm.*

NDIN } r = 0.13

COMPIN } p = 0.121

r is low and not statistically significant, therefore H4a is *rejected.*

H4b: *The higher the rate of environmental change, the higher the innovativeness of the firm.*

NPDIN } r = 0.32

CHANGSU } p = 0.000

r is in the medium range and *statistically significant, H4b is accepted.*

H5: *The higher the importance of the external barriers as perceived by the owner manager, the lower the innovativenes.*

The hypothesis is tested by calculating the correlation of variables :

NPDIN } r = 0.12

EXBARSUM } p = 0.17

r is low and not statistically significant, therefore H5 is *rejected.*

H6: *The higher the innovativeness of a firm, the higher its performance.*

H6 is tested by calculating the correlation coefficient of :

NPDIN } r = 0.39

BENCHSUM } p = 0,000

r is in the medium range and statistically significant, therefore H6 is *accepted.*

H7: This hypothesis was rephrased as follows :

The networking intensity (N) is not the same in sectors (1. . 5) i. e $N1 \neq N2 \neq N3 \neq N4 \neq N5$.

For testing the hypothesis a one way analysis of variance (ANOVA) for more than two groups is used for the variable LINKIMSU which is a measure of networking intensity.

LINKIMSU SECTOR (1. . 5)

Group (Sector)	Mean
1	8.4333
2	8.2000
3	8.0000
4	7.1600
5	9.4400

Fratio = 1,68 Fprob = 0.15 (Not significant)

Levene test of the homogeneity of variance: 0.133 (2-tail sign) = Not significant

Sheffee-test: No two groups are significantly different at the 0.050 level.

ANOVA suggests that networking intensity is the same (not significantly different) among sectors 1. . 5, therefore H7 is *rejected.*

H8: *The more integrated in networks firms are, the higher their innovativeness.*

For testing H8 hypothesis the Pearson correlation coefficient between NPDIN and LINKIMSU is calculated.

NPDIN } r - 0.05

LINKIMSU } p = 0.517

There is a very low correlation which is not statistically significant. Therefore H8 is *rejected.*

Table No.: 5. 5 Summary of Hypotheses Testing

Hypothesis	Accepted	Rejected
H1		✓
H2a	✓	
H2b	✓	
H2c		✓
H2d	✓	
H3a	✓	
H3b		✓
H3c	✓	
H3d	✓	
H3e	✓	
H3f	✓	
H3g	✓	
H3h	✓	
H3i	✓	
H4a		✓
H4b	✓	
H5		✓
H6	✓	
H7		✓
H8		✓

Source: Survey Data Analysis

5. 1. 3 Multiple Regression

An investigation of the relative impact of several independent variables on innovativeness (NPDIN) as the dependent variable is made through multiple regression analysis. The independent variables include five interval-level variables for example performance (BENCHSUM), cooperation with external technology providers (COOPFSUM), etc. and sixteen independent dummy variables (representing seven ordinal level variables) e.g. number of employees, percentage spent on R&D, number of scientists and engineers etc. Table No: 5.6a below indicates the dependent and independent variables.

Table No: 5. 6a Multiple Regression Analysis
Dependent/Independent Variables

Dependent Variable	Independent Variables	Independent Variables
Interval Level	Dummy (Dichotomous)	Interval - Level
NPDIN	1. EMPLNO X1	17. BENCHSUM
	2. EMPLNO X2	18. COOPFSUM
	3. EXPR	19. COMPIN
	4. SECTOR X1	20. CHANGSU
	5. SECTOR X2	21. SITINF
	6. SECTOR X3	
	7. SECTOR X4	
	8. RDPRC X1	
	9. RDPRC X2	
	10. RDPRC X3	
	11. SENGNO X1	
	12. SENGNO X2	
	13. SENGNO X3	
	14. STRATEXR	
	15. EDLEVR X1	
	16. EDLEVR X2	

A stepwise procedure was used:

Six variables were found to be 'good' predictors of the Innovativeness (NPDIN). These are the following in order of importance (in explaining the variance of NPDIN) (Table No. 5.6b). The total amount of variance explained by all six variables is 38% ($R^2 = 0.38$) and adjusted 35% (Adjusted R square = 0.35)

Table No. : 5. 6b Multiple Regression Analysis Results

Variable	Standardised Regression Coefficient	Significance
1) STRATEXR (Existence of Strategy) .	(b = 0. 30)	Sign T = 0. 0001
2) RDPRCX11 (R&D Expenditure as percentage of Sales)	(b = 0. 30)	Sign T = 0. 0002
3) BENCHSUM (Performance)	(b = 0. 29)	Sign T = 0. 0001
4) EMPLNOX1 (Number of people employed)	(b = 0. 23)	Sign T = 0. 0033
5) SITINF (Significance of Technological Information sources).	(b = 0. 22)	Sign T = 0. 0032
6) COOPFSUM (Cooperation with Technology Providers).	(b = 0. 15)	Sign T = 0. 045

The residuals were examined in order to make sure that none of the basic multiple regression statistical assumptions (normality, linearity, lack of multicollinearity etc.) has been violated. The histogram of the standardized residuals is very close to normal and the normal P-P plot of Regression Standardized Residuals is almost a straight line. Also inspection of the plots of studentized residuals against the predicted values of Innovativeness and the partial correlation plots of independent variables versus the dependent variable do not suggest any violation of the assumptions. Tolerances and VIF values are in the accepted range. Therefore the statistical assumptions for multiple regression are met.

Due to space limitations the voluminous detailed computer print-outs for multiple regression, or the other statistical analyses discussed below, are not presented here, or in the appendices. They are kept, however, by the author on paper and electronic files.

5. 1. 4 Multiple Discriminant Analysis

A multiple discriminant analysis (MDA) was run with Innovativeness (NPDINMNN) as the dependent variable. The latter was suitably re-coded for the MDA by the polar extremes approach (Hair et al, 1995) i.e. the extreme two groups of values (3-6) = 1 and (11 - 15) = 2 were used, while the middle group (7 - 10) = 0 was excluded from the analysis.

Nine independent variables (representing six original variables) were used:

1) RDPRC X11
2) RDPRC X22
3) RDPRC X33
4) STRATEXR
5) SITINF
6) COOPFSUM
7) BENCHSUM
8) EMPLNO X1
9) EMPLNO X2

The independent variables were those which were proved as predictors in multiple regression analysis. The method used was the simultaneous estimation [Hair et al, 1995] (All independent variables used).

The canonical discriminant function is highly significant and displays a canonical correlation of $(0.7717)^2 = 0.5955$ i.e. 59.55% of the variance in the dependent variable (Innovativeness) can be accounted for (explained) by this model which includes 9 independent variables. The group centroid for non-innovative firms (group 1) is: 1.14052, while the group centroid for the innovative firms (group 2) is 1.25089.

Box's M test is significant (Differences in the group covariance matrices). Therefore the statistical assumptions for MDA are met. The classification matrix has a classification accuracy of 90.77% which is quite high. Comparing it with the proportional chance criterion Cpro = 0.50 the classification accuracy of 90.77% is substantially higher than the proportional chance criterion of 50%. [Group 1: 34 cases, Group 2: 31 cases. Cpro = $p^2 + (1-p)^2$. Therefore p = (34/65)x100 = 0.523 and Cpro = $(0.523)^2 + (0.477)^2$ = 0.273 + 0.227 = 0.50.]

The order of importance of independent variables in discriminating between innovative/non innovative firms (based on their Discriminant Function Loadings) is shown in Table 5.7 below. It is based on the structure matrix (pooled -within groups-correlations between discriminating variables and canonical discriminant functions)

Table 5.7 Discriminant Function Loadings

Variable	Name	Discriminant Loading
1. BENCHSUM	(Performance)	0.46637
2. STRATEXR	(Existence of strategy)	0.43876
3. SITINF	(Significance of Technological Information sources)	0.43052
4. COOPFSUM	(Cooperation with Technology Providers)	0.41420
5. RDPRCX11	(R&D Expenditure as percentage of Sales)	0.32262
6. RDPRCX22	(R&D Expenditure as percentage of Sales)	0.20511
7. RDPRCX33	(R&D Expenditure as percentage of Sales)	0.19262
8. EMPLNOX1	(Number of people employed)	-0.14368
9. EMPLNOX2	(Number of people employed)	0.05114

N.B The last two variables i.e EMPLNOX1 and EMPLNOX2 have a very low discriminating power.

5. 1. 5 Factor Analysis

Since the aims of this research project include the examination of the underlying dimensions in the perceptions of the owner/manager in terms of e.g. external barriers to innovation, attitudes towards business and technology etc. factor analysis is used for the uncovering of the underlying dimensions.

A). Factor Analysis of the External Barrier Perceptions of Owner/Managers (25 items)

This analysis seeks to find factors related to external barriers to innovation as perceived by the owner/manager.

Assumptions of Factor Analysis.

a. Bartlett test of sphericity: 1163.9607. Significance = 0.00000. Correlations significant at 0.0001 significance level.
b. Kaiser - Meyer - Olkin Measure of Sampling Adequacy = 0.70809 in the acceptable range (well above 0.50) (Hair et al, 1995).

Therefore the assumptions for carrying out factor analysis are met.

Eight factors were extracted in the unrotated factor solution with eigenvalues over 1. These eight factors explain 65.3% of the variance. Two of the items were rejected (Exbar 5 and Exbar 24) due to their low communalities in the first rotated solution to improve the factor analysis. A more parsimonious solution was then sought by inspecting the factor scree plot (Chart No.3, p.364, App. B). Four factors were retained and the factor analysis was repeated. These four factors explain 48.2% of the variance which is still an acceptable percentage. The compromise is worthwhile because the factor solution is easier to interpret.

Rotation. A varimax rotation was applied which converged in 6 iterations.
Naming the Factors. According to the accepted guidelines for identifying significant factor loadings (Hair et al, 1995) 0.30 was accepted as the cut-off point for interpretation purposes. The factors with the highest loadings are first taken into account in naming the factors.

FACTOR 1 : Government Market Regulation Policies

Item	Loading	Description of Item
3	0. 77	Wages policy
2	0. 69	Social insurance policy
4	0. 69	Policy on patents & licenses
14	0. 64	Goverment policies on competition
21	0. 58	Consumer protection policy
9	0. 52	Effect of technical standards on new products
18	0. 44	Short-term economic, monetary and financial policies.
8	0. 42	Policy on public contracts & government purchasing
25	-0. 41	Innovation too easy to copy
10	0. 36	Government Policy to assist small firms

FACTOR 2 : Problems with inputs (especially physical ones, labour and finance)

Item	Loading	Description of Item
7	0. 68	Problems with inputs (raw materials & components)
12	0. 68	Inadequate technical training of employees
6	0. 67	Lack of Government assistance
15	0. 61	Bank policies on credit
11	0. 59	Inadequate university education of employees
22	0. 51	Lack of venture capital
18	0. 41	Short-term economic, monetary and financial policies.
10	0. 40	Government Policy to assist small firms
25	0. 37	Innovation too easy to copy
13	0. 35	Foreign Trade Policy (import tariffs)
1	0. 33	Shortage of skilled labour

FACTOR 3 : Access to Technology Providers

Item	Loading	Description of Item
17	0. 85	Limited access to Research Institutions
23	0. 74	Lack of opportunities for cooperation with other firms and technological institutions
16	0. 67	Lack of Testing Institutions
18	0. 31	Short-term economic, monetary and financial policies.
10	-0.32	Government policy to assist small firms

FACTOR 4 : Government's environment, labour and consumer protection policies

Item	Loading	Description of Item
19	0. 72	Government's Health & Safety Policies
20	0. 64	Government's environmental policy
22	0. 42	Lack of venture capital
21	0. 38	Consumer Protection Policy
15	0. 36	Bank policies on credit
1	-0. 34	Shortage of skilled labour
8	0. 33	Policy on public contracts and government purchasing
25	0. 30	Innovation too easy to copy

In this section four factors were identified as the main dimensions behind the perceptions of the owners/managers about the external barriers to innovation. These factors and their implications will be discussed in Ch. 6. The reliabilities of factors (Cronbach's alpha values for the items loading on each factor) are as follows:

Factor 1	a = 0.75
Factor 2	a = 0.76
Factor 3	a = 0.61
Factor 4	a = 0.58

The reliabilities of the first two factors are good (above 0.7 - Bryman and Cramer,1990), while those of the last two are fair, but still acceptable.

B).Factor Analysis of Personal Statements (attitudes) of owner/managers to business, technology etc. (19 items).

Assumptions of Factor Analysis:

a. Bartlett test of sphericity: 672.99680 Significance: 0.00000 Significant at .000001 level.

b. Kaiser - Meyer - Olkin - Measure of Sampling Adequacy: 0.72 (in the acceptable range - well above 0.50)

Therefore the assumptions for carrying out factor analysis are met.

Seven factors were extracted in the unrotated factor solution with eigenvalues over 1. These seven factors explain 66.8% of the variance. One of the items was rejected, (PASTAT 4) due to its low communality in the first rotated solution, to improve the factor analysis.

Again the factor scree plot was examined (Chart No.4, p.365, App.B) and four factors were retained. The factor analysis was repeated and the four factors explain 50.4 % of the variance which is an acceptable compromise for a more parsimonious solution.Varimax rotation was applied and it converged in 7 iterations.

Naming the Factors Again factor loadings 0.30 and above were accepted as the cut-off point for interpretation.

FACTOR 1 : Attitudes related to NIP, New Technology and Training

Item	Loading	Description of Item
12	0. 73	Government should do more to introduce new manufacturing technology
14	0. 72	Try to read articles on new technology
16	0. 70	Government training of Technicians
17	0. 64	Sector specific industrial strategies are needed
10	0. 60	Manager should encourage risky innovation
15	0. 56	Buy New Equipment
3	0. 32	Promote Innovation versus independence

FACTOR 2 : Management related issues

Item	Loading	Description of Item
9	-0. 78	Responsibility for personnel management
8	-0. 72	On job training versus academic education
5	0. 67	Delegation of authority (decisions)
7	0. 53	Concentrate on managerial issues rather than technical issues
11	0. 43	Active role in politics
6	0. 38	Cooperation of firms versus independence

FACTOR 3 : Cooperation versus independence of the firm and delegation of authority

Item	Loading	Description of item
6	0. 65	Cooperation of firms versus independence
13	0. 63	Small firms should cooperate
3	0. 52	Promote Innovation versus independence
5	0. 47	Delegation of authority
19	0. 42	Less Bureaucracy and minimal Governmental Interference is what small firms really need
10	0. 37	Manager should encourage risky innovation

FACTOR 4 : Management methods and government policies for SME

Item	Loading	Description of Item
2	0. 71	SME should use same management methods as large firms
18	-0. 63	Small firms should be supported by a special Government Policy
13	-0. 43	Small firms should cooperate
3	0. 38	Promote Innovation versus independence
15	0. 37	Buy New Equipment

The reliabilities of the above factors are:

Factor 1	a = 0.77
Factor 2	a = -0.26
Factor 3	a = 0.62
Factor 4	a = 0.19

The reliability of the first factor is good and that of the third one is fair. The reliabilities of factors 2 and 4 are very poor, however, and the factors should be interpreted with caution. Since factor analysis is used in an exploratory mode here, and factors are not used in the construction of scales or further analysis, the poor reliability of some of them is not a major problem.

C).Factor Analysis of the Objectives of SME Owners/Managers (12 Items)

Assumptions of Factor Analysis:

a. Bartlett test of sphericity : 507.60358, Significance = 0.00000

b. Kaiser - Meyer - Olkin Measure of Sampling Adequacy: 0.75455 in the acceptable range.

Therefore the assumptions for carrying out factor analysis are met.

Three factors were initially extracted in the unrotated factor solution with eigenvalues over 1. A fourth factor is very close to one (0.988) and was decided (after inspecting the scree plot: Chart No.5, p.366, App.B) to be included in the analysis. These four factors explain 66.8 % of variance. One item (IPOB 9) was dropped from factor analysis due to its low communality in the initial rotated solution. The factor analysis was repeated for the four factors. In this final solution the four factors explain 70.8% of the variance which is a relatively high percentage.

FACTOR 1 : Creativity/job satisfaction

Item	Loading	Description of item
12	0. 84	Being a creative entrepreneur
8	0. 82	Job satisfaction
11	0. 76	Self-Fulfillment
3	0. 72	Making high quality products
5	0. 62	Playing an active role in society

FACTOR 2 : Status and rewards from business

Item	Loading	Description of item
7	0. 86	High social status
6	0. 82	Attractive life style
10	0. 49	High level of income
5	0. 47	Playing an active role in society

FACTOR 3: Independence/Continuity

Item	Loading	Description of item
2	0. 88	Building up a business for your family
1	0. 86	Personal independence

FACTOR 4: Financial Benefits

Item	Loading	Description of item
4	0. 81	Financial independence
10	0. 70	High Level of Income

The reliabilities of the above four factors are:

Factor 1	a = 0.83
Factor 2	a = 0.70
Factor 3	a = 0.72
Factor 4	a = 0.52

The reliabilities are good for the first three factors and fair for the last one.

D).Factor Analysis of Network Related Variables

Assumptions of Factor Analysis

a. Bartlett test of sphericity: 2287. 8566 Significance = 0.00000
b. Kaiser - Meyer - Olkin Measure of Sampling Adequacy = 0.69287 in the acceptable range.

Therefore the assumptions for carrying out factor analysis are met.

Ten factors were extracted in the unrotated factor solution with eigenvalues over 1. These ten factors explain 72% of variance. Five items (NTINSEC, NPDFBR, LSRELR, COOPF5, FFRELR) were dropped from further analysis due to their low or very low (below 0.20) communalities. By applying the scree test criterion (Chart No.6, p.367, App.B) four (4) factors were retained and the factor analysis was repeated. The four factors explain 51.6 % of the variance which is an acceptable solution.

Rotation: Varimax rotation was applied. It converged in 17 iterations.

Naming the Factors: Using 0.30, as above, as the cut-off point for interpretation purposes the factors were named as follows:

FACTOR 1 : Collaboration with local suppliers

Item	Loading	Description of Item	
MSUPR 3	0. 96	Local machinery suppliers rating	(After sales service)
MSUPR 1	0. 96	Suppliers rating	(Technical adequacy)
MSUPR 4	0. 95	Suppliers rating	(Technical advice)
MSUPR 2	0. 94	Suppliers rating	(Prompt delivery)

FACTOR 2 : Collaboration with local non-competitors

Item	Loading	Description of Item	
COREL 3	0. 82	Rating of relationships with local firms in other sectors	(Quality)
COREL 4	0. 81	Rating of relationships with local firms in other sectors	(Technical Advice)
COREL 5	0. 75	Rating of relationships with local firms in other sectors	(After Sales Service)
COREL 2	0. 69	Rating of relationships with local firms in other sectors	(Delivery)
COREL 1	0. 59	Rating of relationships with local firms in other sectors	(Price Setting)

FACTOR 3 : Cooperation with competitors

Item	Loading	Description of Item
LINKIM 1	0. 77	Importance attached to links with local firms in the same sector
COLENDR	0. 60	Lending materials/equipment to competitors
COCONTR	0. 58	Discussing state of industry with competitors
LINKIM 2	0. 56	Importance attached to links with competitors (Cypriot firms in other towns)
NTINEXR	0. 55	Passing technological information to competitors
NCOLENDR	0. 51	Lending materials/equipment to non-competitors
COLINT 1	0. 41	Collaboration with other firms in the sector in production

FACTOR 4: Technical cooperation with foreign technology providers and local/foreign firms

Item	Loading	Description of Item
COOPF 2	0. 71	Cooperation with technology providers (Foreign Universities)
COOPF 1	0. 70	Foreign R&D Institutes
COOPF 3	0. 70	Foreign Testing Centres
COLINT 3	0. 48	Intensity of Collaboration with other firms in the sector in Product Development and Technical Research
LINKIM 3	0. 44	Importance attached to links with foreign firms.
COLENDR	-0. 38	Lending materials/equipment to competitors
NCOLENDR	-0. 36	Lending materials/equipment to non-competitors

The reliabilities of the above four factors are:

Factor 1	a = 0.99
Factor 2	a = 0.80
Factor 3	a = 0.70
Factor 4	a = 0.41

The reliabilities are good to excellent for the first three factors and relatively low for the last one. Therefore the last factor has to be interpreted with this fact in mind.

Summary

Factor analysis has identified a relatively small number of factors in each case which account for the perceptions of managers on certain management and technology issues. The discussion of the possible meanings of factors in combination with other analysis is left for Ch.6.

5. 2 Qualitative Research

5. 2. 1 Case Studies - The Cross Case Comparisons

The 25 case firms are compared under the five major 'themes' which were introduced in section 4.2.1. The comparison under specific themes makes the discussion orderly and brings out better the similarities and differences among the case firms.Then section 5.2.5 tries to link the cases with patterns from the literature as presented in Ch.4. While most information is presented in tables, in every section snippets of cases are presented for a rich description within the available space limitations. The codes (rankings) in the tables below are based on available objective data combined with the judgement of the researcher, where necessary, which is based on qualitative information obtained during the interview and personal observation.

A) Firm Characteristics

Table 5. 8 summarizes some basic data on firm characteristics. Demographic data are presented first i.e. the firm size (number of employees), age of firm in years, location and sales turnover (in million Cyprus pounds) and the percentage of exports in total sales. The percentage of exports is an indicator of the internationalization of the firm. Some indicators of the dynamic performance and organization of the firm are then given in Table 5.9. These include, the sales growth, the growth in employment and the local market share (rated as low, medium and high). Market share is also an indicator of market position (in Cyprus).

The number of competitors (broadly indicated as low, medium and high) and including both local and foreign competitors is an indication of the competitive pressure on the firm. The degree of functional specialization (rated as none, low, medium or high) is a measure of the formality of the firm's structure. 'None' means in this case the classical very small firm where the owner /manager is the 'hub' of all activities and the employees are simply his/her helpers without any sign of even the basic functions. 'High' in the Cyprus context means a fully functionally specialized firm with the major functions (marketing/sales, production, finance, although not necessarily personnel) clearly discernible.

The degree of formal strategy/planning rated as none, low, medium and high in the firm is an indirect evidence that major decisions including the ones concerning innovation and technology are following a certain pattern rather than taken ad hoc. The criteria used for the rating of strategy were the existence of goals, a long-term planning horizon and a clearly set agenda of major strategic issues like product lines, markets and technology.

Table No 5. 8 Basic Firm Characteristics

Case Code	Size Emplno	Age/Firm Years	Location	Sales CP Mil.	Exports % Sales
C1	80	30	Nicosia	5. 2	40
C2	24	8	Ni	1. 4	18
C3	55	31	Ni	1. 5	10
C4	15	14	Ni	0. 7	0
C5	20	18	Ni	0. 5	0
P1	65	27	Larnaca	2. 5	60
P2	10	11	Ni	1. 1	0
P3	5	6	Ni	0. 8	0
P4	48	37	Limassol	1. 5	0
P5	8	4	Ni	0. 4	80
M1	15	14	Ni	1. 2	0
M2	22	14	Ni	1. 3	15
M3	6	4	Ni	0. 5	15
M4	4	14	Ni	0. 6	0
M5	25	12	Ni	1. 1	35
F1	44	32	Ni	1. 3	20
F2	53	33	Ni	1. 6	5
F3	65	11	Ni	2. 1	75
F4	73	20	La	3. 2	40
F5	11	11	Ni	0. 9	0
T1	4	3	Li	0. 3	0
T2	31	16	Li	1. 3	5
T3	19	18	Ni	0. 8	25
T4	43	46	Ni	1. 9	10
T5	12	11	Ni	0. 8	0

Code
C = Chemicals P = Plastics M = Metal F = Food T =Textiles
1CP = Cyprus Pound =1. 4 Sterling Pound Emplno = Number of Employees
Location Ni = Nicosia La =Larnaca Li = Limassol

Table No. : 5. 9 Dynamic and Functional Characteristics of the Firm

Case Code	Sales Growth	Employment Growth	Market Share	Comp. No	Functional Specializ.	Strategic Planning
C1	**	***	**	**	***	**
C2	***	***	**	*	*	*
C3	**	**	**	**	**	**
C4	*	*	**	**	*	*
C5	0	0	*	***	*	0
P1	*	(-)	***	*	**	**
P2	***	**	*	**	0	*
P3	*	**	*	**	0	0
P4	0	*	*	**	0	0
P5	**	*	*	0	0	*
M1	**	*	*	***	0	0
M2	**	*	**	***	*	**
M3	*	*	*	*	0	**
M4	**	*	*	**	0	**
M5	***	***	**	*	**	***
F1	**	*	**	***	*	*
F2	***	**	**	***	*	**
F3	**	*	*	*	*	*
F4	**	*	***	*	**	**
F5	**	**	**	*	0	0
T1	**	*	***	0	0	0
T2	**	*	**	*	*	*
T3	*	(-)	*	***	*	***
T4	*	*	*	**	0	0
T5	*	*	*	**	0	*

Code
C = Chemicals P = Plastics M = Metal F = Food T =Textiles
Code: 0 = None * =Low ** = Medium * = High (-) = Negative**
Comp. = Competitors Specializ. = Specialization

B) Innovation climate

Firms are compared in Table 5.10 on the level of their awareness of National Innovation Policy (NIP) measures. Other indicators related to NIP are 'Use of Government grants for innovation' and 'Technical change initiated by the firm due to the legislation'. All three measures and the ones mentioned below are rated as above i.e. none, low, medium and high. An overall rating by the owner/manager of the 'Industrial Policy Effectiveness' is then presented. The concept of 'Industrial Policy' instead of NIP was used as more familiar to the Cypriot O/M. The rating of importance of the external and internal barriers appears next in the table.

The above comparisons give only the broad picture. They are complemented with specific comments and views as quoted by O/M regarding the government policy, the business practices in Cyprus, finance and labour issues.

Government's industrial policy(IP). Most firms are highly critical of what they perceive as ineffectiveness of IP. Few consider it as somewhat effective and none as effective. It is not quite clear from their comments what they would consider as an effective IP. Some argue for protection against 'low cost' imported products dumping the Cyprus market in their view, others for easier finance, special grants for manufacturing industry, better infrastructure and export subsidies.

The owner/manager of T3 said:

> "Industrial policy is virtually non-existent. The Government departments participate in meetings among them selves or with industrialists with their own 'hidden' agendas. They adopt suggestions (of industrialists or advisers) 'piece-meal' and only when their own interests are promoted (or at least not threatened !!)".

He also talked about "the lack of cooperation and coordination of activities of the many different government bodies involved [in industry support] e.g. the Productivity Centre, the Development Bank etc.". The O/M of M2 said:

> "The public sector officials lack strategic vision for the future state of industry, the tourist sector has monopolized their attention."

Business Practices. According to many case firms (e.g. P1, P3, F10 competition is frequently using price cutting as a method of entry to new customers or market sectors. They also complain that competitors tend to copy successful ideas or products instead of innovating themselves. M2: "Competitor F. has even copied our advertising leaflet". Several cases of 'opportunism' from business associates have also been mentioned from payment delays or defaults to quality defects.

Finance. Commercial banks are reportedly overcharging for their services. They tend to favour loans for personal consumption rather than loans to industry. The O/M of P1 said:

> "If I go to the bank and ask for a loan for a luxurious Mercedes of 50.000 pounds, I shall get it easily under a scheme of hire/purchase where the profit of the bank is high. If, however, I ask them for a loan to buy a new machine they will demand a feasibility study and make all sorts of questions, while it will take ages to come back with an answer. You see, their profit margin is much lower in idustrial loans."

Labour isssues. Firms in the labour intensive sectors, such as textiles/clothing (e.g. T2, T4) attribute the erosion of their competitiveness in the last few years, especially in export sales, to the strength of the trade unions and their high demands for wage increases. Many of the case firms (e.g. C1, M1, T4) mentioned also the problems of low quality, lack of professionalization and unwillingness to work overtime of their existing workers and the severe shortage of labour they face.

Regarding the local technical education there were many complaints especially about the low level of technical high schools (in contrast to what was the norm 15-20 years ago). The owner/manager of M2 said:

> "The technical education is completely neglected. It attracts only the weakest pupils. Apart from that it is difficult to find technical school graduates (they end-up in other sectors of the economy, especially tourism). It is somewhat easier to find technicians at the HND level, and quite easy to find university educated, but inexperienced engineers".

Table 5.10 Innovation Climate

Case Code	Awareness of NIP	Use of Grants	Technical Change Legislation	Industrial Policy	External Barriers	Internal Barriers
C1	***	***	*	**	*	*
C2	*	0	0	*	**	*
C3	***	*	**	*	**	**
C4	*	0	0	**	*	*
C5	*	0	0	*	***	***
P1	***	*	*	*	***	*
P2	*	0	0	*	**	**
P3	0	0	0	**	**	*
P4	*	0	0	*	**	*
P5	**	**	0	*	**	**
M1	*	*	*	**	***	**
M2	***	*	0	*	**	*
M3	**	*	*	*	**	*
M4	***	*	0	**	***	*
M5	***	*	0	**	*	*
F1	*	0	*	*	**	**
F2	**	*	**	*	**	*
F3	*	0	0	**	*	*
F4	**	**	***	*	*	*
F5	0	0	0	**	*	**
T1	0	0	0	**	*	*
T2	*	*	*	**	**	**
T3	***	0	0	*	*	*
T4	0	0	0	**	*	*
T5	0	0	0	*	*	**

Code
C=Chemicals P=Plastics M=Metal F=Food T=Textiles
Code: 0 = None * =Low ** = Medium * = High (-) = Negative**

C) The Characteristics of The Owner/Manager

A number of characteristics are cross-tabulated in Table 5.11. These include the age of O/M (it is assumed that the stage of his/her life-cycle has an important effect on innovation efforts, because the objectives in life and motivation are different in each stage); and the tenure (years in the present business). Regarding the tenure it is frequently argued that experience is of value for innovation, but on the other hand many years in the same business may lead to formation of hard-to-challenge stereotypical views about ways of doing business. Previous work experience in relevant sectors (rated as none, low, medium, high) is also included as an important component of individual learning with effects on organizational learning and innovation.

Detailed data are then given on O/M education i.e. the highest level in education achieved and where relevant the specialization in tertiary level education. Technical and management education are assumed to be important inputs to the innovation process. Cosmopoliteness is measured through the frequency of travelling abroad, knowledge of foreign languages and connections with foreign firms (and broadly classified into none, low, medium and high). It is expected to have a major impact, especially during the first stages of innovation, that is new product concept generation, awareness of technological developments and technology selection.

The type of entrepreneur (broadly equated to the owner/manager) is expected to illuminate his/her role in the innovation process. The distinction between 'craftsmen' and 'opportunist' entrepreneurs of the literature (Barkham et al, 1996) is extended here by subdividing the opportunist group into technical and managerial entrepreneurs.

The *craftsman entrepreneur* (Cr) is characterized by low levels of formal education i.e. at the technician's level or lower and usually high technical ability, and is closely involved in the technical details of his/her firm's operations. The Cr is typically characterized by a lack of managerial orientation.

The *technical entrepreneur* (Te), as defined here, has a technical or scientific education at university level and is heavily involved in the technical aspects of the firm's operations, but is typically not very strong on management issues.

The *managerial entrepreneur* (Me) has a degree level education, a high level of managerial capability and is primarily concentrated on management issues (even if he/she had initially a technical background).

This type of classification is believed to give a fairer description of the roles of O/M especially with relevance to innovation activities. It is based on the judgment of the researcher as it was formed during the interview from qualitative data and also objective data about the background, education, and involvement in technical issues of the O/M.

The family involvement in the firm (classified as none, low medium and high) gives an idea of the internal climate and the way of management/control of the firm as a separate entity or as an extension of the O/M's family. The classification was based on data about the number of family members working in the firm or participating in the board of directors. The higher the family involvement in key positions, the higher the direct control on employees and the lower the chances for career progression for non-family members.

Finally the dominance of O/M in technological innovation (classified as low, medium and high) is a direct description of his role as initiator, coordinator and actor in innovation. High dominance means lower delegation of authority to technical people and over-concentration of tasks and activities in O/M's hands. One of the reasons is that the O/M is usually afraid (e.g. O/M of C1) that once the employee has the technical knowledge and contacts with suppliers and customers will leave the company and due to the low entry barriers will start a business competing directly against his former employer.

Table 5.11 Characteristics of the Owner/ Manager(O/M)

Case Code	Age O/M	Tenure	Previous Work Experien	Highest Education	Specialization	Cosmo-polite	Entrepr. Type	O/M Domin	O/M Involv
C1	65	30	**	Bsc	Chemist	***	Te	**	***
C2	47	8	***	Hs	-	***	Cr	***	***
C3	40	10	0	Msc	Manag.	***	Me	*	***
C4	50	15	0	Bsc	Manag.	***	Me	*	*
C5	48	18	0	Bsc	Science	*	Me	**	***
P1	52	24	*	Bsc	Law	***	Me	***	***
P2	48	16	**	Hs	-	*	Cr	***	***
P3	54	6	***	Hs	-	0	Cr	***	***
P4	70	37	*	Hs	-	**	Me	***	***
P5	55	4	**	Hs	-	**	Cr	***	*
M1	50	14	**	Ts	-	*	Cr	**	**
M2	51	14	**	PhD	Mech. Eng.	***	Me	***	*
M3	37	4	***	Msc	Mech Eng	**	Te	***	*
M4	46	14	*	PhD	Chem. Eng.	***	Te	***	0
M5	·38	9	**	Msc	Elec. En.	***	Me	***	0
F1	56	32	0	Bsc	Manag.	**	Me	**	**
F2	30	7	0	Bsc	Manag.	**	Me	**	***
F3	55	11	***	Bsc	Manag.	***	Me	**	***
F4	48	15	**	Bsc	Chem. Eng.	***	Me	**	*
F5	49	12	*	Hs	-	*	Cr	***	**
T1	54	4	***	HND	Manag.	**	Me	*	***
T2	48	16	*	Msc	Chem. Eng.	**	Me	***	***
T3	50	18	**	Bsc	Mech. Eng.	***	Me	***	***
T4	56	30	0	Bsc	Textiles	**	Te	***	***
T5	40	11	*	HND	Textiles	*	Te	**	***

Code: Te=Technical enterpreneur, Me = Managerial enterpreneur

Cr = Craftsman

Hs = High school, Ts=Technical school

0 =None, * =Low, ** = Medium, * = High**

Experien. =Experience, Manag. = Management, Domin. = Dominance

Chem. = Chemical, Eng. =Engineering, Involv. = Involvement

D) INNOVATION

Cases are compared in Table 5.12 and 5.13 against their many characteristics regarding innovation. For the present purposes, and just for the sake of easier presentation, data were broadly divided into Facilities (Table 5.12) and Capabilities (Table 5.13).

Sources of technical information. The variety in technological sources, the use of external training and to some extent the use of licenses from foreign firms are indicators of efforts invested in technological learning.

Innovation input. The employment of scientists and engineers (expressed as a percentage of the total work force), the expenditure on research and development (classified as low, medium and high) and the availability in testing equipment (again classified as low, medium and high) give an indication of the technological capability of the firm and its potential to innovate. It should be noted that the classification of R&D expenditure (mainly development and less research in the Cyprus context) is only a relative comparative measure and does not imply that firms in the 'high' category spend a high percentage of their turnover in R&D (compared to that of firms in developed countries).

Process Innovation. The investment in advanced manufacturing technology, the degree of adaptation of machinery, as well as the design capability (all rated as none, low, medium and high) give a measure of the process innovation record of the firm. Design capability means here ability to design modifications in equipment and/or product design capacity in the broadest sense.

Product innovation. The relative number of new products introduced in the last three years (classified as none, low medium and high) combined with the degree of novelty as judged by the O/M themselves (low, medium, high) and the design capability give an indication of the new product innovation record.

Organizational and administrative innovation. The adoption (or not) of the ISO quality standards and the degree of computerization of the firm as indicators of organizational innovations are assumed to be related to product and process innovativeness in the sense that an innovator in product or process is usually an organizational innovator as well.

Innovativeness and Innovation strategy. A composite score of product and process innovation is used for a broad classification of firms to non-innovators, low medium and high innovators. Innovation strategy is classified as none (non-existing), proactive (innovation is stimulated by market/technology opportunities) and reactive (defensive) i.e. innovation is forced upon the firm, which in general has a wait-to-see attitude (passive), by competitor moves or legislation. The classification was made by the researcher and was based on the qualitative information received during the interviews, and other available data (e.g interviews with industry experts). Specific examples of innovation strategy (or the lack of it) in case firms are given in sections 5.2.2 and 5. 2.3.

Table 5.12 Innovation Facilities Characteristics

Case Code	Variety Tech. Info.	External Training	Licence	Employed S&E %	R&D Expend.	Testing Equipm.	AMT Investm.
C1	***	***	+	22	***	***	*
C2	***	*	0	0	**	0	0
C3	**	**	0	8	**	**	*
C4	*	*	+	7	0	*	0
C5	*	*	+	10	0	*	*
P1	***	**	+	2	**	*	*
P2	*	0	0	0	*	0	0
P3	*	0	0	0	0	0	0
P4	*	*	0	0	0	**	0
P5	**	0	0	0	**	0	0
M1	*	*	0	0	0	0	**
M2	***	***	+	10	**	*	**
M3	***	*	+	17	*	*	**
M4	***	***	0	75	***	**	0
M5	***	**	0	32	***	***	**
F1	*	0	0	2	0	*	0
F2	**	**	0	2	*	*	0
F3	**	0	0	0	*	*	0
F4	***	**	+	5	*	**	*
F5	*	0	0	0	0	0	0
T1	**	0	0	0	0	0	*
T2	**	0	0	6	*	0	***
T3	***	***	0	6	**	0	*
T4	*	*	0	5	*	*	0
T5	*	0	0	0	0	0	*
Code: 0 = None * = Low, ** = Medium, * = High, + = Yes**							

Table 5.13 Innovation Capabilities Characteristics

Case Code	Machine Adaptation	Design Capability	New Product Number	New Product Novelty	New Markets	ISO 9000	Computerization
C1	*	**	***	***	***	+	***
C2	*	**	***	**	***	0	*
C3	*	**	**	**	*	0	**
C4	0	0	*	*	0	0	*
C5	0	*	*	*	0	0	0
P1	*	**	**	**	***	+	*
P2	*	**	**	**	**	0	0
P3	0	0	0	0	0	0	0
P4	0	0	0	0	0	+	*
P5	**	**	**	**	***	0	*
M1	**	*	*	*	*	0	0
M2	*	**	**	**	**	0	*
M3	***	***	**	**	**	0	**
M4	***	***	**	**	**	0	**
M5	***	***	***	***	***	0	***
F1	0	*	**	*	*	0	*
F2	0	**	***	**	**	0	*
F3	0	**	**	**	***	0	*
F4	**	**	**	**	**	+	**
F5	**	*	*	*	0	0	0
T1	***	*	*	**	0	0	0
T2	*	**	**	**	0	0	**
T3	*	***	***	***	0	0	***
T4	0	*	*	*	*	0	**
T5	**	**	**	*	**	0	*

Code:			
0 =None	* =Low	** = Medium	*** = High
+ = ISO 9000 Adoption			

Table 5.13 Innovation Capabilities Characteristics (Continued)

Case Code	Innovativeness	Innovation Strategy
C1	***	P
C2	***	P
C3	**	R
C4	0	N
C5	0	N
P1	***	R
P2	**	R
P3	0	N
P4	0	N
P5	***	P
M1	**	R
M2	***	P
M3	***	P
M4	***	P
M5	***	P
F1	*	N
F2	**	R
F3	**	R
F4	**	R
F5	0	N
T1	**	R
T2	**	R
T3	**	P
T4	0	N
T5	**	R

Code 0=None * = Low ** = Medium * = High**
N=Non-Innovator P=Proactive R=Reactive Innovator

E) Networks

Table 5.14 depicts the main types of networks and the extent of involvement of the case firms in them. Mainly innovation related networks are considered in order to have some comparison between the networking activities of the case firms. Relative ratings are used based on statements of the owner /manager, data from the survey, and the overall impression of the interviewer. A uniform classification is used running from none to low, medium and high. First the technological linkages with customers separately for local (L) and foreign (F) are considered. Linkages are rated according to the degree of feedback received from customers during product development and the degree of participation of customers in the innovation process (for example as initiators and prototype testers).

Technological linkages with local (L) and foreign (F) suppliers are similarly classified. The criteria used were the amount of technological information received from suppliers, the extent of their assistance during the various stages of the innovation process (e.g. testing of prototypes and training in use of advanced manufacturing technology). The above were examples of the vertical type relationships. The relations with local competitors provide an example of horizontal type relationships. The following are examples of lateral type relationships.

The involvement of firms in trade associations and of the owner /manager and/or the employees in professional associations are indicators of active networking behaviour in relation to two important facets of organizational/personal activity. The degree of cooperation with governmental and non-governmental technological institutions [both local (L) and Foreign (F)] gives an indication of the types of external technological resources used and the importance of these resources for the technological innovation efforts of the firm. These institutions include research, testing and standards institutions and technical consultancies.

The amount of time that the owner/manager devotes to networking (e.g. by visiting key customers, suppliers and government institutions) is an indicator of the overall importance of strategic networking for the firm. The identification of the main boundary spanners as either the O/M or one of the scientists/engineers of the firm is another indication of the role of O/M in the networking activities of the firm.

Based on the scores of the above measures an overall score, the N-score, is estimated and the firms are broadly classified by the researcher into four categories i.e. isolators (o), low (*), medium (**), and high (***) networkers. The higher the N-score, the higher the level of the networking activity and the diversity of the networks of a particular firm. The content of network relationships, their role and importance for innovation and the motivation to enter networks can only be illustrated with examples from the cases. Such examples are presented in the following.

Frequency of contacts in local networks. Local firms have many opportunities for frequent contacts due to the small size of industry and Cyprus. For example the O/M of the plastics processing firms meet not only during the meetings of their trade asssociation, but also during seminars, visits to trade fairs and social occasions. Those of them located in the same industrial area e.g. in Limassol within an area of a few hundred metres have many chance contacts. They also make planned meetings or telephone calls to each other to discuss matters e.g. new laws or standards affecting their sector.

Content of relations in local networks. The use of subcontracting is relatively limited in the sectors under study, apart from the textiles sector. Only six (6) out of the 25 firms i.e. the P3, M3, M4, F1, T2, T3, subcontract work to other local firms (usually smaller ones). Only one (C4) undertakes subcontract work for another local firm. Work is subcontracted for secondary product lines and non-core activities. Subcontracting for specialized work is less common. For example F1 subcontracts to a small local firm close to its factory the production of one secondary product which is then sold under F1's trade mark. M3 subcontracts specialized work to a former employer of its O/M (due to lack of facilities and personnel as the O/M of M3 has put it).

Horizontal relations include, apart from subcontracting, the exchange of favours (e.g. lending of raw materials when one firm faces a sudden shortage) and exchange of information usually on pricing/marketing and sometimes on experiences with particular brands of machinery and testing equipment. Exchange of materials and sometimes common purchasing of raw materials are more usual among smaller firms, which can not afford to have adequate stocks for their needs. For example P2 lends frequently materials to other firms of similar size.

Most of the case firms generally avoid relations with direct competitors in their core product lines. The level of trust even among non direct competitors appears to be low and firms tend to base relationships on past experience and social bonds. Direct competitors frequently blame each other for price-cutting and unprofessional behaviour. Larger firms tend to consider small low-cost family firms as 'pirates' in business.

Regarding vertical relations i.e. between suppliers and buyers there are sometimes close relations among local suppliers (e.g. metal firms supplying machinery or equipment) and buyers (e.g. firms in the chemical or food sector). M3 is cooperating closely with customers, even supplying service for imported machinery from his competitors abroad. For example he discovered and rectified a design mistake in a piece of imported machinery which the original supplier could not adapt to customer's needs. According to M3 service is not the only competitive advantage of a local supplier.

> "In Cyprus machinery designers have to deal with all aspects of design, have therefore a more holistic view (than the narrowly specialized engineers in large foreign firms) which leads to better designs. In addition to that the local supplier is closer to customer's needs, mentality and problems."

Supplier/customer relations are frequently under tension due to delays in payment for goods or services bought. This is the most frequently mentioned business problem. Other causes of adversarial relations are the monopoly power of some suppliers and the lack of attention to quality standards. C2 complained about the substandard raw material supplied by a local firm, which is practically the only supplier. C2 had to make costly adjustments to their production in order to solve the problem.

The social basis of relations. The O/M of T3 has commented about the tradition of collaboration in rural Cyprus especially before independence and the emergence of industry i.e. before the 1960s. For years farmers in the villages helped each other especially during the crop collection periods. The O/M of T3 lamented the fact that these social norms and the spirit of cooperation have apparently not been maintained among industrialists. In the subsistence agriculture stage farmers were, however, not really competitors and interdependence among them was limited within the extended family circle. In the modern industrial sector in Cyprus social network relations extend and complement the business network relations and frequently form their basis.

The above mentioned exchange of favours is more usual among friends or firms with a family connection. For example the technical manager of C4 exchanges raw materials and technical information with his schoolmate and friend, the plant manager of C1 (firms are in the same sector, but not direct competitors). Social relations of the O/M are very important for getting new clients, and extending one's resources especially during the formation stage of an SME. They have also some relevance for innovation. C2 mentioned that a friend helped in the first experimental application of a new product. Social relations are also important for innovation in another sense. Information about new products, new investments in equipment by a particular firm and new technologies travel fast around the market by way of informal discussions mainly through the social network.

From the above it is apparent that firms enter local network relationships (usually on the basis of pre-existing social connections) to get information, exchange favours etc. Collaboration very rarely, if ever, extends to joint action in innovation activities e.g. joint development of new products since there are no complementarities among the firms (for example the one having the technical knowledge and the other the marketing experience). Other factors are the relative lack of specialization among the firms of a particular sector, the short vertical (supply) chains and the low level of trust in local transactions. There are examples of vertical relations, but usually firms turn to foreign ones for obtaining technology as explained below.

International Networks. They have a particular importance as expected for a small developing country, where technology transfer from developed countries is the most important mode of technology acquisition. Most Cypriot firms seek 'strategic alliances' i.e. exclusive inter-organizational relationships with foreign firms in such forms as joint ventures, representation agreements and licences. Firms seek mainly to ameliorate their technical weaknesses through these relations, but the fact that there is considerable power 'asymmetry' between them and the usually giant multinational technology suppliers, means that the cost/benefit balance is frequently not in favour of the Cypriot firms. Cypriot expatriates, traditional suppliers (for example U. K firms) or contacts created during the O/M's studies abroad are usually the 'initiators' in these international networks.

Table 5.14 Networks

Case	Tech. Links	Tech. Links	Tech. Links	Tech. Links	Local	Trade	Profes.	Gov.
Code	Cust L	Cust F	Supl L	Supl F	Compet	Assoc	Assoc	Instit
C1	***	*	*	***	*	***	***	***
C2	**	**	0	***	0	*	0	0
C3	***	*	0	***	*	**	**	0
C4	0	0	0	***	0	*	*	0
C5	**	0	0	***	*	**	0	0
P1	**	***	0	***	0	***	*	**
P2	***	0	***	**	**	0	0	0
P3	*	0	0	**	**	*	0	0
P4	*	0	0	***	*	**	0	*
P5	*	**	*	***	0	0	0	0
M1	**	0	*	***	*	*	0	**
M2	*	*	*	***	*	***	***	**
M3	***	*	0	***	0	**	**	*
M4	***	0	*	***	0	***	***	*
M5	***	***	0	**	0	**	**	0
F1	*	0	*	**	*	*	*	*
F2	*	0	*	***	**	***	*	**
F3	0	*	0	**	0	**	0	0
F4	0	*	*	***	0	*	**	**
F5	*	0	0	*	*	0	0	0
T1	**	0	0	***	0	0	0	0
T2	**	0	0	***	0	**	0	0
T3	*	*	0	**	*	*	***	0
T4	*	0	0	**	0	*	0	0
T5	**	0	*	**	0	*	0	*

Code: L = Local F = Foreign
0 =None * = Low ** = Medium * = High**
Tech. =Technological, Cust. =Customer, Profes. = Professional
Supl. = Supplier, Comp. = Competitor, Gov. = Government
Assoc. = Association, Instit. = Institution.

Table 5.14 Networks (Continued)

Case Code	NGo T. I L	NGo T. I F	O/M Involvement	Boundary Spanner	N Score
C1	*	*	**	O/M	***
C2	0	*	***	O/M	**
C3	0	**	***	S/E	***
C4	0	0	0	S/E	0
C5	0	*	*	O/M	*
P1	0	*	***	O/M	***
P2	*	0	**	O/M	**
P3	0	0	*	O/M	*
P4	0	0	0	0	*
P5	0	*	***	O/M	**
M1	*	**	**	O/M	**
M2	*	**	***	O/M	***
M3	*	**	***	O/M	***
M4	0	**	***	O/M	***
M5	0	*	***	S/E	***
F1	0	*	*	O/M	*
F2	*	**	**	O/M	***
F3	0	0	*	0	*
F4	0	*	*	O/M	**
F5	0	0	*	O/M	0
T1	0	0	*	0	*
T2	0	0	*	O/M	*
T3	0	**	**	O/M	*
T4	0	0	0	O/M	0
T5	0	0	0	O/M	*

Code: NGo = Non- Governmental T. I =Technical Institution
N Score = Networking Score
L = Local F = Foreign S/E = Scientist / Engineer
0 =None * = Low ** = Medium * = High**

5. 2. 2 The Proactive Innovators

In the Cyprus context the proactive innovator is the exception rather than the rule. Very few firms come close to the ideal pattern of the proactive innovators. Some examples of such firms are given below.

M5 is a small size firm (25 employees) in a specialized market segment with 35% of sales as exports and a respectable performance rate (high sales and employment growth) in the last three years. It is rapidly expanding in export markets. It is a knowledge-based firm with an unusually high (for the Cyprus context) percentage of scientists and engineers in its employment (32% of the total work-force). The firm has clear goals and a conscious (although unwritten) strategy to achieve them by expanding gradually into related product markets as well as new geographical ones.

The managing director (and one of the three partners) although described as a 'managerial entrepreneur', since he is more involved in the administrative and sales rather than the technical aspects, has however a technical background plus an MBA and can conduct complex negotiations with customers including technical matters. The managing director has a high need for achievement and is tolerant to risk (evidenced by the fact that he left a permanent post with good career prospects in one of the major commercial banks in order to join the very small at that stage firm). He said:

> "I was attracted by the challenge of creating something new and pioneering in a team with other professional colleagues."

The geographical expansion of M5 is a bold step, since it involves considerable investment in establishing a sales subsidiary abroad, expansion of production, frequent visits there of the managing director and undertaking of more sophisticated jobs, of which the company has little experience till now.

The firm uses a wide variety of sources for technological innovation and the managing director travels extensively to trade fairs in Europe and elsewhere, technical seminars etc. He keeps contacts with suppliers and technical consultants. M5 cooperates with foreign component suppliers and keeps close contacts with local and foreign customers, adapting the design of products to their needs. It had started purchase of components from a local supplier, but faced problems due to quality defects.

The team approach and informal methods of management served well during the first years of hard work for the establishment of the firm. Growth however, has created the need for re-organization and functional specialization. A separate technical service team has been created and individual functions like production and sales have been allocated to the partners. However the re-organization is a painful process, as the managing director has put it:

> "The re-organization should be done in such a way that the team spirit, the cooperation and job satisfaction for the highly qualified engineers of the firm is maintained".

The full description of case M5 is given in Appendix D.

C1 is a medium size firm, long established and a market leader in its subsector in the local market. Exports represent 40% of its total sales and it has achieved good sales and employment growth during the last three years. C1 exports to many international markets and continuously adds new ones. It has a close and long established cooperation with some major foreign suppliers (a must in its field). C1 has invested a lot in testing equipment, which is partially used for new product development (but mainly for quality control). It has introduced pollution prevention equipment and plant safety measures long before the legislation asked for them. Even now the anti-pollution systems exceed by far the requirements of legislation. The firm has made a major investment in plant automation in order to be able to increase and diversify its exports. C1 has in the last few years repeatedly won export awards. A team of scientists and engineers deals with production, quality control and customer technical support, but also with product development, improvement of formulations and production problem solving.

The owner/manager is a technical enterpreneur, cosmopolitan, with wide connections in the local market. His informal contacts in the trade association, government committees and among fellow industrialists give important clues about environmental changes, opportunities and threats. He maintains contacts with competitors, but mainly related to pricing, marketing and regulations issues. The O/M is still personally involved in new product development, since it is a job he enjoys and judges as most important for his attention.

C1 has a vision for the future and a relatively well articulated strategy. It follows closely the trends in the international environment in its field. Its structure has evolved from an informal into a functional one over the years. C1 maintains close relations with foreign firms in its sector, foreign and local machinery and equipment suppliers (e.g. M3), Government bodies etc.

M4 is a very small (4 people), but highly specialized knowledge-based firm. It undertakes the design and installation of pollution prevention and other industrial equipment. In many such projects it has provided a locally made ingenious solution to pressing problems of its customers at a fraction of the cost of similar imported equipment.

Machinery construction is subcontracted to local machinery workshops under the supervision of the O/M of M4. The O/M has, however, many complaints about the ability of the workshops to follow his designs and complete the work in time. He also commented that the workshops are not willing to cooperate among themselves in order to produce a part of the equipment, each of them according to their abilities and the machinery they have. In his opinion it is a matter of 'image' and 'professional pride'for the workshop owners to show that they are able to produce and assemble the machine and present it as a finished item with their 'signature'. The O/M of M4 has also expressed concern about the illegal copying of his designs by the workshops for other machines for their own clients. Recently an industrial furnace was designed by M4, constructed by a workshop and installed by M4 in the client's plant.

The O/M is a highly qualified engineer (PhD), with a strong need for achievement. He has repeatedly rejected opportunities to join the civil service at a high salary. He undertakes considerable risk in some of the projects due to the delay in payments from his clients, their requirements for guarantees, and his limited finances. He has a clear vision of the future for his firm and a long-term strategy for gradual expansion with an own laboratory and work-shop. M4 uses a wide variety of technological information sources (such as contacts with technological institutions in Cyprus and abroad and technical literature).

The O/M of M4 is highly critical of the Government's industrial policy. He considers 'help' from government as an obstacle rather than a facilitator for innovation. He said: "Government officials lack the specific knowledge about industry's problems. Their motivation is rather their career progression than a genuine interest in promoting innovation. Even with the best intentions the complex bureaucratic rules do not allow them to act fast enough".

P5 is a very small size young firm specialized in a market niche. The firm received last year an award for developing new products for export. The owner/manager is a craftsman, who has modified locally available machinery in order to start production of novel products in a field that even internationally is not yet a well developed one. The O/M has clear goals, a vision of what he would like to achieve and a strong need for achievement. He is now importing machinery for expansion at considerable risk (taking into account his limited finances). He had to overcome many barriers in his efforts to innovate and is highly critical of the government's industrial policy for not supporting pioneers, but rather established firms.

C2 started production under license from a major UK firm. The O/M made many efforts to master the process of production and collected information from several sources (apart from the licenser) carrying out a lot of experimentation at the same time, in order to build gradually an indigenous technological capacity. This long-term strategy of gradual technological learning served C2 well when the licenser made exorbitant demands for increased license fees, when an opportunity arose for export sales. C2 was able to break the relationship with the licenser and compete successfully against the new licensee in the local market, while making exports on his own.

He has recently started exports of new products to the UK market. During the first interview he was still at the development stage of these products for the 'Do-it-yourself' market. He had to solve a number of technical problems at the laboratory and production level. As he mentioned he visited suppliers abroad, his distributor in the UK, trade fairs and a potential licenser in order to find solutions to his problems. By the time of the second interview, six months later, he had worked out solutions and started the first shipments initially of a limited variety of the product range to keep the risk under control. His aim was to increase gradually the range.

5. 2. 3 Reactive Innovators

This group is as expected less homogenous than the other two, since it includes firms at various levels of 'innovativeness' and pushed to innovation by different forces. Some examples are presented below.

M1 is a small size firm with slowly growing sales and employment and a low market share, one of the many metal workshops in Cyprus. It has no functional specialization and there is no sign of planning or long -term strategy. It is a family firm with high family involvement. Due to difficulties in finding technical labour and because of the high turnover of the technical employees the O/M, who is a craftsman, was forced to invest in computer-controlled machinery. He preferred, however the low-risk strategy of importing second-hand machinery. The difficulties of putting these machines in operation are indicative of the dangers in that approach. The 'low-risk' strategy proved actually a high-risk option, probably because of inadequate search and technology selection procedures. More details on M1 are given in Appendix D.

F2 is a medium size firm with high sales and moderate employment growth in the last three years. It has a medium market share in the local market with a large number of competitors. F2 has very low export sales at present. The firm has introduced several new products in the last three years, mainly as a response to moves made by the market leaders and with the aim to offer a full range of products.

Another trend which forced F2 to introduce new products (and upgrade its facilities) is the continuously increasing, due to mergers, power of the retail chains which are the main customers of the firm. F2 has invested in imported machinery in order to increase its productivity and boost its image as a modern manufacturer. Another motive was the desire to conform to government regulations about hygiene of food plants. The O/M is 30 years old with studies in management. He is mainly dealing with the sales/marketing aspects of the business, although he has also been involved in the firm's major machinery investment project and the product development efforts. The O/M maintains close contacts with customers, suppliers and the trade association of his industry. His participation in a special training scheme for small business managers has given him the opportunity to make useful contacts with other local business people.

T5 is a small size firm with low sales and employment growth, no planning or strategy and without functional specialization. Due to the difficulties of the textile sector, the firm has made considerable investments in, mainly, second -hand machinery for expansion of its production facilities in new more specialized product sectors within the broad textile field. The O/M has an HND in textile technology and is the chief technician of the firm. His sources of technological information are rather limited (mainly his suppliers of machinery and raw materials and occasional visits to trade fairs). He has collaborated with a local electronics firm for installing upgraded control systems on his machines.

P1. A trend in the market may be clear for a number of years before the reactive innovator decides that further delay in introduction of an innovation into the firm would seriously affect its competitiveness. P1, a medium size firm, had seen, in trade fairs initially and then in the European markets, that a new material was substituting the one he was using for years. The substitution in his firm would mean change of moulds, experimentation with a material that was not familiar to them (with different processing properties) and eventually the purchase of new machinery.

It was only in early 1995 that the first move was made to use the 'new' material on a limited scale. During the first interview with the O/M the difficulties faced in the transition stage were discussed. The material was still processed on an existing machine that was suitably adapted to the purpose. The second interview, six months later, coincided with the installation of new machinery (special for the new material) by the technicians of the supplier. The O/M was personally involved in the trial operation of the machine (although he has no technical background). He wanted to make sure that the engineers of his firm had been adequately trained for the operation and trouble-shooting of the new machine and that he had himself a basic knowledge of the operation of the machine. More details on P1 are given in Appendix D.

5. 2. 4 Non Innovators

This is a relatively large group including many micro-businesses, but also small, medium and even large firms. Some examples are given below.

P4 is a medium size firm, without exports (although in the past they had made some efforts to export into neighbouring countries). P4 has almost stagnant sales and no employment growth. It has no functional specialization or any form of planning. It produces the same range of products for several years and its main effort is to maintain the traditional sales by minimizing cost. The most recent investment in machinery was three years ago for a machine from the same supplier of the largely old machinery of the plant. The O/M is now over 70 years old and maintains his traditional methods of management. P4 is a low networker.

P3 is a small, relatively young (6 years old firm) with low sales and employment growth. It is a family firm, having exclusively family members as employees. P3 has no strategy and it is only concerned about its survival and the maintenance of the family income. Apart from some subcontracting to other small firms for non-core activities, P3 is a low networker.

T4 is a medium size, long established firm, with low exports and practically no sales and employment growth. The owner/manager is 55 years old with a degree in textiles technology. He has a conservative attitude to business and has not introduced new products in the last few years. He is deeply concerned about the negative trends in the local clothing industry and pessimistic about the future. The O/M complains about problems of credit collection and the adversarial relations with customers because of the payment delays. He also said that he can not trust his employees, therefore has to supervise most of the operations himself.

C5 is a small, long established firm with stagnant sales and a low market share. The firm produces for years the same products. It depends on a license for one line of specialized products, but has failed to make the necessary marketing effort to promote these products. It can be described as a marginal operation with a permanent cash flow problem and a very short term horizon. C5 uses the available network relations of the O/M and the production manager only to borrow materials from other firms in the sector in order to be able to continue its production.

C4 is a small firm without exports and almost stable sales and employment. It is totally license dependent. Its products are produced under the license and the trade mark of a well-known German manufacturer. C4 relies on the licenser for all technical information and it only applies its instructions for the occasional re-formulation of products and the introduction of new ones. It can be described as a non innovator in the sense that the occasional innovation does not originate from its own initiative. C4 has also very limited contact to other local firms. It can be rated as 'isolator'.

5. 2. 5 Identification with the Innovator Patterns

The cases under study identify relatively well with one of the three proposed patterns i.e. the polar patterns of proactive innovators and non-innovators and the intermediate one of reactive innovators. In real life situations a variation is seen as expected and identification with patterns is less than perfect, but variation within the three groups on the differentiation variables (taxonomy criteria) is less than that across the groups. The group of reactive innovators has a larger within -group variation than the other two.

Proactive Innovators fall into two rather distinct sub-groups: the first includes sophisticated firms with a relatively well developed technical infrastructure (such as employment of scientists and engineers and testing equipment) and involved in medium to high technology product sectors e.g. chemicals. Examples are such firms as C1, M5.
The second includes small firms with an owner/manager of the craftsman type who is personally involved in experimentation with new product prototypes or the modification/adaptation of machinery and has both the talent and perseverance to proceed overcoming the myriad of barriers in his way. Examples are firms as P5, C2.

The proactive approaches in the Cyprus context seem to fall into two of the four categories proposed by Urban and Hauser (1980) i.e. the entrepreneurial type where "the innovation activity is high risk and opportunistic, but not necessarily very technically novel" and the marketing based type for anticipatory product innovation. The other two categories i.e. R&D based major innovations and the acquisitive type (i.e. acquisition of innovator companies) are rare, if not entirely non-existent in Cyprus.

II) *Reactive innovators* is a group which includes firms with different levels of innovativeness from those which are close to proactive ones regarding innovation to firms which innovate very infrequently. Most reactive strategies are of the types imitative and defensive following again the classification of Urban and Hauser (1980). Imitative means reacting to new product introduction of competitors by introducing similar products, while defensive in this case means modifying existing products as a reaction to competitor moves. The types responsive (reaction to customer's request for innovation) and second-but -better are more rare, although not unknown e.g. P2 (responsive) and T1 (second-but-better).

III) *Non-innovators.* In the population of Cypriot firms, this is probably the largest group by far. Three subgroups can be distinguished:

a) Medium size traditional firms. They rely on cost control and volume to maintain profit and stay with existing markets and products continuing to operate for years with their traditional technology e.g. P4, T4.

b) Small and micro-businesses which try only to survive by producing at the lowest possible cost, usually by using family labour e.g. P3, C5.

c) Firms which are totally dependent on a foreign licenser (e.g. C4). Even if they introduce new products they exercise very little or no autonomous effort, but merely apply the instructions of licenser in both marketing and production. They even use in several cases the advertising spots of the licenser. The reasons for getting the license are marketing oriented i.e. to have well-known trade marks, rather than enter seriously into technology transfer.

5. 2. 6 Matching Feature Profiles and Innovator Patterns

Only the first subgroup of proactive innovators appears to have some form of formal strategy and planning with evidence of setting targets, making market share projections and preparing budgets. Both sub-groups of proactive innovators have, however, an agenda of key strategic issues, a long planning horizon and a clear vision of a desirable future with alternative courses of action to achieve it. The discussions with O/M provide evidence for these elements, despite the fact that they are frequently informal and in O/M's head. Innovation strategy, although frequently not a distinct and separate part, is a key element of the overall strategy.

Proactive innovators use a wider variety of technological information sources than the other two groups. They are stronger than them in the core and enabling processes of innovation (The concepts of core and enabling processes were discussed in Section 4.2.3). The actual use of the systems and tools (i.e. the available sophisticated techniques for managing the innovation process e.g. project management and creativity enhancing techniques) is however quite low. This is not a surprising finding for rather simple firms in a small developing country.

The investment in formal innovation inputs (such as employment of scientists and engineers, R&D spending and testing equipment) is higher for only the first subgroup of proactive innovators against reactive ones and non-innovators as also evident from Table 5.12 (p.234). Proactive innovators of the second sub-group make also substantial investments, in relation to their financial means, into development of prototypes and in production innovation, although this may not be immediately discernible.

Proactive innovators are usually proactive strategic networkers as well. Some reactive innovators are, however, equally active in networking, while non-innovators are characteristically low networkers and in some cases isolators. The first two groups (proactive and reactive) are especially active in networking with overseas suppliers of equipment and raw materials, who are at the same time the main (but not the only) sources of technical information and assistance. In some cases (e.g M5) there is also evidence of networking with demanding overseas customers.

The local networks are mainly sources of market-related information and to a lesser extent technological information (especially contacts with Government institutions). These local networks are, however not as important as hypothesized in models such as the 'flexible specialization' model or the 'production network' model which emphasize the importance of regional/local networking for innovation (see Section 2.5.1). The lesser importance of local networks for technological innovation can be attributed to the relatively underdeveloped and short vertical supply chains, the lack of complementarities among the local firms due to their low degree of specialization in product markets, and perhaps the ' fortress' mentality of many firms.

Proactive innovators are internationalized i.e. have substantial exports and other overseas activities, but that holds true for some reactive innovators as well, although non-innovators typically operate in the local market. The same lack of differentiation among the first two groups is also valid for organizational innovation (ISO quality standards and computerization) i.e. the larger firms in the first two groups are organizational innovators. Again the technological non-innovators are also laggards in organizational innovation.

The hypothesis about the characteristics of the owner/manager in proactive innovator type of firms is strongly supported. Vision, commitment to innovation, the belief that innovation is possible and within their power (i.e. an internal locus of control) and the high need for achievement, all these features come out clearly. O/M in reactive innovators tend to complain more about the lack of governmental support and see many external barriers to innovation (which sometimes they use as an excuse for inaction). Reactive innovators and especially non-innovators perceive their environment as more hostile (regarding competition, labour shortage and strength of trade unions) and believe that innovation is difficult in the Cyprus context (evidence of a rather external locus of control).

Proactive innovators have either a technical entrepreneur (mainly subgroup one) or a craftsman O/M (subgroup two) as their head. Sometimes it is a managerial entrepreneur type in sub-group one, but frequently with a technical background. The fact that O/M with technical backgrounds or previous functional experience in production tend to give more attention to technical matters (including technological innovation) is supported in the literature (e.g. Piatier, 1984).

There is no clear differentiation in performance between the proactive and the reactive innovators, while the non-innovators are typically low performers. Proactive innovation could actually be a double-edged sword as revealed from discussions with managers for example the O/M of P5. He mentioned another firm (not in the sample of cases) that had entered the same field (as P5) 2-3 years before 1995, but had failed mainly due to miscalculations about the potential market and some bad luck (i.e. unexpected price changes in the raw materials). P5 took advantage of the failure of the pioneer, both by buying cheaply some of its raw materials and equipment and by avoiding the problematic product line.

Taxonomies such as the above discussed are by their nature static, in reality there are movements of firms from the one group to the other, occasionally even in relatively short time periods. For example T4 a non-innovator has moved towards the direction of a reactive innovator when visited for a second time after a 6 months period. The owner's son, who had joined the firm after technical and marketing studies abroad, had finally persuaded his conservative father to introduce gradually new methods in production, including the use of computer-based ones. This was achieved after long discussions which had extended over a period of two to three years.

5. 2. 7 Interviews

More than 25 interviews were conducted with officials from various government departments, trade associations and science and technology institutions. A list of the institutions where interviews were made with one and in many cases two or more people appears in Appendix E. Fifteen (15) of these interviews took place before the start of the survey and case studies research and another 12 during the period of the research.

The aim of the initial interviews were to get a feeling about the innovation related government policies and their tools. Also to explore ideas about conducting a survey on the innovation activities of manufacturing firms in Cyprus and possible problems. The second wave of interviews aimed to clarify specific issues of innovation policy and recent developments in policies. An additional objective was to investigate the cooperation of public and private sectors and probe the views of officials on the problems of the manufacturing industry.

Apart from the interviews a lot of supporting material was collected by following several seminars and public discussions on the manufacturing industry and its problems. As an example a seminar organized by the Institute of Technology is mentioned here, where firms which used the services of the Institute for changes, including in several cases technological ones, presented their experiences.

It is not possible to present within the space limitations of the thesis the content of interviews in detail. Important points based on interview material are presented in the relevant parts e.g. in Chapter 3 on Cyprus and Chapter 6 where discussion and conclusions are presented. The main points of interviews and some of the most interesting issues are briefly summarized in the following separately for Government officials and others.

A.) Interviews with Government Officials

An interview with the senior industrial research officer in the Statistics Department provided an initial orientation into the population of the manufacturing firms, the main manufacturing sectors and a possible sampling frame. Some important facts about the local industry and its approximate size composition were discussed. Although there is a large number (several thousands of manufacturing firms most are micro-businesses (under 5 employees) with relatively little innovation capabilities. There are about 400 manufacturing firms with over 20 employees (and only 40 with over 100 employees). These 400 firms was the population of the main interest for the study of innovation, although some specialized firms with less than 20 employees may also be innovative and had to be included. Information on the surveys conducted for the compilation of industrial statistics was sought and obtained.

According to the experience of the Statistics Department the most interesting sectors, in terms of technological innovation capacity are:

i) Chemicals (including pharmaceuticals)

ii) Food (especially dairy products and canning/beverages)

iii) Plastics

iv) Metal

Several interviews with officials in the Industrial Extension unit of the Ministry of Commerce and Industry (MCI) dealt with the technological level of individual sectors e.g. chemicals, plastics, metal and the identification of the technological leaders in each sector. An interview with the senior industry officer (head of the extension unit) concentrated on the general problems of the manufacturing sector as perceived by the government officials. They can be briefly summarized as: the family character of firms, strategic planning deficiencies, and the mentality of dependence on government support (expressed with demands for protection of local market from imported products and bailing out of sectors in trouble by grants and government guaranteed loans). An internal report on the problems of the manufacturing industry, prepared by the MCI officers, was obtained.

A long interview was conducted with the Director of Industry in MCI. The discussion covered the major changes in the Cyprus manufacturing industry environment in the last few years. The government had tried to apply the trade liberalization at a faster rate than that pre-specified in the Cyprus-E.U customs union agreement, especially during the second phase of it as a pressure measure for industrialists to re-structure and adapt to the new competitive environment.

The local industrialists failed, however to respond and realize the inevitability of changes, preparing themselves for them. They continued to look to the government as a last minute life saver. The result was the rapid decline of some major traditional export sectors as clothing and footwear. These sectors had based their growth on the availability of cheap labour and easy exports to undemanding markets. The inevitable gradual increase of the labour cost and lately the shortage of labour and problems in traditional export markets found them unprepared. Few had invested in-time in upgrading of technological capabilities and product innovation.

The disappointing response of industrialists to the incentives for consortia (and other forms of cooperation formation was also pointed out). Only in the furniture industry were some consortia formed. An example of such a cooperation in the marketing side was mentioned and another more recent one for common production of certain components.

The Planning Bureau was visited to get information on the preparation of the five year indicative development plans. In the last few years, mainly after 1990 the plans include a section on technology, the need for its upgrading and ways to achieve it. The Planning Bureau follows closely the developments in the European Union and has tried to include Cyprus in European programmes for industry funding, SME support, and research cooperation schemes.

During an interview with an official of the Central Bank of Cyprus the macroeconomic conditions in Cyprus were discussed and the issue of licensing agreements and inward direct foreign investment in manufacturing. Data were collected on the number and value of licensing agreements by sector.

Interviews in the Industrial Training Authority and the Productivity Center looked into their available training programmes and productivity schemes and the response of the manufacturing industry to them. While small firms are willing to participate they can not in several cases release their personnel which is badly needed in daily activities.

B) Others

Interviews were conducted with three members of the Technology Advisory Group (TAC) (an advisory body on technology and management issues with most members from the private sector). TAC prepared a Masterplan for problem diagnosis and remedial action for management and technology use practices and made specific recommendations on the base of it. The general feeling was that their suggestions were never put into practice.

Three interviews were conducted with the Director of the Technology Institute (IT) the one before the survey and the other two during it. The efforts of the TI to introduce subsidized consultancy schemes for diagnosis of problems and preparation of projects in various management areas, including technology and innovation management and the response of firms by size and sector were discussed at length. It seems that those firms which need most these projects are the least probable to respond.

Discussions with officials in trade associations e.g. the Cyprus Chamber of Commerce and Industry and and the plastics converters association concentrated on the services supplied to industrialists, specific problems and more general ones affecting the manufacturing sector as a whole. The small size of the local market was repeatedly raised as a major constraint in industrial development.

The Cyprus Development Bank (CDB) was visited to get information on their criteria for industrial loans and their specific consultancy schemes for industry support. The bank also organizes special training schemes for SME managers which include organization of visits to successful SME abroad. The CDB has been involved in cooperation with foreign consultants in a project aiming to promote the idea of consortia formation in industry. The examples of the furniture and metal sectors were discussed. It was pointed out that a major reason for the limited success of these efforts was that the cooperating firms: "instead of pursuing the logic of the adopted new system, they tend to go off on a tangent by trying to continue the existing policies with the new scheme".

Examples of failure of innovation with serious repercussions for the firms were also discusssed. The adoption of advanced manufacturing technology in these cases did not fulfilled the initial expectations. The reasons of failure were not technical in most cases. It was usually the miscalculation of marketing factors which led to under-utilization of the expensive new equipment, or the inability of the staff to make full use of the potential of the advanced technology.

Finally an interview with a professor of chemistry in the local university dealt with his early efforts for cooperation with the local industry and the rather disappointing results of the contacts with industrialists. The local firms were reluctant to enter agreements for applied research in their field. The bureaucratic obstacles to such cooperation, from the University rules and regulations and the rigid administrative structures, were also discussed, as well as ways to avoid them and suggestions for changes.

CHAPTER 6

6. Conclusions and Implications

6. 1 Introduction

The research problem in this thesis was introduced in Section 1.2 of Chapter 1 (Introduction to the thesis) as *'an investigation of:*

a): the factors affecting innovation and the methods and means used by the owners/managers of manufacturing small and medium size enterprises to address technological innovation issues, in the context of a small developing country (Cyprus) and,

b): the effectiveness of a resource-based strategic innovation management perspective in the research of these issues'.

It was stated there that management of technological innovation even in industrialized countries is not well understood, despite the several years of research, due to the complexity of the phenomenon. It was then argued that management of innovation in developing countries, especially small ones is different from that in industrialized countries, it is under-researched and worthwhile of further investigation.

After a general introduction to innovation concepts, the literature review attempted to collect evidence from extant research and other academic work that management of innovation is indeed different in developing countries and in small against large firms and discussed the available evidence on the factors relevant to innovation, the controversies about them and the research gaps. A number of hypotheses were developed on the basis of these gaps. They have been summarized in the end of Chapter 2 and they were tested one by one in Chapter 5 (with the exception of the first two which were made as general propositions and frames for the rest and are further discussed in 6.2.4). The literature review presented also a theoretical framework based on the resource based view of strategy which provides a context for a unified treatment of the hypotheses. This framework attempts to illustrate that the individual factors as noted in the separate hypotheses, are in fact interrelated and interact with each other. By the end of this conclusion I will try to show that this framework is operational.

The methodology used in the research design and implementation, including that for the testing of hypotheses, was discussed in Chapter 4. The results of this testing were presented in a comprehensive table (No. 5.5). These results will be discussed individually and evaluated against related results in the literature in Section 6.2 below. Findings of the research which are only indirectly related to the hypotheses, but are still relevant for the overall research problem, especially its strategic and policy aspects, are also discussed in the appropriate points of Section 6.2. They are also compared to the results of the existing literature. The results of the qualitative research are discussed in parallel with those of the survey and compared and contrasted with them throughout Section 6.2.

Section 6.3 highlights some limitations of the research, while 6.4 presents the conclusions about the research problem, and 6.5 the implications of the research for theory, policy and practice. Finally Section 6.6 makes some suggestions for further research.

6. 2 Discussion of Research Results

6. 2. 1. The Individual Level - Characteristics of the Owner/Manager

This discussion is presented in four levels starting from the individual and continuing with the micro-, meso- and finally the macro-level (national innovation policy). The individual level is treated here separately from the micro-level in order to increase the clarity of presentation.

It was confirmed that the *education* of the entrepreneur (Hypothesis H2a) has a positive correlation to the innovativeness of the firm. Kimberly and Evanisco (1981) have found, in their research in health organizations, that the education level of hospital administrators positively predicted technological innovation. Lall et al, 1994 have found that firms with superior technologies in Ghana have better educated entrepreneurs, managers (and production workers). The level and type of education of the O/M are important since they play an important role in shaping his/her management style (Romano, 1990).

Regarding *age* of the owner/manager (H2b) innovativeness is higher, the younger the entrepreneur is, as found in other studies (Kim et al, 1993). Young people are assumed to be more open to new ideas and more risk tolerant.

Innovativeness was not statistically correlated to *prior business experience* of the entrepreneur/manager (H2c). Many of the owners in the sample are of the second generation in family businesses and have entered directly after their studies or after working 1-2 years abroad in only one business. Kimberly and Evanisco (1981) in the research mentioned above have found a positive association of tenure, which is admittedly a somewhat different concept, and can be broadly equated to prior business experience, but within the firm, as positively associated to technological innovation. Prior business experience, either within the sector or in other sectors, familiarizes the manager with management techniques, marketing aspects, technologies and learning mechanisms.

Innovativeness has a low but statistically significant correlation to the extent of *cosmopolitanism* (as indirectly measured by the number of trips abroad per year) and as also found previously in the literature (Kimberly and Evanisco, 1981).

The case research has illuminated the importance of the characteristics of the owner/manager for the innovativeness of the firm. Apart from his or her background characteristics (age, prior business experience, education, cosmopolitanism etc.) equally or more important are his vision, commitment to innovation and involvement in its various phases.

Regarding the attitude to risk Cypriot managers generally agree with the statement 'A manager should encourage innovation even if it is risky, if considered useful to the firm'. In the literature 'attitude to risk' is considered as a predictor of innovativeness (Miller and Toulouse,1986). The assumption is that the attitude predicts the action. This is however not always the case.

Factor analysis of the statements of owners/managers on the importance of a number of objectives for them identified the following four factors:

Creativity/Job satisfaction

Status and rewards from business

Independence and continuity

Financial benefits

Our factor analysis confirmed that these objectives bundles are separate constructs in the managers minds. The noteworthy importance of independence for owners/managers of the mostly family firms in Cyprus explains probably to some degree their reluctance to seek close collaboration with other local firms in the sense of joint production, marketing etc. as explained below in the section about networks, despite the frequent contacts and exchange of information or even materials and equipment. This is in contrast to the close links with foreign firms which are perceived as less threatening to their independence for reasons explained later on.

The three top-ranking objectives of owner/managers are financial independence (93% of managers ranked it as highly or very highly important) followed by self-fulfillment (89%) and job satisfaction (88%). The least important objectives are high social status (44% of managers consider it as of no or low importance) and attractive life style (43%). It is interesting to note that the ranking of objectives by the Cypriot managers is very similar to the ranking of objectives by European managers of small firms as reported in the STRATOS, 1990 study. Financial independence, self-fulfillment and job satisfaction are among the top five objectives in the just mentioned study, while high social status and attractive life style are similarly among the least important.

Cypriot managers strongly agree that government should support introduction of new manufacturing technology and have sector-specific strategies and that managers should plan, be directly involved in personnel management and cooperate with fellow businessmen. On the other hand they strongly disagree that managers should concentrate on management rather than technical issues and that SME should use the same management methods as large firms.

The disagreement on the preponderance of management against technical issues is indirect evidence of the importance attached to the latter and the close involvement of managers in technical issues as also confirmed in the case studies research.

In connection to the discussion above on independence versus cooperation around 62% of managers agree with the statement 'Firms should cooperate with other firms to be more effective even at the expense of some independence', but almost half of the managers disagree with the statement that 'managers should promote innovation even at the expense of the firm's independence', with another 20% having no opinion. It seems, in combination with the results of case study research, that while managers realize the benefits of cooperation they tend to avoid it, fearing its hazards.

Factor analysis of the attitudes of O/M on a number of statements on various innovation and management issues has given the following four factors:

1. Attitudes related to NIP, new technology and training
2. Management-related issues
3. Cooperation versus independence of the firm and delegation of authority
4. Management methods and government policies for SME

The above indirectly confirm the findings of case study research that managers/owners are personally involved in all stages of technological innovation. This is not always a good thing since lack of time (the main internal barrier to innovation as mentioned below) may delay or inhibit implementation. In addition to that the avoidance of delegation of authority or tasks may discourage technical staff from getting involved in innovation or supporting it.

6. 2. 2. The Micro-level - The Characteristics of the Firm

There is a low, but statistically significant, correlation of the *size* of firms (as measured by the number of people employed) to the innovativeness of firms (H3a). It implies that, in the Cyprus context, medium and large firms, which are better resource equipped (i.e. can employ more scientists and engineers, spend more on development and have slack resources) than their smaller counterparts can innovate more. The low correlation, however, suggests that size is not an informidable barrier and small firms can be innovative as also Acs and Audretsch (1990) report. Size (measured by the number of employees) is one of the predictor variables of innovativeness in the multiple regression model, although fourth in importance. It has, however, a very low discriminating power in the multiple discriminant model.

Size as also mentioned in Section 2.4.2 can be considered as a surrogate measure of several dimensions that lead to innovation e.g. total resources, slack resources and organizational structure (Rogers, 1983, p.359). Since some of them can not be easily measured e.g. slack resources, size is a convenient stand-in variable for these variables.

According to the case research small size does not seem to be a major barrier to innovation. It is especially not a barrier in some knowledge-based subsectors of chemicals and metal-working. A critical size of perhaps 50 employees is, however, important for more sophisticated innovations that need complicated machinery for their production and advanced testing equipment for quality control e.g. in the food sector.

The *age of firm* is not a significant influence on innovativeness (H3b). To some extent this is surprising since experience of operating in the market is assumed to be correlated to innovation. Most of the firms in the sample are however rather long established ones. Kimberly and Evanisco (1981) have found a positive relationship between age and both technological and administrative innovation. Aiken and Alford (1970) suggest, in contrast, a negative relationship due to the development of bureaucracy and rigidity over the years.

Sales turnover has a low, but statistically significant, correlation to innovativeness (H3c) similarly with the other measure of size of the firm (i.e the number of people employed) as discussed above.

Firms with a *written strategy* tend to show higher innovativeness (H3g). The confirmation of the hypothesis H3g seems to suggest that better organized firms with specific plans for the future pay more attention to innovation. Similarly the existence of a written strategy is the most important predictor of innovativeness in the multiple regression model and second most important discriminating variable in the multiple discriminant model. Cooper (1984) found strategy to be a significant predictor of firms' product innovation; the most innovative ones showing "a union of technological prowess and aggressiveness with a strong market orientation". Internationalization (e.g through exports) as a component of strategy is weakly correlated to innovativeness (H3d). Molero (1996) also reports a positive relationship.

Almost two thirds of the firms claim that they have a technology strategy, in most cases not written, against only 50% having an export strategy and a minority 29% having a human resources strategy. This suggests that technology is considered important for competitive strategy. The majority of firms consider automated machinery as the most important type of new technology in order to compete in their business sector.

The issue of strategy was studied in some depth in the case studies since it was felt that only superficial information can be obtained on it through the survey. The classification of firms into types according to their innovation strategy was proved meaningful and worthwhile. Its value for an innovation audit of the individual firm and for policy practice is discussed below. The variables that proved useful for the classification of firms in the case studies, include those such as R&D intensity and the number of employed scientists and engineers that were proved in a later stage of analysis also significant in the multiple discriminant model of classification to innovators/non innovators. These variables are indicators of commitment to an innovation strategy.

The case study research emphasizes strategy consciousness as an important feature of proactive innovators. The dimensions of innovation strategy (proactiveness, risk taking etc.) are strong discriminators between firms regarding innovativeness and allow the classification of firms into groups which correspond to theoretical patterns. Each group follows a particular mode of innovation and is characterized by a specific configuration of strategic, structural, process and contextual variables which are interrelated and interactive giving an integrated whole. The personality and background characteristics of the owner/manager as the central actor in the SME affect and shape directly and indirectly strategy, structure and the evolution of the innovation process.

Other researchers e.g. Miller and Blais (1992) have reached similar conclusions regarding the existence of configurations or groups of firms according to innovation behaviour. Their taxonomies have some common characteristics with the taxonomy of the present research e.g. the existence of polar patterns of proactive innovators and non-innovators but also many differences for the intermediate groups due to the different context of their research.

There is a medium level positive correlation ($p = 0.45$ $p = 0.000$) (one of the highest in this study) between *R&D expenditure* and innovativeness (H3e) as expected and widely mentioned in the literature. R&D expenditure is also the second in importance variable (after strategy) in the multiple regression model with innovativeness as the dependent variable which further confirms the association. It is also one of the discriminating variables in the multiple discriminant analysis.

Cooper (1984) in the research cited above has found that innovative firms place more emphasis than less innovative ones on R&D. Khan et al (1989) have found the 'percentage of research and development expenditure to cost of goods sold' as a significant variable in both their models i.e. multiple regression model with product-service innovation as the dependent variable and the multiple discriminant model for the classification of firms into innovative and non-innovative classes. They consider as a surprise the fact that it is a weak correlate of product-service innovation ($r = 0.23$, $a = 12.33\%$) and assume that in combination with the other common variables it becomes a good predictor. Kim et al (1993) report a highly significant positive association between R&D intensity, considered by them a strategic factor, and technological innovation, although R&D intensity does not enter as a predictor in their discriminant model.

Most firms (64%) in the sample of the INNOCYP survey have some R&D activity although a substantial proportion (36%) have no R&D. The majority spend less than 2% of their sales turnover on it. For the vast majority of firms there is no separate R&D department and to be precise one should speak of various types of development rather than research in the Cyprus context. The case study material suggests that Cypriot firms make substantial efforts to improve their products, adapt formulations to local needs and substitute foreign with locally available raw materials or more frequently raw materials from alternative lower cost sources. They also adapt imported machinery and equipment and sometimes construct locally their machinery, usually with the help of local machine workshops. They also use extensively the factory as a laboratory (Leonard-Barton, 1991). Production trials are probably the most important form of development efforts in Cyprus since many firms do not have well equipped laboratories or the required specialized personnel for carrying out extensive tests before the actual production trial.

Similarly firms which employ a higher *number of scientists and engineers* are higher in innovativeness (H3f). This variable does not enter however the multiple regression model. Kim et al (1993) have similarly found that professionalization (defined as the level of professional knowledge of organizational members) a concept related to, but far from identical with, the employment of scientists and engineers, is positively associated with technological innovation and a predictor in discriminant analysis between innovative and non-innovative firms.

On the contrary Khan et al (1989) have found a <u>negative</u> coefficient for technocratization (broadly equivalent to the employment of scientists and engineers) in their multiple regression model mentioned above. Their explanation for this <u>surprising</u> finding is that "in small firms, an emphasis on highly trained engineers and scientists on the staff appears to be less necessary for successful innovation than something as straightforward as risk-taking" (p. 192) (See also Section 2.4.4 for criticism of this statement.)

In large countries and for relatively large firms the number of scientists and engineers directly involved in R&D is used in innovation studies ; such a measure would not be very meaningful in the Cyprus context. Here, as mentioned above, separate R&D departments are very rare and technical people are usually responsible for many tasks e.g. quality control, production planning and supervision in addition to new product development or machinery adaptation.

The employment of scientists and engineers increases the firm's openness to new ideas and new technology. Their personal links with higher education institutions and their professional associations and individual colleagues are important for technological information input. Similar arguments are put forward by Roper, 1995 for graduate staff in general but are equally, if not more, valid for scientists and engineers. According to Miller and Friesen, 1984 p. 158 "Scientists and engineers possess the knowledge and training that often make them most capable and motivated to discover new products and processes." The case study material further suggests that if the owner/manager of the firm has a technical background this fact increases the chances that the firm will appreciate and pursue innovation.

Firms which use more *sources of technological information* and make higher use of them tend to be more innovative (H3h), therefore environmental scanning seems to be a positive factor for innovation. Apart from correlation analysis this hypothesis was also supported by the fact that the relative variable is among the predictor variables of the multiple regression model and enters also in the multiple discriminant model. The case study material suggests that proactive innovators actively seek technological information from many sources and maintain contacts for fast access to such information.

Kim et al (1993) have similarly found that environmental scanning for ideas of technological innovation, technological information etc., which they consider a strategic factor, has a highly significant association with technological innovation. It is also a predictor in their discriminant model between innovative and non-innovative SME.

Although suppliers are mentioned in INNOCYP survey as the top ranking source of technological information, business contacts abroad e.g. with firms in the same sector and visits to trade exhibitions abroad are also very important sources. Cypriot managers keep close contacts in Europe and visit regularly the important trade fairs of their industry. They are broadly aware of developments in their field. Licensers are an important source of technical information for 37% of firms. Technical consultants are a rather minor source of technical information mentioned by only 20% of firms.

Firms with higher levels of *cooperation with technology providers* (universities, technical institutes etc.) are higher in innovativeness (H3i). There is, however, in absolute terms, a low level of cooperation of Cypriot firms especially with universities and other academic centres and a somewhat higher one with testing centres. The variable measuring the extent of cooperation is a predictor of innovativeness in the multiple regression model and it is among the variables of the multiple discrimination model.

Rothwell and Dodgson (1991) have found that external technology linkages are positively associated with technological innovation. Kim et al (1993) consider building of external technological linkages as part of the strategic efforts of the firm and have found it as a significant predictor of technological innovation, although not a predictor in their discriminant model.

Gemuenden et al (1992) report that what they call "technological interweavement" is important for innovation success. They have found, through both bivariate and multivariate analyses, for a sample of German manufacturing companies that:
"close contacts with lead users, cooperations with universities and research institutes as well as R&D cooperations with other companies, all show a highly significant influence on technological innovation success" (ibid., p.372).

Some of the reasons of the low cooperation with technology providers as they come out from case research are the cost, the distance from foreign sources, the lack of suitable local specialized technical centres and a belief that all the technical information needed can be obtained from suppliers or licensers at no or minimal extra cost. Lack of previous experience and tradition are also some of the reasons according to material from interviews (Section 5.2.7) e.g. discussions with a pioneer professor of chemistry in the local university who had a disappointing response in his efforts to cooperate on research issues with the local industry. The limited demand for technological services is a usual situation in developing countries as also Lall et al (1994) report for Ghana.

A substantial proportion of firms i.e. one third of them (34%) admit that they get no feedback from customers during development and before launch of a new product. This is an alarming sign in view of the importance of the involvement of customers in new product innovation as suggested by the literature (Cooper, 1984). It should be kept in mind, however, that a significant proportion of firms sell products to final consumers rather than other firms. Most studies (e.g. Von Hippel, 1988) refer to the involvement of industrial/institutional users in innovation. Even in consumer goods industries customer perceptions and suggestions should be taken into account early in the design phase of new product development e. g through consumer panels (Cooper 1984).

Use of innovation management tools, for example new product project management techniques, technology audits, and technology forecasting, is very limited as revealed by the case study research. Some use is made of simple financial evaluation such as payback period and net present value methods by the more sophisticated firms. The importance of learning, especially of its technological variant was frequently mentioned particularly in the proactive innovators group and specific actions were aiming at its promotion.

There is a medium level ($r = 0.39$ $p = 0.000$) correlation between innovativeness and *performance* of the firm (H6). Roper (1995) in a comparative study of product innovation in three countries (Germany, UK and Ireland) has found a strong positive association between innovation and output (sales turnover) growth; although mixed results for the relation of innovation to employment growth. Deshpande et al (1993) have found a positive correlation of organizational innovativeness with performance in Japanese firms. Gemuenden et al (1992) in the above mentioned study also have found that technological innovation success influences commercial innovation success which then positively affects the growth of sales. Manu and Sriram (1996), in contrast, have found that both product and process innovators exhibit poor financial performance, while former pioneers have superior performance on various financial measures, but not on market share growth.

The direction of causation is not however at all clear, i.e. whether it is innovation that leads to performance or highly successful firms have the means to innovate. Actually in the multiple regression analysis, performance is one of the important predictors of innovativenes. Performance is also the best discriminating variable between innovators/non-innovators in the multiple discriminant model. It is possible that highly successful firms in terms of growth and profitability can afford the human and material resources that are necessary for innovation success. The latter further contributes to their profitability and growth in a virtuous cycle.

The type of study that measures innovativeness and performance at the same time period is not suitable to find about the effects of innovativeness on performance (There is usually a three or more years lag before results of innovative actions start to affect performance). Even when the time lag is taken into account in a suitable research design, it is difficult to isolate the effects of innovative actions from other factors (market, strategic etc.) which affect the performance of firms).

6. 2. 3. Meso-Level /Environmental Characteristics

The *intensity of competition* does not seem to be correlated to innovativeness (H4a). This is a surprising finding taking into account the results of reported research in the literature as detailed below. Cypriot firms probably tend to use other measures e.g. cost cutting, marketing techniques etc. to defend against strong competition rather than innovate. This explanation is reinforced by the fact that the majority of O/M believe that price competition (81%) in their sector is strong or very strong, and 66% believe the same for competition in distribution against only 40% stating that product development competition is strong or very strong in their sector. It is interesting that the STRATOS, 1990 research project among European SME has also shown that the most intensive type of competition is price competition.

Kimberly and Evanisco (1981) on the contrary have found that environmental hostility (indicating the degree of competition the firm faces in the market) tends to increase the likelihood of innovation adoption by the firm. Kim et al (1993) have found a highly significant positive association between environmental hostility and technological innovation, although this variable is not a predictor in their discriminant model.

The number of competitors is an indication of the degree of concentration in particular industries, although an additional measure like the market share held by the three largest firms in the industry would be needed for a proper evaluation. Almost half of the firms have more than 5 competitors and a very small minority of 3% mentioned that they have no competitor.

Innovativeness and *rate of environmental change* as perceived by managers are correlated (H4b) as also reported in the literature (Burns and Stalker, 1961/Miller and Friesen, 1982). Kim et al (1993) have found environmental dynamism (indicating how frequently elements in the environment are changing) as highly significantly correlated to technological innovation, although not a predictor in their discriminant model.

It is interesting to note that firms had not noticed major changes in the business environment (only one third mentioned major to critical change in technology and competitors' behaviour), although the three years before 1995 was a period of significant change especially regarding import penetration and difficulties in export markets.

Innovativeness and importance of *external barriers* as perceived by the entrepreneur have a low, not statistically significant, correlation in contrast to hypothesis H5. The reason may be that innovative firms although facing important barriers tend to find ways to overcome them, while non-innovative firms which do not make serious efforts to innovate tend to underestimate (or not be aware of) the pitfalls/problems associated with innovation in the Cyprus context. Similarly Garsombke, 1989 reports that low technology firms in his sample saw fewer barriers to technology, while high technology users were more cognizant of external and internal barriers.

The importance of barriers does not seem to induce firms to develop their networking relationships (at least the horizontal ones). No correlation was found between the corresponding variables. The literature suggests that firms facing barriers to innovation, especially SME, tend to use network relationships to overcome these barriers, for example Malerba (1992) and Biemans (1992). In Cyprus firms are probably using mainly their vertical network relationships as explained above.

It is interesting to note that two of the top five external barriers as ranked by the Cypriot owners/managers (i.e. financing of innovation by banks and shortage of skilled labour) are broadly similar to two of the top five barriers as summarized by Piatier (1984) for a study that covered eight (8) industrialized countries of the then European Economic Community (Table No. 6.1). The role of government is also common, although in EEC it was mainly the regulation aspects (norms and standards) that were emphasized. In Cyprus venture capital companies are practically absent. In a small country like Cyprus innovation is largely incremental and therefore 'too easy to copy'. There is therefore a major issue of "the appropriability of returns to innovation" (Teece, 1986) i.e. the extent to which innovations can be protected from competition. Fast introduction of new products to markets and secrecy are some of the ways of protection against innovation copying.

Table No. : 6.1 External Innovation Barriers

Top five barriers in INNOCYP research	Top five barriers in EEC Piater(1984)
1. Innovation too easy to copy	**Effect of education and training upon employment in enterprises**
2. Governmental bureaucracy	*Effect of action by banks upon the financing of innovation*
3. Lack of Government assistance	Effect of action by venture capital companies upon the financing of innovation
4. **Shortage of skilled labour**	Norms and standards-product controls-effect upon the manufacture of new products
5. *Bank policies on credit*	Norms and standards-product controls in other Community countries; action on exports to those countries.

The main factors from factor analysis of the attitudes of O/M on the importance of external barriers were identified as:

- Government market regulation policies
- Problems with inputs especially physical ones, labour and finance
- Access to technology providers
- Government environment, labour and consumer protection policies

These underlying constructs have remarkable similarities to the top ranking barriers. Government policies have a central place in the managerial preoccupations. There is an ambivalent position against government action. Over 50% of the firms do not feel any government supportive measures and the majority consider the current innovation measures as inadequate. Most firms (68%) mentioned that Government Industrial Policy did not affect their decision to adopt new technology. These results differ from the results of the STRATOS project which reports that 54.9% of the SME perceive government interference, in a supporting sense, (against 45.7% in our sample). Giving incentives was the most important role of Government in STRATOS research, while for Cypriot firms it was the import/export policy. The latter refers mainly to import protection as revealed by the case study material. 'Government market regulation policies' was mentioned above as a factor derived from the analysis of barriers perceptions of Cypriot managers. Government's role as the guardian of the market system was the second most important type of the roles of Government in STRATOS project, while its role as customer/promoter was the first.

A lot of the discussion during the case studies interviews was coming back again and again to government action and especially inaction. The role of government and its policies have a special significance for the firms in a small developing country and this is a basic difference with firms in industrialized countries. This issue is further considered below in Section 6.2.4.

Regarding the *internal barriers* lack of time was the top ranking one, followed by inadequate R&D and related facilities within the firm and inadequate financial means. Cypriot owners/managers try to do as many tasks as possible within the firm themselves. This is understandable for micro-businesses and small firms, but it becomes a problem when the firm grows e.g. beyond the 50 employees. Fire-fighting and routine work then drives out planning for the future and concentration on future-related activities including innovation. Only the technically progressive firms realize the importance of having adequate testing equipment for both quality control and research and development for new products. Financing as a problem, especially for new product development, is a common complaint due to the attitude of commercial banks which insist on collateral. This is not the case for new machinery which is used as collateral, although it is a barrier for the improvement of old machines or local construction of them.

Innovativeness was also not found to vary substantially between *sectors* (H1). Therefore there are no clearly 'innovative' sectors. This is not a surprising finding for a developing country with mainly traditional manufacturing sectors, without substantial high technology sectors. According to the literature (e.g. Pavitt, 1991) technological change impacts differently on individual sectors with some sectors offering greater technological opportunities. This probably applies only to industrialized or large developing countries with a differentiated industry mix.

The *networking intensity* measured as the horizontal, within the sector, component of networking in this study, was not found to show greater variations between sectors as hypothesized than within each sector. Sectors as used in this research survey are broad-based (including several subsectors) and this fact may explain the rejection of H7.

It had been hypothesized that firms more integrated into networks are more innovative but apparently this was not confirmed in H8. Either the type of relationships that Cypriot firms enter are not directly relevant to innovative activities (but rather related to marketing, including pricing etc.) or non-innovators are equally active in networking. The alternative explanation is again that horizontal networking is not necessary for innovation in contrast to the vertical networking with suppliers and licensers.

According to the case research evidence proactive and reactive innovators are both medium to high networkers, but non-innovators tend to be isolators. The apparent contradiction with the above mentioned finding of the survey research is explained by the fact that the network measure in the survey research was related more to horizontal networking (within the sector), while in the case studies all networking activities, including the vertical type which is higher among innovators, were considered.

Past experience plays a major role in business cooperation and firms attach importance to links with other firms in their sector especially foreign ones. Over one third of firms consider important links with local firms in their sector. Most firms (77.9%) discuss the state of the industry with competitors, have relatively frequent contact with them and exchange materials and equipment.

Collaboration however in production, sales and especially product development among Cypriot firms of the same sector is very low. Only 20-30% of firms have such arrangements and in most cases the case study evidence suggests it is a limited form of subcontracting. Factor analysis of all responses related to the various aspects of networking including relationships with customers, suppliers, competitors, other firms (non-competitors) and technology providers has derived the following four factors:

1. Collaboration with local suppliers
2. Collaboration with local non-competitors
3. Cooperation with competitors
4. Technical cooperation with foreign technology providers and local/foreign firms

The above factors tend to suggest that owners/managers attach different significance to relationships with the various sets of probable collaborators. In other words networking is a multidimensional activity.

It is noteworthy that firms have long term relations with foreign as well as local suppliers especially the former, and 43% rate their relationships with local suppliers as less close in comparison to the relationships with foreign suppliers, against 33% more close. Many firms (64.3%) have close relations to foreign firms in their sector. Supply of technical information by foreign suppliers is very common and many firms stated that they receive extra services and facilities from their foreign suppliers which suggest close relationships. Interestingly enough only 26. 8% of firms mentioned supply of technological information as one among the three main factors influencing cooperation with main suppliers. (The three top ranking factors were price, quality and reliable delivery).

It seems that international networking is very important for local firms and a major source of technological information. Exchange of information with suppliers was actually the top ranking technology transfer mode mentioned by O/M. The case study material corroborates these finding. Although it is natural for firms in a small developing country to look abroad for technological resources, it appears that there is an over-dependence on suppliers on issues related to technological innovation which can have adverse effects on local technological efforts and the development of alternative sources of technology and of local innovation networks.

The case study material also suggests that, despite the extensive informal interaction of local firms and the exchange of information and materials, the actual formal (local) networks are not very common. Joint ventures, franchising or interlocking directorates are very limited and subcontracting is limited to few specialized tasks or more frequently to exploiting the sweat labour of micro-businesses for the production of standard parts e.g. in clothing.

The low degree of cooperation of local firms in product development or production can be explained by the low degree of differentiation of local firms i.e. low asymmetry in resources (including information and know-how) and the low complementarity of the resources controlled by different firms. The literature (e.g. Teece, 1986) suggests that the last two factors are predictors of network formation. Due to the above there is limited potential for economies of scale or scope through cooperation. This explanation based on the resource dependence theory clarifies also the observed higher degree of vertical i.e. across the supply chain inter-dependence against the low degree of horizontal interdependence (e.g. between firms of the same sector.)

An alternative explanation would involve the relatively low level of trust, as revealed by the case study material, in the transactions among local firms despite their frequent contacts and in many cases long-term relations.

Finally the networking intensity does not seem to affect the performance of firms. The two variables are not correlated. It seems that in the Cyprus context networking which is rather low, at least in terms of cooperation in product development, is not a major factor in the performance of firms and other factors e.g. market power etc. predominate.

6. 2. 4. The Macro-Level /NIP

The first two hypotheses, as formulated in Chapter 2, served mainly as the broad frame for the other more specific hypotheses. The nature of a small developing country, according to hypothesis No.1, affects innovativeness at the level of the firm. This hypothesis cannot, strictly speaking, be confirmed or rejected by the results of the current empirical research conducted within one country. Comparative research across several countries would be needed for its proper testing. Such research is beyond the means of a single researcher.

The results of the little available research and the opinions of academic experts in the literature, and indirectly the results of the current research, tend, however, to suggest that indeed the nature of the business environment in a small developing country and the deficiencies mentioned below affect the innovation climate and the innovation performance of the local firms. Chapter 3 on Cyprus presented the main features of the Cyprus business environment, while the characteristics of the firm and its owner/manager, as presented above in the current Chapter 6, supplement the picture with empirical details.

The findings in Cyprus can be projected, with due care, to other small developing countries providing a more realistic basis for policies at the state level and management of innovation at the level of the firm, as discussed below, than the prevailing models and prescriptions. These models and recommendations were developed in the context of large industrialized countries or large developing ones which face completely different innovation conditions.

Small developing countries offer a rich variety in terms of culture, institutions, technological capabilities, etc. and comparisons cannot be easily made. They share, however, a number of important characteristics arising from their small size, their colonial heritage, and from recent development efforts under the guidance of international bodies (e.g. the World Bank, IMF etc.).

Cyprus is an interesting case as a small country in an <u>intermediate</u> position between the newly industrializing small countries (Hong-Kong, Singapore etc.) and those with a very low GDP per capita. Some of the implications from a study of national innovation policy in Cyprus for other small countries are discussed below.

Hypothesis No. 2 states that the National Innovation Policy (NIP) particularly in the context of a small developing country, affects innovation at the level of the firm. This second hypothesis, could on the face of it, be tested by asking the owners/managers of firms whether NIP has influenced or not their innovation performance in the recent past. Several questions on the questionnaire tested directly and indirectly the reaction of O/M to government innovation related policies.

It appears that O/M do <u>not</u> consider NIP as an important factor affecting the innovativeness of their firms. For example on a multiple choice question, listing various ways of government influence and non-intervention, the majority of O/M (54%) selected the latter as their main response. Innovation measures especially new product subsidies and technical guidance were rated as grossly inadequate or inadequate by the vast majority of owners/managers [(83%) and (74%) respectively].

Cypriot managers are very skeptical about the effectiveness of Government industrial policies. The protected nature of the Cyprus economy (especially of the manufacturing sector) in the past has probably generated distorted expectations from government policies. The brief review of industrial policy in Cyprus has shown that it was fragmented and inconsistent over time. It has failed to pass the message that the manufacturing sector has to adapt to an open economy environment or shrink. A national innovation policy in the usual meaning of the term in industrialized countries was mainly absent in Cyprus till the end of the 1980's, while the emergent NIP in the 1990's is not yet fully developed.

On the other hand most owners/managers are pre-occupied with governmental industrial and other innovation related policies and have many complaints against and expectations from these policies. They agree, as mentioned in Section 6.2.1, with the statements that 'government should support introduction of new manufacturing technology' and 'government should have sector specific strategies'. Regarding barriers to innovation lack of government assistance is seen as a major barrier, but also governmental bureaucracy. Similarly at least three of the five factors arising from factor analysis of the attitudes of

O/M on the importance of external barriers to innovation are related to governmental policies as mentioned in Section 6.2.3.

The case study material is especially revealing in this respect and suggests that the majority of O/M admit that governmental policies have a major impact on the success of their firms. Most probably, however, proactive innovators, according to the case studies evidence, although they take advantage of NIP measures, they do not rely on them or wait for them in order to go ahead with innovation. When investing in new technology their motives are much more related to their own cost structures and export expansion strategies. Reactive innovators and non-innovators tend to turn more to government for the solution of their problems.

Therefore NIP indeed matters and influences innovation both directly and indirectly. The direct influence, as mentioned above, is the use that innovators make of the available infrastructure and innovation measures. As examples, the services of the Technology Institute, new product or new investment tax allowances and industrial training, can be mentioned. Regarding the indirect influences, the macroeconomic policies for example provide a stable investment climate, while the environmental and health protection policies push firms to introduce new technology and methods.

The argument here is that NIP not only matters, but it matters disproportionately more , in other words, much more than in industrialized countries. The argument of the importance of the state in small countries is well founded in the literature (Argenti et al, 1990/Johnson, 1988). The term NIP is probably a misnomer, the proper expression is innovation-related government policies, because NIP may convey the wrong impression that there is in place a well organized and functioning integrated national innovation policy. This is, as already explained , not the case, neither in Cyprus nor in several other small developing countries.

Cyprus shares with many of these other developing states a number of constraints in developing a proper NIP including:

- The lack of experience in policy making and application in science and technology based sectors.

- The relatively limited linkages between sectors of the economy and among firms of the same sector due to lack of complementarities, the current structure of the industry, etc. These limited formal linkages are in stark contrast to the dense, inter-personal networks of the owners of the mostly family-based firms and to their close contacts with foreign firms (as licensers, suppliers, etc.).
- The underdevelopment of privately funded research in the manufacturing sector.
- Cost disadvantages due to limited economies of scale and scope and the low level of industrial specialization.

The emergent NIP in Cyprus has some interesting lessons for other small developing countries. Firstly, good intentions aside, NIP implementation remains problematic. It is not just a matter of the capability of the Government to apply some grandiose plans. In Cyprus it is not a lack of ability on behalf of the civil servants, but rather a matter of conflicting embedded interests and political considerations which put constraints on NIP implementation.

The overall conclusion must be that the selection of the 'proper mix of tools' is not the end of NIP (as some economists may tend to view it), but rather that the process of its formulation and implementation is equally, if not more, important. Some suggestions for policy formulation and implementation are offered below in Section 6.5.3.

A NIP based on firm-level data (e.g. characteristics of SME owners, etc.) can have a greater, more practical impact in small developing countries rather than tools designed at the more abstract level of the macro-economy based on the experiences of larger industrialized countries (e.g. USA or Japan).

Finally it can be concluded that some state role as catalyst and facilitator of the upgrading process of industry is necessary in order to overcome the market or institutional inadequacies to which small developing countries are particularly prone.

6. 3 Limitations of the Innocyp Research Project

The research suffers from some obvious limitations:

I) Since the survey sample is not, strictly speaking, a random one, the results apply only to the sample of firms studied (and for the time-period during which the survey was conducted). The sample is, however, reasonably representative of the population of firms in the sectors under survey which can be practically equated to the Cyprus manufacturing industry, as discussed in Chapter 4, and the findings can be extrapolated to the manufacturing industry of Cyprus with the above reservations in mind. It is assumed that although the economic conditions in Cyprus are under change the main findings of the study preserve their value for management and policy practice, as well as for theory since the end of 1995. Generalizing the results of a study, derived from cross-sectional self-reported data restricted to companies of one country, to other countries must be undertaken with care as also noted by Avlonitis and al, 1994.

II) This type of research (cross-sectional) can only establish correlation between variables ; causality can not be implied. Also the cross-sectional nature of the data limits us to an analysis of correlations among contemporaneous variables. It was also not possible to include all variables mentioned in the literature in the antecedents model. Some of the omitted variables may be of unexpected importance.

III) Industrial sector differences may influence the results in non-obvious ways.

IV) There may be a bias due to having collected the data from a single key respondent the owner/manager (as usual in this type of empirical surveys). O/M are however knowledgeable key informants abut innovation management (as per previous research). Multiple informants are typically used in an in-depth analysis of a few firms.

V) There is also the risk of common method bias especially for innovativeness and those of the predictors e.g. performance based on subjective measures since the evaluation in both cases is made by the same respondent. As a safeguard the correlation of the summated scale measures with relatively more objective indicators was established in Chapter 4 to ascertain convergent validity.

The work on *case studies* has also a number of limitations. The recall of events related to innovation and networks by the owner/manager introduces some form of bias, since post-rationalization, selective memory etc. may present a different picture of what happened. Innovation may be presented as a linear, well planned rational process, while it was actually a chaotic stop-go process. The use of relatively recent examples and the involvement of the researcher in long-term relationships with the case firms counteracts this type of bias to some extent.

The single respondent as a source of bias has also been mentioned above for the survey research. It is assumed however that in the small and medium size firms the O/M has a 'helicopter view' of the total activities of the firm and is actually involved in the innovation activities of the firm. The occasional discussions with scientists and engineers and other executives counteracts some of this type of bias.

The study is not truly longitudinal. The time of study should have been extended to two/three years or even more in order to claim that it is truly longitudinal. However the type of innovation projects (mainly incremental innovation) are such that they do not extend to long time periods.

The sample of cases was a theoretical one and can not claim to be statistically representative of the whole population. Finally the analysis of findings has its own limitations, since it is beyond the researcher's time resources to make full use of the mass of qualitative data obtained. This is however a typical situation in case study research. All conclusions have to be interpreted, therefore, with the above sources of possible bias in mind.

6. 4 Conclusions about the Research Problem

The main factors which affect innovativeness in SME in Cyprus, as identified by the survey research, and shown in the multiple regression analysis are all organizational characteristics. They include strategy, 'research and development intensity', overall performance of the firm, extent of technological information scanning, extent of cooperation with technology providers and size. It is noted that apart of size and performance the other relate directly or indirectly to strategy. All (apart probably of size in the short term) are under the, at least partial, control of the firm and it seems that innovativeness can be influenced by the attention to these strategic issues.

The above statement does not of course imply that individual and environmental variables are unimportant. They probably affect organizational characteristics, and through them innovativeness, as indicated by the case study research and further discussed below. It should not also be forgotten that 65% (100 - 35) of the variance of innovativeness is not explained by the variables in the multiple regression model.

Although owner characteristics are not among the main factors as they have been determined in the multiple regression and multiple discriminant analysis models they are still very important. Some of them e.g. education, cosmopolitanism and age are positively correlated to innovativeness and case study research indicates that in small firms strategy is defined to a considerable extent by the values, abilities and personality of the owner/manager. He or she is the main actor in the innovation act.

The case study material confirmed that Cypriot managers in the innovative firms are directly involved in both the initiation and implementation phases of innovation and that they use mainly informal methods, their personal and social networks and personal interaction in innovation management. There are, however major deficiencies in the use of sophisticated innovation management tools.

The case study research has further confirmed the existence of clearly differentiated behaviour patterns among firms regarding innovation. The categories of proactive innovators, reactive innovators and non-innovators can be used within the context of small developing countries with some further subdivision of the main categories and adaptation of the definitions of proactive and reactive ones to the realities of small countries. Managerial capabilities, internal technological resources (skills, knowledge of engineers and scientists obtained through gradual learning processes) and resources of the network which the firm has developed explain to a considerable extent the differences in innovation behaviour of firms. It should be noted that the most important dimensions of the network are vertical and international relationships rather than horizontal and local.

It can thus be said that the sets of individual, organizational and environmental variables (in the latter networks and Governmental policy can be included) interact in a complex way and affect innovativeness. These variables eventually affect also the performance of the firm. Performance was shown to be positively correlated to innovativeness although this association is *not* proof of causation. Performance is also not necessarily influenced *through* innovativeness e.g. size may have a direct effect on performance, while performance may have direct effects on some of the variables mentioned above. Innovativeness possibly influences some of the assumingly antecedent variables in a latter phase of the firm's life cycle. The inadequacies of a static simplified model such as the antecedents model are obvious.

The resource-based perspective has been proved useful, as a theoretical base, in the study and research of innovation in SME. This issue is further developed below in Section 6.5.1.

6. 5 Implications for Innovation Theory/Policy and Practice

6.5.1 Implications for Innovation Theory

An attempt was made in this study to test a mid-range theoretical model specifying sets of variables that influence innovativeness in the context of small developing countries where it had not been tested so far. The antecedents model is similar to those used in previous studies in both industrialized and large developing countries.

The SME network model can be considered as a higher level version of the antecedents model and a more comprehensive model, in other words, while the antecedents model is the perspective from within the SME and can be considered as a partial view of the innovation situation, the network model is the helicopter view from outside and above SME, focusing on it as being in the centre of a network field. Secondly, the network model can serve as a framework for data collection, for both surveys and case studies, as well as a blueprint for visualization of the innovation process as it really occurs at the small enterprise level.

The antecedents model is in principle a contingency model based on sets of factors and their interactive effects under various circumstances. It assumes the strategic adaptation perspective i.e. that managers have, within certain limits, the choice to influence certain of the variables by adapting the strategy and structure of the firm to fit with certain environmental conditions. The ways of adaptation are described by the resource dependence view which is discussed in the following. This approach is in contrast for example to the population ecology view which assumes that the environment pre-selects the types of firms which will survive leaving managers little, if any, chance to maneuver (Hannan and Freeman, 1977).

Important environmental dimensions not covered in previous studies on antecedents were those of networking, the effect of national innovation policy and the perception of barriers. The structural variables aspect which had received much attention in previous studies was played down for reasons explained in the methodology section. This survey based research was complemented with case studies to clarify some of the relationships and give additional insights by observation of firms in their natural settings.

The adapted antecedents model proved in general valid for the case of small developing countries. Attention to the differentiated meaning of the constructs in some cases e.g. that of R&D intensity was drawn to avoid improper comparisons. The different potency of the explanatory variables in the settings of small developing countries was pointed out. Small countries are not miniatures of the large ones (as small firms are not small copies of the large firms) and their peculiarities have to be reflected in a model of innovation adapted to their realities. Small firms in such counties are main actors in the market scene (i.e. not restricted to market niches). They face a number of important barriers to innovation. The barriers refer to resource deficiencies and environmental obstacles as perceived by the managers themselves. The perception of the environment and uncertainties connected to it are important since it is the 'enacted environment' that matters in managerial action (Weick, 1979 as cited in Kitchell,1995).

The owner/manager and strategies devised and applied by him as well as government policies are the relatively most important influential factors for innovativeness. In contrast to that models of innovation focusing on large firms in the context of industrialized countries are pre-occupied with organizational issues which include structural arrangements and inter-functional cooperation, but also with internal politics and power games and their effect on innovation strategy formulation and implementation.

Firms were classified into innovation strategy groups according to qualitative data and the identification of the real cases with the ideal patterns was reasonably good. The classification reinforced the argument that levels of innovativeness are determined by specific configurations of contextual, strategic, structural and process variables. These sets of variables are interacting and cluster together forming integrated wholes. In other words innovation requires the alignment of various internal and external factors. These conclusions agree with the theory of configurations of Miller D. and Friesen (1982) and their empirical research, as well as, the results of research of others e.g. Miller R. and Blais (1992).

The resource dependence theory provides some theoretical reasons why such types or configurations exist. The basic argument is that firms through a proper strategy accumulate over time knowledge-based resources within the firm (e.g. technological resources like R&D capabilities, experienced scientists and engineers) and complementary resources through networking with other organizations which enable them to innovate. The inclusion of time dimension is consistent with the evolutionary theory of Nelson and Winter (1982).

The study moved from the individual (O/M) to the firm (micro-) to the meso-level (networking and sectoral aspects) and finally the macro-level (Governmental policies). This multi-level approach has been suggested as necessary for the study of the complicated and multi-dimensional phenomenon of innovation (Hillebrand et al, 1994).

The resource dependent theoretical perspective combined with the configurational view provided the theoretical background for the discussion of the empirical findings and the placement of the largely empirical model in a theoretical framework. An integrated theory of innovation, if at all feasible, is however a distant target and testing out of mid range theories in new settings with efforts to place the findings in some theoretical frame is probably adequate at this stage.

6.5.2 Implications for Methodology

The research indicated how insights gained from quantitative and qualitative data can enrich one another. Statistically significant results of the survey research were supplemented by qualitative data to make them more credible, to explain them in their context and clarify some measurement problems or explain counterintuitive results. The case studies added some insights into the causal mechanisms behind the correlations found in the quantitative analysis. The triangulation of data has increased the validity of the analysis.

Survey research alone can not identify the actual inner or interpersonal transactions that bring about the relationships within an organization and across organizations during the innovation process as also Romano (1990) has noted. Only qualitative case study analysis can explore the complex human aspects of innovation, drawing in the experience of participants in their own terms, and provide a rich description for a better understanding of the problems. Such a multi-paradigm approach as increasingly used in innovation research (Kitchell, 1995) will hopefully lead to more valid cumulative results.

6. 5.3 Implications for Policy and Practice

Implications of the research for managers and recommendations to improve the innovation management at the level of the firm are discussed first, then implications for the National Innovation Policy are presented. The implications and suggestions are based on two assumptions:

1. Past innovators will continue to be innovative in the future (otherwise their characteristics and actions can not serve as models for others).
2. Managers and policy-makers are interested in the present and future, while the survey and case research (as most other research in the literature) refer to the past.

The research is then a useful guide for future action only if there is no technological paradigm shift which makes past practices obsolete. This seems a reasonable assumption for small developing countries, although not necessarily for the industrialized ones.

While the results refer to Cyprus the implications can by analogy be extended to other developing countries especially small ones. Cyprus is in an intermediate position among developed and developing countries with a relatively high GDP per capita and can serve as a model for other small countries which are trying to improve their economic situation. The findings have therefore some implications for management in the context of such developing countries.

Implications for managers. The most important factors as revealed by the multivariate analysis include several factors under the control of managers e.g. technological resources within the firm and use of a variety of external sources. The role of strategy is essential. This means that before anything else managers have to realize the importance of innovation for growth and eventually survival of their firms in an increasingly competitive environment. This is essential because people have a tendency to continue to do things in the same way as in the past hoping that past success will continue in the future. Only the sustained efforts of the top manager can overcome these natural inertia forces and tap the creativity and innovation potential of employees and co-workers.

The planned firm strategy should aim at enlarging the network of relationships of the firm in specific dimensions most appropriate to the firm. Since networking requires valuable time and commitment of resources pre-assessment of the expected benefits and costs combined with past experience should guide managers in their decisions.

Relationships with customers is an important aspect of networking. Many firms tend to ignore their importance as a source of innovation ideas and the effect of their continuous involvement in the innovation process on innovation success. Their full utilization implies commitment and resources allocated to technical customer service and management of the relationships with particularly innovative customers who might anticipate market trends and requirements.

Success in innovation requires the coordination of a large number of influential factors and investment in suitable resource combinations. This resource base can not be built overnight it takes considerable time and effort. Human resources are a major part of innovation resources. The central role of the owner/manager in the innovation process in small firms implies that management development of the O/M him- or herself is the first step. It should be accompanied with the managerial and professional development of the other staff and especially scientists and engineers. Investment in physical resources includes not only technologically advanced production equipment, but also scientific instrumentation for testing and development.

Most managers in the survey firms tend to have a mentality of treating technology as a 'know how' resource tradable in open markets as other resources e.g. capital or labour. The most successful among them have gradually realized that this is frequently not the case, even for the relatively mature technologies needed in small developing countries, and have invested in know-why development. A change in mentality will be needed for the majority of managers.

Knowledge and application of formal methods of innovation project management and of innovation evaluation is, as revealed by the case study research, rather limited. Managers can improve their knowledge of new product development techniques, and technology assessment methods through seminars, books etc.

The revealed innovation success factors have also implications for the managers of firms in developed countries as exporters of goods and technology to developing countries. This applies for example to managers who try to select licensees for relatively technologically sophisticated products or joint venture partners in developing countries. Their criteria of selection in such cases should include information on the characteristics of the owners/managers of the target firms, evidence on their strategic planning and indicators of commitment to innovation such as R&D expenditure and numbers of scientists and engineers employed. Since the emphasis of the study is on the developing countries themselves, and how their firms can improve their innovation records, the implications for developed countries are not discussed any further. Table 6.2 below summarizes an action list for managers.

Table No. : 6. 2 - Action list for managers

1. Realize that innovation is a necessity for survival , not a luxury.
2. Decide on objectives for the future and plan action accordingly
3. Fit innovation in the overall plan
4. Build a technological base within the firm with special attention to human resources
5. Plan learning for yourself and staff and develop know-why capabilities
6. Plan and manage networking activities making use of existing personal networks
7. Start familiarization with formal innovation tools

Implications for the National innovation Policy. Given the importance of the manufacturing sector for a balanced growth of the economy, and the special importance of Governmental policies in a small developing country, a number of measures have to be taken in the frame of an integrated policy. These measures will help the manufacturing industry to address at least some of its problems. A small country has to overcome the liabilities of smallness in order to improve its position in the international division of production.

A national innovation policy in the context of a small developing country should be formulated with three sets of guidelines:

- The international best practice as currently applied in the industrialized countries and summarized in the literature e.g. in Dodgson and Bessant (1996).
- The peculiar conditions connected to smallness and the state of underdevelopment.
- The particular conditions prevailing in the specific country as revealed by innovation research at the level of the firm.

In view of the above the need for *selectivity* makes the formulation and implementation of NIP a complicated matter. Only some principles and general suggestions can be offered here based on the literature and especially the results of this research. The first principle is that of active participation of industrial firms' owners/managers (through their associations) in all stages both in the formulation and implementation of NIP, while the second is the agreement of all concerned on clear and feasible targets. One of the main targets should be to increase the technological capabilities of industrial firms, as a first step of improving the innovation capabilities. The overall aim should be an integrated, consistent and consensual NIP.

The research has revealed a number of barriers to innovation as perceived by the managers. Action is needed for the removal of these barriers and further research is probably required to examine them in more detail. Policy makers frequently concentrate on 'objective' barriers as reported in the literature for other countries or as perceived by them rather than by managers in the Cyprus business environment. The research has also revealed some weaknesses in the socioeconomic context for example the problem of financing new product development, or local construction of machinery, the shortage of specialized technical labour and weaknesses in the supply of technical services.

Based on the results of the research some specific recommendations are made. The main issues on which action is needed are summarized in Table 6.3.

- Measures to stimulate industry to increase its investment in research, development and innovation are required. For example public purchasing of local products based on high quality standards and where appropriate innovative features rather than the lowest price, as is the practice now. Grants, instead of the ineffective tax allowances, for R&D expenditure are needed and especially for the employment of qualified scientists and engineers.

- Support to the local machinery work-shops and the local equipment suppliers in order to help them in their technological upgrading.
- Incentives for cooperation in production among the local machinery suppliers as a priority and more generally among firms in each sector.
- While the recently announced formation of a research council for the coordination of the research in all sectors of the economy is useful, the formation of a technology transfer council is proposed here. The latter will aim to promote the diffusion of advanced manufacturing technologies, including materials technology, and is probably much more relevant for the promotion of innovation in the local industry of a small country.
- The technology transfer council may be part of the existing Technology Institute or a separate organization. It should create contacts with universities and research organizations in order to assist private firms in practical terms with technology familiarization, transfer and exploitation. The technology transfer council should be focusing, as already mentioned, on the so called 'transfer sciences' such as CAD, CAM and related production technologies (Dodgson and Bessant, 1996).
- One of the major tasks of this council will be not just to improve the local technology know-how, but to help towards the building-up of 'know-why' i.e. deep knowledge of the technologies and their applications for potential local improvements and adaptation to the small scale and the needs of the local industry.
- Promotion of a proper innovation climate valuing enterprise, quality and initiative for change. This is connected to the promotion of a learning culture among local firms. The message should be clear that innovation is a matter of time and investment requiring long horizons and hard work rather than emphasis on short-term easy profits.
- Education of local managers on the importance of innovation, its types and the formal innovation tools.

A specific policy towards small firms in the Cyprus context (as discussed in Ch.3) would mainly mean a policy for the micro-businesses (with less than 10 employees). While a small firm policy is a side issue for the present work, which is not specifically dealing with the problems of micro-businesses, it seems that micro-businesses need more than larger firms special support for innovation and special communication mechanisms about the available incentives and technical up-grading schemes.

Table No. : 6. 3 Issues for Government Policy Action

1.	Formation of a technology transfer council
2.	Measures to promote industrial investment in research, development and innovation.
3.	Support of the local machinery and equipment industry and industrial services firms.
4.	Attention to the important issue of finance for innovation, since lack of investment capital is among the top five barriers.
5.	Improvement of the availability of skilled labour especially at the specialized worker and the technician level.
6.	Coordination of innovation related public services.
7.	Mechanisms to communicate incentives to small and micro-businesses.
8.	Education of owners/managers on the importance of innovation and formal innovation tools.
9.	Establishment of innovation parks.

6. 6 Implications and Suggestions for Further Research

The above research is among the first steps in the study of innovation management in the context of small developing countries. Extension of this or similar type research to other small developing countries will add to the knowledge base and compare and contrast the present findings to research results in other environments. The accumulation of research in this area will increase its generalizability. It can also be extended to include organizational innovations e.g. the spreading of Japanese management techniques.

Another study could be directed more to the informal sector i.e. the micro-enterprises which form the vast majority of firms. Their innovation record is probably not impressive, but there even small innovations can increase their growth and survival rates with major implications for the small country economy.

With hindsight there are possibilities to improve the research design. Some examples of refinements are the following:

- Use of more objective measures of innovativeness (incorporating a measure of the novelty dimension).
- Use of more sophisticated measures of network activity which would reflect its multiple aspects.
- Getting data on proactive /reactive innovation strategy which will permit a statistical analysis of the behavioural characteristics of these two groups of firms by e.g. logistic regression in a survey type research.
- Use of more sophisticated research designs for example path analysis to study the interconnection of a limited number of the most important factors e.g. selected antecedents, innovativeness and performance.

Alternatively the research could be a truly longitudinal one in the process tradition. This does not exclude the mixed approach (i.e. combination of qualitative and quantitative data which as argued above has a number of advantages).

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APPENDIX A

QUESTIONNAIRE - INNOCYP PROJECT

Introductory Statement

Purpose of the Research

This is a survey on the management of technological innovation in small and medium size firms of the manufacturing sector in Cyprus.

Confidentiality

This research is strictly confidential and is being carried out for academic purposes only. Whatever you say will be treated with absolute confidence and nobody will be able to identify any individual or firm in the final report.

No need to answer

The Questions try to avoid asking for sensitive or confidential information but, of course, if you do not wish to answer any particular question please feel free to move to the next one.

Report/Findings

A summary of findings will be supplied to you at the end of the study so that you can see how your experiences and views compare with those of other SME owners/managers.

SECTION 1. NATURE OF BUSINESS

Q.1 How many people does your firm employ? (Average of 'full time equivalent' number of working persons in the last 12 months period.)

a. Less than 10
b. 10 - 20
c. 21 - 50
d. 51 - 100
e. More than 100

Q.2 How 'old' is your firm.

a. Less than 3 years old
b. 3 - 5
c. 6 - 10
d. 11 - 20
e. More than 20

Q.3 In what sector of economic activity is your firm engaged? (Main Activity)

a. Chemicals and related industries (Paints,plastics, detergents, cosmetics).
b. Food
c. Metal - working
d. Furniture
e. Textiles
f. Other (Please specify)

Q.4 What is your approximate annual sales turnover (in Cyprus Pounds):

a. Less than 100.000
b. 100.000 - 500.000
c. 501.000 - 1000.000
d. 1001.000 - 5000.000
e. over 5000.000

Q.5 Have sales in the last three years been:

a. Increasing
b. More or less the same
c. Decreasing

Q.6 Has the number of employees in your firm in the last three years been:

a. Increasing
b. Approximately the same
c. Decreasing

Q.7 How many competitors do you have (approximately) in your main market?

a. None
b. Five or less
c. 6 - 10
d. More than 10
e. Don't know

Q.8 How intensive is competition in your main market with regard to:

		Very Weak	Weak	Medium	Strong	Very strong
a.	Prices	1	2	3	4	5
b.	Product Development	1	2	3	4	5
c.	Advertising	1	2	3	4	5
d.	Product Quality	1	2	3	4	5
e.	Distribution	1	2	3	4	5

Q.9 Do you have a formal (written - down) long term strategy?

a. Yes
b. No

Q.10 Does your long term strategy include the following? (Please tick all relevant).

a. Market Development.
b. Technology Development.
c. Export Development.
d. Human Resources Development.

Q.11 How Important are the following types of new technology in order to compete in your business sector?

	Completely Unimportant	Unimp	Neither Important Nor Unimp.	Import.	Very Import.
a. Automated Machinery	1	2	3	4	5
b. Computer Aided Design	1	2	3	4	5
c. New Materials Technology	1	2	3	4	5
d. New Packaging Technology	1	2	3	4	5
e. Other (Please specify)	1	2	3	4	5

Q.12 How much change <u>relevant to your business</u> has there been in the following areas during the last <u>three</u> years?

<u>Areas</u>	No change	Minor change	Some change	Major change	Critical change
a. Distribution Patterns	1	2	3	4	5
b. Financial/Credit Markets	1	2	3	4	5
c. Technology	1	2	3	4	5
d. Raw Materials/Energy	1	2	3	4	5
e. Human Resources	1	2	3	4	5
f. Competitors' behaviour	1	2	3	4	5
g. Legislation	1	2	3	4	5

Q.13. How far ahead would you say you can predict demand for your products?

a. Less than 1 month
b. 1 - 3 months
c. More than 3 months but less than six months.
d. More than 6 months but less than a year.
e. More than 1 year.

Q.14. Are you exporting part of your production? If yes what is the percentage of your export sales?

a. Less than 10%
b. 10 - 30 %
c. 31 - 50%
d. Over 50%

Q.15 Has the percentage of export sales in the last three years?

a. Increased.
b. Remained the same.
c. Decreased

Q.16. Is the quality of exported products compared to that of the products sold to the local market?

a. The same
b. Higher
c. Lower

SECTION 2 - INNOVATIVE ACTIVITIES

Q.17. How many qualified scientists / engineers (university graduates) do you employ?

a. None
b. 1 - 3
c. 4 - 10
d. More than 10

Q.18. What is the predominant type of innovation in your firm? Please select one only.

a. Product Innovation (including Packaging)
b. Process Innovation
c. Other type of Innovation (e.g. Organizational, New Distribution Channels, Information Technology etc)
d. None of the above

Q.19. What is the level of Research and Development Expenditure in your firm as a percentage of sales?

a. No R & D
b. Less than 2%
c. 2 - 5%
d. More than 5%
e. I don't know

Q.20. How many new products has your company introduced in the last three years?

a. None
b. 1 - 3
c. 4 - 10
d. More than 10

Q.21. What percentage constitute today your new products (introduced in the last three years) of:

A. Total Sales
a. Less than 5%
b. 5 - 10%
c. More than 10%

Q.22. What percentage constitute today your new products (introduced in the last three years) of:

B. Total Profits
a. Less than 5%
b. 5 - 10%
c. More than 10%

Q.23. In a new product introduction how often is your company:

	Never				Always
a. First-to-market with new product	1	2	3	4	5
b.Later entrant in established, but still growing markets	1	2	3	4	5
c. Entrant in mature, stable markets	1	2	3	4	5
d. At the cutting edge of technological innovation	1	2	3	4	5

Q.24. Who decides the direction of the new product development process in your company?

a. Nobody systematically
b. A functional head (Marketing, Production, R & D etc)
c. The Managing Director
d. A Management Committee.
e. Other (Please specify)

Q.25. Do you get feedback from your customers during development and before launch of a new product?

a. No
b. Yes If yes in what ways? Please specify.

Q.26. Please indicate the significance of the following sources of technological information for your firm.

	Insignificant	Slightly Signif.	Signif.	Very Signif.	Crucial
a. Business Contacts in Cyprus	1	2	3	4	5
b. Business Contacts abroad	1	2	3	4	5
c. Licensors/Principals	1	2	3	4	5
d. Suppliers	1	2	3	4	5
e. Consultants	1	2	3	4	5
f. Visits to trade exhibitions	1	2	3	4	5
g. Technical magazines/Literature	1	2	3	4	5
h. Other (Please Specify)	1	2	3	4	5

Q.27. Have you introduced any new forms of Advanced Manufacturing Technology (e.g. Computer Aided Design, Computer Aided Manufacturing, Industrial Robots etc) in your firm in the last 3 years?

a. No b. Yes If yes, please specify.

Q.28. What were your three main objectives in introducing the above forms of AMT (Advanced Manufacturing Technology).

a. Reduction of production costs
b. Tax incentives / Subsidies
c. Improvement of product quality
d. Reduction of reliance on labour.
e. To match similar competition moves.
f. Other (Please specify)

Q.29. To what extent has AMT fulfilled your initial objectives?

a. Not at all
b. Somewhat
c. Much
d. Very Much

Q.30. Have you installed new processing technology in the last three years?

a Yes
b No

Q.31. If yes, was it?

a. New to Industry
b. New to Cyprus
c. New to your firm.

Q.32. Has Government Policy affected your decision to adopt new technology?

a. No
b. Yes

Q.33. If yes in what ways? Please choose <u>all</u> relevant ones.

a. Taxation Considerations
b. Subsidies
c. Compulsory License for New Machinery
d. Price Controls
e. Other (Please specify)

Q.34. What are the <u>three</u> main modes of Technology Transfer from external sources to your firm?

a. Licensing
b. Embodied in new machinery purchased
c. Joint Venture
d. Hiring of experienced personnel
e. Information Exchange (Getting Information from suppliers etc.)
f. Other (Please specify)

Q.35. Have you modified/adapted to your needs, in any way, imported machinery in the last three years?

a. No
b. Yes If yes how?
I. With your own personnel.
II. With the help of other local firms
III. With the help of the original machinery supplier.

Q.36. Have you ordered locally any machinery or equipment for your plant in the last three years?

a. No
b. Yes

Q.37. If the answer to Q.36 was Yes, how would you rate the local machinery / equipment supplier in terms of the following:

	Very Bad	Bad	Neutral	Good	Very Good
a. Technical Adequacy	1	2	3	4	5
b. Prompt Delivery	1	2	3	4	5
c. After Sales Service (e.g. maintenance etc)	1	2	3	4	5
d. Technical Advice	1	2	3	4	5

Q.38 Who has designed the locally constructed machine / equipment?

a. Your own personnel
b. The local supplier
c. Design was imitated / copied from blue prints of imported machinery.

Q.39 Are you cooperating with some of the following? Please indicate the <u>frequency</u> of cooperation.

	No	Infrequently	Occasionally	Frequently	Very Frequently
a. Foreign Universities/ Technical Institutes	1	2	3	4	5
b. Foreign Research & Development Institutes	1	2	3	4	5
c. Foreign testing centres	1	2	3	4	5
d. Local testing centres	1	2	3	4	5
e. The local University/ Higher Technical Institute	1	2	3	4	5

Q.40 What types of technical services do you need which are not offered locally?

a. Testing
b. Calibration (of instruments etc)
c. Contract Research
d. Supply of spare parts
e. Machinery / Equipment Repair
f. Other (Please specify)

Q.41 How do you usually finance the development of New Products?

a. with own funds
b. Bank loans
c. Bank overdraft
d. Other (please specify)

Q.42 How do you usually finance the Purchase of New Machinery?

a. With own funds
b. Bank loans
c. Bank Overdraft
d. Other (Please specify)

Q.43 Relative to our firm's largest competitor we have:

	Less	Same	Greater
Profitability	1	2	3
Size	1	2	3
Market Share	1	2	3
Growth	1	2	3

SECTION 3 - NETWORK LINKAGES

3a. LINKS WITH FIRMS IN OWN SECTOR

Q.44 What are the three main factors influencing your business cooperation with other firms in your sector.

a. Family ties.
b. Past Experience
c. Social relationships (e.g. friendship)
d. Origin from same village/town
e. Professional attitude of competitors.

Q.45 How important are links with other businesses in the same sector?

	Not Imp.	Slightly Imp.	Neither Important nor Unimportant	Imp.	Very Import.
a. Locally based firms (within 30 kilometres from your base)	1	2	3	4	5
b. Cypriot firms in other towns	1	2	3	4	5
c. Foreign firms	1	2	3	4	5

Q.46 Do Government Policies affect your relationships with other firms in your sector?

a. Yes b. No If yes in what ways?

Q.47 Do you collaborate with other firms in your sector in the following activities and how intensive is this collaboration?

	No Involvement	Slight	Medium	Close	Very Close
a. Production	1	2	3	4	5
b. Sales and Physical Distribution	1	2	3	4	5
c. Product Development and Technical Research	1	2	3	4	5

Q.48 Do you discuss the state of the industry with your competitors?

a. Yes, b. No

Q.49 If yes how often

a. once a week, b. once a month c. every few months

Q.50 What are the main topics of discussion?

a. Trade Information, b. Prices, c. Technical Information d. Other (Please specify)

Q.51 How good would you say relations are between local businesses in your sector?

a. No relations with competitors
b. Business like relations
c. Friendly relations

Q.52 Do you ever lend materials or equipment to other firms in your sector?

a. Yes b. No

Q.53 Do you pass information about your experiences with new technology and other changes to other people in the industry?

a. No b. Yes If yes who to?

Q.54 Are there occasions when you have kept technological information to yourself because you feel it would give you a business advantage?

o Yes o No If yes, how often?

SECTION 3 NETWORK LINKAGES

3b. LINKS WITH SUPPLIERS / OTHER FIRMS (NOT DIRECT COMPETITORS)

Q.55 Do you have long - term relationships with your main foreign suppliers?

a. Yes b. No

Q.56 Do you have long - term relationships with your main local suppliers?

a. Yes b. No

Q.57 How would you rate your relationships with local firms in other sectors (e.g. your materials / equipment etc suppliers)

	Poor	Fair	Good	Very Good	Excellent
a. Price Setting	1	2	3	4	5
b. Delivery	1	2	3	4	5
c. Quality	1	2	3	4	5
d. Technical Advice	1	2	3	4	5
e. After Sales Service	1	2	3	4	5

Q.58 Do you ever lend materials or equipment to other local firms who are not your competitors?

a. Yes b. No

Q.59 What are the three main factors influencing your cooperation with your main suppliers?

a. Price
b. Quality
c. Reliable Delivery
d. Supply of technological information
e. Credit facilities
f. Other (Please specify)

Q.60 How good are relationships with your main foreign suppliers? Please tick all relevant from the following services/facilities provided by them:

a. Supply of formulations, technical information etc.
b. Supply of complementary materials not produced by the supplier himself.
c. Testing of samples of your products in supplier's laboratories.
d. Free-of-charge trouble-shooting by supplier's technical specialists/representatives.
e. Training of your personnel in suppliers laboratories, technical centres or factories.
f. Advice on future technological opportunities/threats.
g. Other (Please specify).

Q.61 Are your relationships with your local suppliers in comparison to your relationships with foreign suppliers:

a. Equally Close
b. Less Close
c. More Close

Q.62 Do you maintain close relationships with foreign firms in your sector?

a. Yes b. No

SECTION 4 CHARACTERISTICS OF OWNER / MANAGER

Q.63 What is your education level?

a. Primary School
b. High School
c. Trade Qualifications (e.g. technician)
d. College / Higher Technical School
e. University (first degree)
f. Postgraduate (MSc / PhD)

Q.64 Please indicate your age group.

a. 20 - 30
b. 31 - 40
c. 41 - 50
d. 51 - 60
e. Over 60

Q.65 In how many businesses had you worked before starting your own business?

a. None
b. 1 - 3
c. More than three

Q.66 How often do you travel abroad for business?

a. 1 - 3 trips per year
b. 4 - 10 trips per year
c. More than 10 trips per year.

Q.67 Are you a member in any of the following?

Please indicate all relevant.

a. Professional Bodies
b. Business Associations
c. Social Clubs (e.g. Rotary etc)
d. Government Committees
e. Political Parties
f. Other (Please specify)

Q.68 Please indicate your personal attitude to the following statements:

	Strongly Disagree	Disagree	No opinion	Agree	Strongly Agree
I. Business should take preference over family life	1	2	3	4	5
II. Small firms should use the same management methods as large firms	1	2	3	4	5
III. The Manager should promote innovation even at the expense of the firm's independence.	1	2	3	4	5
IV. Managers should plan rather than follow their intuition	1	2	3	4	5
V. Those who carry out day - to - day decisions should have a hand in making them.	1	2	3	4	5
VI. Firms should cooperate with other firms to be more effective even at the expense of some independence.	1	2	3	4	5
VII. A small business manager should concentrate more on management issues rather than technical issues.	1	2	3	4	5
VIII. For a small business manager it is more important to have been trained 'on the job' than to have had an academic education (e.g. university).	1	2	3	4	5
IX. Small business managers should be directly responsible for personnel management.	1	2	3	4	5

Q.68 (continued) Please indicate your personal attitude to the following statements:

	Strongly Disagree	Disagree	No opinion	Agree	Strongly Agree
X. A manager should encourage innovation even if it is risky, if considered useful to the firm.	1	2	3	4	5
XI. Managers should have an active role in local and national politics.	1	2	3	4	5
XII. The Government should do more to encourage the introduction of new manufacturing technologies.	1	2	3	4	5
XIII. Small businesses should cooperate more rather than practise cut-throat competition.	1	2	3	4	5
XIV. I try to read articles about new technology in my trade journals.	1	2	3	4	5
XV. I often buy new equipment to stay ahead of my competitors.	1	2	3	4	5
XVI. The Government should do more in organising training of technicians.	1	2	3	4	5
XVII. Sector specific strategies are needed rather than a universal Governmental Industrial Strategy.	1	2	3	4	5
XVIII. Small firms should be supported by a special Governmental Policy.	1	2	3	4	5
XIX. Less Bureaucracy and minimal Governmental Interference is what small firms really need.	1	2	3	4	5

Q.69 What importance do you attach to each of the following personal aims and objectives?

	No Importance	Low importance	Medium Importance	High Importance	Very High Importance
I Personal Independence (= working for yourself and organizing your own firm)	1	2	3	4	5
II Building up a business for your family	1	2	3	4	5
III Making high quality products	1	2	3	4	5
IV Financial Independence	1	2	3	4	5
V Playing an active role in society	1	2	3	4	5
VI Attractive Life Style	1	2	3	4	5
VII High social status	1	2	3	4	5
VIII Job Satisfaction	1	2	3	4	5
IX Doing better than other business people	1	2	3	4	5
X High level of income	1	2	3	4	5
XI Self-fulfilment	1	2	3	4	5
XII Being a creative entrepreneur	1	2	3	4	5

SECTION 5. INNOVATION CLIMATE

Q.70 How does the Government intervene to help your industry? Please indicate all the relevant ways:

a. By being an important customer.
b. By giving subsidies
c. By regulating prices.
d. By laying down standards (e.g. product standards, safety standards etc).
e. By its import or export policy.
f. By tax regulations
g. By its Industrial Policy (e.g. specific plans to support your sector).
h. Other (Please specify).
i. No Government interference

Q.71 Generally how would you rate the current measures taken by the Cypriot Government for encouragement/support of technological innovation in your sector?

	Compl. Inad.	Inade quate	Neutral	Adeq.	Excell.
1. Research & Development (New Product) Subsidies	1	2	3	4	5
2. Tax reliefs	1	2	3	4	5
3. Low cost Loans	1	2	3	4	5
4. Technical Guidance	1	2	3	4	5

Q. 72 What additional measures of innovation support do you feel are necessary (for your sector)?

Q.73 To what extent are the following factors important as barriers in the adoption/ development of innovations?

	Not Applicable	Of little Importance	Important	Very Important
a. Shortage of skilled labour	1	2	3	4
b. Social Insurance Policy	1	2	3	4
c. Wages Policy	1	2	3	4
d. Policy on Patents and Licenses	1	2	3	4
e. Governmental Bureaucracy	1	2	3	4
f. Lack of Government assistance	1	2	3	4
g. Problems with inputs (Raw Materials & Components)	1	2	3	4
h. Policy on public contracts and government purchasing	1	2	3	4
i. Effect of technical standards on new products	1	2	3	4
j. Government Policy to assist small firms	1	2	3	4
k. Inadequate University Education of employees	1	2	3	4
l. Inadequate Technical Training of employees	1	2	3	4
m. Foreign Trade Policy (Import tariffs).	1	2	3	4
n. Government Policies on Competition	1	2	3	4
o. Bank policies on credit	1	2	3	4
p. Lack of testing institutions	1	2	3	4
q. Limited access to Research Institutions	1	2	3	4
r. Short-term economic, monetary and financial policies.	1	2	3	4

Q 73 (continued) To what extent are the following factors important as barriers in the adoption/ development of innovations?

	Not Applicable	Of little Importance	Important	Very Important
s. Government's Health and Safety Policies	1	2	3	4
t. Government's environmental policy	1	2	3	4
u. Consumer Protection Policy	1	2	3	4
v. Lack of venture capital companies	1	2	3	4
w.Lack of opportunities for cooperation with other firms and technological institutions.	1	2	3	4
x.Lack of customer responsiveness to new products and processes.	1	2	3	4
y.Innovation too easy to copy	1	2	3	4

Q.74 What are the three most important internal (within your firm) barriers to innovation?

a. Lack of time (e.g. one man responsible for many tasks).
b. Lack of qualified managerial/technical personnel in your firm
c. Inadequate financial means
d. Resistance to change in the enterprise
e. Inadequate R&D, Design, Testing and other technical facilities within the firm.
f. Lack of a clear Technology Strategy.
g. Lack of motivation (e.g. high profitability with current product mix).
h. Lack of technological experience necessary for development of specific innovations.
i. Lack of information on markets
j. Pay-off period of innovation too long
k. Excessive perceived risk of innovation
l. Innovation costs hard to control
m. Other (Please specify)

Q.75 How do you see the <u>prospects</u> for your sector in the next three years?

a. Bad
b. Good
c. Excellent

Q.76 How does your firm intend to address these prospects?

a. Employ more (less) staff
b. Expand (restrict) product mix
c. Penetrate new markets
d. Other (Please specify).

Q.77 Does your enterprise <u>intent</u> to develop or introduce any technologically changed products or processes in the next three years?

a. Yes b. No

APPENDIX B

Survey Data Analysis

Table 1 Trend of Sales in the Last Three Years

Sales Trend	Increasing	Same	Decreasing
Count	78	48	14
Percentage %	55.7%	34.3%	10.0%

Table 2 Trend of Employment in the Last Three Years

Employment Trend	Increasing	Same	Decreasing
Count	44	67	29
Percentage %	31.4%	47.9%	20.7%

Table 3 Number of Competitors in the Main Market

Number of Competitors	None	Five or Less	6-10	More Than 10	Don't Know
Count	4	70	33	32	1
Percentage %	2.9%	50.0%	23.6%	22.9%	0.7%

Table 4 Intensity of Competition in the Main Market

Competition	Very Weak	Weak	Medium	Strong	Very Strong
Prices	0.7%	1.4%	17.1%	39.3%	41.4%
Product Development	6.4%	18.6%	34.3%	30.0%	10.0%
Advertising	26.4%	27.1%	21.4%	18.6%	5.7%
Product Quality	5.0%	17.9%	55.0%	16.4%	5.0%
Distribution	5.0%	6.4%	22.1%	32.9%	32.9%

Table 5 Existence of Formal (Written-Down) Long-Term Strategy

Strategy existence	Yes	No
	1.00	2.00
Count	42	98
%	30 %	70%

Table 6 Long-Term Strategy Components

Strategy Component	No	Yes
	0	1
Market Development	22.9%	77.1%
Technology Development	33.6%	66.4%
Export Development	49.3%	50.7%
Human Resources Development	70.7%	29.3%

Table 7 Importance of New Technology Types

New Technology Type	Completely Unimportant	Unimp.	Neither Important Nor Unimp.	Import.	Very Import.
	1	2	3	4	5
A. Automated Machinery	5.7%	5.7%	11.4%	42.1%	35.0%
B. Computer Aided Design	37.1%	15.0%	13.6%	16.45	17.9%
C. New Materials Technology	3.6%	8.6%	23.6%	49.3%	15.0%
D. New Packaging Technology	26.6%	12.2%	12.9%	22.3%	25.9%
E. Other (Please Specify)	-	-	-	2.1%	2.1%

Table 8 Change Relevant to Firm's Business in the Last Three Years

Areas	No Change	Minor Change	Some Change	Major Change	Critical Change
	1	2	3	4	5
A. Distribution Patterns	20.7%	25.0%	42.1%	9.3%	2.9%
B. Financial/Credit Markets	11.4%	20.0%	53.6%	11.4%	3.6%
C. Technology	4.3%	15.7%	45.7%	29.3%	5.0%
D. Raw Materials/Energy	5.7%	27.1%	37.1%	27.1%	2.9%
E. Human Resources	13.6%	47.1%	27.9%	11.6%	-
F. Competitors' Behaviour	7.1%	16.4%	40.7%	29.3%	6.45
G. Legislation	17.9%	31.4%	40.7%	6.4%	2.9%

Table 9 Demand Forecast

Demand Forecast	Less than 1 Month	1-3 Months	More than Three, but less than Six	6-12 Months	Over 12 Months
Count	11	35	57	25	12
Percentage %	7.9%	25.0%	40.7%	17.9%	8.6%

Table 10 Existence of Export Sales

Exports	Yes	No
	1	0
%	67.9%	32.1%

Table 11 Percentage of Export Sales

Export Sales	Percentage
None	31.4 %
Less than 10%	20.7%
10-30%	25.0%
31-50%	7.1%
Over 50%	15.7%

Table 12 Export Sales Trend in Last Three Years

Export Sales Trend	No Exports	Exports Increased	Exports the Same	Exports Decreased
Count	50	22	28	40
Percentage %	35.7%	15.7%	20.0%	28.6%

Table 13 Quality of Exported Versus Locally Sold Products

Exported Product Quality	No Exports	The Same	Higher	Lower
Count	50	80	3	7
Percentage %	35.7%	57.1%	2.1%	5.0%

Table 14 Number of Scientists and Engineers Employed

Scientists And Engineeers Employed	None	1-3	4-10	More than 10
Count	36	70	29	5
%	25.7%	50.0%	20.7%	3.6%

Table 15 Predominant Type of Innovation

Innovation Type	Product Innovation	Process Innovation	Other	None
Count	85	32	7	16
Percentage %	60.7%	22.9%	5.0%	11.4%

Table 16 Research and Development Expenditure as a Percentage of Sales

R&D Expenditure Level	No R&D	Less than 2%	2-5%	More than 5%
Count	51	57	19	13
%	36.4%	40.7%	13.6%	9.3%

Table 17 Number of New Products Introduced in the Last Three Years

New Products	None	1-3	4-10	More than 10
Count	13	45	60	22
%	9.3%	32.1%	42.9%	15.7%

Table 18 New Product Sales as a Percentage of Total Sales

New Product Sales	None	Les than 5%	5-10%	More than 10%
Count	10	29	39	61
Percentage %	7.2%	20.9 %	28.1%	43.9%

Table 19 New Product Profits as a Percentage of Total Profits

New Product Profits	None	Less than 5%	5-10%	More than 10%
Count	12	37	33	57
Percentage %	8.6%	26.6%	23.7%	41.0%

Table 20 New Product Innovation Behaviour

	Never				Always
	1	2	3	4	5
First-to-Market with New Product	6.4%	19.3%	28.6%	34.3%	11.4%
Later Entrant in Established, but Still Growing Markets	4.3%	12.1%	30.0%	48.6%	5.0%
Entrant in Mature, Stable Markets	8.6%	33.6%	33.6%	18.6%	5.7%
At the Cutting Edge of Technological Innovation	39.3%	30.0%	19.3%	10.0%	1.4%

Table 21 Main Decision Maker for New Product Development

Decision Maker	Nobody	Functional Head	Managing Director	Committee	Other
Count	4	10	59	66	-
Percentage %	2.9%	7.1%	42.1%	47.1%	-

Table 22 Feedback from Customers for New Product Development

Feedback	No	Yes
Count	47	93
Percentage %	33.6%	66.4%

Table 23 Significance of Sources of Technological Information for the Firm.

Sources of Technological Information	Insignificant	Slightly Signif.	Signif.	Very Signif.	Crucial
	1	2	3	4	5
Business Contacts in Cyprus	16.4%	44.3%	23.6%	12.1%	3.6%
Business Contacts Abroad	4.3%	8.6%	20.0%	43.6%	23.6%
Licensors/Principals	50.7%	12.1%	10.7%	14.3%	12.1%
Suppliers	1.4%	7.9%	22.1%	44.3%	24.3%
Consultants	52.1%	27.9%	12.9%	6.4%	0.7%
Visits to Trade Exhibitions	10.0%	7.1%	14.3%	39.3%	29.3%
Technical Magazines/Literature	7.9%	16.4%	22.1%	37.9%	15.7%
Other (Please Specify)					

Table 24 Introduction of Advanced Manufacturing Technology in the Last Three Years

Introduction of AMT	No	Yes
Count	95	45
Percentage %	67.9%	32.1%

Table 25 Types of AMT Introduced in the Last Three Years

AMT Type	None	CAD	CAM	Robots
Count	95	20	32	4
Percentage %	67.9%	14.3%	22.9%	2.9%

Table 26 Objectives in Adoption of Advanced Manufacturing Technology

Objective	Count	Percentage %
Reduction of Production Costs	45	32.1%
Tax Incentives/Subsidies	2	1.4%
Improvement of Product Quality	49	35.0%
Reduction of Reliance on Labour	40	28.6%
To Match Competition Moves	8	5.7%
Other	-	-

Table 27 Extent of Fullfilment of Objectives For AMT

Extent of Objective Fullfilment	Count	Percentage %
Not at All	2	2.5%
Somewhat	6	7.5%
Much	33	41.3%
Very Much	9	11.3%

Table 28 Introduction of New Process Technology in the Last Three Years

NPT Introduction	Yes	No
Count	91	48
Percentage %	65%	34.3%

Table 29 New Process Technology Type

NPT	None	New to Industry	New to Cyprus	New to the Firm
Count	48	10	38	44
Percentage %	34.3%	7.1%	27.1%	31.4%

Table 30 Government Policy Effect on the Adoption of New Technology

Gov. Policy Effect	No	Yes
Count	95	21
Percentage %	67.9%	15.0%

Table 31 Ways of Government Policy Effect on The Adoption of New Technology

Type of Policy	Yes	Percentage %
Taxation	4	10.0%
Subsidies	5	11.4%
License	1	2.9%
Price Controls	1	2.9%

Table 32 Technology Transfer Modes (from External Sources to the Firm)

Technology Transfer Mode	Percentage %
Licensing	31.9%
Embodied in New Machinery Purchased	61.4%
Joint Venture	44.4%
Hiring of Experienced Personnel	20.9%
Information Exchange (Getting Information from Suppliers etc.)	84.3%
Other (Please Specify)	8.3%

Table 33 Adaptation of Imported Machinery

Machinery Adaptation	No	Yes
Count	84	52
Percentage %	60,0%	37.1%

Table 34 Modes of Adaptation of Imported Machinery

Adaptation Type	Count	Percentage %
With Own Personnel	34	24.3%
With Help of Local Firms	14	20.9%
With Help of Supplier	14	18.7%

Table 35 Local Purchase of Machinery

Local Purchase of Machinery	Yes	No
Percentage %	38%	62%

Table 36 Rating of Local Machinery Suppliers

	Very Bad	Bad	Neutral	Good	Very Good
	1	2	3	4	5
A. Technical Adequacy	-	-	5.7%	23.6%	5.0%
B. Prompt Delivery	1.4%	5.0%	14.3%	12.1%	1.4%
C. After Sales Service (e.g. Maintenance etc.)	-	2.1%	11.4%	17.1%	3.6%
D. Technical Advice	1.4%	0.7%	17.1%	12.9%	2.1%

Table 37 Designer of Locally Constructed Machinery

Designer	Count	Percentage %
Own Personnel	21	15.0%
Local Supplier	35	36.1%
Imitation	12	16.7%

Table 38 Frequency of Cooperation with Technology Providers

Cooperation	No	Infrequently	Occasionally	Frequently	Very Frequently
	1	2	3	4	5
A. Foreign Universities/ Technical Institutes	1.4%	81.4%	10.7%	5.0%	-
B. Foreign Research & Development Institutes	72.1%	15.7%	8.6%	3.6%	-
C. Foreign Testing Centres	64.3%	17.9%	12.1%	5.0%	0.7%
D. Local Testing Centres	61.4%	17.1%	17.1%	4.3%	-
E. The Local University/ Higher Technical Institute	77.9%	11.4%	10.0%	0.7%	-

Table 39 Types of Technical Services Needed Which are not Offered Locally

Type of Service	Count	Percentage %
Testing	77	55%
Calibration (of Instruments etc)	31	22.1%
Contract Research	17	18.5%
Supply of Spare Parts	75	53.6%
Machinery / Equipment Repair	76	54.3%
Other (Please Specify)	1	4.0%

Table 40 Modes of Financing New Products

Mode of Financing	Count	Percentage %
Own Funds	91	65%
Bank Loans	63	45.0%
Bank Overdraft	62	44.3%

Table 41 Modes of Financing New Machinery

Mode of Financing	Count	Percentage %
Own Funds	55	42.0%
Bank Loans	123	87.90%
Bank Overdraft	17	14.0%

Table 42 Performance against Largest Competitor

	Less	Same	Greater
	1	2	3
Profitability	30.7%	43.6%	25.7%
Size	54.3%	9.3%	36.4%
Market Share	50.7%	7.9%	41.4%
Growth	28.6%	25.0%	46.4%

Table 43 Factors Influencing Cooperation with Firms in the Same Sector

Factor	Count	Percentage %
Family Ties.	21	21.9%
Past Experience	101	72.1%
Social Relationships (e.g. Friendship)	73	59.3%
Origin from Same Village/Town	9	13.6%
Professional Attitude of Competitors	76	54.3%

Table 44 Importance of Links with Other Businesses in the Same Sector

	Not Important	Slightly Important	Neither Important Nor Unimportant	Important	Very Important
	1	2	3	4	5
Locally Based Firms (Within 30 Kilometres from your Base)	28.6%	10.0%	16.4%	32.1	10.7%
Cypriot Firms in Other Towns	31.4%	20.7%	14.3%	27.1	3.6%
Foreign Firms	22.9%	14.3%	7.1%	35.0	17.9%

Table 45 Government Policy Effect on the Relationships with Other Firms

Effect	Yes	No
Count	14	124
Percentage %	10%	88.6%

Table 46 Collaboration with Other Firms in the Same Sector

	No Involvement	Slight	Medium	Close	Very Close
	1	2	3	4	5
Production	67.9%	10.7%	14.3%	5.0%	2.1%
Sales and Physical Distribution	77.1%	14.3%	5.7%	2.9%	-
Product Development and Technical Research	80.0%	8.6%	7.1%	1.4%	2.9%

Table 47 Contacts with Competitors

Contacts	Yes	No
Count	109	30
Percentage %	77.9%	21.4%

Table 48 Frequency of Contacts with Competitors

Frequency	Count	Percentage %
Once a Week	12	8.6%
Once a Month	45	32.1%
Every Few Months	51	36.4%

Table 49 Main Discussion Topics with Competitors

Discussion Topics	Count	Percentage %
Trade Information	99	70.7%
Prices	91	65.0%
Technical Information	30	32.3%
Other	3	9.4%

Table 50 Relations between Local Firms

Relation Type	Count	Percentage %
None	22	15.7%
Business Like	103	73.6%
Friendly	12	8.6%

Table 51 Lending Materials / Equipment to Others

Lending	Yes	No
Count	82	58
Percentage %	58.6%	41.4%

Table 52 Sharing Technological Information with Others

Sharing	No	Yes
Count	99	41
Percentage %	70.7%	29.3%

Table 53 Keeping New Technology Information Secret

Keeping Secret N.T Information	Yes	No
Count	133	7
Percentage %	95.0%	5.0%

Table 54 Long Term Relations with Foreign Suppliers

Long Term Relations	Yes	No
Count	133	6
Percentage %	95.0%	4.3%

Table 55 Long Term Relations with Local Suppliers

Long Term Relations	Yes	No
Count	127	10
Percentage %	90.7%	7.1%

Table 56 Relationships with Local Firms in Other Sectors

	Poor	Fair	Good	Very Good	Excellent
	1	2	3	4	5
A. Price Setting	2.9%	28.6%	49.3%	18.6%	-
B. Delivery	1.4%	28.6%	46.4%	20.7%	2.9%
C. Quality	1.4%	18.6%	62.9%	15.0%	2.1%
D. Technical Advice	7.9%	51.4%	25.0%	14.3%	1.4%
E. After Sales Service	6.4%	33.6%	40.7%	17.9%	1.4 %

Table 57 Lending Materials / Equipment to Non-Competitors

Lending	Yes	No
Count	90	50
Percentage %	64.3%	35.7%

Table No.A58 Main Factors Influencing Cooperation with Suppliers

Factors	Count	Percentage %
Price	131	93.6%
Quality	118	84.3%
Reliable Delivery	90	64.3%
Supply of Technological Information	19	26.8%
Credit Facilities	57	43.2%
Other	2	6.7%

Table 59 Importance of Relationships with Main Foreign Suppliers

Type of Relationship	Count	Percentage %
Supply of Formulations, Technical Information etc.	134	95.7%
Supply of Complementary Materials not Produced by the Supplier Himself.	14	17.7%
Testing of Samples of your Products in Supplier's Laboratories.	53	41.1%
Free-of-Charge Trouble-Shooting by Supplier's Technical Specialists/Representatives.	34	31.5%
Training of Your Personnel in Suppliers Laboratories, Technical Centres or Factories.	69	55.2%
Advice on Future Technological Opportunities/Threats.	74	56.5%
Other	1	25.0%

Table 60 Closeness of Relationships With Local Vs Foreign Suppliers

Relation Type	Count	Percentage %
Equally Close	29	20.7%
Less Close	59	42.1%
More Close	46	32.9%

Table 61 Closeness of Relationships with Foreign Firms in Same Sector

Close Relation	Yes	No
Count	90	50
Percentage %	64.3%	35.7%

Table 62 Education Level of the Owner/Manager

Education Level	Percentage %
Primary School	2.9%
High School	14.3%
Trade Qualifications (e.g. Technician)	6.4%
College / Higher Technical School	11.4%
University (First Degree)	38.6%
Postgraduate (Msc / PhD)	26.4%

Table 63 Age of Owner/Manager

Age	Percentage %
20-30	7.1%
31-40	29.3%
41-50	42.1%
51-60	20.0%
Over 60	1.4%

Table 64 Number of Businesses the Owner/Manager Worked Before in

No of Businesses	Count	Percentage %
None	48	34.3%
One to Three	85	60.7%
More Than Three	7	5.0%

Table 65 Number of Business Trips of Owner/Manager

No of Travels	Count	Percentage %
None	4	2.9%
One to Three	73	52.1%
4-10	52	37.1%
More than 10	11	7.9%

Table 66 Membership of Social and Business Associations

Membership of :	Count	Percentage %
Professional Bodies	62	53.4%
Business Associations	100	71.4%
Social Clubs (e.g. Rotary etc.)	30	28.6%
Government Committees	18	40.9%
Political Parties	12	27.3%
Other	3	9.4%

Table 67 Personal Attitude Statements to Business Matters

Statement	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
	1	2	3	4	5
i. Business should take preference over family life	10.0%	52.1%	10.0%	25.7%	2.1%
ii. Small firms should use the same management methods as large firms	18.6%	47.9%	3.6%	25.7%	4.3%
iii. The manager should promote innovation even at the expense of the firm's independence.	7.9%	41.4%	17.9%	29.3%	3.6%
iv. Managers should plan rather than follow their intuition.	-	5.7%	7.9%	67.9%	18.6%
v. Those who carry out day - to - day decisions should have a hand in making them.	5.0%	34.3%	7.1%	42.1%	11.4%
vi.Firms should cooperate with other firms to be more effective even at the expense of some independence.	4.3%	27.9%	5.7%	54.3%	7.9%
vii. A small business manager should concentrate more on management issues rather than technical issues.	22.9%	45.0%	4.3%	25.7%	2.1%
viii. For a small business manager it is more important to have been trained 'on the job' than to have had an academic education (e.g.university).	12.1%	40.7%	2.9%	31.4%	12.9%

Table 67 Personal Attitude Statements to Business Matters (continued)

Statement	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
	1	2	3	4	5
ix. Small business managers should be directly responsible for personnel management.	0.7%	11.4%	4.3%	37.1%	46.4%
x. A manager should encourage innovation even if it is risky, if considered useful to the firm.	0.7%	21.4%	4.3%	55.0%	18.6%
xi. Managers should have an active role in local and national politics.	3.6%	52.5%	26.6%	15.1%	2.2%
xii. The government should do more to encourage the introduction of new manufacturing technologies.	-	-	3.6%	45.7%	50.7%
xiii. Small businesses should cooperate more rather than practise cut-throat competition.	-	5.7%	9.3%	60.7	24.3%
xiv. I try to read articles about new technology in my trade journals.	0.7%	10.0%	9.3%	40.7%	39.3%
xv. I often buy new equipment to stay ahead of my competitors.	2.1%	15.0%	11.4%	42.1%	29.3%
xvi. The government should do more in organising training of technicians.	-	2.1%	15.0%	50.7%	32.1%
xvii. Sector specific strategies are needed rather than a universal governmental industrial strategy.	-	-	8.6%	56.4%	35.0%

Table 67 Personal Attitude Statements to Business Matters (continued)

Statement	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
	1	2	3	4	5
xviii. Small firms should be supported by a special governmental policy.	-	15.0%	11.4%	42.9%	30.7%
xix. Less bureaucracy and minimal governmental interference is what small firms really need.	2.1%	15.7%	11.4%	46.4%	24.3%

Table 68 Importance Attached to Personal Aims and Objectives

Objective	No Importance	Low Importance	Medium Importance	High Importance	Very High Importance
	1	2	3	4	5
i. Personal independence (= working for yourself and organizing your own firm)	-	1.4%	19.3%	40%	39.3%
ii. Building up a business for your family	-	6.4%	28.6%	37.9%	27.1%
iii. Making high quality products	0.7%	4.3%	20.7%	40.0%	34.3%
iv. Financial independence	-	-	7.1%	67.9%	25.0%
v. Playing an active role in society	0.7%	18.6%	42.1%	27.1%	11.4%
vi. Attractive life style	5.7%	37.1%	37.1%	15.0%	5.0%
vii. High social status	7.9%	35.7%	28.6%	25.7%	2.1%
viii. Job satisfaction	-	-	12.9%	40.0%	47.1%
ix. Doing better than other business people	2.9%	11.4%	41.4%	26.4%	17.9%
x. High level of income	-	0.7%	28.6%	59.3%	11.4%
xi. Self-fulfilment	-	0.7%	10.0%	47.9%	41.4%
xii. Being a creative entrepreneur	-	2.9%	18.6%	40.0%	38.6%

Table 69 Government Policy Measures to Support Industry

Policy Measure	Percentage %
1. By being an important customer	22.9%
2. By giving subsidies	17.7%
3. By regulating prices.	8.8%
4. By laying down standards (e.g. product standards, safety standards etc.	30.7%
5. By its import or export policy.	32.1%
6. By tax regulations	25.0%
7. By its industrial policy (e.g. specific plans to support your sector).	22.7%
8. Other (please specify).	3.2%
9. No government interference	54.3%

Table 70 Rating of Government Innovation Support Measures

Support Measures	Compl. Inad.	Inadequate	Neutral	Adeq.	Excell.
·	1	2	3	4	5
1.Research & Development (New Product) Subsidies	45.0%	37.9%	13.6%	3.6%	-
2. Tax Reliefs	30.0%	39.3%	22.1%	8.6%	-
3. Low Cost Loans	43.6%	27.1%	24.3%	5.0%	-
4.Technical Guidance	38.6%	35.7%	19.3%	6.4%	-

Table 71 Importance of External Barrriers to Innovation

External Barrier	Not Applicable	Of Little Importance	Important	Very Important
	1	2	3	4
a. Shortage of skilled labour	5.0%	23.6%	50.0%	21.4%
b. Social insurance policy	64.3%	25.7%	7.9%	1.4%
c. Wages policy	45.7%	27.9%	20.0%	5.7%
d. Policy on patents and licenses	54.3%	27.9%	8.6%	9.3%
e. Governmental bureaucracy	2.9%	20.7%	58.6%	17.9%
f. Lack of government assistance	0.7%	25.7%	43.6%	29.3%
g. Problems with inputs (raw materials & components)	5.0%	48.6%	32.1%	14.3%
h. Policy on public contracts· and government purchasing	27.9%	33.6%	26.4%	12.1%
i. Effect of technical standards on new products	27.1%	43.6%	20.7%	8. 6%
j. Government policy to assist small firms	4.3%	40.7%	37.9%	17.1%
k. Inadequate university education of employees	34.3%	40.0%	19.3%	6.4%
l. Inadequate technical training of employees	6.4%	27.1%	50.0%	16.4%
m. Foreign trade policy (import tariffs).	10.7%	30.7%	33.6%	24.3%
n. Government policies on competition	25.0%	52.9%	12.9%	9.3%
o. Bank policies on credit	2.9%	25.7%	50.7%	20.7%
p. Lack of testing institutions	7.1%	22.1%	47.9%	22.9%

Table 71 Importance of External Barrriers to Innovation (continued)

External Barrriers	Not Applicable	Of Little Importance	Important	Very Important
q. Limited access to research institutions	16.4%	32.9%	34.3%	16.4%
r. Short-term economic, monetary and financial policies.	6.4%	61.4%	22.9%	9.3%
s. Government's health and safety policies	10.7%	38.6%	42.9%	7.9%
t.Government's environmental policy	16.4%	41.4%	30.0%	12.1%
u. Consumer protection policy	37.9%	44.3%	12.1%	5.7%
v. Lack of venture capital companies.	15.0%	57.1%	20.7%	7.1%
w.Lack of opportunities for cooperation with other firms and technological institutions.	9.3%	44.3%	37.1%	9.3%
x.Lack of customer responsiveness to new products and processes.	6.4%	35.7%	47.1%	10.7%
y.Innovation too easy to copy	4.3%	11.4%	45.0%	38.6%

Table 72 Internal (within the Firm) Barriers to Innovation

Internal barrier	Count	Percentage %
Lack of time (e.g. one man responsible for many tasks).	84	60.0%
Lack of qualified managerial/technical personnel in your firm	35	25.0%
Inadequate financial means	58	44.6%
Resistance to change in the enterprise	12	18.8%
Inadequate R&D, design, testing and other technical facilities within the firm.	72	51.4%
Lack of a clear technology strategy.	8	13.8%
Lack of motivation (e.g. high profitability with current product mix).	10	16.1%
Lack of technological experience necessary for development of specific innovations.	34	24.3%
Lack of information on markets	17	25.8%
Pay-off period of innovation too long	38	41.3%
Excessive perceived risk of innovation	19	27.1%
Innovation costs hard to control	13	32.5%
Other (please specify)	1	

Table 73 Evaluation of Prospects for Own Sector

Prospects	Count	Percentage %
Bad	28	20.0%
Good	93	66.4%
Excellent	19	13.6%

Table 74 Modes of Response to Future Prospects

Modes of Response	Count	Percentage %
Employ more (less) staff	35	25.9%
Expand (restrict) product mix	97	69.3%
Penetrate new markets	86	61.4%
Other (please specify).	1	-

Table 75 Intention to Innovate in the Next Three Years

Intention	Yes	No
Count	104	74.3%
Percentage %	36	25.7%

Table No.76 Introduction of AMT by Sector (Contigency Table)

		Sector	Sector	Sector	Sector	Sector	Row Total
AMT INT		1	2	3	4	5	
1,0	Count	27	26	10	21	11	95
	Exp Val	20.4	20.4	20.4	17.0	17.0	67.9%
	Tot Pct	19.3%	18.6%	7.1%	7.9%	7.9%	
2,0	Count	3	4	20	4	14	45
	Exp Val	9.6	9.6	9.6	8.0	8.0	32.1%
	Tot Pct	2.1%	2.9%	14.3%	2.9%	10.0%	
	Column	30	30	30	25	25	140
	Total	21.4%	21.4%	21.4%	17.9%	17.9%	100%

Chi Square	Value	DF	Significance
Pearson	37.51454	4	0.00000
Likelihood Ratio	38.28736	4	0.00000
Linear - by -linear Association	11.97797	1	0.00054

Mimum Expected Frequency	8.036
Number of Missing Observations	0

Table No.77 Innovativeness (NPDINR) by Education Level (EDLEVR) (Contigency Table)

		EDLEVR	EDLEVR	EDLEVR	Row Total
NPDINR		1.0	2.0	3.0	
1.0	Count	24	17	10	51
	Exp Val	17.9	19.7	13.5	36.4%
	Tot Pct	17.1%	12.1%	7.1%	
2.0	Count	21	26	11	58
	Exp Val	20.3	22.4	15.3	41.4%
	Tot Pct	15.0%	18.6%	7.9%	
3.0	Count	4	11	16	31
	Exp Val	10.9	12.0	8.2	22.1%
	Tot Pct	2.9%	7.9%	11.4%	
	Column	49	54	37	140
	Total	35.0%	38.6%	26.4%	100%

Chi Square	Value	DF	Significance
Pearson	17.05532	4	0.00189
Likelihood Ratio	16.81756	4	0.00210
Linear - by -linear Association	12.19079	1	0.00048

Mimum Expected Frequency	8.193
Number of Missing Observations	0

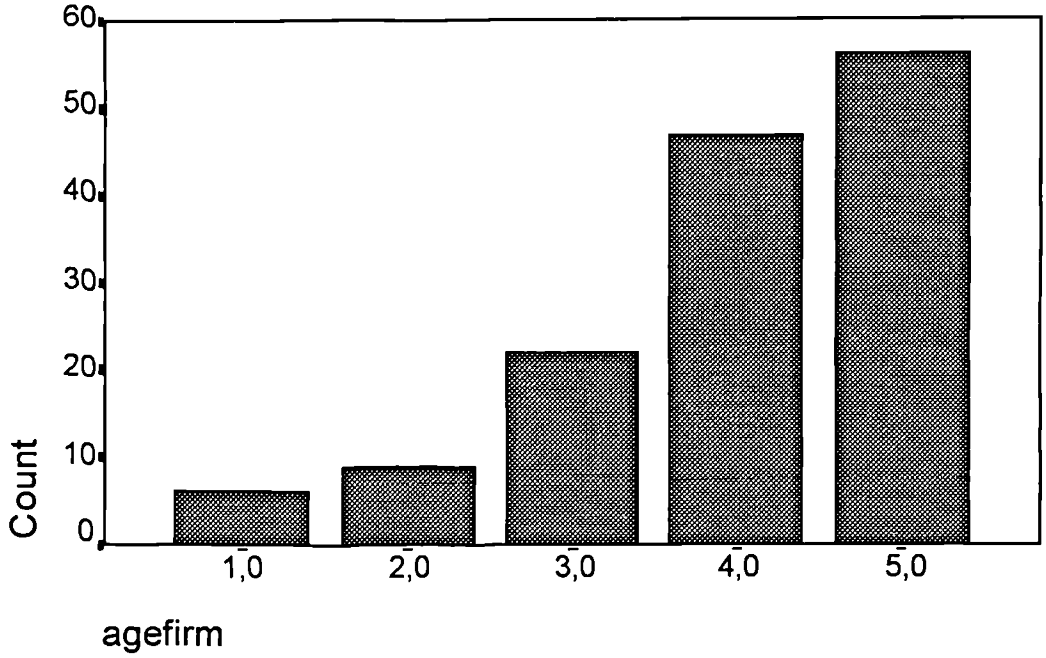


Chart No. 1 Distribution of the age of the sample firms

Category	Age Group
1,0	Less than three years old
2,0	3-5
3,0	6-10
4,0	11-20
5,0	More than 20

Size category	Percentage of firms
A (Less than 10)	21.4
B (10-20)	22.1
C (21-50)	24.3
D (51-100)	16.4
E (More than 100)	15.7

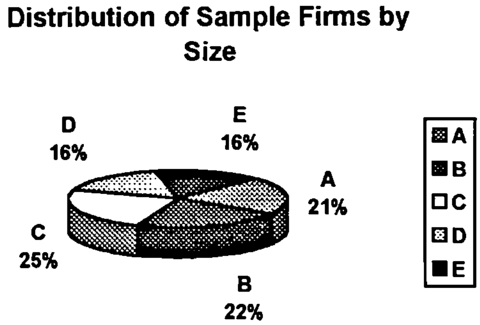
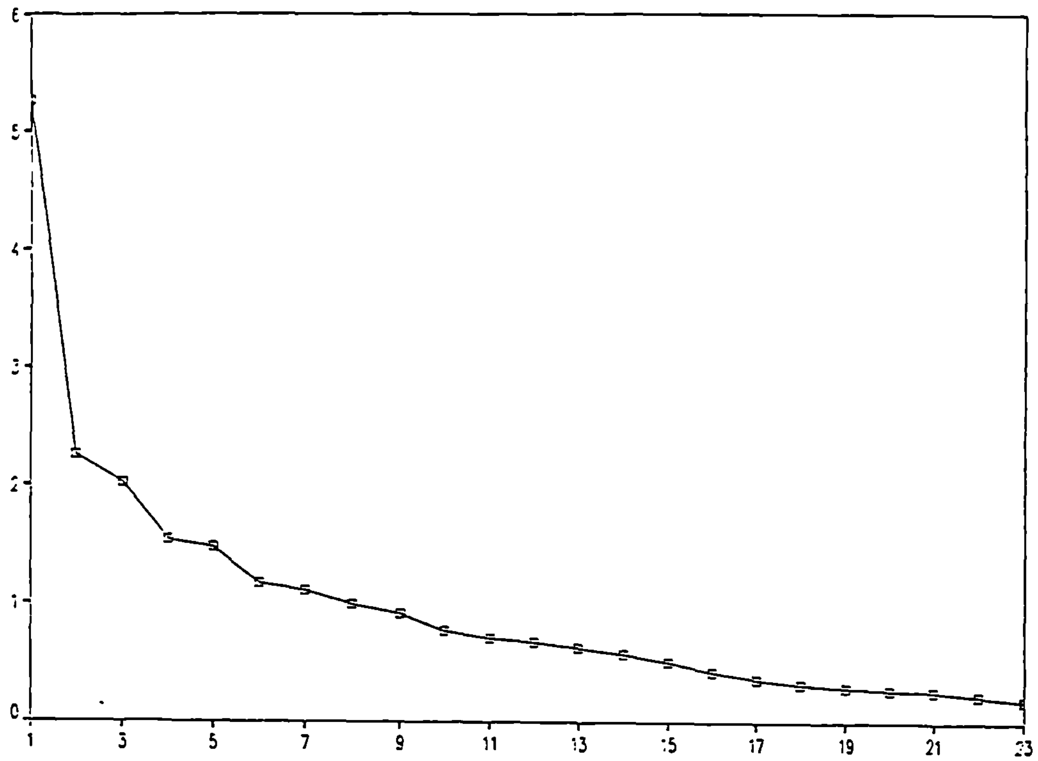


Chart No.2 Distribution of Sample Firms by Size

Eigenvalue by Factor Number



<u>Chart No.3 Factor Scree Plot I - Factor Analysis of External Barrier Perceptions of O/M</u>

Eigenvalue by Factor Number

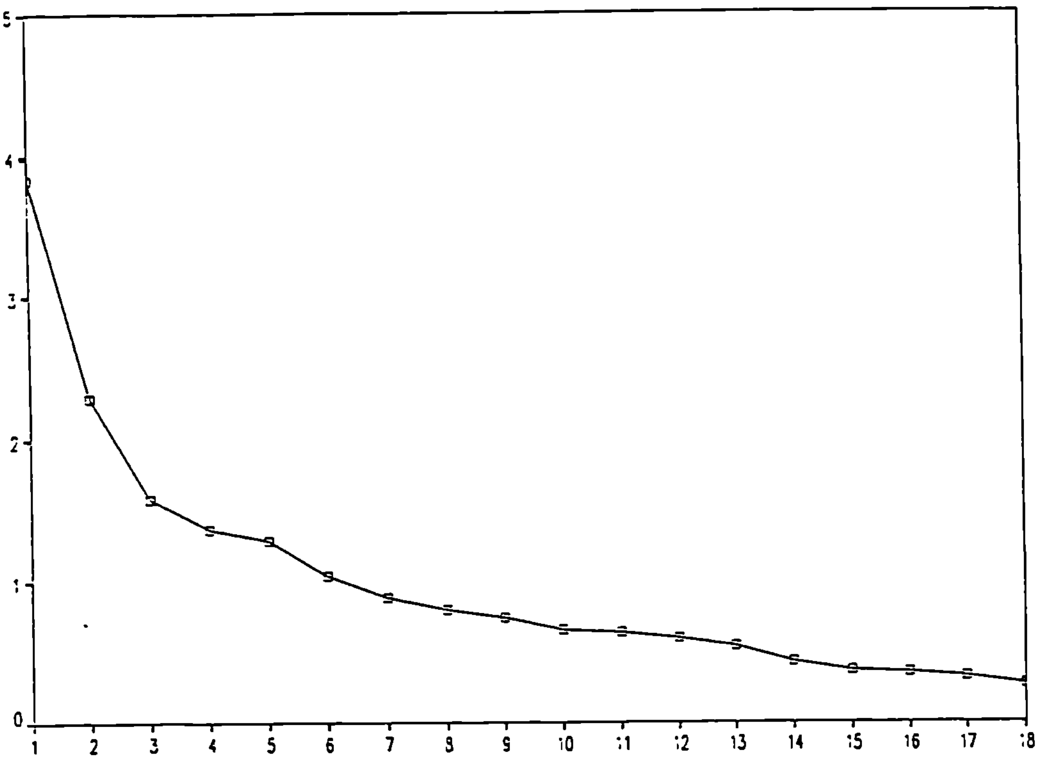


Chart No.4 Factor Scree Plot II - Factor Analvsis of Personal Statements of O/M

Eigenvalue by Factor Number

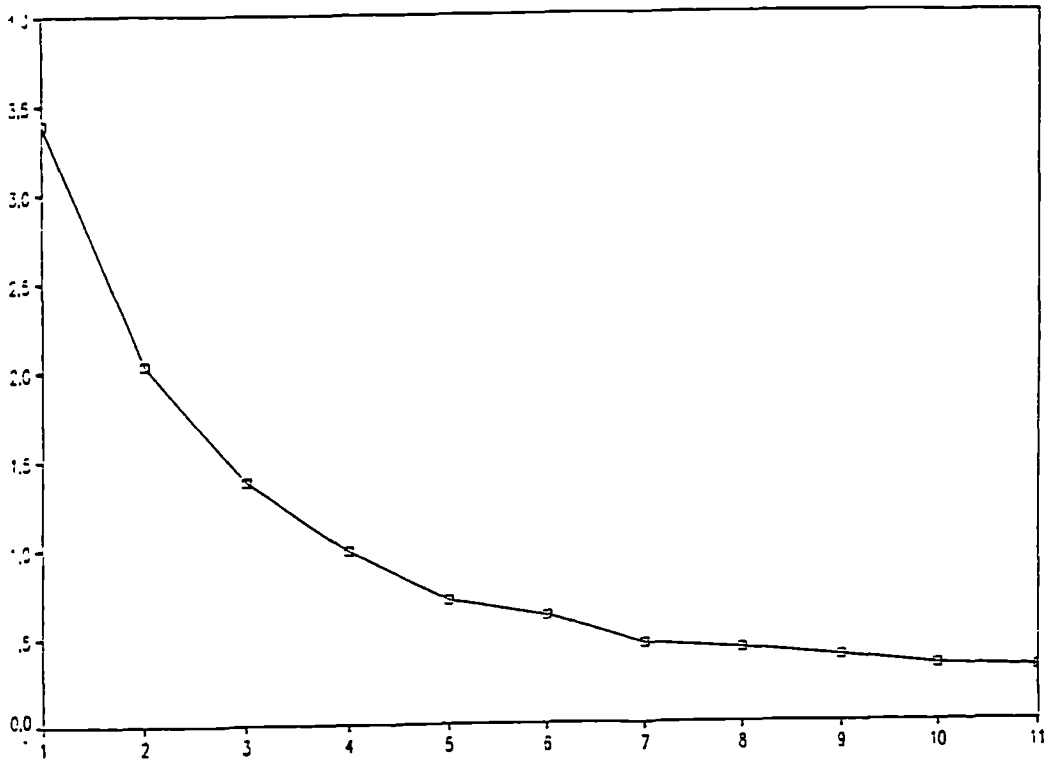
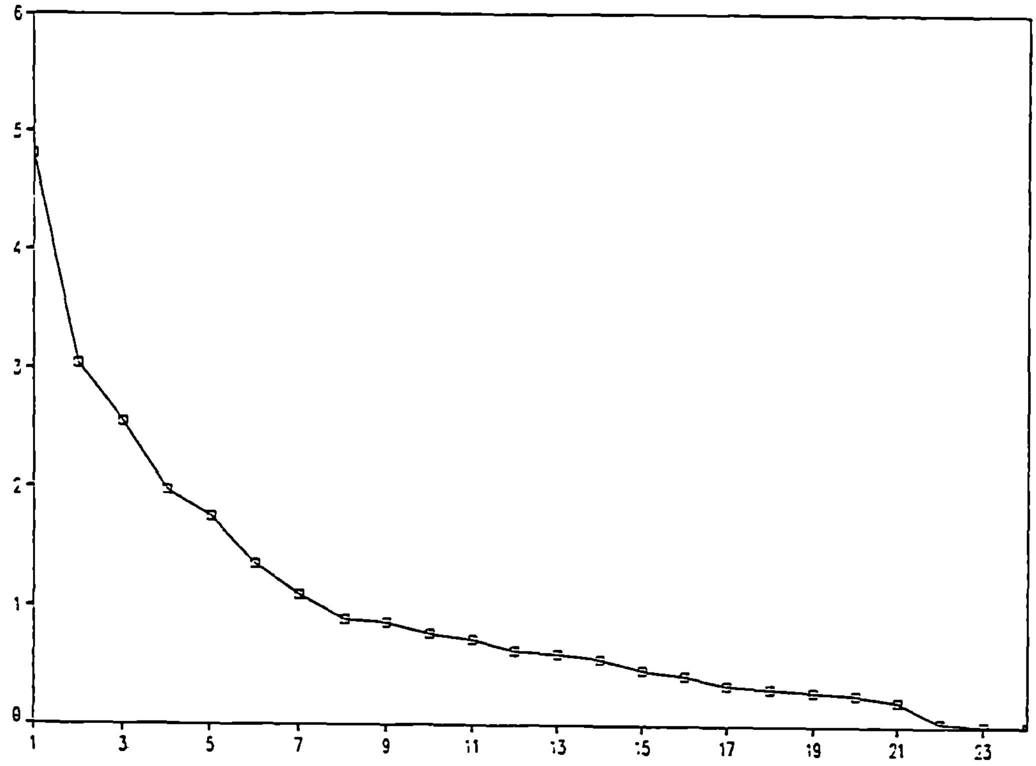


Chart No.5 Factor Scree Plot III - Factor Analysis of the Objectives of O/M

Eigenvalue by Factor Number



<u>Chart No.6 Factor Scree Plot IV - Factor Analysis of Network Related Variables</u>

APPENDIX C

TABLES/FIGURES ON CYPRUS

Sector	Initial	Percentage %
Primary	P	6.7
Secondary	S	23.0
Tertiary	T	57.2
Government Services	G	12.4
Other Producers	O	0.7

Percentage Distribution of Gross Value Added by Activity

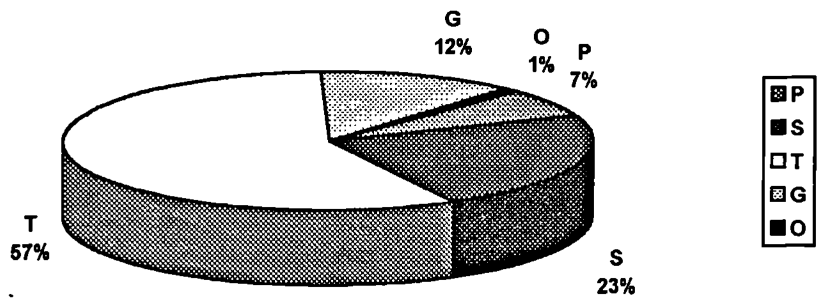


Figure No.1a Percentage Distribution of Grosss Value Addded by Activity, 1995

Source: Annual Report 1996, Central Bank of Cyprus

Subsector	Initial	Percentage of Secondary Sector	Percentage of Total Gross Value Added
		%	%
Manufacturing	M	52	12.0
Electricity, Gas and Water	E	11	2.6
Construction	C	37	8.4
Secondary Sector	S	100	23.0

Distribution of Gross Value Added by Activity in the Secondary Sector

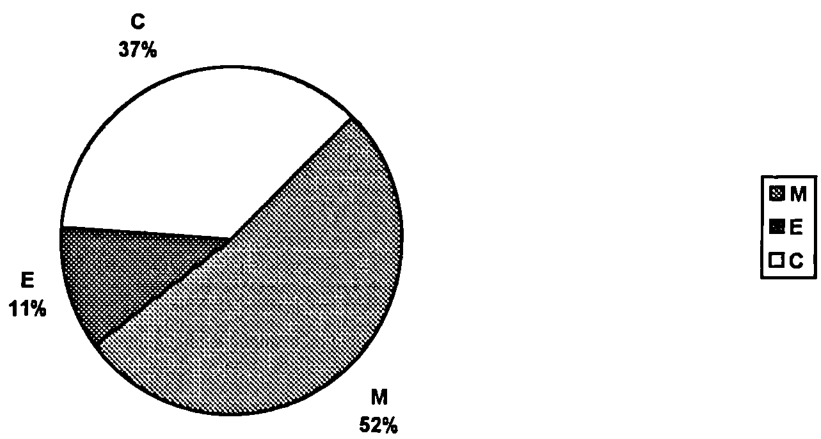


Fig No. 1b Percentage Distribution of Grosss Value Addded by Activity in the Secondary Sector, 1995

Source: Annual Report 1996, Central Bank of Cyprus

Industry	Percentage %
Food	33
Textiles	16
Wood	10
Paper	7
Chemical	10
NM (Non-Metal)	10
Metal	12
Other	2

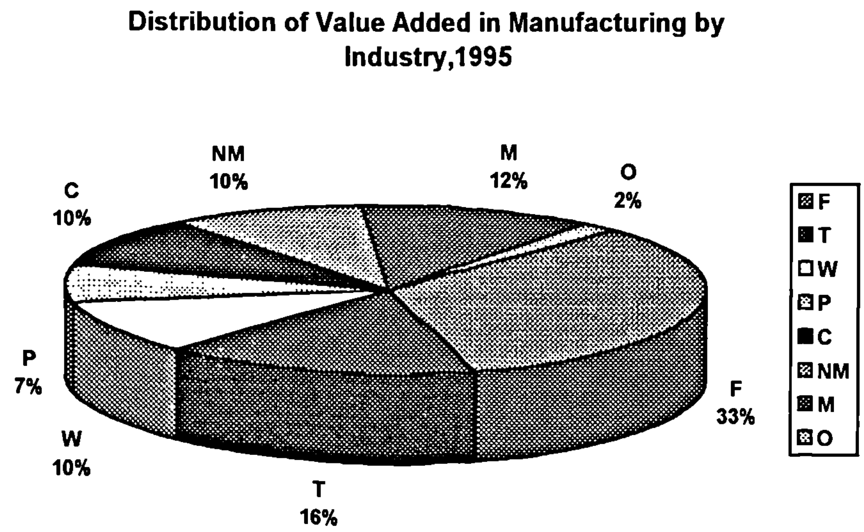


Figure: No.2 Distribution of Value Added in Manufacturing By Industry, 1995

Source: Industrial Statistics, 1995 - Statistics Department

Table 1 Basic Economic Indicators of Cyprus, 1994

GNP US$ million	7338
Real growth rate (1985-1992) of GNP %	6.0
Population 000's	734
Per Capita GNP US$	11567
Inflation (Consumer prices increase of 1994 over 1993)	4.7
Unemployment (% of labour force)	2.7

Source: Economic Report 1994, Statistics Department

Table 2 GDP by Economic Sector, 1992-1996, £Mln (Constant Market Prices of 1985)

	1992	1993	1994 (Est)	1995 (Est)
Primary Sectors	142.4	148.8	129.8	147.4
Agriculture etc.	135.9	141.0	121.3	139.5
Mining &Quarrying	6.5	7.8	8.5	7.9
Secondary Sector	566.2	546.8	560.9	580.4
Manufacturing	296.5	278.4	287.0	287.0
Electricity etc.	73.4	81.2	87.8	103.6
Construction	196.3	186.9	186.1	189.8
Tertiary Sectors (A)	1474.1	1493.1	1606.7	1677.5
Trade, Restaurants&Hotels	494.7	463.0	498.3	519.7
Transport, Storage and Communication	215.0	235.4	257.4	259.3
Finance, Insurance, Real Estate and Business Services (B)	361.7	362.3	390.0	412.4
Community, Social & Personal Services	127.1	140.3	157.1	171.2
Total Industries	1907.1	1896.6	1993.6	2090.5
Government services	260.6	275.8	286.2	296
Subtotal	2182.7	2188.7	2297.4	2405.3
Less: Imputed Bank Service charge	70.9	62.5	67.9	71.8
Plus:Import duties	142.1	115.4	116.2	120.3
Plus: Value Added Tax	28.1	82.6	91.9	101.9
G.D.P at Market Prices	2282.0	2324.2	2437.5	2558.2

A) It Includes also Government and Other Services
B) It Does not Include Government and Other Services
Note: Est. = Estimate

Source: Economic Outloook, 1995 - Planning Bureau

Table 3 Domestic Exports by Broad Economic Sector, 1995

Economic Sector	C P 000,s	Percentage %
Agricultural Products (Raw)	67666	29.2
Minerals	341	0.1
Industrial Products of Agricultural Origin	29178	12.6
Industrial Products of Mineral Origin	2287	1.0
Industrial Products of Manufacturing Origin	132433	57.1
Unclasssified	80	-
Grand Total	231985	100

Note: CP = Cyprus Pounds

Source: Imports and Exports Statistics January - December, 1995

Table 4 - Education in Cyprus

Education	1961	1975	1994
Illiteracy Rate (%)	18	10	6
Males	9	4	3
Females	27	15	10
Distribution of Population by Educational Level(%)			
-Without Education	25	13	5
Elementary	59	53	40
Secondary	15	25	38
Higher/University(Tertiary)	1	9	17
Enrolment Ratio (%)			
Pre-Elementary	N.A	N.A	59.1
Elementary	104	112	96
Secondary	43	78	92
Higher/University (Tertiary)	N.A	27	37
Number of Students per 1000 Persons	N.A	25	26.6
Public Expenditure on Education /GNP(%)	2.6	4.3	4.5
Total Expenditure on Education /GNP(%)	3.3	6.3	6.7
Expenditure Abroad	0.6	1.7	1.3

Note: N.A = Not available
GNP = Gross National Product

Source: Economic and Social Indicators - Planning Bureau,1995

Table 5 Gross Manufacturing Output by Major Industry at constant market prices of 1990.

Industry	1992	1993	1994	1995*
Food, Beverages and Tobacco	288.187	277.395	296.493	301.982
Textile Wearing Apparel and Leather	214.511	170.721	157.604	153.009
Wood and Wood Products, Including Furniture	80.978	80.537	85.170	87.491
Paper and Paper Products; Printing and Publishing	67.823	65.781	71.926	73.063
Chemicals and Chemical, Petroleum, Rubber and Plastic Products	153.902	162.960	183.698	184.743
Non-Metallic Mineral Products	81.513	81,505	81.690	82.560
Metal products, Machinery and Equipment	129.545	124.927	126.611	128.657
Other Manufacturing Industries (Including Cottage Industry)	29.598	29.107	30.161	29.999
Total Manufacturing	**1.046.057**	**992.933**	**1.033.353**	**1.041.504**

Note: * = Estimate

Source: Industrial Statistics, 1995, Department of Statistics.

Table 6 Distribution of Manufacturing Establishments by Size (Number of Employees)

Size	Number	Percentage %
0.5	347	4.4
1	2784	35.3
2- 4	2854	36.2
5 - 9	966	12.2
10 - 14	346	4.4
15 -19	193	2.4
20 -29	151	1.9
30 - 39	99	1.2
40 - 49	42	0.5
50 - 99	67	0.8
100 +	41	0.5
Total	7890	100

Source: Labour Statistics, 1994 - Statistics Department

Table 7 Domestic Exports of Industrial Products of Manufacturing Origin By Area, 1995

Area	Exports CP 000's	Exports %
EU Countries	63870	48.23
Other European Countries	13521	10.21
Arab Countries	37232	28.11
Other Countries	17810	13.45
Total	132433	100

Note: CP = Cyprus Pounds
: EU = European Union

Source: Imports and Exports Statistics, January - December, 1995 /
Department of Statistics

Table 8 Employment in Research and Development by Economic Activity, 1991&1992

Industry Code (ISIC,1968)	Economic Activity	Total Employment		Scientists and Engineers	
		1991	1992	1991	1992
3	Manufacturing (Total)	32	37	18	20
31	Food, Beverages and Tobacco	9	13	5	7
35	Chemicals and Chemical, Petroleum, Rubber and Plastic Products	13	14	5	5
38	Fabricated Metal Products	10	10	8	8

Source: Research and Development Statistics (1992) - Department of Statistics

Table 9 Expenditure on Research and Development by Economic Activity, 1991&1992

Industry Code (ISIC,1968)	Economic Activity	Total Expenditure CP000,s		Capital Expenditure CP000,s	
		1991	1992	1991	1992
3	Manufacturing (Total)	553	635	178	197
31	Food, Beverages and Tobacco	125	135	8	18
35	Chemicals and Chemical,Petroleum, Rubber and Plastic Products	285	350	142	143
38	Fabricated Metal Products	143	150	28	36

Code: CP = Cyprus Pound

Source: Research and Development Statistics, 1992 (Department of Statistics)

Table 10 Number of Licences by Manufacturing Subsector

Manufacturing Sector	Year				
	1990	1991	1992	1993	1994
Shoe Industry	7	5	2	3	4
Cosmetics, Detergents,etc	22	20	19	21	24
Paints, Emulsions, Chemicals, etc	8	9	11	13	16
Clothing Industries	23	18	24	28	32
Soft Drinks,Liquors, Beer	4	4	1	1	1
Food, Snacks, Fast Food, Sweets, Edible Oils, etc.	8	12	8	8	11
Car Batteries	3	3	1	1	1
Cigarettes	3	4	2	2	4
Other	17	20	10	12	18
Manufacturing Total	**95**	**95**	**78**	**89**	**111**

Source: Central Bank of Cyprus Statistics,1995.

APPENDIX D

CASE STUDIES

Case 1: M5

1.1 The Firm

M5 is a small firm with 25 employees. It is specialized in a unique market niche of complete electronic systems embedded in large metal cases for indoor and outdoor use (as 'signs' etc.). It has also other related product lines. The company was founded in 1984 and it is a partnership between two electronic engineers and a mechanical engineer. The latter is also the Managing Director and sales manager, while the other two partners concentrate on the technical side.

This is one of the few knowledge-based firms in Cyprus operating in a specialized field with only 20-25 companies worldwide. Most of these firms are small. The reason why there are only few suppliers in this product field is because it involves detailed design of custom-made products and includes installation on site and service which only an expert team can provide. M5 has a sales turnover of over 1.5 million US Dollars per year and has shown a respectable rate of growth (of over 20%) in both sales and employment in the last three years.

The company has a sales and service subsidiary in Greece established in 1993 with its sales rapidly increasing and expected to match those in Cyprus market probably this year (1995). The market in Greece is much larger and there are very few (only 2-3) manufacturers/suppliers of individual products in the same product range, but no integrated supplier as the M5. In Cyprus there is no local competitor (i.e. manufacturer). There is however both in Cyprus and Greece a lot of competition from imported products (mainly from Taiwan and other East-Asia countries). The traders/importers of these products are not however usually able to offer the required installation, maintenance and technical support at the same level as M5.

1.2 Organization of M5

The company started according to the O/M as a 'flat' hierarchy firm (i.e. without hierarchy and with a team approach. There was no specialized installation and service team. In the beginning the same people who were involved in the production were also undertaking the external installation work according to arising needs.

Now due to the growth of the firm and its expansion to other markets a number of new tasks have arisen according to the managing director. These are:

I. Sales Promotion and presentation of products

II. Negotiations with customers (Especially for new projects lengthy negotiations are required about the technical requirements, price and service aspects etc.)

III. Production coordination for in-time delivery.

IV. Planning of materials and components requirements and placement of orders to suppliers.

V. Planning of installation and technical service at a much larger scale.

VI. Organization for exports of finished products.

VII. Planning of visits to new and existing customers in export markets.

The Managing Director together with his partners have decided that there is a need for re-organization, allocation of responsibilities and functional differentiation of the firm with clear reporting relationships. As a first step they started with the formation of a separate installation and service team. The Managing Director considers the current stage as a critical one in the firm's development due to the expansion in the number of products, the number of employees and the volume of work but most importantly due to the expansion of the scope of tasks as he put it.

On the other hand the Managing Director feels that M5 has to maintain the team spirit the cooperation and job satisfaction for the highly qualified engineers who contribute to the innovative approach of the firm in the design and manufacture of new and improved products.

1.3 M5 Strategy

M5 has a clear strategy with a long-term plan to enter related product-market sectors and to expand to new export markets. The geographical expansion is a bold step since it involves considerable investment in the establishment of sales subsidiaries abroad, the expansion of production and especially the undertaking of more sophisticated projects in which the company has little experience till now. It will also require more visits abroad of the managing director and members of the application service team. Similarly the expansion into new product lines involves risk since the company has to give guarantees to customers for the good operation of its products.

1.4 The Managing Director

The interview was taken from the Managing Director who is 37 years old with a first degree in Mechanical Engineering and an MBA from a respected European Management School. He started his career in management information systems with one of the major local commercial Banks. When he met his two partners (who were the original founders of M5) during a project which involved them as suppliers of their systems to the bank he decided to leave the secure employment in the Bank and join them in what appeared as a challenging effort. He said:

> "I was attracted by the challenge of creating something new and pioneering in a team with other professional colleagues".

He can be described as a 'managerial entrepreneur', although of a technical background, because he is concentrating on management and marketing/sales issues. He is however able to conduct the complex negotiations with customers which involve technical matters as well as pricing and administrative ones. He travels extensively abroad to export markets. He also visits, frequently together with one or both of his partners general electronic trade fairs as well as more specialized ones in the field of M5.

1.5 Innovation

The company has three people working full time on new products. Actually it is one of the very few firms in Cyprus that have employees exclusively devoted to Research and Development. It can adapt to new requirements and develop new products very quickly. According to the Managing Director all the staff of the company can work together effectively as a tightly knit team. One of the company's promotion leaflets states that "Quality of products, ease of service and thorough documentation is always put before all other considerations". Expenses on R&D are over 5% of sales. Eight of the 25 employees (almost one third of them) hold university degrees in various branches of engineering and computer science.

The company has its own metal assembly workshop, automated wave soldering facilities, testing equipment and an excellent CAD design section, with facilities for prototype printed circuit board production. The software design which is an important part of product development covers both assembly software, using an Intel microprocessor development system and high level language development with C and 4GL languages etc.

Although M5 uses CAD as mentioned above, they have not moved yet to computer aided manufacturing. They have studied carefully the possibility but a fully automated (computer operated) IC assembly machine costs over two million US Dollars and has a huge capacity far beyond their current and projected needs. What they plan to buy is a relatively cheap, small semi-automatic machine that will be modified and adapted to their needs by themselves. They will also adapt existing software for its operation.

The product systems are made modular for easy maintenance and trouble shooting. One peculiarity is that the electronic components for the boards are not the state of the art ones but of somewhat older technology. The reason is simple, they do not need the latest miniaturized components since the metal cases are large anyway according to their customer's requirements and the components of the 'previous' generation are equally effective and reliable and much cheaper than those of the latest one.

PCBs (Printed circuit boards) are imported from Taiwan, while other components are ordered to Taiwanese/Japanese suppliers. The only local PCB supplier has recently gone out of operation plagued by quality problems (PCB defects) as shown by statistical failure testing according to the managing director of M5. The firm uses a wide variety of sources for technological information apart from suppliers. These include the technical literature, participation in technical seminars, visits to trade fairs, contacts with foreign technical consultants, contacts with customers etc.

1.6 Networks

The firm has very close relationships with customers both local and foreign due to the nature of products which have to be custom-made and adapted to customer's needs. There is also usually a contract for service and maintenance of the product systems which implies continuous and frequent contact with customers. International networks with suppliers, consultants etc. are much more important than local ones for M5, from an innovation point of view, since they are sources of technological information and market information regarding foreign competitor moves, changes *in international markets, component price developments etc.* Local contacts to customers, banks, firms in the broad metal sector etc. are significant sources of market information, local business trends etc.

The participation of the Managing Director in the Technology Advisory Council (an independent body for the supply of suggestions for improvement of Government's Industrial Policy) was an opportunity to develop contacts with other industrialists and with Government circles. He was however disappointed when many of the suggestions of the Council were not put into practice by the Government for the support of the industry.

1.7 Innovation Climate

The managing director of M5 considers the innovation climate in Cyprus as far from supportive for new ventures. He mentioned many example from his experience of pioneers in fields related to his own who failed, despite a promising start, largely due to the difficulties to obtain finance, to find suitable people, to develop exports and to get public contracts. He emphasized that for small firms exports, although necessary to survive, are also costly in the beginning. An export market has to be developed with frequent visits and possibly establishment of a sales subsidiary or at least a local distributor. Organization and documentation of export sales means also additional personnel. Without Government help he said small firms face major difficulties in exporting their products.

1.8 Developments in the Last Six Months

M5 has recently introduced new, more complicated systems for Stock Exchange Announcement electronic bulletins. This type of system has much higher requirements than the systems they were developing till now.

M5 is now cooperating with another local firm which has recently imported computer controlled machinery of the latest generation for metal cutting and shaping. M5 subcontracts some of the metal forming operations to them.

Case 2: P1

2.1. The Firm

P1 is a firm in the plastics sector with about 65 employees. It was established in 1969. In the 1980's it was employing 80-100 people, but this number has declined in recent years. The firm is specialized in the production of plastics food packaging. The products are adapted to customer's needs. The owner/manager (O/M) of P1 said that what he offers to his industrial customers is a 'total package' which includes the design of the container, the printing and appearance and the technical service (e.g. trouble-shooting in customer's filling line etc.). There is a second line of production i.e. the disposable cups which are mass-produced low cost items. Disposable cups can not compete in export markets.

P1 is a partnership between a Cypriot family and a Lebanese entrepreneur (who is actually a 'sleeping partner'). The firm is a market leader in its sector. There is one main local competitor plus the imported products.

The firm has a wide customer base selling to some major customers (7-8) and a large number (over 100) of smaller ones. It exports the 'industrial line' of products to countries such as Greece, Israel etc. It used to export over 70% of its production to the Arab countries in the nineteen eighties. That export market area was gradually lost due to the establishment of local plants and the raise of import duties in these countries on the one hand, and the erosion of competitiveness of P1, because of the rising wage costs in Cyprus as the O/M has put it, on the other. Recently great efforts have been made to penetrate the market of Russia and other countries of the former Eastern Bloc. The current figure of exports is around 60% of P1 production.

The firm can be described as a family one despite the existence of the foreign partner with about 40% of the shares in the company (according to data obtained from the office of the Registrar of Companies). Till recently the Managing Director and owner was responsible for all the main decisions (in consultation perhaps with his partner especially about new investments). Since 1995 the owner's two sons have joined the firm as Production and Finance Managers respectively after finishing their studies in USA.

The three of them form now the management team. There is a functional differentiation into Sales, Production and Finance Departments. The company is now in the process of introducing the ISO 9000 quality standard and the ISO consultants have helped in the construction of a new organizational chart which more clearly delineates the hierarchy of authority and responsibility within the company.

2.2 The Owner/Manager (O/M)

The O/M is 52 years old and has a degree in Law from the University of Athens, Greece. He has founded the firm initially in the garage of his home, while still working as a manager in a food company. Within three years the small workshop was turned into a factory and he left the salaried position to run P1.

The O/M can be described as a 'managerial entrepreneur' rather than a 'technical' one although he has been closely involved with the technical details from the foundation of his firm (even without a technical background). An example indicative of his management style of 'hands-on management' is the following: during the second interview the installation of a new machine, for a new project to be dealt with in the following, was taking place. As he recounted, he spent hours on the floor working together with the technician of the supplier firm who was installing the machine, in order to get himself a working knowledge of the operation of the new machine and make sure that the quality of products produced by the machine was according to P1's standards, while his technicians had learned from the foreign technician everything necessary to run the machine and carry out adjustments, maintenance etc.

The O/M speaks good English and travels extensively for the promotion of sales, keeping close personal contact with the main export customers. He also visits all the major European trade fairs for plastics and packaging in order to learn about new technological developments and trends and have contacts with materials and machinery suppliers.

The O/M has been the Chairman of the Cypriot Plastics Processors Association for a number of years. He has personally initiated the affiliation to European Plastics Processors Association and the close cooperation with the latter so that Cypriot Plastics Processors take advantage of information on market trends, materials prices etc. and the contacts available through the European Association. The O/M describes himself as a workaholic "My hobby is my work". He states that he starts work at six o'clock in the morning and stays in the office till late in the afternoon.

He had political ambitions and was a candidate for a position in the Parliament. His management style could be described as 'domineering' according to his-own self-presentation i.e. being in the hub of all activities taking place within the firm. "Survival is the name of the game" according to his words. His main objective is the continuation and growth of the firm for the sake of his two sons who have recently joined the company.

2.3. Innovation

The O/M of P1 had seen in the European market, in trade fairs etc. that a 'new material' was substituting the one he was using for years. The substitution would mean change of moulds, experimentation with a material that was not familiar to them (with different processing properties) and eventually purchase of new machinery. P1 made feasibility studies and then decided to wait till the further penetration of the new material in the European Food Packaging market. The O/M stated:

"The long gestation period for the introduction of 'X' in our firm permitted us to get a good appreciation of the advantages and disadvantages of this material in <u>our</u> production from the experience of others".

The next step was to start experimenting with the new material on an existing machine with some modifications made in house to the machine (and some help from the machine supplier).

Then in 1995 a decision was made to go ahead with the purchase of the first machine specifically designed for the thermoforming of the new material. This was part of a three-year investment plan and further machines will be gradually added. During the first interview the difficulties forced in the transition were discussed. The O/M said that the machine will be used mainly for disposable cups for export. The main motive according to the O/M for the decision to go ahead at the specific time period was that most international competitors had already made similar moves. The main technological information sources for the project were the raw materials suppliers. The O/M and his son have visited the main supplier's plant and the laboratories and had discussions with the technical experts.

The usual sources of technological information apart from the suppliers are contacts in trade fairs, trade associations, and the technical literature but very rarely, if ever, technical consultants or academic institutions. P1 has got a license for a secondary line of products from a British firm. It makes its own moulds and has an own workshop for machine maintenance, small adaptations etc.

2.4. Networks

The O/M maintains close relationships with all the main local and foreign customers. He visits them regularly and discusses all types of problems that may arise. In the new export markets, Russia etc. he is personally involved in the selection of agents/distributors.

The relationship with suppliers is also a long-term one especially with machinery suppliers. The problem in the relations with materials suppliers is that they are large multinationals therefore the relationship is highly asymmetric in power terms with P1 in a disadvantaged position. It is a very small customer in absolute terms (although a relatively 'large' purchaser of plastics raw materials in the Cyprus context). Since the raw material is a large percentage of P1's cost (over 50%) negotiations on price are one of the O/M's main concerns.

The O/M maintains relations with all the major plastics processors but <u>not</u> with his competitor who till recently was not a member of the Plastics Processors Association (He has now joined the Association). Due to the O/M's position as the Chairman of the Plastics Processors Association he has close contacts with the Chamber of Commerce and Industry, Government Departments etc. Since both machinery and raw materials and several of the ancillary materials needed in production are imported P1 has very few local suppliers. The firm uses of course local services (e.g. auditors, quality management consultants, legal advisors etc.).

2.5. Perceptions of the Innovation Climate

The O/M of P1 believes that Government should take a more active role in the support of the local industry. He said:

"Cyprus is a small place and Cypriot firms can not survive by selling to the local market only, especially if they are specialized in a particular market niche (as my firm is) they have therefore to export and Government has to support them in their exporting efforts due to their own limited resources".

According to his view industrial policy is weak and poorly implemented since industry is not a strong lobby (compared to agriculture and tourism. It is therefore usually a loser in the political power games in policy formulation and subsequent implementation.

The main constraints in industrial development according to P1's O/M are:

- The cost of Electricity which is higher (!) for industrial purposes than for household consumption (similarly the telephone cost is also higher.)
- The 'Cost of Living Allowance' which is given to employees automatically by law.

- The strength and concentration of the retail chains which then put tough demands on their small industrial suppliers (but regarding price and especially credit terms and to a much lesser degree regarding quality).
- The role of commercial banks which give easily credit for consumption purposes but not for new machinery.

Funding for new product development is even more difficult to get since no collateral can be offered. He said:
"If I go to the bank and ask them for a loan for a luxurious Mercedes of 50.000 pounds I shall get it easily under a scheme of hire/purchase where the profit of the bank is high. If, however, I ask them for a loan to buy a new machine they will demand a feasibility study and make all sorts of questions, while it will take ages to come back with an answer. You see, their profit is much lower in industrial loans".

In his view the role of the Technology Institute has been rather limited in the support of manufacturing and the Industrial Extension Service had little to offer, although recently it has made new efforts to find out about the real needs of the manufacturing firms. He appreciates the role of the Chamber of Commerce and Industry in getting European Union Funds, representing industrialists in international meetings etc.
The O/M of P1 said that he applauded the introduction of product standards by the Cyprus Standards Organization, but was dissatisfied from the delay in introduction of a strong monitoring scheme of the conformance to these standards of all the local firms as well as of the imported products.

He was particularly critical of the business practices in Cyprus especially the issue of delays in credit payments and the lack of trust in business relations. Although as he said he has very good relations with some of the main customers he has faced several problems with others.

2.6. Developments During the Last 6 Months (The Second Interview).

The second interview coincided with the installation of the new machine for the project of introduction of the new material that was mentioned above. Plans for further addition of machinery and ancillary equipment (e.g. printers) have been prepared for the next two years.

P1 has signed major contracts for exports of custom made products to Russia and other markets. The owner of P1 has made recently many visits to these markets. Regarding recent trends the O/M of P1 mentioned the wave of mergers and acquisitions among the retail chains that has further increased their concentration. Two retail chains are now dominating the market and this will have adverse affects for P1's customers (the food manufacturers). Indirectly this development will affect the firm (since its customers will face cash flow difficulties and will not be able to pay P1 in time).

Case 3: M1

3.1. The Firm

M1 is a small company with 15 employees. It was established in 1982. This firm is a general metal workshop. The main product range includes steel tanks, roadside rails etc. The company has its own trucks and installation teams for the latter. M1 competes against the many other metal workshops of similar size and facilities for the steel tanks and similar products, while the road side rails is a rather specialized market with fewer competitors. Most items are produced to order, only one of them (boilers) is produced for stock. There is no functional differentiation in the firm the managing director is responsible for the technical operations, but also the sales, personnel matters etc. An external accountant is used for keeping the books of the company.

3.2. The Owner/Manager

The firm is run by two brothers. The senior brother, who is the managing director, is around 50 years old and a technical school graduate. He has substantial technical experience accumulated in other firms before he started his own. It is a classical case of a 'craftsman' who establishes a firm in his own field after getting the experience and the connections. He is rather well aware of the technical changes in metal-working. He decided to invest in AMT (Advanced Manufacturing Technology) after seeing other larger metal work-shops installing computer operated (CNC) machines.

3.3 The Networks

The owner/manager has wide connections with other colleagues (i.e. technicians/ owners of metal-working firms) but also with customers, suppliers etc. His contacts with technicians in the Public Works Department and Government officials are important since a substantial part of the business i.e. the roadside rails is based on public procurement. He has close contacts (through telephone calls etc.) with the machinery suppliers and travels occasionally to Europe in order to find out new machinery.

He mentioned discussions with metal workshop owners not only about the market, pricing etc. but also about technical matters. These firms are not however direct competitors and the owner/manager of M1 had previous contacts with them on a social level. M1 undertakes the supply, installation and service of metal work (not in its core product lines) for other firms (e.g. in the plastics and chemicals sectors) mainly in the same industrial area (i.e. in the locality).

3.4. Innovation

The workshop has the usual drilling equipment and lathes. They have over the years accumulated technical expertise in metal forming, welding etc. M1 has a CNC cutting machine, advanced photo-optical equipment for cutting patterns in metal (with plasma, oxygen and gas cutting options). It also has advanced welding equipment (a welding robot). All three pieces of advanced equipment were imported from Germany second-hand. The company faced severe technical problems with their installation since there is no local expertise according to the O/M in installation and trouble-shooting and for second-hand equipment no much help from the original machine manufacturer.

Regarding the comment about lack of local expertise in electronic engineering as the O/M explained there are electronic engineers, some even highly qualified, but without working experience of the specific type of equipment. These people without the 'tacit' knowledge of the machine manufacturer can not be of much help. M1 had thus to bring in a technician from Greece for the installation of the CNC - machine.

The machine is still not working because the screen is not illuminated (perhaps due to the high temperatures especially during summer in Cyprus). A German technician from the machine manufacturing firm who was consulted on the matter suggested air-conditioning of the space where the machine works (an expensive solution to the problem!). M1 has also problems with the welding robot, which as mentioned above is also not working. The pieces to be joined (welded) have to be of very close tolerances for a perfect welding, but this is difficult to be achieved without CNC cutting, as they have discovered after the purchase of the robot. The result is the low utilization rate of the existing AMT. The company does not use Computer Aided Design (CAD) probably because a skilled engineer would be needed to operate it and the firm has only technicians and no university trained engineers.

The O/M referred to the problem of finding spare parts in Cyprus. They have to be imported from abroad which leads to delays in their receipt, while the machine stands idle for weeks. The 'solution' that the O/M and others in the trade have found is to import machines at least two of a kind in order to take spare parts from the one to operate the other to secure uninterrupted production. The O/M mentioned the case of a friend in Limassol who had to do the same with laser cutting equipment.

The O/M realizes the need for technological upgrading (despite the difficulties). His main motives are 1) to reduce the labour cost 2) to reduce especially the dependence on the hard-to-find specialized technicians 3) to keep up with technological changes in Europe (being able to compete against imported products) 4) to increase the flexibility of the firm and its fast response to market changes.

3.5. Innovation Climate

The O/M does not consider Government's Industrial Policy as giving any incentives for AMT investment. He has however praised the courses of the Industrial Training Authority for technicians. He complained about the low productivity of workers and the lack of skilled technicians who are lured away from the industry and join the services sector at higher wages and a relatively more pleasant working environment.

3.6. Recent Developments

Not much change was reported for the six months period between the first and the second interview apart from the increasing difficulty to collect credit sales dues.

APPENDIX E

SUPPLEMENTARY INTERVIEWS

Table 1 Institutions where interviews were made

Number	Institution
1	Institute of Technology
2	Statistics Department
3	Ministry of Commerce and Industry
4	Ministry of Labour
5	Cyprus Standards Organization
6	Technology Advisory Group
7	Industrial Training Authority
8	Productivity Centre
9	Central Bank of Cyprus
10	University of Cyprus
11	Cyprus Development Bank
12	Planning Bureau
13	Chamber of Commerce and Industry
14	Plastic Converters Association

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