MANUFACTURING STRATEGY

AN ANALYSIS OF THE SAUDI MANUFACTURING PRIVATE SECTOR

BY

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A THESIS SUBMITTED FOR THE PH.D DEGREE

TO

THE DEPARTMENT OF MANAGEMENT STUDIES

GLASGOW BUSINESS SCHOOL

UNIVERSITY OF GLASGOW

AUGUST 1991

DEDICATION

TO: My Parents

My Brothers

My Sister

My Wife

My Son, Muaath

My Daughter, Mai

DECLARATION

No portion of the work referred to in this study has been submitted in support of an application for another degree or qualification of this or any other university or institution of learning.

ABSTRACT

This study is motivated by the desire to develop an understanding of the manufacturing strategy concept within the Saudi business environment. More specifically the objectives of the study are to detect the existing type of manufacturing strategies in Saudi plants in the last two years (i.e., 1987 and 1988) as well as in the next two years (i.e., 1990 and 1991); to use SWOT analysis to find out strengths and weaknesses within the plants surveyed as well as opportunities and threats in the environment; and finally to test six hypotheses of the model of manufacturing strategy. The model consists of eight factors: organisational environment, corporate and business strategies, manufacturing task statement, manufacturing task, the role of the production manager, structural category of decisions, infrastructural category of decisions, and finally organisational performance.

In order to achieve these objectives, three sets of questionnaires were used. They were destined for three managers in each plant; general manager, production manager, and sales manager. Data were collected from 117 plants (a total of 351 sets of questionnaire) of four industries of the Saudi manufacturing private sector. These are the food, paper, chemical, and metal industries. Furthermore, governmental reports were consulted to obtain primary data for the study.

The results showed that the manufacturing strategies for the Saudi plants during 1987 and 1988 were that of "quality" and "on-time delivery", and that it is "a low price" strategy for 1990 and 1991. The results of SWOT analysis corroborate the detected strategies and offer solutions to the problems confronting Saudi industries.

The results of testing the six hypotheses of the manufacturing strategy model showed a significant relationship in every hypothesis. The results of the hypotheses revealed that: environmental uncertainty influences the manufacturing task of the plant; the plant's manufacturing infrastructure associates with its manufacturing task; the higher the congruence between environmental uncertainty and manufacturing task, the better the performance; the higher the congruence between manufacturing task and manufacturing infrastructure, the better the performance; the higher the top management and production management task congruence, the better the performance; and finally the greater the involvement of production managers in strategic decision making, the better the performance.

Acknowledgments

First of all, thanks to the Almighty God for enabling me to complete this project.

I am deeply grateful to Dr Geoff Southern for his supervision, encouragement, and guidance. His friendly style in supervision was very helpful in completing this thesis. I look forward for more academic cooperation with Dr Southern.

I extend my thanks to the members of the Scottish Doctoral Programme. The programme has directly or indirectly helped this research. I am grateful to Mrs Mary Latham of the University of Glasgow for her assistance in familiarising me with the SPSS^{x}. I also acknowledge the advice given by Dr James Currall and the staff of the Department of Statistics at Glasgow University on the Statistical techniques for this study.

I would like to thank the Deputy Minister for the Ministry of Industry and Electricity in Saudi Arabia, engineer Mubark Al-Khafrah, for his valuable comments and assistance during the field work. My thanks are also due to the members of that Ministry for their help in providing primary data for this research. Thanks must be mentioned to the respondents of the surveyed plants who were very patient and cooperative despite their heavy duties and responsibilities.

I would like to express my appreciation and gratitude to my mother who throughout my studies constantly encouraged me and sustained my spirit. The time has now come for you to be compensated for raising me. Thanks are due to my brothers, Saleh and Suliman, to my sister Fatmah for their encouragement, and to my niece, Nora, for helping me sorting the questionnaire.

I remain for ever indebted to my wife, Fawzeah, and to my children Muaath and Mai. They sacrificed their leisure time to enable me to work, even at weekends.

Finally, I express my thanks to the Saudi government, represented by King Abdulaziz University, for offering me a scholarship to complete my studies.

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CHAPTER ONE

INTRODUCTION

The aim of this Chapter is to acquaint the reader with the background to the research, its importance, its objectives, its limitations and to present the overall structure of the thesis.

1.1 BACKGROUND TO THE STUDY

Top managers in many companies rely heavily on cost and efficiency as performance indicators for the manufacturing function. In so doing, they are neglecting other indicators of the manufacturing function and leading their firms into lack of success. Skinner says:

> A ... major cause of companies getting into trouble in manufacturing is the tendency for many managements to accept simplistic notions in evaluating the performance of their manufacturing facilities. By this I am referring to the general tendency in most companies to evaluate manufacturing primarily on the basis of cost and efficiency (Skinner, 1985:47).

Top managers also ignore the role of the production manager, as a representative of the manufacturing function, in formulating corporate strategy. They often if not always allow finance, marketing and other functional managers to play a bigger role in corporate strategy level meetings, and then expect manufacturing to react to the outcomes (Skinner, 1978; Wheelwright, 1978; Hill, 1985).

It is surprising that such a situation occurs when the manufacturing function controls the major assets in most industrial firms. New and Myers have pointed out the responsibilities of the manufacturing function.

> In most manufacturing companies, the manufacturing function itself is responsible for employing around 70% of the labour spending some 70-80% of all current cash flow and controlling around 80% of the capital assets of the business (New and Myers, 1986:v).

Terry Hill has stated clearly the overlooking of the production manager role in the corporate strategy process as follows:

> In the majority of cases, manufacturing is simply not geared to the business's corporate objectives. The result is a manufacturing system, good in itself, but not designed to meet company needs. Manufacturing left in the wake of corporate decisions is often at best a neutral force, and even sometimes inadvertently pulls in the opposite direction. Seen as being concerned solely with efficiency, the question of production's strategic contribution is seldom part of the corporate consciousness. What does all this mean for production managers? One clear consequence is the need to change from a reactive to a proactive stance (Hill, 1985:25).

As a result of increasingly severe competition, companies which rely solely on a cost efficiency indicator and or do not allow production representation in the formulation of corporate strategy have tended to lose their competitive edge.

The introduction of the manufacturing strategy amends this situation. It calls for multiple performance criteria for the manufacturing function, and for a greater role for production managers in strategic decision making (see Chapter Two). Manufacturing strategy leads manufacturers to beat their competitors by strengths stemming from the manufacturing function. More important, manufacturing strategy requests managers to think strategically; i.e., to think in terms of "effectiveness" rather than "efficiency". For example, when managers decide to buy a piece of equipment: they should ask themselves "how can we compete effectively using this piece of technology?" rather than "how much this piece of technology improve our financial indicators?". In other words, effectiveness may mean "doing the right thing", whereas efficiency means "doing things right" (Bedeian, 1984).

Manufacturing strategy is an emerging field of study and improving the manufacturing operations, as its main aim, is a promising concept. Yet more has to be learned about this new field.

1.2 SIGNIFICANCE OF THE STUDY

Industrialisation is the main hope in most developing countries to diversify their economy, among them Saudi Arabia has moved rapidly into industrialisation. Between 1975 and 1986 the number of its plants increased sharply from 473 to over 2000 (Ministry of Industry and Electricity, 1986a). All these plants, regardless of their ownership (i.e., public or private), have to be professional in manufacturing in order to face competition, be it national or international. Manufacturing strategy, as a valuable tool, paves the way towards this end.

The significance of this study lies in its contribution at various levels.

First, to the best of the researcher's knowledge, the study tries to verify empirically the validity of the Sandcone model and the Japanese cumulative model concerning the competitive priorities for the first time.

Second, it is one among three studies that shows how manufacturing policies (or programmes variables) are linked statistically to competitive priorities.

Third, it is the first empirical study about manufacturing strategy to incorporate a SWOT analysis. Other studies have only included strengths and problems (e.g., Swamidass, 1986).

Fourth, this study has tested six hypotheses of the manufacturing strategy model in more than one industry and has validated two hypotheses for the first time. It is hoped that the results of these hypotheses will have direct contribution to the literature.

Fifth, research in manufacturing strategy is required in developing countries to permit cross-cultural comparison of results. Such comparisons would reveal similarities and dissimilarities between developed and developing countries. The researcher believes that more research is needed in this emerging field to fill the gaps in the unsettled issues (e.g., trade-offs notion) or undeveloped issues (e.g., measurement).

Sixth, at the methodological level, controlling plants in terms of capital and number of employees on the industry level as well as on the subindustry is a unique feature of this study, which should make the sample more homogeneous.

Finally, the study which is conducted on an individual level provides empirical data with a large sample that rarely exist about Saudi Arabia. It is expected that manufacturers in Saudi Arabia will utilise such data.

1.3 OBJECTIVES OF THE STUDY

The objectives of this study are to develop an understanding of the manufacturing strategy concept and to find out the type of manufacturing strategies that exist among Saudi enterprises. More specifically, the study is aimed at:

1. Detecting the manufacturing strategy for the Saudi plants in the last two years (i.e., 1987 and 1988).

2. Detecting the manufacturing strategy for the Saudi plants in the next two years (i.e., 1990 and 1991).

3. Using SWOT analysis to find out strengths and weaknesses within the surveyed plants as well as opportunities and threats in the environment.

4. Testing the following six hypotheses of a model of manufacturing strategy on the Saudi manufacturing private

sector:

H1 Environmental uncertainty correlates with manufacturing task.

H2 A plant's manufacturing infrastructure correlates with its manufacturing task.

H3 The higher the congruence between environmental uncertainty and manufacturing task, the better the performance.

H4 The higher the congruence between manufacturing task and manufacturing infrastructure, the better the performance.

H5 The higher the top management and production management task congruence, the better the performance.

H6 The greater the involvement of production managers in strategic decision making, the better the performance.

The researcher decided to use the word "Detect" rather than "survey" here because the literature suggests that manufacturing strategy is not well understood among practitioners (e.g., Schroeder et al., 1986; Swamidass, 1986). However, the facts speak for themselves that they must be practicing it.

1.4 LIMITATIONS OF THE STUDY

The fundamental limitations are:

1. The scarcity of studies in manufacturing strategy especially at the first stage of this research was a major limitation. In some cases, articles were not published then, thus the researcher had to request them directly from the authors.

2. The generalisation of the findings of this study are limited to the manufacturing private sector (not including public or semi-private).

3. The generalisation of the findings may be limited to large plants in terms of capital and number of employees.

1.5 ORGANISATION OF THE DISSERTATION

Following this introductory Chapter which presents the objectives of the study, its importance and limitations, the thesis consists of the following Chapters:

Chapter Two reviews the literature of manufacturing strategy, theoretically and empirically. It presents major emphasis on the attack on the "Trade-offs" notion.

Chapter Three introduces the kingdom of Saudi Arabia to the reader. Special emphasis will be given to the Saudi industrial sector since it represents the population for the survey of the study.

Chapter Four informs the reader about the research methodology adopted and the selected and the achieved sample of the study.

Chapter Five presents characteristics of the sample.

Chapter Six provides a preliminary data analysis of the whole model of manufacturing strategy.

Chapter Seven tests the six hypotheses of the manufacturing strategy model.

Chapter Eight develops the components of manufacturing strategy and the expected strategy.

Chapter Nine conducts a SWOT analysis.

Chapter Ten, Finally, summarises the main findings of the study and addresses implications of the study and suggestions for future research.

CHAPTER TWO

LITERATURE REVIEW

INTRODUCTION

Manufacturing strategy (also known as operations strategy) is a young and emerging field. Although the study of manufacturing strategy is just over twenty years old, it has only begun to attract researchers as well as practitioners in the last decade. In its early stage of research, manufacturing strategy was reported to be poorly understood among practitioners (Schroeder et al., 1986; Swamidass, 1986). This is still the case and in 1990 two major conferences were held in the United Kingdom and the United States of America to advance research in manufacturing strategy.

The purpose of this Chapter is to review the literature on manufacturing strategy. In this review, other disciplines were incorporated to promote the manufacturing strategy literature as suggested by Adam and Swamidass (1989); Anderson et al. (1989) and Leong et al. (1990). In the first section, several definitions of manufacturing strategy are considered and a working (adopted) definition of manufacturing strategy is specified. The next section, discusses briefly the literature development. The third and the fourth sections respectively present guidelines for a comprehensive strategy to set up a manufacturing strategy model. The final section, provides a hypothesised manufacturing strategy model.

2.1 DEFINITIONS OF MANUFACTURING STRATEGY

In studying manufacturing strategy (MS), one can discern easily that the area lacks a universal accepted definition. In reviewing manufacturing strategy literature, Anderson et al. (1989:136) pointed out that it "does not provide a clear or consistent definition of operations strategy."

The following paragraphs present definitions of manufacturing strategy that were classified as either general or less specific. The criterion for classifying a definition as "general" is its failure to mention one of the following key words (or their synonymous): Competitive priority/strategy/advantage/weapon, strength and pattern of decision. These key words were stated because they were used by the manufacturing strategy's contributors to symbolise the meaning of manufacturing strategy as it will be clear throughout this Chapter.

Accordingly, the following two definitions were classified as general definitions.

- **Manufacturing strategy** is concerned with the development and implementation of plans which affect the firm's choice of production resources, the deployment of these resources, and the design of the infrastructure to control operations activities (Cohen and Lee, 1985: 153).

- **Manufacturing strategy** involves the development and deployment of manufacturing capabilities in total alignment with the firm's goals and strategies (Swamidass, 1986: 472).

On the other hand, the next four definitions were classified as "less specific" definitions.

- **Manufacturing strategy** is to guide the business in putting together the manufacturing capabilities that will enable it to pursue its chosen competitive strategy over the long term (Ferdows et al. 1986: 8).

- **Manufacturing strategy** is viewed as the effective use of manufacturing strengths as a competitive weapon for the achievement of business and corporate goals (Swamidass and Newell, 1987: 509).

- **Manufacturing strategy** is defined in four elements: mission, objectives, policies and distinctive competence (Schroeder et al., 1986:409).
  The Manufacturing mission : ... specifies what operation must be accomplished for the business to succeed.
  Manufacturing objectives : ... specific statements of expected results - a refinement of the mission (measurable terms).
  Policies : ... support the manufacturing objectives and mission. The policies should be consistent with each other and with what is intended to be accomplished by manufacturing (policies are defined by resources).
  The distinctive competence : ... what sets manufacturing apart from the competition and thus can be defined in terms of uniqueness. The distinctive competence gives strength to manufacturing in dealing with the competition (the same definition is provided by Schroeder, 1984 and Schroeder & Lahr, 1990).

- **Manufacturing strategy** consists of a sequence of decisions that, over time, enables a business unit to achieve a desired manufacturing structure, infrastructure, and set of specific capabilities (Hayes and Wheelwright, 1984: 32).

As such, the preceding definitions do not represent a clear comprehensive picture of manufacturing strategy (see Section 2.3). The following definition of manufacturing strategy has been suggested.

- **Manufacturing strategy** is a two stage process (Southern and Al-Shuaibi, 1990: 797).

> **First, a statement of tasks which is developed at the corporate and business levels with the active participation of the manufacturing function which defines strengths and weaknesses within the organisation as well as opportunities and threats in the environment.**
> **Second, a series of consistent decisions to accomplish the objectives of that statement.**

Southern and Al-Shuaibi's definition of manufacturing strategy encompasses many specifications. These are as follows:

1. It emphasises the formulation of objectives (ends) through using "a statement of tasks", that is, the tasks that the manufacturing function must accomplish, as expressed by Skinner (1985).
2. It implicitly indicates the implementation of plans and resources allocation (means) through using "a series of consistent decisions."
3. It defines strengths and weaknesses (internal environment) as well as opportunities and threats (external environment) in search for a competitive advantage.
4. It involves the participation of all levels of strategies (corporate, business and functional levels).
5. It indicates that the implementation of a strategy takes the form of a process (i.e., a series of consistent decisions).

On the basis of the above specifications, this study adopted the definition of Southern and Al-Shuaibi (1990) as a working definition of manufacturing strategy.

2.2 MANUFACTURING STRATEGY LITERATURE DEVELOPMENT

Skinner is considered a pioneer in highlighting the issue of manufacturing strategy. In his article, Manufacturing-Missing Link in Corporate Strategy, Skinner (1969) postulated that manufacturing considerations were "missing" in the formulation of corporate strategy. He stressed the need to link manufacturing into business and corporate strategies, so it can be managed from a strategic level in order to be used as a competitive weapon in the business. Thus, the name manufacturing strategy emerged. It is worth noting that Skinner describes the firm's manufacturing function as either a competitive weapon or a corporate millstone. A major reason for neglecting manufacturing in the formulation of corporate strategy is top management's traditional view of manufacturing as an engineering's job (Skinner, 1969). Another reason in this regard, is the traditional reactive behaviour of the Production Manager as a representative of the manufacturing function (Hill, 1985). Such behaviour has developed into a role for the production manager.

Following Skinner's pioneering work, several writers as well as researchers have enthusiastically endorsed managing manufacturing at a strategic level. Writers and researchers in the field of manufacturing/operations management have agreed that there are essentially two categories of decision leading to manufacturing strategy (Skinner, 1969, 1978, 1985; Hayes and Schmenner, 1978; Wheelwright, 1978; Buffa, 1984; Hayes and Wheelwright, 1984; Wheelwright, 1984; Cohen and Lee, 1985; Fine and Hax, 1985; Hill, 1985, 1991; Schmenner, 1987; Hayes et al., 1988; Macbeth, 1989). These two categories are structural and infrastructural decisions; the former relate to building and equipment and the latter relate to people and systems (see Figure 2-1).

Decisions in these two categories and in particular in the infrastructure category should be consistent with each other to promote manufacturing in four competitive priorities (known as manufacturing task): cost, quality, flexibility and delivery. These competitive priorities are called the content of manufacturing strategy by the contributors of MS (e.g., Skinner, 1978; Hayes and Wheelwright, 1984; Hill, 1985; Schroeder et al., 1986). Therefore, manufacturers have the opportunities to compete in all these four priorities rather than being evaluated on the basis of cost and efficiency only (see section 2.4.1). The empirical work of De Meyer (1986), Schroeder et al. (1986), Swamidass (1986), Roth (1987), Miller et al. (1989) and Roth et al.(1989) are examples of manufacturing strategy content.

On the other hand, addressing how decisions are reached in the organisation in respect of the manufacturing function (e.g., selecting a low price strategy) is called the process of manufacturing strategy (Leong et al., 1990). The empirical work of Schroeder et al. (1986), Anderson et al. (1990) and Voss (1990) are examples of manufacturing strategy process.

Figure 2-1: Manufacturing strategy decision categories

A - Structural Category

1. Facilities
2. Choice of process
3. Capacity
4. Vertical integration

B - Infrastructural Category

5. Workforce
6. Quality
7. Production planning/materials control
8. Organisation management
9. New products development
10. Performance systems

Sources: Hayes and Wheelwright (1984:31)
: Hayes et al. (1988:351)

To facilitate the process of manufacturing strategy, various models were developed. A "top-down" model set up by Skinner (1969), consists of 15 steps. A "bottom-up" model was developed by Wheelwright (1978). Of these two models, the "top-down" is the dominant view (Leong et al., 1990). A "loop-framework" model by Hill (1985), consists of 5 steps. These three models illustrate clearly that manufacturing strategy implementation is an iterative process (Macbeth, 1989; Voss, 1990).

Because manufacturing strategy is in its infancy, research in both content and process is still needed (Adam and Swamidass, 1989; Anderson et al., 1989; Leong et al., 1990). In fact, this is an important missing theme in the literature as reported by Adam and Swamidass (1989: 190), which states that "operations strategy research needs distinct research streams investigating strategy content and strategy processes."

While "the frameworks of manufacturing strategy have been well developed" (Voss, 1989: 3), the area is not well investigated in detail by researchers and practitioners. Measurement of the competitive priorities as well as the conflict over the "trade-offs" notion, for instance, are among the top issues that need further research. The present study prominently highlights the controversy over the "trade-offs" notion theoretically and empirically.

2.3 GUIDELINES FOR A COMPREHENSIVE STRATEGY

Before presenting some guidelines for a comprehensive strategy, it is important to distinguish between strategy and tactics. Strategy, as defined by writers in the business policy field, is concerned with the development of organisation's objectives as well as the allocation of resources (Chandler, 1962; Andrews, 1980). Tactics; however, are concerned with the deployment of resources in detail (Krajewski and Ritzman, 1987; Schultz et al., 1987). In other words, tactics follow the development of strategy (Schroeder, 1989).

It is worth noting that the word "strategy" emanated from the Greek

Military term "strategos", meaning literally the general art (Hayes and Wheelwright, 1984). From a military point of view, the term means defeating the enemy at the lowest cost of your own side (Macbeth, 1989). From a management point of view, strategy should lead the company to be unique among its competitors in the market place.

In a recent work on strategy, Hax and Majluf (1988), after reviewing several definitions of strategy offered by leading scholars in the field of business policy, provided what is similar to guidelines for a comprehensive strategy. These guidelines indicate that a strategy should satisfy five criteria:

1. **Define and determine long term objectives, action programmes and resources allocation priorities.**

This emanates quite explicitly from the definition of Chandler; the initiator of the work of strategy (Schendel and Hofer, 1979).

> **Strategy** is the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals (Chandler, 1962: 16).

This definition emphasises the formulation of goals and objectives (ends) as well as the implementation of courses of action and resources allocation (means) to accomplish these ends. It is important to mention that both ends and means were recognised in the adopted definition of manufacturing strategy (see section 2.1).

2. **Search for a competitive advantage.**

> **Competitive strategy** is the search for a favourable competitive position in an industry, the fundamental arena in which competition occurs. Competitive strategy aims to establish a profitable and sustainable position against the forces that determine industry competition (Porter, 1985: 1).

Accordingly, the main thrust of strategy is the search for a competitive advantage. That is, strengths within the organisation, if utilised, gives the organisation a favourable competitive position in the industry. In a manufacturing strategy setting, manufacturers who are able to operated under low cost production, will compete under a low price strategy in the industry. The adopted definition of MS has included the search for a competitive advantage in forming the strategy.

3. **Respond to the external and internal environment of the organisation.**

> **Strategy** formulation and implementation include identifying opportunities and threats in the organisation's environment, evaluating the strengths and weaknesses of the organisation, designing structures, defining roles, hiring appropriate people, and developing appropriate rewards to keep those people motivated to make contributions (Argyris, 1985: 1).

This definition explicitly indicates the two stages of process, namely formulation and implementation. In the formulation stage, strengths and weaknesses as well as opportunities and threats are included. In the implementation stage, organisation's structure, resources and people are involved. strengths and weaknesses as well as opportunities and threats were included in the definition of manufacturing strategy of Southern and Al-Shuaibi (1990).

4. **Determine the economic and non-economic contributions it intends to offer to stakeholders (e.g., shareholders, employees, managers, suppliers, customers).**

> **Corporate strategy** is the pattern of decisions in a company that determines and reveals its objectives, purposes, or goals, produces the principal policies and plans for achieving those goals, and defines the range of businesses the company is to pursue, the kind of economic and human organisation it is or intends to be, and the nature of the economic and non-economic contribution it intends to make to its shareholders, employees, customers, and communities (Andrews, 1980: 18).

This is a rich and a popular definition of strategy. It includes ends, means, range of businesses, and economic and non-economic contributions. More importantly, it indicates that the process of strategy takes the form of a pattern of decisions. The adopted definition of MS has indicated that the process of the strategy involves a series of consistent decisions to achieve the objectives.

5. **Involve participation of all levels of strategy (see section 2.4.2).**

The purposes of the foregoing definitions of strategy are twofold:

1. To examine in depth the adopted definition of manufacturing strategy in the light of these strategy definitions that collectively form a comprehensive definition of strategy. The examination reveals that the adopted definition of

manufacturing strategy clearly represents a comprehensive definition.

2. To synthesise a manufacturing strategy model.

2.4 THE MANUFACTURING STRATEGY MODEL

In this section a manufacturing strategy model which is a synthesis of several disciplines is developed. The model is based on manufacturing/operations management literature, organisational theory literature and business policy literature. Both Anderson et al. (1989) and Leong et al. (1990) have recommended integrating well established concepts of organisation theory and business policy literature into manufacturing strategy to further the level of understanding.

Figure 2-2 illustrates a comprehensive model for manufacturing strategy. The model consists of organisational environment, corporate and business strategies, manufacturing task statement, manufacturing task, the role of the production manager, structural and infrastructural categories of decision and finally organisational performance. Because of the importance of the manufacturing task in understanding MS, it will be discussed first.

2.4.1 Manufacturing Task

The concept of "task" links manufacturing with corporate strategy to create a competitive weapon of the manufacturing function (Skinner, 1978, 1985). Skinner defines the manufacturing task statement as "a clear and explicit concept of what the manufacturing function must accomplish". In other words, the manufacturing task statement is a display of the "manufacturing philosophy that relates ends and means and links them together conceptually with a total plan and its rationale" (Skinner, 1985: 85).

According to Skinner and other writers (e.g., Stobaugh and Telesio, 1983; Fine and Hax, 1985; Schroeder et al., 1986), the manufacturing task statement is translated into objectives that are more meaningful (measurable) to operations in the business level strategy, called the manufacturing task (see Figure 2-2).

It is worth noting that manufacturing task is termed differently by writers in the field of manufacturing management. Some of the terms used are: "Manufacturing task" (Skinner, 1978, 1985), "Performance criteria" (Wheelwright, 1978), "Competitive priorities" (Hayes and Wheelwright, 1984; Schmenner, 1987; Krajewski and Ritzman, 1987), "Manufacturing Mission" (Cohen and Lee, 1985), "Manufacturing Objectives" (Fine and Hax, 1985; Schroeder et al., 1986; Schroeder and Lahr, 1990), "how do products win orders in the market place" (Hill, 1985, 1991), "the Manufacturing deliverables" (Macbeth, 1989). Such a use of different terms could lead to confusion (Adam and Swamidass, 1989; Anderson et al., 1989). In this study, the terms "Manufacturing task" and "Competitive priorities" will be used interchangeably.

As mentioned at the beginning of this Chapter, there is unanimity

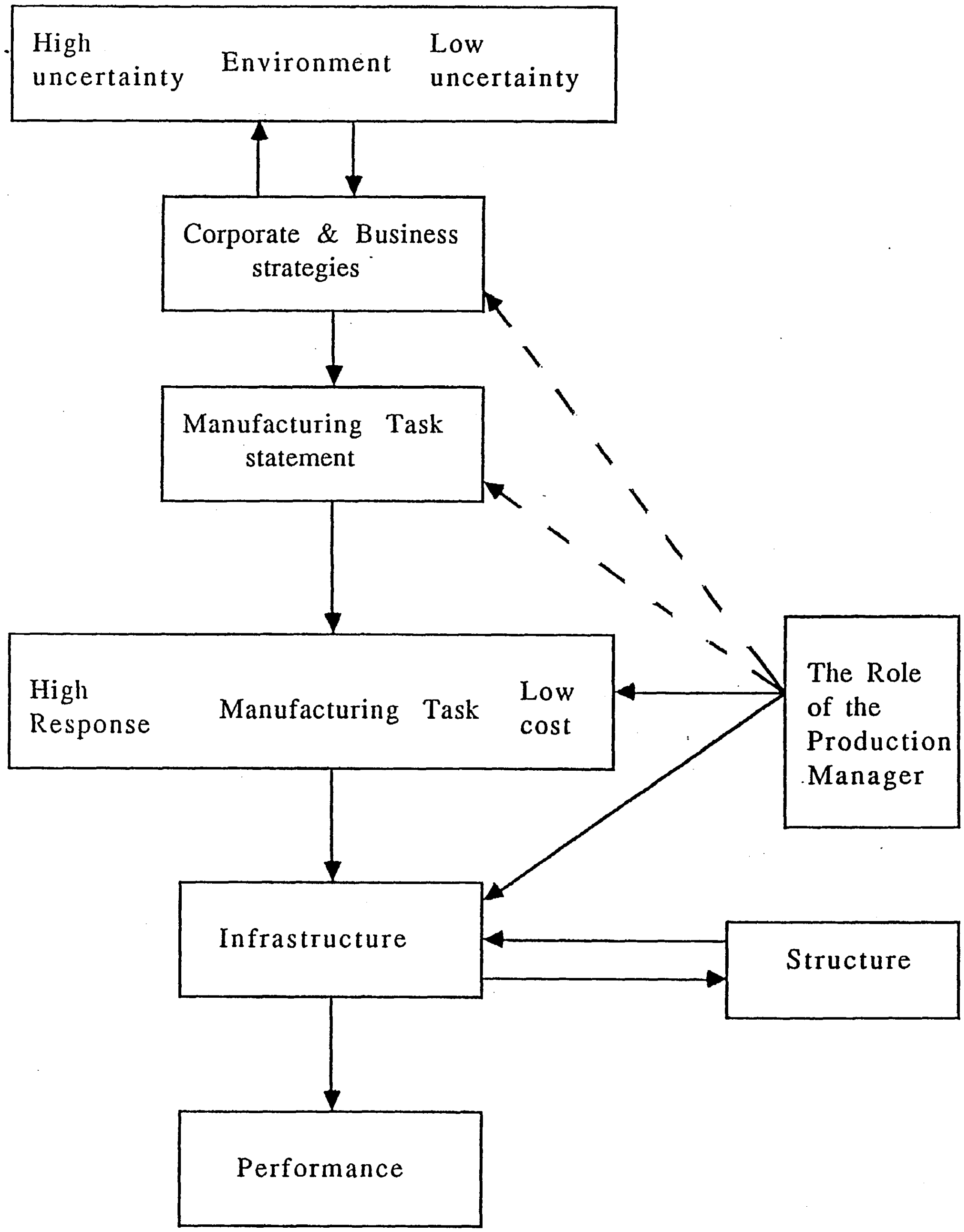

Figure 2-2 : A Manufacturing Strategy Model concerning the major elements of manufacturing task (competitive priorities) among contributors to the issue of manufacturing strategy. These elements or priorities are cost, quality, flexibility and delivery (content of MS). Accordingly, competition among manufacturers is based on these elements. Therefore, forming manufacturing task is the key to make manufacturing strategy operational. In other words, this means that selecting one (or more) competitive priority and pursuing it successfully is the organisation's manufacturing strategy (this point will be discussed further in section 2.4.5.2).

Porter (1980) has identified "overall cost leadership" as one of the three generic strategies, the other two are "differentiation" and "focus". Product differentiation means uniqueness (Porter, 1980). Uniqueness can be accomplished through quality (e.g., Rolls Royce, Jaguar, Mercedes Benz), flexibility (e.g., rapid design changes in the product) and delivery (e.g., fast delivery time in filling customers orders) (see Figure 2-3). The concept of focus means concentration on few tasks so as to avoid complexity (Skinner, 1974). This concept offers a major contribution to the issue of manufacturing strategy and will be discussed in section 2.4.5.1 a.

The content of the generic strategies is somewhat similar to the content of manufacturing strategy. The three generic strategies were identified to deal with the five competitive forces that determine the underlying structure of an industry (Porter, 1980). These competitive forces are:

1. threats of newcomers.
2. bargaining power of buyers.
3. bargaining power of suppliers.
4. threats of substitute products.
5. extreme competition among existing organisations.

As reported by Porter, the structure of an industry influences profitability as well as competition and more important the formulation of strategy in the industry. One could say that as well as providing a competitive advantage for the organisation, manufacturing strategy also copes with the five competitive forces mentioned above.

Terry Hill (1985) contributes to the discussion on competitive priorities by outlining the difference between qualifying and order-winning criteria in the market. A qualifier can be one of the competitive priorities or a part of one of them (e.g., a product's features) over a period of time. It allows the product to enter or to stay in a certain market over a period of time in order to be ready to compete with other products on the basis of the order-winning criteria. For instance, high quality for a specific product in a certain market over a period of time could be a qualifier, whereas low price is the order-winning criterion. Hill adds that while it is advantageous for a qualifier to move forward to be an order-winning criterion, manufacturers should be aware of the situation when the order-winning criteria move to the opposite direction to become order-losing criteria. Managers in some

Figure 2-3 : Refined list of competitive priorities

Priorities	Definition
Cost	Low price.
High performance design	Superior features, tolerances, and long life.
Consistent quality	Meeting the design specifications.
Product flexibility	Offering customised products, new products, and rapid design changes in the products.
Volume flexibility	Offering rapid volume changes in the rate of production to handle large fluctuations in demand.
On-time delivery	Meeting delivery time promises.
Fast delivery	The time between receiving the order and filling it.

Source: Krajewski and Ritzman (1987:43-47)

situations, for example, may be encouraged to increase the price of a certain product to qualify it for competition with other foreign products which are offered in high prices. This indicates the importance of integrating the marketing and the manufacturing functions to deal with the issues of qualifying and order-winning criteria. These changes on the issues of qualifying and order-winning criteria indicate that the content of manufacturing strategy is dynamic and several writers have pointed out that strategy is dynamic (e.g., Hofer et al., 1984; Macbeth, 1989). Empirical studies are needed in this area. The literature overwhelmingly neglects highlighting this issue, the work of Macbeth (1989) is an exception. However, the review of the literature concerning competitive priorities indicates that the **"trade-offs"** notion is a crucial issue that should be considered prior to the qualifying and order-winning criteria or at least simultaneously.

The trade-offs notion - proposed by Skinner (1969) - implies that achieving one competitive priority (e.g., low cost) means trading off the advantages of the other priorities (quality, flexibility and delivery). This can be inferred from the following statement made by Skinner (1969: 138):

> A lack of awareness among top executives that a production system inevitably involves trade-offs and compromises and so must be designed to perform a limited task well, with that task defined by corporate strategic objectives.

In a more specific statement, Skinner (1969: 140) says:

> The variables of cost, time, quality, technological constraints, and customer satisfaction place limits on what management can do, force compromises and demand an explicit recognition of multitude of trade-offs and choices.

In other words, Skinner says, it is difficult for manufacturers to compete in cost, quality, flexibility and delivery simultaneously, assuming there is no slack in the production system (e.g., underutilisation of capacity). The literature suggests that most contributors to the issue of manufacturing strategy have accepted the trade-offs notion, which is depicted in Figure 2-4. The Figure shows that competing with quality means at least trading-off cost, while competing with flexibility means at least trading-off delivery.

Recently, the trade-offs notion has come under attack. The era has witnessed some companies that became able to defy the trade-offs notion. To name a few, Yamazaki machine tool plant in the United Kingdom manufactures four times more models in the third of the industry time average with quality that beats or at least matches the high Japanese standard (Jones et al, 1988). Nippon Denso's radiator plant in Japan can shift from one model to another without jeopardising efficiency. Apple Computer's Cork plant, in Ireland, can assemble several models of computers together on the same assembly line without "changeover penalty" (Ferdows and De Meyer, 1989). These are examples of many of the excellent manufacturers in the world that follow "a distinct sequence of improvement programmes which aim at building one capability (competitive priority) upon and not instead of another" (Ferdows and De Meyer, 1989: 3).

Surprisingly, even a recent literature review on manufacturing strategy fails to cast doubt upon the trade-offs notion (Adam and Swamidass, 1989). The work of Anderson et al. (1989) is an exception of this. The authors remark: (p. 138)

> Recently, trade-offs have been called into question as operations are being designed which have better quality, lower cost and faster delivery than the competitors. These operations have moved to a new level of performance rather

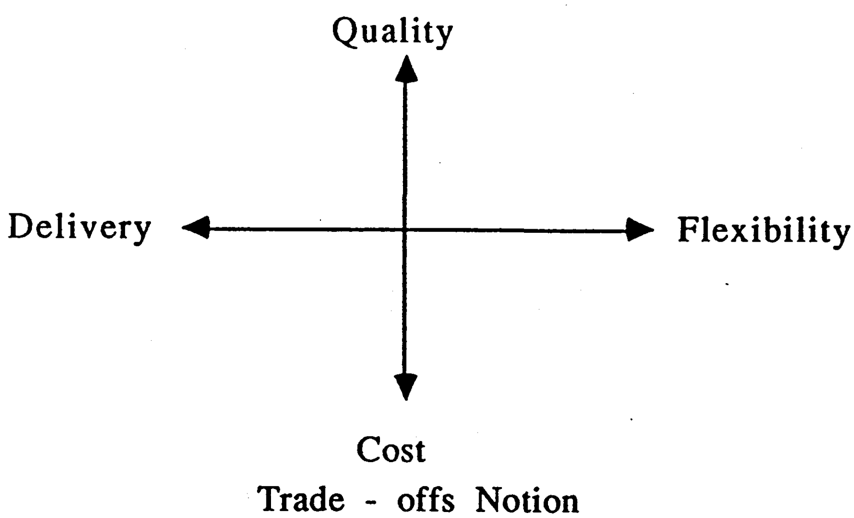

Figure 2-4 : The Western Model (Adopted from Wheelwright, 1981)

> than making trade-offs on an existing level. Because of these new insights, the exact nature of trade-offs is no longer clearly understood. More research needs to be done to clarify the precise nature of trade-offs in operations.

Ferdows and De Meyer (1989) propose that the best view of competitive priorities (i.e., the trade-offs notion) stems from the Japanese model. The Japanese view of the competitive priorities model can be read in the statement of Jinichiro NaKane - a researcher at Waseda University, Tokyo - (Ferdows and De Meyer, 1989: 7).

> In general, if some (Japanese) companies want to offer flexibility as a competitive priority, it is necessary that at least they have already qualified for a minimum level of abilities on quality, dependability (delivery) and cost improvement. If they have not such an ability, they get a chaos condition and end tragically.

The above observation means that the Japanese model with regard to competitive priorities is a "cumulative" model (see Figure 2-5), that is, moving to build another competitive priority when securing the previous one. The Japanese cumulative model, starts with quality; then has quality and delivery; then quality, delivery and cost efficiency and finally all the previous three plus flexibility (Ferdows and De Meyer, 1989). The western model, in contrast, starts with any competitive priority that the plant is capable of at best which builds one priority at the expense of the other priorities (Skinner, 1985). Considering trade-offs between the competitive priorities implies that the operations strategy is not strategic. According to Wheelwright (1981:72), "an operations policy becomes strategic when it avoids the acceptance of false dichotomies like cost versus quality."

Ferdows and De Meyer have slightly modified the Japanese cumulative model in the sense that they consider cost efficiency to be the last competitive priority to be achieved (flexibility comes before cost). They justify their modification by saying because "cost improvements remain the ultimate goal of most manufacturers, (they) see these cost improvements also as an ultimate consequence of resources and management efforts invested in the improvement of quality, dependability and reaction speed of the company" (Ferdows and De Meyer, 1989:7). Although their justification is tenuous, the model itself as building up priorities is highly needed. The model, which Ferdows and De Meyer (1989) have called the "Sandcone" model as seen in Figure 2-6, is derived from the process of building up priorities. Ferdows and De Meyer's work (1989) is supported by several writers

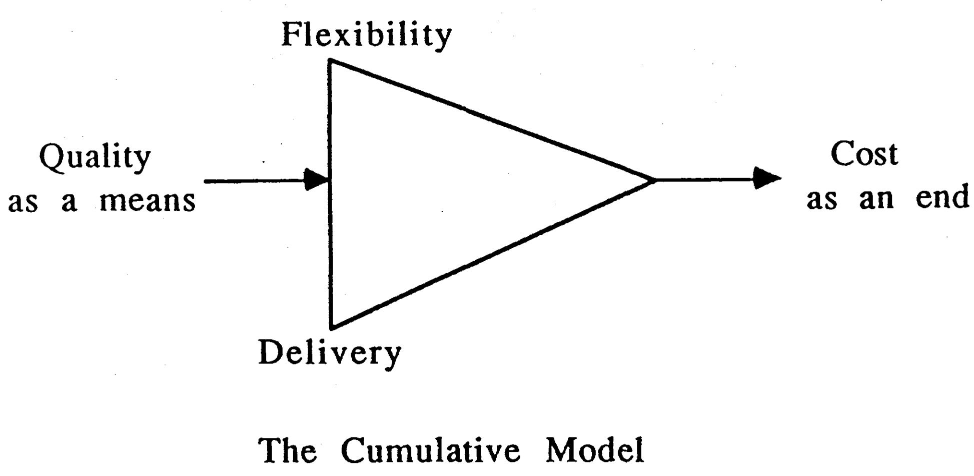

Figure 2-5 : The Japanese Model
(Adopted from Wheelwright, 1981)

and researchers who suggest making analogies between the Japanese and western philosophies in order to gain a better understanding of manufacturing strategy (Bolwijn and Brinkman, 1987; Pendlebury, 1987; Schmenner, 1987). Wheelwright (1981), also, offers a comparison between the Japanese and the western approaches regarding competitive priorities.

Ferdows and De Meyer (1989) investigated the Sandcone model empirically. Their investigation resulted mostly in questioning the trade-offs notion besides validating the model to a certain degree. Thus, one could say that the relationship between/among competitive priorities should be based on a linkages notion rather than the trade-offs notion.

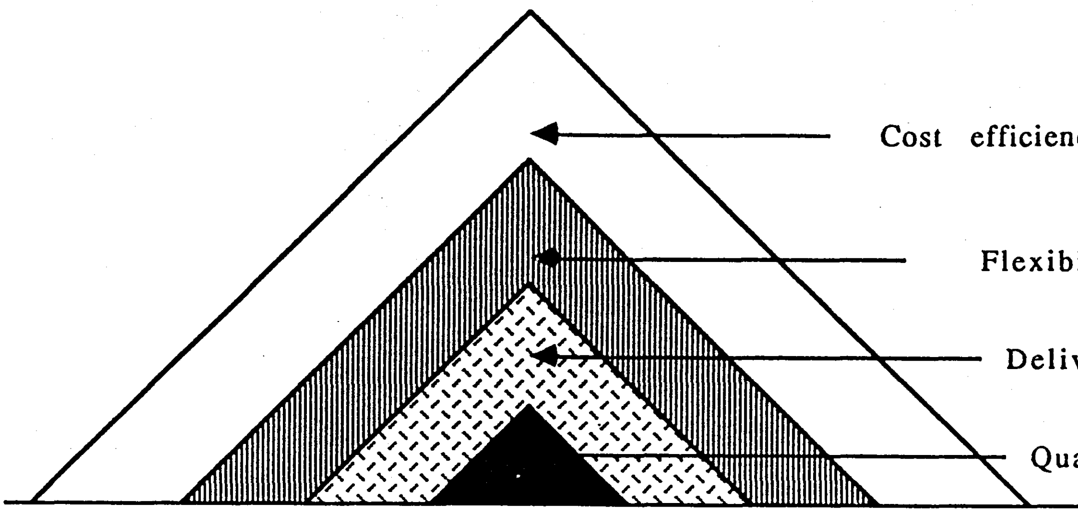

Figure 2- 6 : Sandcone Model
(Adopted from Ferdows & De Meyer, 1989)

The researcher takes both the Japanese cumulative model and the Sandcone model one step further to support their validity. The validity of these two models can be better understood in light of the product life cycles concept. As it is well known, the product life cycles consists of four stages: introduction, growth, maturity and decline (e.g., Hayes and Wheelwright, 1984; Hill, 1985). It is at the beginning of the growth stage that manufacturers emphasise quality and delivery to keep up with demand, and it is towards the end of the maturity stage that manufacturers stress low cost and flexibility so as to ease the pressure from the competitors. This again means that competitive priorities are <u>built</u> on each other, rather than replacing each other.

It must be mentioned that both the Japanese and the Sandcone models neglect the capabilities of the production function because of the sequential order in achieving competitive priorities.

As mentioned earlier, because Ferdows and De Meyer's justification for modifying the Japanese cumulative model (i.e., cost is the last competitive priority) is weak, the researcher believes that the perspective regarding competitive priorities should be on the basis of the Japanese cumulative model (i.e., flexibility is the last competitive priority). For it is costly to switch to different types of flexibility. In other words, when production cost is down, manufacturers can achieve flexibility. This involves:

1. offering customised products.
2. introducing new products.
3. offering rapid changes in the product.
4. offering rapid volume changes in the rate of the production (see Figure 2-3).

To sum up the arguments about the Japanese cumulative model and the Sandcone model, one should point out that both models are far better than the trade-offs notion. Furthermore, the difference between these two models in their second part should be settled in the light of the benchmarking concept (see section 2.4.6). In other words, it is time for academicians to discuss the two models with those world class companies that have shown successful records in accomplishing all competitive priorities simultaneously.

Working independently of the above two models, Roth (1987) empirically identified three types of strategies; product focus, delivery / flexibility, and price, that could be achieved over a period of time (five years) through several programmes (activities). She failed to mention whether there is a slack in the system or not. As pointed out in the discussion earlier, if there is slack in the system it would be easier for these companies to accomplish all these strategies simultaneously. On the other hand, assuming there is no slack in the system, if these companies (and others) became able to achieve these strategies simultaneously, this would support the Japanese cumulative model as well as the Sandcone model.

Several researchers and writers have expanded and refined the four competitive priorities, though these refined priorities can still be classified within the original competitive priorities (De Meyer, 1986; Roth, 1987; Krajewski and Ritzman,1987). Each competitive priority with the exception of cost is split into two dimensions as shown in Figure 2-3 (some writers refer to fast and on-time delivery as speed and reliability delivery respectively (Hill, 1985)). The purpose of having these competitive priorities in this form is to ensure accuracy in measurement (Krajewski and Ritzman, 1987). Accordingly, each competitive priority is viewed by management as a continuum of low and high function. For example, managers make their company's objective with regard to fast delivery to be one of the shortest or one of the longest in the industry.

The list of competitive priorities was investigated empirically by several researchers. In a survey of three regions - Europe, North America, Japan - conducted in 1983 and replicated in the subsequent year, managers of each region were asked to rank the seven competitive priorities depicted in Figure 2-3, plus "after-sales service" in order of importance (Ferdows et al., 1986) (the same survey for 1983 alone is reported by Krajewski and Ritzman (1987), and McClenahen (1987)). Ferdows et al.'s study revealed some differences in terms of priorities ranking between the Japanese on one side and the Europeans with the Americans on the other. The Japanese ranked low price first in the list then rapid design changes in the product for 1983 and 1984. The Europeans and the Americans, on the other hand, ranked consistent quality first in the list then high performance design for both years. This means that while the Japanese relatively had already won a quality and delivery and are now aiming at competing in low price and product flexibility, the Europeans and the Americans are now aiming at winning a quality and delivery (Ferdows et al., 1986).

The result of the above study is confirmed by a manufacturing futures survey (De Meyer et al., 1989) which found that the Japanese still postulate low price at the top of their list of important priorities, followed by flexibility. The Europeans and the Americans, on the other hand, are still working on quality and delivery. In view of the time elapsed between the two studies (Ferdows et al., 1986; and De Meyer et al., 1989) one can conclude that it takes time to accomplish a certain competitive priority. Interestingly enough, De Meyer et al. (1989) reported that the Europeans and the Americans had come to agree with the Japanese that quality is the first priority to be achieved.

The above two empirical studies (Ferdows et al., 1986; and De Meyer et al., 1989) support the Japanese cumulative model and lend some support to the Sandcone model.

The continuous development of manufacturing strategy provides new perceptions of competitive priorities. From 1988 several writers begin to highlight "time" as a Major Asset for competitive priorities (Bower and Hout, 1988; Istvan, 1988; Stalk, 1988). They present many examples of Japanese and western companies which reduced timescales in almost all the production and related functions. These companies, for example, became able to develop new products faster and to deliver existing products in shorter time than they used to. So, is the concept of time-based competition just concerned with performing tasks faster? The chief executive of a major Italian company, Olivetti, expresses the essence of the concept in the following statements (Azzone et al., 1990: 428).

> Getting competitive advantage through time does not really mean doing faster the same things with the same organisation. The result would be just chaos and worse products. Managing time effectively means rethinking the structure of organisations in a new way.

This means reorganising the company in a way that will lead to a competitive time advantage in every aspect of it, and more important having an instant information system to allow managers to make decisions faster. Empirical evidences, however, are required in this area.

The concept of "time-based competition" has something in common with the qualifying and order-winning criteria which are suggested by Hill (1985). Both use time as a tool for competition. In the former (i.e., the qualifier), time is employed as an external competitive advantage, while, in the latter (i.e., time-based competition), time is used as an internal competitive advantage.

2.4.1.1 Measurement Of Competitive Priorities

Manufacturing strategy is still at its early stage of development and measurement of competitive priorities is at the same stage. Practitioners and academicians alike need to know what variables represent each competitive priority. Practitioners, in particular, need to know these measures in order to devote time, effort and resources to gain these competitive priorities. In the literature some measures are proposed for competitive priorities, but they lack empirical support (Leong et al., 1990). Recently, in an intensive study of measurement, Sharma (1987) was able to verify measures for only three of the competitive priorities listed in Figure 2-3. The following are discussions of these measures.

(i) Cost is measured by the unit cost of production, labour, material; inventory turnover (raw materials, work-in-process, finished goods); capacity utilisation; and capital productivity (Fine and Hax, 1985). Sharma (1987), using a sample of 121 firms, confirmed that production cost, labour productivity, capacity utilisation and productivity are measures of cost. Wheelwright (1978) has proposed return on investment and return on sales in addition to inventory turnover as measures of cost.

(ii) Quality is measured by internal failure cost (percentage of scrap/rework & percentage of defective/rejected products); external failure cost (frequency of failure in the field); and mean time between failure (Garvin, 1983; Fine and Hax, 1985). Furthermore, supplier quality was found to be a measure of quality (Leong et al., 1990). In a recent study, Sharma (1987) found that product performance, product durability and product technology are measures of high-performance design. Sharma also found that product reliability, conformance to design, improving manufacturing quality, percentage of scrap and rework are measures of quality consistency.

(iii) Flexibility is measured by new products, product mix, product customisation and adjusting volume fluctuations (Slack, 1983; Fine and Hax, 1985).

(iv) On-time delivery (dependability) is measured by the percentage of on time delivery promises (Wheelwright, 1978; Hayes and Schmenner, 1978; Slack, 1983; Fine and Hax, 1985). Fast delivery (speed), on the other hand, is measured by delivery lead time (Krajewski and Ritzman, 1987; De Meyer et al., 1989).

2.4.2 Corporate And Business Strategies

In order to put manufacturing strategy in perspective, it is important to recognise its position in the various levels of organisational strategies.

A three level hierarchy of organisational strategy has gained widespread acceptance among the writers in business policy (Christenson et al., 1982; Schendel and Hofer, 1979; Hofer et al., 1984). The three levels of strategies are summarised as follows:

a) **Corporate Level Strategy** is concerned with two questions; (1) What business(es) should an organisation be in ? and (2) How should it designate resources among those businesses ?

Much attention has recently been given to the second question due to its importance, especially when the organisation operates in more than one business. Chandler (1962) was the first to include "allocation of resources" in his definition of strategy. The first question received a great deal of attention when the trend was to add new businesses in the early 1960s (Hofer et al., 1984).

b) **Business Level Strategy** deals with the question ; How should an organisation compete in its selected businesses ?

c) **Functional Level Strategy** is concerned with two questions; (1) How should an organisation incorporate its subfunctional activities such as manufacturing, marketing, finance and human resources ? and (2) how should it relate the policies of these functional areas to the changes occuring in the external environment of the organisation? (e.g., product flexibility).

From this description of the levels of strategies it is obvious that manufacturing strategy is viewed as part of the functional level strategy, and therefore as one of the components of corporate and business strategies. In a successful organisation, functional strategy should support business strategy which in turn support corporate strategy. If manufacturing strategy (MS) is one of the components of corporate and business strategies, there must be an influence and interaction of these two levels on it.

2.4.2.1 Corporate Strategy And MS

Few writers and researchers in the field of manufacturing management have suggested how corporate strategy influences manufacturing strategy. Hayes and Schmenner (1978) suggest that corporate strategy influences manufacturing strategy through three factors: dominant orientation (e.g., market, product); pattern of diversification (e.g., market-geographic or consumer); and perspective on growth (e.g., product or market).

From the comprehensive definition of strategy (guideline no. 3), a fourth factor could be added to those suggested by Hayes and Schmenner. Corporate strategy influences manufacturing strategy through industry environment. As can be seen from the model (Figure 2-2), corporate strategy affects and is effected by the external environment of the organisation which, in turn, affects manufacturing decisions. Sharma (1987) noticed that dominant orientation, growth and industry environment are three factors which influence manufacturing strategy through corporate strategy.

The three previous factors suggested by Hayes and Schmenner (1978) and the competitive priorities form the "organisation's philosophy" (Wheelwright, 1984; Hayes and Wheelwright, 1984).

The diversification pattern represents strategic directions at the corporate level. Huete and Roth (1987) empirically linked corporate strategic directions with manufacturing strategy. In a survey of 213 managers, they identified four corporate strategic directions: integration, market selection, product innovation and market share. Using regression analysis, they found that integration and market selection relate to flexibility. Moreover, product innovation relates positively with quality and flexibility and negatively with low price. Their study failed to relate market share to any competitive priority.

2.4.2.2 Business Strategy And MS

The link between business strategy and manufacturing strategy was first proposed by Skinner (1978). Skinner introduced the notion of manufacturing task statement as a means of translating business strategy into objectives that are more meaningful to operations (see section 2.4.1). Other researchers have advocated that business strategy defines the primary objectives and task of the manufacturing function (Stobaugh and Telesio, 1983; Fine and Hax, 1985; Schroeder et al., 1986; Schroeder and Lahr, 1990).

More specifically, business strategy interacts with manufacturing strategy through competitive priorities (see section 2.4.2). That is, by defining how the organisation is planning to compete in its selected industry the business strategy guides the manufacturing function to achieve the desired competitive priority. For instance, if an organisation is planning to compete on a low price strategy, the business strategy guides the manufacturing function to support all the channels that lead to cost reduction. In Figure 2-2 business strategy is linked with the manufacturing task statement and the latter, in turn, is connected with the competitive priorities (manufacturing task).

In an empirical study of 39 companies Schroeder et al. (1986) found that product, price, delivery and operations are elements of business strategy. Although this sample is somewhat small, the results have strong implications for manufacturing strategy. This study clearly supports earlier studies concerning elements of business strategy.

In a study of 64 companies in eight industries, Hall (1980) found that low costs and quality are two indicators of success in competitive industries.

Schoeffler et al. (1974), in an extensive empirical study on "the Profit Impact of Market Strategies (PIMS)" involving 57 corporations with 620 diversified businesses, found several major determinants of profitability. The study found that market share, quality, investment intensity (total investment to sales) and company factors (e.g., size & diversity) are significant determinants of profitability (ROI).

The above three empirical studies reported that low cost, quality and delivery are elements or competitive weapons of business strategies. Since "business strategy is usually evaluated in terms of its impact upon sales and profitability objectives" (Aaker, 1984: 175), these elements or competitive weapons are accomplishable only through manufacturing.

2.4.3 Organisational Environment

Writers on organisation theory have taken two approaches to the study of organisations: a "closed system" and an "open system" approach. As closed systems (a classical approach), organisations are closed to external environment forces (Kast and Rosenzweig, 1974). In contrast, as open systems organisations are "greatly influenced by the properties of their associated surroundings" (Bedeian, 1984: 176). That is, organisations do not function in vacuum. Of these two theories, the open system is the most relevant to the study of strategy, because it affects the strategic level of the organisation (Kast and Rosenzweig, 1974). The consequences of the "open system" theory have led to the development of the "contingency" theory (Woodward, 1965; Lawrence and Lorsch, 1969). The contingency theory "seeks to understand the interrelationships within and among subsystems (of the organisation) as well as between the organisation and its environment and to define patterns of relationships or configurations of variables" (Kast and Rosenzweig, 1974: 21). Both theories established a link between the organisation and its external environment.

The significance of these theories to managers is expressed by the organisational theorists who emphasised that "organisations must adapt to their environment if they are to remain viable" (Duncan, 1972: 313). Further support to this claim came from Hall (1977: 62) when he noted that "strategic decisions are made as a response to the environment." In fact, the contingency theory, in particular, "emphasises the role of managers as a diagnostician, pragmatist and artist" (Kast and Rosenzweig, 1974: 21).

Several empirical studies found that environment is a primitive influence on strategic decision making in the organisations (Jamison, 1981). Other investigations came to the conclusion that the consistency between environment and strategy does influence performance (Bourgeois, 1980a; Prescott, 1986; Venkatraman and Prescot, 1990).

It is worth mentioning that opportunities and threats exist in the external environment of the organisation (Bedeian, 1984; Glueck and Jauch, 1984). Therefore, organisations that adapt to their external environment derive the advantage of the opportunities and / or decrease the threats of the environment or turned them into opportunities.

Organisational environment is a large and complex study area. Dill (1958) proposed the term "task environment" to refer to those parts of the organisation's external environment that are potentially relevant to organisations' goal. Bedeian (1984) provided a helpful distinction between general and task environment. The value of task environment as expressed by Bedeian (1984: 177) rests

> ... in the distinction between the general environment in which all organisations function and the more immediate environment of customers, suppliers, employees, competitors and government regulatory agencies in which individual organisations operate.

In studying the effect of task environment on strategy, researchers have focused on environmental uncertainty (Bourgeois, 1980b; Jamison, 1981). Swamidass (1983) incorporated environmental uncertainty in his study of manufacturing strategy.

In the literature, uncertainty is defined in a number of perspectives. According to the **information theory**, "the uncertainty of an event is the logarithm of the number of possible outcomes the event can have ..." (Garner, 1962: 19). In **decision theory**, uncertainty is defined as "those situations where the probability of the outcome of events is unknown as opposed to risk situations where each outcome has a known probability" (Duncan, 1972: 317). In **organisation theory**, uncertainty is caused by: lack of clarity of information concerning environmental factors; long time span for feedback; and general uncertainty of causal relationships (Lawrence and Lorsch, 1967). Of these three definitions of uncertainty, the most appropriate to the present study is that of Lawrence and Lorsch. The first two definitions are too complex for managers in manufacturing sectors.

Lawrence and Lorsch's definition means that environmental uncertainty is very important to strategy studies because it is the focal point for a company to adapt to its environment (Lawrence and Lorsch, 1967; Thompson, 1967; Duncan, 1972). The model in Figure 2-2 illustrates that environmental uncertainty affects corporate and business strategies.

The study of environmental uncertainty has been furthered by the incorporation of the dimensions of organisational environment. Two main dimensions of organisational environment can be distinguished from the work of organisational theorists: the simple-complex dimension, and the static-dynamic dimension (Emery and Trist, 1965; Thompson, 1967; Terreberry, 1968). In the simple environment, the decision maker deals with few homogeneous factors (e.g., a lower level of production unit), whereas in the complex environment he copes with many heterogeneous factors (e.g., a planning department). On the other hand, the static-dynamic dimension refers to factors that remain constant in the environment or to those that are in a continuous change respectively (e.g., production, materials and marketing departments). Accordingly, organisations that operate in dynamic-complex environments encounter high uncertainty, while those that operate in static-simple environments face the lowest perceived uncertainty (Duncan, 1972). In the model, environment stretches from one end of low uncertainty to another of high uncertainty (see Figure 2-2).

2.4.3.1 Measurements Of Environmental Uncertainty

In the literature there is a controvesy concerning the appropriate measure for environmental uncertainty (Bedeian, 1984). Lawrence and

Lorsch (1969) as well as Duncan (1972) employed a measure for environmental uncertainty based on the perceptions of top managers. Their work was questioned by Tosi et al. (1973), Downey and Slocum (1975) and Downey et al. (1975) because they failed to replicate Lawrence and Lorsch's results using objective measures. Aldrich (1979: 128) summarised the essence of the controversy in the following observations:

> The central issue is the extent to which organisational structures and activities respond to the types of objective environmental uncertainties that are partially captured in the measures of Tosi et al. or to the cognitive environment that decision makers spin for themselves out of information brought into the organisation.

Miles et al. (1974), Starbuck (1976), Weick (1977), and Manning (1982) have strongly advocated perceived measures over objective measures. The reason for this according to Starbuck, is that an organisation (via its managers) responds only to what it perceives and that perceptions may or may not reveal the objective reality of the environment. Many empirical studies continue to use perceived measures (Bourgeois, 1980b; Jamison, 1981; Boulton et al., 1982; Swamidass, 1983).

2.4.4 The Role Of The Production Manager

Skinner (1978), Wheelwright (1978), and Hill (1985) have indicated that the role played by production managers in corporate strategy is "passive or less than desirable". Their observations imply that top management often, if not always allow finance, marketing and other functional managers to play a bigger role in corporate strategy level meetings, and they expect manufacturing by itself to react to the outcomes. Hill (1985: 35) describes this situation as "can't say no" syndrome. He then points out "at this time, the production manager accepts the current and future demands placed upon the systems and capacities he controls and then goes away to resolve them". Accordingly, the role of the production manager is a reactive role (Skinner, 1978; Hayes and Wheelwright, 1984; Hill, 1985). This is why, as mentioned earlier, one of the probable causes of manufacturing neglect in the formulation of corporate strategy is the type of role played by the production manager. It has been reported that evidence of negative consequences exists for not involving production managers in the strategic planning process (Swamidass and Newell, 1987).

Skinner (1978, 1985), Hayes and Wheelwright (1984), Hill (1985) and others argue strongly that the role of the production manager should be proactive rather than reactive in the formulation of corporate strategy. Hayes and Wheelwright (1984: 41) clearly describe this role in the following statements.

> Common sense suggests that manufacturing should play an equal role with other functions in defining the competitive strategy for the business. That is, top management should consult manufacturing to get its perspective on the major issues facing the business, the strategies being proposed by other functional heads, and the options open to manufacturing.

Thus, the proactive role for the production manager is strongly needed for two main reasons. First, the production manager (as a representative of the manufacturing function) has more knowledge of the capabilities of the manufacturing function. Second, the production managers' knowledge of the virtues of manufacturing function could strengthen the competitive advantage of the company. (The second reason is also noted by Hayes and Wheelwright, 1984). On the basis of these two reasons and others, the MS definition by Southern and Al-Shuaibi (1990) was adopted. The model in Figure 2-2 shows that the production manager should participate in the development of the manufacturing task statement. Researchers have found that, in successful companies, production managers are active participants in the strategic planning process (Anderson et al., 1989). Adam and Swamidass (1989) have identified the "role of manufacturing managers" as one of the manufacturing strategy process variables. It can be concluded from the writings of Hayes & Wheelwright, Hill and Skinner that failure to include production managers in strategic planning process would weaken the strategic value of the manufacturing function. However, a proactive role for production managers requires a re-evaluation of several criteria such as their levels of education, training programmes and performance measures in order to strengthen their position against their peers (Hayes and Wheelwright, 1984; Hill, 1985).

2.4.5 Structural And Infrastructural Categories Of Decision

At the beginning of this Chapter it was stated that structural and infrastructural decisions lead to the formation of manufacturing strategy (see Figure 2-1). Structural decisions relate to building and equipment, whilst infrastructural decisions refer to people and systems. It is worth noting that, once installed, it is difficult to alter structural decisions because of the huge capital investment (Buffa, 1984; Hayes and Wheelwright, 1984; Hill, 1985; Skinner, 1985). Decisions in these two categories should be consistent with each other for a better implementation of manufacturing strategy. Hayes et al.'s view (1988) of the distinction between structural and infrastructural categories is similar to the distinction made between hardware and the software in computing.

Manufacturing strategy highlights the view of these two categories of decision as being strategic or non-strategic (operational). Prior to the introduction of manufacturing strategy, western managers treated the first four areas of decision (i.e., structural category) as being the only strategic, and the remaining areas of decision (i.e., infrastructural category) as being operational (Wheelwright,1981; Williamson, 1984). Manufacturing strategy calls for the treatment of both categories as strategic.

By treating both categories as strategic (as the Japanese do), managers, for example, will be able to "avoid a false choice between quality and cost in production operation and yet acknowledge a link, not a conflict, between short-term and long-term goals" (Williamson, 1984:18). Interestingly enough, treating both categories as strategic results in establishing a link, among competitive priorities, which supports both the Japanese cumulative model as well as the Sandcone model (see section 2.4.1).

Ward et al. (1988) empirically investigated these two categories of decision. Using factor analysis, they report nine areas of strategic concern existing in the literature that match these two categories of decision. In the next subsections both categories of decision will be discussed.

2.4.5.1 Structural Decision Category

Structural decision category includes decisions related to facilities, choice of process, capacity and vertical integration. In the next subsection, these four areas will be discussed.

a) Facilities

Facilities decisions are related to size, location and specialisation (focus).

In a major empirical study, Scherer et al. (1975) found that scale of economies, tradeoffs between production costs, transportation costs and capital costs are determinants of plant size and location. Moreover, they reported that the characteristics of the organisation's market structure (size, share, concentration) as well as the regulatory environment are important considerations in making decisions related to location and size of the plant.

In a more recent survey, using cluster analysis, Schmenner (1982a) found that location decisions are influenced by five factors. These factors are: appropriate labour climate (e.g., low labour costs, small effect of unionism); proximity to markets; attractive living style; proximity to suppliers and resources; and proximity to organisation's entire/main facilities.

The findings of both studies support each other in some factors, such as production and transportation costs, and offer a comprehensive view for dominant factors to be considered in making facilities decisions. Actually these factors are not new in the area of production/ manufacturing management. What should be new for manufacturers is a reconsideration of these factors within the perspective of manufacturing strategy. A major contribution of the perspective of manufacturing strategy to the facilities decisions came from the concept of focused factory.

Skinner (1974) was the first to introduce the concept of "focused factory" or "focused manufacturing". The concept means: (p.114)

- o Learning to focus each plant on a limited, concise, manageable set of products, technologies, volumes, and markets.
- o Learning to structure basic manufacturing policies and supporting services so that they focus on one explicit manufacturing task instead of on many inconsistent, conflicting, implicit tasks.

The concept of focused manufacturing contributes greatly to manufacturing strategy because it involves "simplicity, repetition, experience and homogeneity of tasks" which lead to competence (Skinner, 1974).

An example of reconsideration of dominant factors in making facilities decisions within the focused manufacturing concept are economies of scale. Some writers argue that economies of scale [a historical concept that says that increasing a plant size reduces the average unit cost (Krajewski and Ritzman, 1987)] is not advantageous within the concept of focused manufacturing (Cohen and Lee, 1985). Such an argument is based on the face value of the definition of economies of scale. Economies of scale can be utilised by building "plants within plants" which yields focused manufacturing (Skinner, 1978; Krajewski and Ritzman, 1987). Many large firms have changed their large facilities into smaller ones. For instance, General Electric Aircraft Engine Group has modified its two large complexes into eight smaller plants (Krajewski and Ritzman, 1987).

But economies of scale, as reported by Scherer et al. (1975) and Schmenner (1982a), is not the only factor that dominates facilities decisions; it is one of a host of factors. Facilities could be focused in a number of ways. In an empirical study drawn from over 300 plants, Schmenner (1982b) identified four multiplant manufacturing strategies that can be taken to partition responsibilities among plants. These are: A Product Plant Strategy, A Market Area Plant Strategy, A Process Plant Strategy, and A General Purpose Plant Strategy.

In conclusion, consideration of facilities decisions within the perspective of manufacturing strategy could assist the manufacturing function to be a competitive weapon.

b) Choice Of Process

Process decisions are associated with the choice of manufacturing technology, and this involves the selection of one or more than one (hybrid) of the types of processes. The well known types of processes are: job shop, large batch, project, assembly line and continuous process (Hayes and Wheelwright, 1984; Hill 1985; Schmenner, 1987). The criteria of selection of these processes depend largely on the activities of the plant. For example, continuous process - as the term implies - suits plants in the food and petrochemical industries.

The relationship between process and product has been discussed by Hayes and Wheelwright (1979a and 1979b) and is best captured by the product-process matrix. They suggest that the type of process must match the characteristics of the product. Hayes and Wheelwright argue that as products are standardised, production volumes increase and organisations shift towards assembly line and continuous processes. Using the product-process matrix, they identify four entrance-exit strategies for the businesses.

Top management has been criticised for leaving process decisions to engineers and process specialists. Top management's act is based on the assumption that engineers and process specialists are the "custodians" of technology (Hill, 1985). In so doing, top management waives an important decision that can strengthen the manufacturing function.

In a famous article, Hayes and Abernathy (1980) argue that the decline of the American economy is the result of poor technology and management leadership. They accuse management of failing to use aggressive new technologies to beat competition; therefore, they managed their way to economic decline. In the same article, Hayes and Abernathy remark that the European and Japanese managers have gained competitive success through technological superiority.

To gain competitive advantage over competitors, the layout of the manufacturing technology (positioning strategy) should be either on product or process (Hill, 1985; Krajewski and Ritzman, 1987). Much research has been done on the relationship between strategy and product (Schmenner, 1982b; Stobaugh and Telesio, 1983; Meyer and Roberts, 1986). In contrast, little research has been undertaken on making the process of technology an integral part of strategy (Anderson et al., 1989).

Voss (1985) outlines eight propositions concerning the impact of new manufacturing technology on organisations. One proposition alleges that full advantage of technology will be possible if there is a match between the manufacturing priorities of the organisation and the capabilities of the technology. Another proposition says that the aim of employing new technology should be to make the organisation more competitive rather than simply more productive. Thus, technology in this aspect reflects what manufacturing strategy calls for.

Skinner (1985) points out that investment in manufacturing equipment and process technology can benefit the organisation in many areas apart from achieving low costs. Some of these benefits are superior quality, fast delivery, lower inventories, shorter new product development cycles and new production economies.

Goldhar and Jelinek (1983) point out that economies of scope, sharing resources among production lines to decrease costs, can be gained by using new technologies [e.g., computer-aided design (CAD), computer-aided manufacturing (CAM), Robotics]. In subsequent articles, Goldhar and Jelinek (1985) and Goldhar et al. (1990) provide more support to this concept and suggest that new technologies should be included in the strategy. Macbeth (1989), Paul and Suresh (1990) and Tranfield et al. (1990) have also indicated that such technologies can lead to cost reduction as well as better quality design in addition to reduction in lead time.

However, the adaptation of new technologies has been moving slowly due to several factors; implementation problems, capital investment, and the anticipated improvements in productivity (Cohen and Lee, 1985). Concerning "anticipated improvements in productivity", it is worth noting that the introduction of manufacturing strategy requires managers to think strategically; i.e., to think in terms of "effectiveness" rather than "efficiency" (see section 1.1).

In a survey of 30 organisations, Voss (1986) reports that a conflict of objectives frequently occurs in the implementation of advanced manufacturing technology. He states that in a few organisations the selection and the design of the systems were made in respect of business objectives such as quality and responsiveness to the market, but were managed with regard to technical objectives. In the majority of the cases, however, the technical control criteria were in direct conflict with the business objectives.

Swamidass (1987) stresses the need for planning technology. Planning for manufacturing technology involves evaluation of deterioration in technology over time. Swamidass argues that there are two cases for modernising technology to sustain the competitive advantage. In the first case, it is required when technology becomes too old to give a competitive edge. In the second case, technology must be modernised when product or market undergoes major changes. Both cases, especially the first, can be noticed by management, but capital investment in technology is a serious commitment. Swamidass suggests using technology characteristics curves to compute when technology is due for modernisation, but he fails to specify how technology should be modernised in the second case.

c) Capacity

Capacity decisions are highly related and determined by facilities, technologies and human resources decisions (Fine and Hax, 1985). Capacity is defined as "the maximum rate of output for a facility" (Krajewski and Ritzman, 1987:250).

Many writers in the area of production management have pointed out that in any plant capacity takes one of three states over a period of time: to be increase, stabilisation or decrease. Krajewski and

Ritzman (1987) have stressed only internal reasons for these states such as ineffective maintenance programmes and ineffective systems in replacement of parts and equipment. An important external reason for the three states of capacity is the demand in the market.

Significant capacity decisions involve planning for long term underlying trends in demands, and also retaining flexibility in capacity to cope with short term fluctuations in demand (Wheelwright, 1978; Fine and Hax, 1985). Several writers (e.g., Hayes and Wheelwright, 1984; Fine and Hax, 1985) mention that capacity decisions should be used to affect the competitors'capacity decisions, but none of them had suggested how to achieve this.

Hayes and Wheelwright (1984:46) distinguish between a capacity decision and a capacity strategy. A capacity decision involves "a capital authorisation request for an expansion of capacity", whereas a capacity strategy "places each capacity decision in the context of a longer-term sequence of such decisions". Krajewski and Ritzman (1987) note three dimensions for capacity strategy: capacity cushions (low and high rate of utilisation); timing and sizing of expansion; and linkages with various decision areas. This indicates that capacity strategy is an important element of manufacturing strategy.

Roth (1987), empirically found that capacity expansion correlates positively with delivery/flexibility priority and negatively with low price priority. More empirical studies are needed to show how capacity decisions should be used to lead to an effective manufacturing strategy.

d) Vertical Integration

Vertical integration decisions are concerned with increased control over distributors (forward integration) or over suppliers (backward integration or "make versus buy"), or both (Hayes and Wheelwright, 1984).

For organisations to decide to integrate in either direction (forward or backward) is a major decision. Furthermore, the extent as well as the balance of the integration are important decisions. Several writers point out the advantages and disadvantages of vertical integration (Porter, 1980; Buffa, 1984). The advantages include: economic benefits of combined operations, technology's impact on other areas, assurance of supply, management's coordination & control, and high barriers of entry for vertically integrated businesses. In contrast, the disadvantages of vertical integration are summed up as follows: capital requirements, costly adjustment to new technology, loss of focusing concept and large volume of output. Therefore, it is the responsibility of managers to optimise the advantages and disadvantages when making vertical integration decision.

Buzzell (1983) makes a major contribution to the issue of vertical integration. In an extensive study of 1649 manufacturing processing businesses, Buzzell provides some guidelines for vertical integration. These can be summarised as follows:

1. **Heed increased investment intensity:** it was empirically found that increasing integration with huge investment leads to low profitability, and increasing integration without huge investment leads to high profitability.

2. **Consider alternate to ownership:** Buzzell (1983) suggests that the essence of integration (i.e., economic benefits) can be captured through long-term contracts with suppliers, This is an approach highly favored by the Japanese (cooperative approach). Hayes and Abernathy (1980:73) point out that "long-term contracts and long-term relationships with suppliers can achieve many of the same cost benefits as backward integration without calling into question a company's ability to innovate or respond to innovation".

3. **Favour large scale units:** it was empirically found that vertical integration is more suitable to firms with large market share than those with small market share.

4. **Avoid Partial Integration:** the evidence showed that firms with low or high level of integration generate more profit than those in the middle level of integration. The implication is that firms with a clear defined position are more likely to succeed (Buzzell, 1983).

5. **Be in doubt of the claims that integration reduces the costs of raw materials:** economists have for long questioned the claim

that vertically integrated businesses are less vulnerable to fluctuations of raw materials costs. (Earlier contributions to the issue of vertical integration are credited to the economists as reported by Hayes and Wheelwright (1984)). Buzzell's findings support the economists in this regard. He found that return on investment was high when vertical integration was low, and vice versa. This could also be the result of capital intensity.

It is worth noting that both distributors and suppliers are major factors in environmental uncertainty (see Chapter 6), and that manufacturing is moving towards less vertical integration and towards external sources of parts for the advantages of lower costs, and higher flexibility and productivity (Gunn, 1987).

2.4.5.2 Infrastructural Decision Category

Infrastructural decision category includes decisions related to elements such as workforce, quality, production planning/materials control and organisation management (Hayes and Wheelwright, 1984; Hill, 1985; Skinner, 1985). Other writers have added new product development and organisation's performance to the preceding areas (Buffa, 1984; Fine and Hax, 1985; Hayes et al., 1988). Decisions in these areas have been traditionally known as the function of production/operations management.

The major factor of manufacturing infrastructure as identified by several writers is the workforce. Management has to make consistent decisions on a myriad of choices related to "day-to-day" operations. In describing this situation, Wheelwright (1978:57) states that "while operating decisions may make sense individually, they may not work cumulatively to reinforce the corporate strategy." This means that consistency in decisions which result in congruence between and among the manufacturing areas is the key for implementing manufacturing strategy.

It was stated earlier that manufacturing task is the key to making manufacturing strategy operational (see section 2.4.1), So accomplishing a certain manufacturing strategy, such as low price, means making all the decisions that lead, in this case, to cost reduction. Accordingly, manufacturing strategy is formulated in the manufacturing task and implemented in the infrastructure category (through the structure category). Figure 2-7 depicts the linkages between competitive priorities and the infrastructure decisions.

A close examination of the literature shows that almost all writers and researchers fail to point out how manufacturing strategy decision variables, in particular the infrastructure variables, should be coupled in support of the competitive priorities. The work of Roth (1987) and Roth, De Meyer and Amano (1989) are exceptions in this respect. In an empirical study of 228 business units, Roth (1987) used canonical correlation to relate manufacturing strategy decision variables to competitive priorities. Roth found several decisions or policies (some overlapped) to support each competitive priority (see Chapter 8). In a similar work but with a different statistical

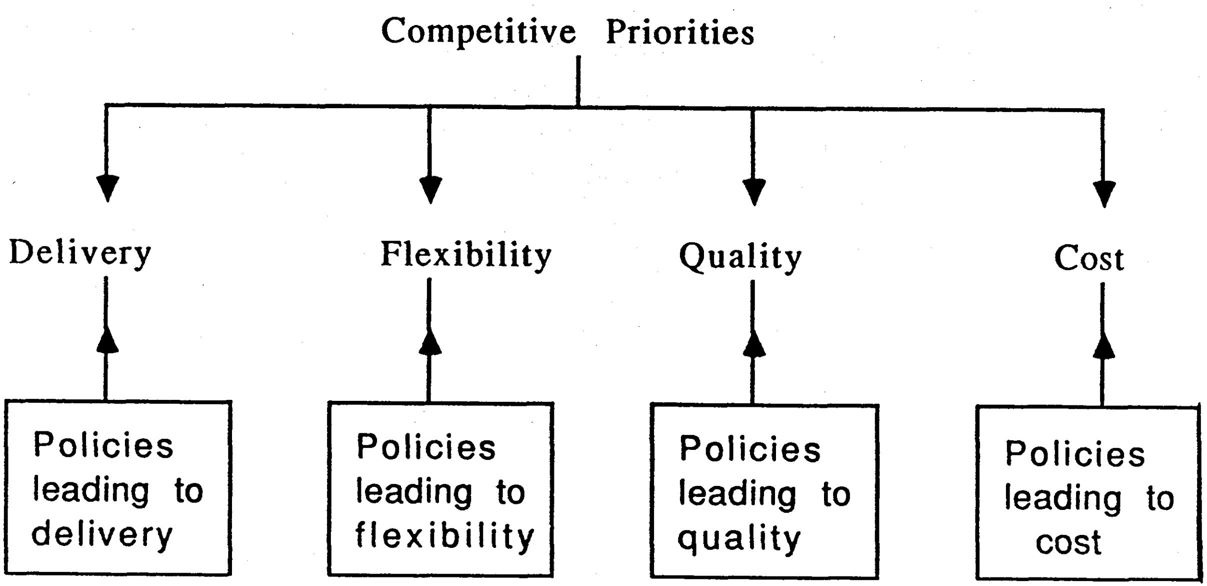

Figure 2-7 : Linkages between competitive priorities and the infrastructure policies (programmes)

technique, Roth et al. (1989) employed regression analysis to detect the manufacturing policies that should be pursued under each competitive priority. The validity of Roth et al.'s study (1989) is weak, because the percentage of variance explained for each policy is very small. These two studies (Roth, 1987; Roth et al., 1989) constitute the major work in this area (i.e., relating manufacturing strategy decisions variables to competitive priorities). Further research is needed to find out as well as to verify the manufacturing policies under each competitive priority.

Quality has also emerged as an important area in manufacturing strategy. According to the Japanese cumulative model and the

Sandcone model, quality is considered the first stone in building up all the competitive priorities. The contributions of the most influential writers about quality (e.g., Crosby, 1979; Deming, 1985; Juran, 1982) should be utilised in manufacturing strategy. Fine (1986), using an analytical model, argues that improvement in quality results in induced learning in the company which leads to improvement in productivity. In an empirical study of 12 plants, Hayes and Clark (1985) also found a relationship between quality (waste) and total plant productivity. Thus, the previous two studies indicate clearly that improvement in quality, as the first competitive priority to be achieved, leads to improvement in productivity. De Meyer and Ferdows (1987) have identified quality as one of eight managerial focal points in manufacturing strategy.

The relationship between the production planning system and competitive priorities was investigated by Van Dierdonock and Miller (1980), using a small sample. They described the production tasks in terms of three factors: complexity, uncertainty and slackness. These factors are related to the production system in respect of information processing system involvement (IPSI), and integrativeness. The authors pointed out that the characteristics of the production tasks rely on competitive priorities. Thus, they postulated that there are relationships between the production system and competitive priorities.

Materials management and purchasing, offer a source of competitive advantage for all the competitive priorities. Roth (1987), using canonical correlation, found a relationship between materials management and each of the following competitive priorities: product focus, delivery/flexibility, and price. Krajewski et al. (1987) found that influence of vendor and inventory decisions have a significant influence on performance measures.

As a closing remark, it is worth noting that Gunn (1987) believes that the first eight areas of the structural and infrastructural categories of decision (see Figure 2-1) are "no longer a sufficient basis" for creating manufacturing strategy. (He calls these eight areas with the exception of vertical integration "Classical Manufacturing Strategy Factors".) Instead, Gunn proposes eight objectives and entitles them "Today's Manufacturing Strategy Objectives." These are (Gunn, 1987:92):

1. shorter new product lead time.
2. more inventory turnovers.
3. shorter manufacturing lead time.
4. highest quality.
5. more flexibility.
6. better customer service.
7. less waste.
8. higher return on assets.

As such, these objectives represent, directly or indirectly, the competitive priorities. Surprisingly, Gunn (1987) did not mention competitive priorities in his discussion of "today's manufacturing strategy objectives". It is worth mentioning that these objectives cannot be achieved without making consistent decisions about the manufacturing strategy factors.

2.4.6 Performance

The ultimate test of a strategy is the performance of the organisation: the purpose of the strategy is to acquire a distinctive competence that sets the organisation apart from its competitors. Good performance demonstrates that strategy is implemented as intended. Several studies have related strategy to organisational performance (Schoeffler et al., 1974; White and Hammermesh, 1981; Hitt and Ireland, 1985).

In literature on Organisational Behavioural there exists two underlying models to the study of organisational performance (effectiveness), namely the goal and the system models. These are considered by many writers and researchers in the field to be the dominant models for measuring organisational performance (e.g., Etzioni, 1960; Price, 1972; Bedeian, 1984). While the goal model advocates comparing achieved goal against stated goal, the system model advocates the relationship between the organisation and its environment in the form of input-output acquisition. Nevertheless, both models suffer from several shortcomings.

One drawback of the goal model is the existence of a gap between the stated goal and the accomplished goal. When stated goal is too ideal, it can lead to disappointment in investigation, and the opposite occurs when stated goal is too simple or ill-defined

(Etzioni, 1960). This is true, because in actual situations organisations tend to be less perfect than they anticipate in their performance. A second drawback is that the accomplishment of one goal may inhibit effectiveness in the achievement of another, or in the case of pursuing multiple goals (Bedeian, 1984). A third drawback is the absence of measures for some goals, or the shortage of full measures for new developed areas as it is the case in the manufacturing strategy.

Shortcomings of the system model include a focus on an ambiguous futuristic goal because the organisational survival is based on the acquisition of resources; a failure to offer guidance for selecting the scarce resources to be used in evaluating performance (Bedeian, 1984); and a neglect in emphasising resource use and resource acquisition in evaluating performance (Bedeian, 1984).

In spite of these shortcomings, a reconciliation between the goal and the system models is likely to improve the organisation's performance (Bedeian, 1984). Both models are directly or indirectly concerned with the goal of the organisation. Thus, the acquisition of resources is undoubtedly a prerequisite for the accomplishment of organisational goals.

Another approach for judging the organisation's performance is to compare it against the best performance in the industry (Tucker, Zivan and Camp, 1987). This approach is called "benchmarking" and is extremely useful in improving the capabilities of the manufacturing function which in turn improve the financial measures (will be discussed in the next section). The practicality of benchmarking is to get a team of the plant to discuss, witness and learn from its counterpart at the target site. Hayes et al. (1988) advocate this approach to improve manufacturing performance, and they cite several examples of successful companies using the benchmarking approach. It is important to note that the controversy over the "trade-offs" notion on the one hand and the Sandcone model as well as the Japanese cumulative model on the other should be settled in the light of the benchmarking approach. However, the problem with benchmarking is that it is difficult to get some information regarding competitors (Tucker et al.,1987).

2.4.6.1 Measurement Of Organisational Performance

The previous section discussed the two approaches for studying organisational performance; the goal and the system models as well as benchmarking. In this section, financial measures for organisational performance are explored.

There is substantial disagreement in the literature regarding the measurement of the two following models; the Univariate and the Multivariate models (Steers, 1975; Lenz, 1980; Bedeian, 1984). The Univariate model recommends the usage of a single measure (e.g., productivity or profit) as an indicator of organisational performance. This model has been criticized for the difficulty in selecting one measure to represent the overall performance of the organisation (Bedeian, 1984). The Multivariate model, on the other hand, suggests the use of multiple measures as indicators of organisational performance. Thus, the multivariate model avoids the dilemma of a single measure. As a result, recent research on organisational performance has shifted away from focusing on a single measure and has concentrated on multiple measures (Bedeian, 1984).

It is worth noting that manufacturing strategy represents multiple measures of the manufacturing function, and that prior to the development of manufacturing strategy, the manufacturing function was evaluated on the basis of cost efficiency only (Skinner, 1978; Wheelwright, 1978; Hill, 1985).

Although recent research has adopted the multiple measures model, Lenz (1980) has suggested a two point approach to research in performance measures; pinpoint the measure(s) that is relevant to the companies under considerations, and be able to compare the results from companies under consideration with previous studies.

2.5 A HYPOTHESISED MANUFACTURING STRATEGY MODEL

From the manufacturing strategy model presented earlier in this chapter (see section 2.4), a hypothesised model can now be developed. This model advocates investigating the relationship between variables of the manufacturing strategy model. Such a hypothesised model will accelerate the development of the literature in this area.

Six hypotheses, which were originally developed by Swamidass (1983), will be presented and investigated more deeply in this study (see Chapter 7). They constitute the major contribution of Swamidass's study (1983) and are depicted in Figure 2-8.

2.5.1 Hypothesis One

Environmental uncertainty correlates with manufacturing task.

This hypothesis tests whether manufacturing task is influenced by environmental uncertainty. In other words, is manufacturing task closely related to the external environment in which the plant operates. The hypothesis is developed in the light of the open system theory and the contingency theory (see section 2.4.3). Both theories indicate that an organisation is affected by its environment. Since manufacturing task statement is defined as a set of goals and means (Skinner, 1985), the formulation of this statement is influenced by the environment. The adopted definition of manufacturing strategy explicitly acknowledges considering environment in formulating manufacturing strategy (see section 2.1).

2.5.2 Hypothesis Two

A plant's manufacturing infrastructure correlates with its manufacturing task.

This hypothesis means that the plant's manufacturing task should be closely related to its manufacturing infrastructure (e.g., activities). It is developed in the light of the contingency theory (i.e., relationships within and among the subsystems of the organisation). It investigates the relationship between manufacturing task and the infrastructure of the plant as theoretically indicated by Wheelwright (1978), Hill (1985) and Skinner (1985) as well as other writers in the field of operations management. Skinner is a strong supporter and the promoter of congruence between manufacturing task and infrastructure. Skinner (1985:95) points out that "the manufacturing organisation should explicitly identify its manufacturing task to be consistent with and supportive of the corporation's competitive strategy and then organise manufacturing structure to accomplish a sharp focus for that task". Furthermore, Skinner aserts that "troubleness" in manufacturing is the result of "mismatch" between manufacturing task and its structure.

2.5.3 Hypothesis Three

The higher the congruence between environmental uncertainty and manufacturing task, the better the performance.

This hypothesis means that the better the "fit" between the manufacturing task of the plant and its external environment (i.e., uncertainty considerations), the better the performance of the plant. It is in a way a corollary of hypothesis one. The hypothesis is also motivated by the contingency theory. Bedeian (1984:223) points out that "a considerable body of research suggests that an appropriate fit between an organisation's structure and its external environment does affect its operational effectiveness (performance)." Since manufacturing task influences the infrastructure of the organisation, one can say that the congruence between environmental uncertainty and

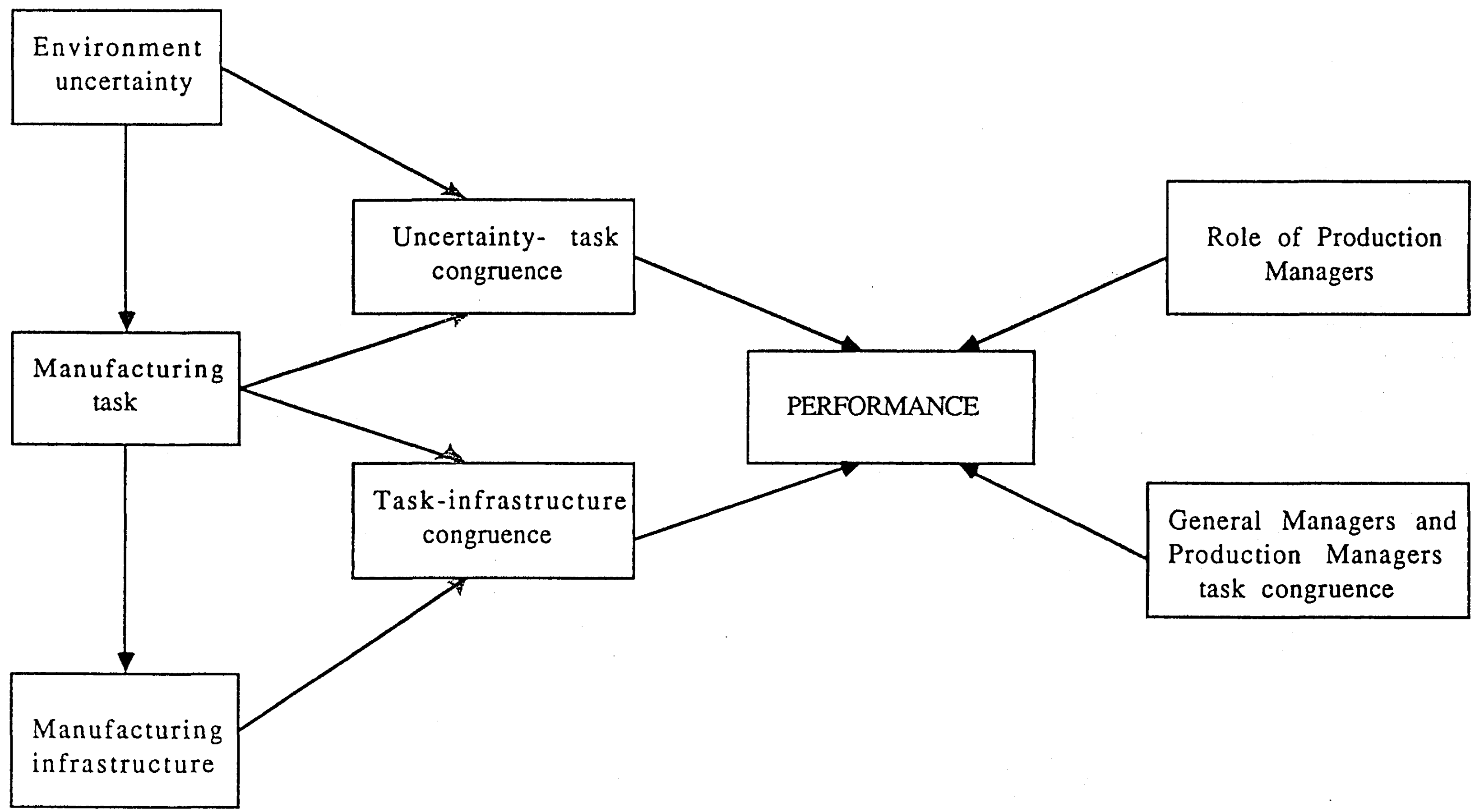

Figure 2-8 : A Hypothesised Model (Adopted from Swamidass, 1983) manufacturing task could influence the performance.

In a similar piece of work, Richardson et al. (1985) found that the "fit" between corporate mission and manufacturing task relates positively to performance. Also, several empirical studies have reported that environment-strategy coalignment does influence performance (Prescott, 1986; Venkatraman and Prescott, 1990).

2.5.4 Hypothesis Four

> The higher the congruence between manufacturing task and manufacturing infrastructure, the better the performance.

This hypothesis means that the better the "match" between the manufacturing task of the plant and its manufacturing infrastructure, the better the performance. It is in a way a corollary of hypothesis two. As mentioned in hypothesis two, writers such as Wheelwright (1984), Hill (1985) and Skinner (1985) have stressed the need for congruence between manufacturing task and the infrastructure (see section 2.5.2). In other words, this hypothesis tests the effect on performance when manufacturing strategy formulation and implementation are congruent.

2.5.5 Hypothesis Five

> The higher the top management and production management task congruence, the better the performance.

This hypothesis means that the higher the agreement on "task" between top management and production management, the better the performance. Several studies have investigated congruence between managerial functions. In an empirical study, Bourgeois (1980b) found that top management congruence on goals and means is associated with economic performance. Yaghmour (1985), in his study of three subsectors of the Saudi metal industry (32 plants) concluded that firms whose manufacturing activities were linked strategically were likely to perform better than those whose manufacturing activities were isolated from the strategic level. In a survey of 19 manufacturing firms, not directly related to manufacturing strategy issues per se, Dess (1987) found that top management congruence (Chief executive officer and representatives of functional areas) on business objectives as well as competitive methods are positively related to performance. In a recent study, Lindman and Callarman (1990) found that congruence on general strategic direction and manufacturing task between strategic planners and manufacturing managers influences manufacturing performance.

The works of Skinner (1978), Wheelwright (1978), Buffa (1984) and Hill (1985) indicate that top management and production management task congruence lead to better performance. Since it was mentioned earlier that manufacturing task is a set of goals and means, task congruence is the degree of consensus on goals and means between top management and production management (see section 2.4.1).

It was stated earlier that production managers play a less than desirable role in strategic decision making (see section 2.4.4).

Skinner (1985:56) also noticed that "... top executives delegating excessive amounts of manufacturing policy to subordinates, avoiding involvement in most production matters ... until their companies are in obvious trouble". This attitude from both top executives and production managers will lead to low task congruence which result in poor performance. Improving this situation will lead to high task congruence which result in better performance.

2.5.4 Hypothesis Six

> The greater the involvement of production managers in strategic decision making, the better the performance.

As suggested by Skinner (1978), Hayes and Wheelwright (1984) and Hill (1985) as well as other writers in the field, this hypothesis tests the involvement of production management in strategic decision making. This involvement would entail the exploitation of manufacturing strengths which could lead to better performance (see section 2.4.4).

SUMMARY

From the discussions about manufacturing strategy in this Chapter, it becomes clear that manufacturing strategy research is still in its infancy. In some areas of manufacturing strategy, the effort of academicians as well as practitioners is needed to clarify some of the controversial issues.

Basically, manufacturing strategy means competing in cost, quality, flexibility and delivery (these areas are referred to as competitive priorities). In this regard, manufacturing strategy aims at correcting the conception according to which cost and efficiency are the adequate goals for manufacturing.

To transform the manufacturing function into a competitive weapon, its strategy must be linked with the business and corporate strategies. Essentially there are two categories of decision that lead to forming manufacturing strategy; namely structural and infrastructural decisions; the former relate to building and equipment and the latter refer to people and systems.

In the first section of this Chapter, several definitions of manufacturing strategy were highlighted, then a working (adopted) definition of manufacturing strategy was provided.

The second section, provides a concise account of the manufacturing strategy development. It is Skinner, in his pioneering article (1969) who postulated that manufacturing considerations were "missing" in the formulation of corporate strategy. This section covered also the most important areas that need high attention from contributors in the field (e.g., trade-offs notion and measurement of competitive priorities).

In the third section, guidelines for a comprehensive strategy were presented. These suggested that a strategy should: define and determine long term objectives, action programmes and resources allocation priorities; search for a competitive advantage; respond to the external and internal environment of the organisation; determine the economic and non-economic contributions to stakeholders; and involve participation of all strategy levels.

In the fourth section, a manufacturing strategy model was developed on the basis of synthesised guidelines for a comprehensive strategy presented in the previous section. The model consists of eight factors: Organisational environment; Corporate and business strategies; Manufacturing task statement; Manufacturing task; The role of the production manager; Structural decision category; Infrastructural decision category; and Organisational performance (see Figure 2-2).

Finally, the last section of this Chapter, presented a hypothesised manufacturing strategy model, from which, six hypotheses were discussed.

CHAPTER THREE

SAUDI ARABIA AND INDUSTRIALISATION

INTRODUCTION

Organisations do not exist in vacuum, and external environmental factors impinge directly or indirectly with their function. Organisations, especially in the private sector, expect to be affected by various opportunities and constraints, and by the general economic conditions prevailing in the country. Hence, it is essential to examine the various environmental parameters of the country in which this study is conducted. This Chapter aims to examine the most salient environmental conditions that prevail in Saudi Arabia and with which the reader needs to be acquainted.

The Chapter is composed of eight sections: general background, location and geographical aspects, demographic features, educational milieu, development plans, manpower, economic context and the industrial sector. These features will be referred to later in the analysis and interpretation of the research results.

3.1 GENERAL BACKGROUND

The Kingdom of Saudi Arabia was founded by the late KING ABDULAZIZ IBN ABDUL RAHMAN AL-SAUD in 1932. Since then, Saudi Arabia has been ruled by Al-Saud family. The government consists of the King, currently FAHD IBN ABDULAZIZ, who also acts as Prime Minister; the crown Prince, currently ABDULLAH IBN ABDULAZIZ, is the First Deputy Prime Minister and Commander of the National Guard ; the second Deputy Prime Minister, currently Prince SULTAN IBN ABDULAZIZ is also Minister of Defence and Civil Aviation; and a host of Ministers appointed by the King.

The religion of the country is Islam. The judicial system is administered by "Sharia" (i.e., Islamic law) and supplemented by decree law. Officially, the country uses the Hijra Calendar which is based on the lunar year. The first year of the Hijra Calendar is the year in which the prophet Muhammad, peace be upon him, emigrated from Makkah to Madinah and corresponds to 622 A.D. In parallel to the Hijra Calendar, the country, also uses the Gregorian Calendar.

All the national population is Arab, and the main language is Arabic. The currency is the Saudi Riyal [UK 1 = 6.73 Saudi Riyals; US $1 = 3.75 Saudi Riyals (exchange rates of April 12th ,1991, AL HAYAT ,1991)]. As the U.S. dollar is the first international currency, all financial figures in this thesis were presented in dollars. Therefore, the exchange rates from 1975 to 1986 are: 3.52, 3.53, 3.53, 3.40, 3.36, 3.33, 3.42, 3.44, 3.50, 3.58, 3.65 and 3.75 respectively (Ministry of Planning, 1986). The average of these exchange rates is 3.50, the highest exchange rate is 3.75 in 1986 and the lowest is 3.33 in 1980.

3.2 LOCATION AND GEOGRAPHICAL ASPECTS

The kingdom of Saudi Arabia which is situated in the south western part of Asia occupies about four-fifths of the Arabian peninsula. The kingdom covers an area of 2,240,000 square kilometers which is equivalent to nine times the area of the United Kingdom. The country has been famous for its deserts. A large part of the southern portion of the kingdom is known as the "Empty Quarter". It covers 230,000 square miles and its one of the world's largest desert. Saudi Arabia is bordered by the Arabian Gulf, the United Arab Emirates, Qatar and Oman to the east; by the Red Sea to the west; by North and South Yemen (currently united) to the south and by Jordan, Iraq and Kuwait to the north (Kurian, 1987; The Europa Year Book, 1988).

The climate in Saudi Arabia is characterised by its very hot summers (38 C to 49 C) and mild winters (quite cool in the north). Humidity is high in the two coastal regions and rainfall is scanty overall in the country (4 inch/year), except for the south-west region where it annually exceeds 12 inch. In addition, Saudi Arabia does not have a single river; therefore, the kingdom suffers from a severe shortage of water which seriously affects agricultural industries and some manufacturing industries (e.g., dairy products). However, as it is being bordered by the Arabian Gulf and the Red Sea, the presence of desalination plants ease the kingdom problems in terms of water shortages.

Saudi Arabia is divided into five distinct regions: central, western, eastern, southern and northern regions. Principal cities in the kingdom are Riyadh (the capital), Jeddah and Dammam, which are respectively located in the central, western and eastern regions.

3.3 DEMOGRAPHIC FEATURES

The population of Saudi Arabia was estimated to be 11,152,000 in 1985 as compared to 7,012,592 in the 1974 Census (Kurian, 1987). Of the population in 1985, 3.5 million are expatriates (Saudi Consulting House, 1986). The figures above show that the population has increased one and a half times from 1974 to 1985. Based on the birthrate, the kingdom's growth rate was 3.94% per annum during the period 1980-1985. The population is expected to reach 18.9 million by the year 2000, and 30.6 million by the year 2020 (Kurian, 1987). The gradual increase of population will increase the density of the population which is presently low. The high rate of the Saudi population growth can be attributed to several factors. Foremost of them are the high birth rate; the drop in the death rate as a result of the enhancement and expansion of the health service as well as the increased degree of awareness among people with regard to this type of service; and finally the improvement of economic and social conditions in the kingdom.

Further analysis of the 1985 census shows that people under working age (14 years) constitute 43.1 per cent, the working age (15-64) represents 54.1 per cent, and people over the working age (65 and over) stand for 2.7 per cent. The male-female ratio is 1.023:1, and almost 73 per cent of the population live in urban areas.

3.4 THE EDUCATIONAL MILIEU

Education - in its various type - plays a vital role in the economic and social development of the society. Nowadays, a society must be "educated" in order to progress, to grow, and even to survive. Saudi Arabia has been devoting a lot of attention to the educational milieu. In a short time, the kingdom has taken the lead among the developing countries in terms of quality and quantity of the educational institutions. The educational budget was 18.6 billion Saudi Riyals (or 5 billion U.S. dollars) which constituted 9.3 per cent of the national budget in 1986-87 (Central Department of Statistics, 1987).

The educational system in Saudi Arabia is of three types:

1. General education (Kindergartens-secondary stage).
2. Higher education (post secondary stage).
3. Technical education and Vocational training.

All these types of education are free and run by the government except for a very tiny portion (less than half a per cent in 1986-87) in the general education which is run by the private sector. In all types of the Saudi educational system, females and males are segregated according to the islamic law.

General education consists of elementary, preparatory, and secondary schooling (Kindergartens are provided on a small scale). The duration of the first cycle is six years, while each of the preparatory and the secondary cycles lasts three years. Education in these cycles is not compulsory. From Table 3-1, one can see the high increase in the number of schools and students in all cycles.

Also, the "Teachers Training Institutes and centres" are classified in the general education type. The duration of these Institutes and centres is two years post-secondary cycle (including community colleges).

The ratios of male-female students for the year 1986-87 in the elementary, preparatory, secondary schooling and the above institutions were 1.2:1, 1.7:1, 1.3:1 and 1.1:1 respectively. The female ratios for the same cycles were lower in 1982-83. The teacher-pupil ratios for 1986-87 in the elementary, preparatory, secondary schooling and institutions were 1:16, 1:14, 1:15 and 1:10 respectively (Central Department of Statistics, 1987).

The higher education system in Saudi Arabia resembles that of any other countries in that it consists of two stages: the under graduate and the post graduate stages. Presently there are seven state-run universities in the kingdom: King Saud University, the Islamic University, King Fahd University for Petroleum and Minerals, King Abdulaziz University, Imam Mohammad Ibn Saud Islamic University, King Faisal University and Umm Al-Qura University. The oldest university opened its doors 34 years ago (King Saud university) and the newest university was inaugurated 10 years ago (Umm Al-Qura). Although the majority of the universities offer education for girls,

Table 3-1: Distribution of number of schools, institutions, universities and students (male and female) in Saudi Arabia.

Educational level		1982-83	1986-87	% increase
Elementary	(schools)	6792	8012	18
	(students)	1073528	1460283	36
Preparatory	(schools)	1922	2456	27.8
	(students)	301498	437157	45
Secondary	(schools)	717	990	38.1
	(students)	130281	198449	52.3
Institutions	(numbers)	179	193	7.8
	(students)	18451	22352	21.1
Universities	(numbers)	7	7	-
	(students)	75118	113939	51.7

Source: Central Department of Statistics (1987:159-162), The Statistical Indicator, Saudi Arabia.

a "General Secretariat for Girls' Colleges" is mainly responsible for girls' higher education as well as general education. Table 3-1 shows that the number of graduate and under graduate students in all the Saudi universities besides the General Secretariate for girls' colleges has increased by almost 52 per cent from 1982-83 to 1986-87. The ratio of male-female graduate and under graduate students is 1.5:1, and the teacher-students ratio for both stages in the universities is 1:13. The number of students who were studying abroad in 1983-84 was 10092, and 9559 in 1984-85.

All these figures in the general and higher education types point to the increasing awareness by the students and all the attention devoted by the government as regards the importance of education.

Technical education and vocational training include programmes for both government and private sectors in the commercial, industrial and agricultural fields. These programmes are supervised by the "General Organisation for Technical Education and Vocational Training" which was established in 1980. Previously these programmes were the responsibility of the Ministry of Education.

By 1986-87, there were two community colleges for each of the commercial and industrial fields with a total number of 439 and 364 students respectively (Saudi Arabian Monetary Agency, 1988). Two more colleges in the industrial field were opened by 1987-88. As for the number of secondary institutes during the same period, there were 11 commercial, 8 industrial and 1 agricultural institutes counting a total of 7383, 5362 and 266 students respectively.

As for the vocational training centres, ten months duration, by 1986-87, their number reached 28 with a total number of 8379 students, of which 5545 graduated (Saudi Arabian Monetary Agency, 1988).

The low level of enrollment in the industrial field, in particular, is attributed to the attitude towards industrialisation - Saudis tend to view the jobs in this field as low class and thus culturally shameful, which is a common view among Arabs. In order to progress industrially, Saudi Arabia should open more colleges as well as centres and offer more incentives to attract Saudis to industrial field.

3.5 DEVELOPMENT PLANS

Since 1970 the development of the Saudi economy has been guided by a sequence of five year development plans:

The First Development Plan (1970-1975), with a total investment of $23.1 billion, emphasised on the development of adequate infrastructure, health and education (Ministry of Planning, 1985).

The Second Development Plan (1975-1980) as well as the Third Development Plan (1980-1985), with a total investment of $142 billion and $235 billion respectively, aimed at achieving a major industrial development in order to shift the economy from its dependence on oil (The Europa Year Book, 1988; The Middle East and North Africa, 1991).

The Fourth Development Plan (1985-1990), which totalled an investment of $266.7 billion, aimed principally to encourage the involvement of the private sector, reduce reliance on foreign labour, and encourage further economic and social integration among the countries of the Gulf Co-operation Council (The Europa Year Book, 1988; The Middle East and North Africa, 1991).

The Fifth Development Plan (1990-1995), which is characterised as flexible and comprehensive, aims at ensuring the continuity of real change in the economic structure via diversification of the productive sectors, namely manufacturing, agriculture and mineral resources (Saudi Arabian Monetary Agency, 1988).

3.6 THE MANPOWER

Manpower is a problem area in Saudi Arabia, the kingdom has a clear shortage of home based manpower. However, this situation did not prevent or delay the development of the kingdom. In fact, it may have accelerated the development. Saudi Arabia has been offering enormous opportunities to foreigners to work in the country financed by its oil based wealth. Afterwards, Saudi Arabia became heavily dependent upon foreign workforce in almost every sector. In 1985, the proportion of non-Saudis in the total employment was almost 60 per cent (see Table 3-2).

The Saudi employment in 1985 was 40.2 per cent, of which the Saudi female workforce constituted only 3.1 per cent which indicates clearly that the participation of the Saudi female in the workforce is very small. This is because the Saudi system (i.e., according to the islamic law) segregates women and men in all aspects of work and thus restricts the female participation to female fields only such as girls education. In addition, the very low level of female participation in the workforce is associated with cultural values, marital status, fertility rate, level of education, and husband's education. Generally, the shortage of the Saudi manpower in the workforce is attributed to several factors. Amongst them are: the small size of the population, the youthfulness of the population (although this is a common characteristic among developing countries (El Mallakh, 1982)), the literacy rate, the attitudes of Saudis toward some low level jobs and especially blue collar ones, and the gigantic development plans which call for fast pace development.

In 1985, the percentage of the economically active population (including expatriates) amounted to 39.9. As for the Saudis only, it amounted to 16 for the same period.

Due to the completion of the kingdom's infrastructure on the one hand (Ministry of Planning, 1985), and the gradual increase in number of educated Saudis, and the population increase on the other, Saudi Arabia is planning to reduce its reliance on non-Saudi manpower. In 1990 the proportion of the non-Saudis in the total employment is projected to decline by 11 per cent (see Table 3-2). As a result of this, the proportion of the Saudi male and female in the total employment will increase by 9.9 per cent and 1.1 per cent respectively. In other words, the Fourth Development plan expects the entry of 374,700 Saudis into the labour market from 1985 to 1990, with an exit of 600200 foreigners. This is considered a major

Table 3-2: Estimated and projected civilian manpower in Saudi Arabia (in thousands)

Type of labour	1985	(%)	1990*	(%)
Saudi male	1649.2	(37.1)	1984.1	(47.0)
Saudi female	136.8	(3.1)	176.6	(4.2)
Subtotal	**1786.0**	**(40.2)**	**2160.7**	**(51.2)**
Non-Saudis	2660.0	(59.8)	2059.8	(48.8)
Total	**4446.0**	**100**	**4220.5**	**100**

* projected

Source: Ministry of Planning (1985: 84), Fourth Development plan (1985-1990), Saudi Arabia

feature of the Fourth Development Plan. During this plan, the annual growth rates for the Saudi workforce were expected to be 3.8 per cent for males and 5.2 per cent for females. These figures are considered encouraging.

The distribution of employment by economic activity in Saudi Arabia is presented in Table 3-3. The inspection of the Table reveals that the services sectors employed more manpower (52 per cent) than the producing sectors (46.5 per cent) in 1985 and this trend is expected to continue up to 1990. At the industrial level, one can observe that all industries with the exception of construction, trade, real estate, social services and public industry (government) expect a growth in employment. The above five mentioned industries expect a decline in employment. The construction as well as the trade industries were expected to have a significant decline in employment from 1985 up to 1990 resulting from the completion of the kingdom's infrastructure. As for the last three industries, a slight decline in employment was to be experienced during the same period. The manufacturing industry was the fifth largest employer and accounted for 9.25 per cent of the total workforce in 1984-85. The same industry was expected to be the fourth largest employer (12.6 per cent) in terms of workforce between 1985 and 1990 indicating a broadening of the manufacturing base in Saudi Arabia.

3.7 THE ECONOMIC CONTEXT

The economy of the kingdom of Saudi Arabia is best described in terms of a single-commodity which is oil. Thus, the Saudi economy is not well diversified. Since the discovery of oil in 1938, Saudi Arabia has taken a higher and richer position among the oil producing countries. Currently, the kingdom is the second largest producer of crude oil to the Soviet Union and possesses the world's largest reserves of crude oil (Johany et al., 1986; The Europa Year Book, 1988). By the end of 1987, ARAMCO (Arabian American Oil Company) reported that the kingdom's proven reserves of crude oil amounted to 170 billion barrels. As a result of the new discoveries, these proven reserves of crude oil were almost doubled by the end of 1989 to reach 315 billion barrels (ARAMCO, 1989). By the end of 1987, Saudi Arabia

Table 3-3: Distribution of employment by economic activity in Saudi Arabia (in thousands)

Economic activity	1985	(%)	1990*	(%)
Producing sectors				
Agriculture	617.4	(13.9)	663.0	(15.7)
Mining	5.1	(.115)	5.2	(.123)
Manufacturing:				
Non-Petrochemicals	411.4	(9.25)	531.2	(12.6)
Petrochemicals	-	(-)	7.0	(.166)
Utilities	147.4	(3.32)	147.4	(3.49)
Construction	885.9	(19.9)	580.9	(13.8)
Sub-total	**2067.2**	**(46.5)**	**1934.7**	**(45.8)**
Services sectors				
Trade	556.1	(12.5)	493.0	(11.7)
Transport	303.4	(6.82)	310.7	(7.36)
Real Estate	12.0	(.270)	10.5	(.249)
Finance	124.3	(2.80)	130.2	(3.08)
Community and Social Services	848.8	(19.1)	829.1	(19.6)
Government**	469.1	(10.6)	446.3	(10.6)
Sub-total	**2313.7**	**(52.0)**	**2219.8**	**(52.6)**
Non-oil sectors	**4380.9**	**(98.5)**	**4154.5**	**(98.4)**
Oil Sectors	**65.1**	**(1.5)**	**66.0**	**(1.6)**
Total	**4446.0**	**100**	**4220.5**	**100**

* projected
** Civilian workers

Source: Ministry of Planning (1985:86), Fourth Development Plan (1985-1990), Saudi Arabia.

had depleted 59.6 billion barrels or 35.1 per cent of the 1987's reserves (ARAMCO, 1987). If one assumes that the yearly oil production will be around 1.64 billion barrels (based on a daily average of 4.5 million barrels, the average production since 1985), this indicates that, starting from 1988, Saudi petroleum reserves will last for over 150 years. This figure is higher than that forecasted by Al-shuaibi's study (1985).

In spite of this satisfactory future estimation, the government's dependence upon oil could be a problem in the future. In particular, the slump in oil prices from time to time has direct impact on the country's revenue and causes some panic. The Saudi government has realised this problem, and has started to maximise the domestic non-oil investment by converting oil wealth into other forms of productive investment in the non-oil sector. Manufacturing and agriculture are notable examples of industries gradually contributing to the total revenues. Financial figures have shown a gradual decrease on the reliance of oil. Between 1974 and 1984, the contribution from crude oil totalled to nearly 85 per cent of the kingdom total revenues (The Europa Year Book, 1988), but by 1987 the reliance on the oil sector had been reduced to almost 70 per cent (Saudi Arabian Monetary Agency, 1988). It is of interest to note, that the oil sector is not a significant source of employment in spite of its huge contribution to the economy due to the continuous nature of the process and the use of high technology (see Table 3-3).

Table 3-4 displays the distribution of the Gross Domestic Product

(GDP) by economic activity at real rates (constant prices - 1970). The Table shows the growth rate average during each of the first three development plans as well as the growth rate during each of the first three years of the Fourth Development Plan (See section 3.5). From 1970 until the end of 1987 there were significant structural changes in the Saudi economy. The oil sector, has shown significant real growth during the First and Second Plans, then a fall (-14.5 per cent) in the Third Development Plan due to decline in oil demand as a result of world recession which started in 1982 (The Europa Year Book, 1988). The negative growth further continued in 1985 and 1987 but a positive high growth occurred in 1986 despite sharp decreases in oil prices ($9 per barrel). The non-oil sector, on the other hand, has witnessed a positive growth rate in the three development plans ranging from 6.2 to 14.8 per cent, and continue up to 1987 with the exception of 1986. All the figures revealed that the non-oil sector has increasingly offered more positive growth than the oil sector.

At the sectorial level of the Saudi economy, the continued positive growth of GDP in agriculture and manufacturing as envisaged participators in the total revenues is noticeable. The growth rate in the agriculture industry went from 3.6 per cent during the First Development Plan (1970-1975) to 9.5 per cent during the Third Development Plan (1980-1985), and then rose to 16.4 per cent by the end of 1987 (see Table 3-4). This robust rise was ascribed to encouragement from the government in the forms of interest-free loans, free land, and subsidies besides the construction of dams to conserve surface and underground water (Al-Shuaibi, 1985; Johany et

Table 3-4: Distribution of GDP by economic activity at constant prices (per cent)

Activity	I Plan	II Plan	III Plan	1985*	1986*	1987
Oil sector	**15.1**	**4.8**	**-14.5**	**-18.9**	**40.3**	**-9.9**
Non-oil sector	**10.1**	**14.8**	**6.2**	**0.7**	**-3.3**	**0.7**
Government	20.1	14.6	2.8	-0.4	-2.5	0.5
Agriculture	3.6	6.9	9.5	18.0	15.0	16.4
Manufacturing	**3.9**	**9.8**	**7.3**	**12.2**	**0.2**	**1.9**
Refining	0.9	6.1	3.0	22.1	4.1	4.9
Other	10.8	15.4	11.7	5.5	-2.8	-0.5
Construction	21.4	15.8	-2.4	-16.9	-12.4	6.4
Elect./Water	3.4	21.9	21.2	6.9	5.5	5.8
Trans. & Comm.	0.7	19.3	7.1	-0.2	-2.7	-2.4
Trade	13.8	22.7	8.7	0.1	-3.8	-1.7
Finance	7.9	23.7	2.5	-8.8	-15.5	-4.0
Comm. & Social	7.1	10.6	4.4	13.7	-4.0	-4.1

*: Revised data

Source: Saudi Arabian Monetary Agency (1988:12), Annual Report, Saudi Arabia.

al., 1986; Saudi Arabian Monetary Agency, 1988). Saudi Arabia is now self-sufficient and an exporter in several agricultural products. The country's main agricultural products are wheat, dates, milk, eggs and broiler chickens (Kurian, 1987; Saudi Arabian Monetary Agency, 1988). In manufacturing, the growth rate went from 3.9 per cent during the First Development Plan to 7.3 per cent during the Third Development Plan, and then after a slight increase in 1986 it edged to 1.9 per cent in 1987. Again, this growth is due to the government's encouragement with the aim of broadening the manufacturing base in Saudi Arabia (see section 3.8).

The remaining industries, with the exception of the Electricity and Water industry, have shown negative growth after the Third Development Plan as a result of the completion of the infrastructure in the kingdom. In fact, some of these industries notably the construction industry have been reduced in their employment.

The structure of the Saudi economy in 1987 is depicted in Figure 3-1.

It should be noted that mineral resources are expected to participate in the Saudi economy in the less far future. The kingdom of Saudi Arabia has been endowed with vast material deposits (Montagu, 1987; Saudi Arabian Monetary Agency, 1988). However, these mineral deposits require transportation systems as well as high capital extraction costs. Principal among these minerals are phosphates with 310 million tons (announced in July 1986 to be the world's largest deposits), Bauxite, Iron ore, lead, zinc, silver, copper, gold and small amounts

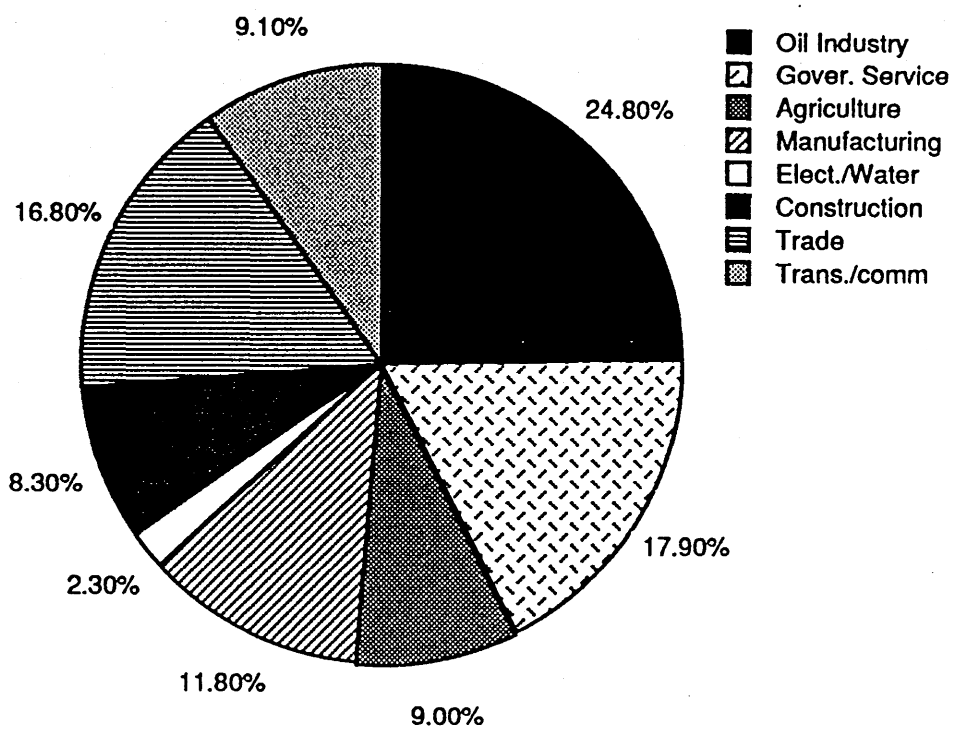

Figure 3-1 : Gross Domestic Product in 1987 (constant prices 1970)

of uranium. In addition, a coal field was discovered in the central region in 1984. Other minerals such as gypsum, limestone, marble, clay and sulphur are in production. These minerals are expected to form a good base for the manufacturing sector.

Because the application of manufacturing strategy lends itself more to the industrial sector, the next section will discuss industrialisation in Saudi Arabia within the available data.

3.8 AN OVERVIEW OF THE INDUSTRIAL SECTORS

The industrial sectors (excluding oil extraction) in Saudi Arabia can be partitioned into three main sectors according to ownership.

These are Petromin, SABIC, and the private manufacturing sector (see Figure 3-2). The development of these manufacturing sectors is almost entirely of recent origin and the exploitation of oil reserves has shown steady growth since 1960. The real boom in these sectors started in 1974 when oil prices jumped from $2.75 per barrel in 1973 to $10.84 per barrel (British Petroleum, 1989). The increase in oil prices allowed the government of Saudi Arabia to set up giant industrial projects and offer incentives to encourage Saudi businessmen and foreigners to invest in the manufacturing sectors.

In 1975, there were only 473 industrial plants in Saudi Arabia, but the number rose to 1401 plants in 1980 and 2022 plants by 1986. This indicates a compound growth rate of almost 20 per cent and 5.4 per cent respectively. As for the workforce in these plants, Table 3-5 shows that there were 38625 in 1975, 96023 in 1980 and 130494 workers by 1986, indicating a compound growth rate of 16.3 per cent and 4.5 per cent respectively. The total capital invested in these plants amounted to $2812.5 million in 1975, increased to $12242.5 million in 1980 and doubled that in 1986 as seen in Table 3-5. This huge investment indicates a compound growth rate of almost 28 per cent and 10 per cent respectively.

These high growth rates came as a result of gigantic Development Plans which involved an attractive industrial policy with huge incentives. The industrial policy was established on the basis of attainable manufacturing objectives.

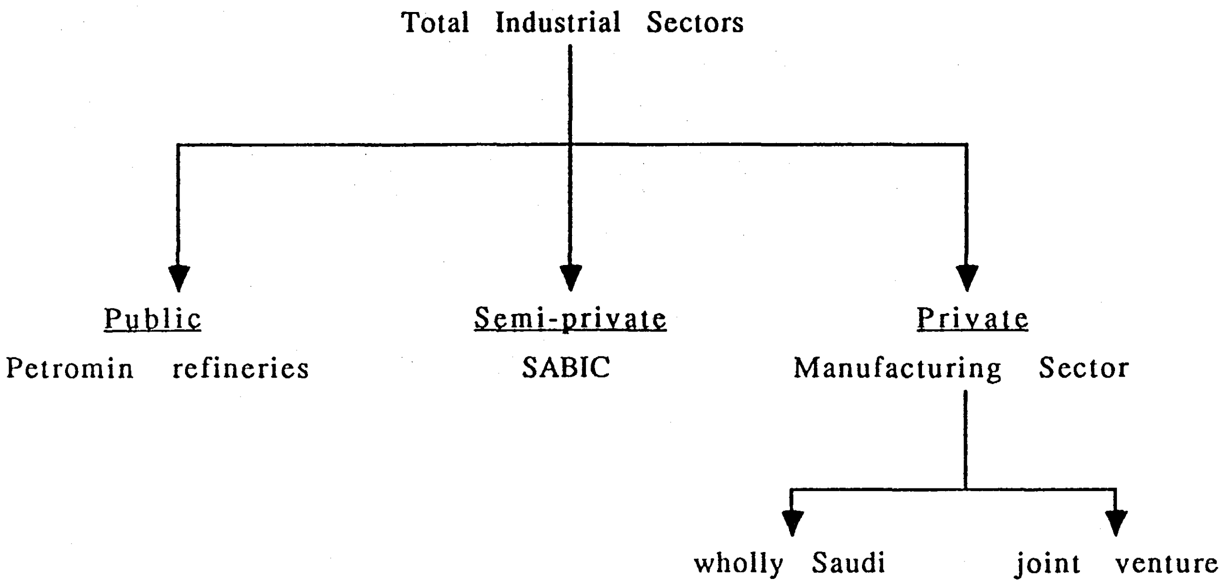

Figure 3-2 : Industrial Structure according to ownership in Saudi Arabia

Table 3-5: Development of plants, workforce and capital in Saudi Arabia

Category	1975	1980	1986
Number of plants	473	1401	2022
Workforce	38625	96023	130494
Capital Invested($)	2812.5	12242.5	24447.7

Source: Ministry of Industry and Electricity (1984:5), Industry and Electricity Progress and Achievements, Saudi Arabia; Ministry of Industry and Electricity (1986a:18, 23 &26), Industrial Statistical Report, Saudi Arabia.

3.8.1 Manufacturing Objectives And The Industrial Policy

The following two subsections are to review the manufacturing objectives and the industrial policy in Saudi Arabia.

3.8.1.1 Manufacturing Objectives

The main objective of Saudi Arabia is to diversify the economy. The objectives for the manufacturing sector are to:

1. Increase the economy's capacity to produce at competitive costs with the widest range of products for domestic as well as for export markets.
2. Exploit the substantial comparative advantages arising out of low cost energy and raw materials from the hydrocarbon related industry, minerals, agricultural and fishery resources.
3. Expand the kingdom's access to modern technology.
4. Encourage a fuller utilisation of capacity in the manufacturing sector.
5. Secure a regionally balanced development of industry.
6. Increase productivity by optimising plant capacity.
7. Reduce dependency on expatriate workers by national skill creation, through the development of general and technical education and on-the-job training schemes for national workers.
8. Promote industrial interrelationship (Saudi Consulting House, 1986: 21).

3.8.1.2 Industrial Policy And Incentives

The industrial policy guidelines were first announced in 1974 to attract the business community within and outside the Kingdom of Saudi Arabia (Saudi Consulting House, 1986:22-29). These are:

1. ... encourage and expand the manufacturing industries including agricultural industries ...

2. ... the economy of the kingdom is based on competition among private, commercial and industrial enterprises, ... businessmen ... will enjoy the full support of the government during all stages of the preparation, establishment and operation of industrial projects which are beneficial to the kingdom. The government is also ready to supplement the efforts of businessmen in the private sector by establishing, financing and participating in the management of those large industrial projects, requiring wide technical experience which the private sector can not undertake alone.

3. The government considers that competition which serves the interests of local consumers is the best means of influencing industry towards beneficial manufacturing and market-oriented projects. ... However, the government will not permit harmful foreign competition, such as dumping.

4. To ensure that businessmen who are ready to participate in the industrial development of the kingdom are acquainted with the information required for the identification, implementation and successful operation of feasible projects, the government shall, from time to time, familiarise them with such industrial and feasibility studies and other useful information as may become available ...

5. In order to encourage businessmen to invest in projects of prospective benefit to the national economy, the government is prepared to offer **encouragement and financial incentives** to all industrial sectors, ... these are:

(a) provision of loans (via Saudi Industrial Development Fund, to be paid back in a maximum period of 15 years);

(b) exemption from customs duties of imported equipment and primary materials;

(c) exemption from taxes on the profit share to the foreign partners of the company as provided in the Foreign Capital Investment Statute (i.e., ten years);

(d) preference given to local producers in government purchase;

(e) imposition of protective customs tariffs on competing imports;

(f) provision of accommodation in industrial cities (nominal fee and discounts on utilities);

(g) granting of subsidies for training Saudi employees; and

(h) provision of assistance for the exportation of products.

6. ... adopting the principle of licensing industrial projects which exceed a specified size of invested capital, employment or production capacity ... (for organisation purposes and security).

7. When the government establishes large and important industrial projects on its own initiative, it will encourage as much participation as possible from the private sector. In such cases and in cases where the government participates in the capital of private projects to supplement an investment from the private sector, in respect of industries other than those relating to national security, it is the policy of the government to sell its share to the public in due course, if this serves the public interest.

8. In implementing its industrial policy the government shall do its utmost to avoid the imposition of quantitative restriction or price control. The government shall not impose restrictions except in cases where competition can not have an effective role, as in the case of commodities which, by their nature, are characterised by monopoly.

9. The government recognises the right of the business community in the industrial field to select, utilise and manage the economic resources, including industrial workers, in order to raise the productivity of industry to its maximum.

10. The government welcomes foreign capital as well as foreign expertise and participation in industrial development projects on cooperation with Saudi businessmen. ... it will always avoid imposing any restrictions on the entry and exit of money to and from the kingdom and that it shall continue its policy based on the respect of private ownership in the Islamic law.

11. The government shall provide public utilities and make any such basic arrangements as are necessary for the setting up of economically feasible industries.

3.8.2 Petromin

Petromin, established in 1962, controls the refinery of petroleum. It is administered by the Ministry of Petroleum and Mineral Resources and is wholly owned by the government. By 1986, there were six refineries in the kingdom of Saudi Arabia: Jeddah Petroleum Refinery, Petromin Refinery Riyadh, Petromin Refinery Yanbu, Petromin Mobil Refinery, Petrolube and Lube oil Refinery (General Petroleum and

Mineral Organisation, 1987). Most of the production of these refineries is consumed locally and a small portion is destined for exporting.

3.8.3 SABIC

The Saudi Basic Industries Corporation (SABIC) was founded in 1976 to develop the basic industries using local hydrocarbon (comparative advantage in oil) and mineral resources as well as to form other supporting industries (Ministry of Industry and Electricity, 1984). In early 1984 SABIC sold off 30 per cent of its shares to Saudis and Gulf Countries Citizens, after being wholly owned by the government and supervised by the Ministry of Industry and Electricity (The Europa Year Book, 1988). In the near future, the government is planning to sell another part of its share in SABIC under the industrial policy guidelines (see section 3.8.1.2, no.7). SABIC has a total of 15 giant industrial companies and 2 marketing and service companies. Between 1981 and 1985, 12 of these companies went on-stream and the remaining were in operation by 1988 (SABIC, 1985). Thirteen of these companies are sited in the two newly industrialised cities (Jubail and Yanbu) and the other two are in Jeddah and Dammam. The city of Jubail is located in the eastern province whereas Yanbu city is located in the western province.

SABIC's first generation industries are partitioned into three sectors that form the industrialisation nucleus in Saudi Arabia (SABIC, 1985). These are:

(a) Petrochemicals: Saudi Methanol Company (AR-RAZI), National

Methanol Company (IBN SINA), Saudi Petrochemical Company (SADAF), Al-Jubail Petrochemical Company (KEMYA), Saudi Yanbu Petrochemical Company (YANPET), Arabian Petrochemical Company (PETROKEMYA), and Eastern Petrochemical Company (SHARQ).

(b) Fertilisers: Saudi Arabian Fertiliser Company (SAFCO), and Al-Jubail Fertiliser Company (SAMAD).

(c) Metal: Saudi Iron and Steel Company (HADEED), and Jeddah Steel Rolling Mill Company (SULB).

SABIC's second generation industries are to support its basic industries. These are: National Industrial Gases Company (GAS), National Plastic Company (IBN HAYYAN), Saudi European Petrochemical Company (IBN ZAHR), and National Chemical Fertiliser Company (IBN AL-BAYTAR).

The two SABIC marketing companies are SABIC Marketing Ltd. and SABIC Marketing Services Ltd. The first company is in charge of selling SABIC's products, whereas the second company provides technical support, product research, and customer service (SABIC, 1985).

Most of SABIC projects are 50-50 joint ventures with leading international manufacturing corporations. Currently, SABIC's companies produce annually 9 million tons of over 20 different top quality products to meet the needs of more than 2000 customers in 65 countries (SABIC, 1986). In 1986, SABIC's sales worldwide amounted to $984.8 million.

3.8.4 The Private Manufacturing Sector

The private manufacturing sector in Saudi Arabia is given enormous number of incentives in order to participate effectively in the economy (see section 3.8.1.2). From the previous descriptions of the limited activities of Petromin and SABIC, it can be concluded that the private manufacturing sector covers all types of industries.

The following subsections describe the aforementioned three sectors in greater detail.

3.8.5 Description Of The Saudi Industrial Sectors

The Saudi industrial sectors use the International Standard Industrial Classification system (ISIC). According to this system, there are eight principal producing industries (sectors) and the ninth is the storage industry (see Table 3-6). First, these industries will be described in terms of number of plants, number of workers, and the total capital invested. Then, the development of these plants by region will be presented.

3.8.5.1 Industrial Sectors In Terms Of Number Of Plants

Table 3-6 presents the number of licensed plants by industrial sector up to September 5th, 1986. All plants in this Table and subsequent Tables are classified, on the basis of ownership, as either national or joint venture plants. The total number of plants on September 5th, 1986 is 2022. This represents an increase of 158 plants or 8.5 per cent of the total number of plants as compared to 1985 (Ministry of Industry and Electricity, 1985). Of the 2022 plants 1631, or 80.7

per cent, are wholly national and 391, or 19.3 per cent, are joint venture. This indicates that the majority of the plants are wholly owned by the Saudis.

As seen from Table 3-6, the highest four industries in terms of number of plants in decreasing order are:

1. The Metal Industry has 28.3 per cent of the total plants of all sectors. It is worth mentioning that 2 joint venture plants which belong to SABIC are included in the 161 plants.
2. The Building Materials Industry has 26.2 per cent of the total plants in all sectors.
3. The Food Industry has 15.9 per cent of the total plants of all sectors.
4. The Chemical Industry has 14.4 per cent of the total plants of all sectors. Of the 81 plants, 8 belong to SABIC. Also, 2 of SABIC plants and 6 of Petromin refineries are included with the national plants in this industry.

The seven remaining industries have low percentages in terms of number of plants as compared to the previous four industries. The total percentage for the plants in these seven industries is 15.2.

3.8.5.2 Industrial Sectors In Terms Of Number Of Workers

Table 3-7 displays the number of workers employed by plants according to industrial sector. The total number of workers (including management) on September 5th, 1986 is 130494. This represents an

Table 3-6: Distribution of plants by industrial sector up to September 5th, 1986*

Class.	Industrial Sector	Total	%	N.Plants	J.Plants
31	Food	321	15.9	285	36
32	Textile	39	1.9	31	8
32	Leather products	10	0.5	10	-
33	Wood	68	3.4	56	12
34	Paper & Printing	122	6.0	106	16
35	Chemical	291	14.4	210	81
36	Non Const. mat.	6	0.3	5	1
36	Building mat.	530	26.2	461	69
37&38	Metal	572	28.3	411	161
39	Other industries	34	1.7	28	6
71	Storage	29	1.4	28	1
Total		2022	100	1631	391

Source: Ministry of Industry and Electricity (1986a:14), Industrial Statistical Report, Saudi Arabia.

*: The end of the year 1406 according to the Hijra calendar.

N. Plants: national plants.

J. Plants: joint venture plants.

increase of 3.4 per cent as compared to 1985 (Ministry of Industry and Electricity, 1985). Of the 130494 workers employed in the 2022 plants 95315, or 73 per cent, are employed by the national plants and 35179, or 27 per cent, are employed by the joint venture plants.

As seen from Table 3-7, the highest four industries in terms of number of workers in decreasing order are:

1. The Building Materials industry employs 30.7 per cent of the total workforce of all industries.
2. The Metal Industry employs 25.5 per cent of the total labour force of all industries. Of the 11360 workers, 1450 workers are employed by SABIC companies.
3. The Chemical industry employs 16.8 per cent of the total workforce of all sectors. Of the 14112 workers, 2939 are employed by SABIC and Petromin companies. Also, of the 7776 workers, 4369 are employed by SABIC companies.
4. The Food industry employs 13.3 per cent of total employment of all sectors.

The rest of the industries (seven) employs 13.7 per cent of the total workforce of all sectors.

3.8.5.3 Industrial Sector In Terms Of Total Capital Invested

Table 3-8 exhibits the total capital invested in plants in each industrial sector. The total Capital invested on September 5th, 1986 amounted to $24447.7 million (U.S. dollars). This represents an

Table 3-7: Distribution of manpower by industrial sector up to September 5th, 1986*

Class.	Industrial Sector	Total	%	N.Plants	J.Plants
31	Food	17388	13.3	14633	2755
32	Textile	3534	2.7	2675	859
32	Leather products	535	0.4	535	-
33	Wood	4183	3.2	3087	1096
34	Paper & Printing	6188	4.7	4319	1869
35	Chemical	21888	16.8	14112	7776
36	Non Const. mat.	1505	1.2	1416	89
36	Building mat.	40080	30.7	31027	9053
37&38	Metal	33277	25.5	21917	11360
39	Other industries	1064	0.8	768	296
71	Storage	852	0.7	826	26
Total		130494	100	95315	35179

Source: Ministry of Industry and Electricity (1986a:14), Industrial Statistical Report, Saudi Arabia.

*: The end of the year 1406 according to the Hijra calendar.

N. Plants: national plants.

J. Plants: joint venture plants.

increase of 7 billion dollars with comparison to the previous year (Ministry of Industry and Electricity, 1985). Of the total capital invested in all sectors $13310.7 million, or 54.4 per cent, are invested in the national plants and $11137 million, or 45.6 per cent, are invested in the joint venture plants. This indicates that the majority of the joint venture plants are capital intensive. It is worth mentioning that the joint venture projects are the result of the government encouragement to foreign investment as pointed out by the industrial policy (see section 3.8.1.2, no. 10).

As seen from Table 3-8, the highest four industries in terms of total capital invested in decreasing order are:

1. The Chemical industry consumes 52.3 per cent of the total capital invested in all sectors. Of the $7436.3 million, $6292.3 million are invested in SABIC companies. Also, of the $5347 million, $4573.9 million are invested in petromin refineries and SABIC companies.
2. The Building materials industry consumes 23.2 per cent of the total capital invested in all sectors.
3. The Metal industry consumes 12.7 per cent of the whole capital invested in all industries. Of the $1799 million, $977.9 million are invested in SABIC companies.
4. The Food industry consumes 7 per cent of the total capital invested in all sectors.

The seven remaining industries consume only 4.8 per cent of the

Table 3-8: Distribution of total Capital invested by industrial sector up to September 5th, 1986* **(million U.S. dollars)**

Class.	Industrial Sector	Total	%	N.Plants	J.Plants
31	Food	1701.7	7.0	1329.3	372.4
32	Textile	186.8	0.7	113.8	73.0
32	Leather products	24.0	0.1	24.0	-
33	Wood	171.5	0.7	145.3	26.2
34	Paper & Printing	471.0	1.9	306.4	164.6
35	Chemical	12783.3	52.3	5347.0	7436.3
36	Non Const. mat.	117.0	0.5	111.0	6.0
36	Building mat.	5667.2	23.2	4458.0	1209.2
37&38	Metal	3110.6	12.7	1311.6	1799.0
39	Other industries	96.2	0.4	51.9	44.3
71	Storage	118.4	0.5	112.4	6.0
Total		24447.7	100	13310.7	11137.0

Source: Ministry of Industry and Electricity (1986a:14), Industrial Statistical Report, Saudi Arabia.

*: The end of the year 1406 according to the Hijra calendar.

N. Plants: national plants.

J. Plants: joint venture plants.

total capital invested of the whole industries.

The huge capital investment in the previous industries results from the participation of the Saudi Industrial Development Fund (SIDF), established in 1974, which finances up to 50 per cent of the total costs of a project (Saudi Consulting House, 1986). In a case of a joint venture project, the Saudi equity must not be less than 25 per cent of the total costs of the project in order to qualify investors for a loan. By 1986, the SIDF spent $3.76 billion to finance 938 projects (Saudi Industrial Development Fund, 1986). Most of these projects are in the industry of building materials (220), metal (151) and food (142).

This description of the Saudi industrial sectors indicates that there are four industries with potential for growth and study. These are the chemical, metal, building materials and food industries. The first three out of the four mentioned industries, ranked first in terms of total invested capital, number of plants and number of workers respectively. The remaining seven industries could be classified as weak or not well developed industries as indicated by the three dimensions (i.e., capital, number of plants and number of workers). The weaknesses in these six industries, excluding storage, may be due to following factors: lack of materials (e.g., leather, forest); labour intensive industry; and low demand industries. On the other hand, the strengths in the four potential industries are mainly attributed to the following: availability of raw materials (e.g., oil); unrisky businesses; and high demand for products of these industries. Furthermore, it becomes clear from above descriptions that the highest number of joint venture projects are in the metal and chemical industries.

Table 3-9 displays the average industry capital as well as the capital per worker for all the Saudi sectors. The chemical industry has the highest average industry capital ($43.9 million), and the leather industry has the lowest average industry capital ($2.4 million). Also, the Table shows that the chemical industry has the highest capital per worker ($0.58 million) followed by the building materials industry ($0.14 million).

3.8.5.4 Development Of Plants By Region

One of the Saudi manufacturing objectives is to "secure a regionally balanced development of industry" (see section 3.8.1.1, no.5). The distribution of plants by region shows that the government of Saudi Arabia through the Ministry of Industry and Electricity has been successful in balancing the development of plants in three out of five regions. As Table 3-10 displays, the three roughly balanced regions are the central, western and eastern. The percentage for each region to the total of the five regions is 38.8, 31.2 and 23.1 respectively. In contrast, the unbalanced regions in terms of development of plants are the West southern and the northern. It is worth noting that the development of plants in each region is concentrated in one or two major cities as it will be seen in Chapter Four. Thus, the unbalanced regions in terms of industrialisation is attributed to the following factors (ELMALLAKH,

Table 3-9: Average industry capital and capital per worker by industrial sector (Million U.S. dollars)

Class.	Industrial Sector	Ave.Ind.Capt.*	Capit./worker**
31	Food	5.3	0.10
32	Textile	4.8	0.05
32	Leather products	2.4	0.04
33	Wood	2.5	0.04
34	Paper & Printing	3.9	0.08
35	Chemical	43.9	0.58
36	Non Const. mat.	19.5	0.08
36	Building mat.	10.7	0.14
37&38	Metal	5.4	0.09
39	Other industries	2.8	0.09
71	Storage	4.1	0.14
Total		12.1	0.19

* Total capital invested over number of plants from Tables 3-6 and 3-8.

** Total capital invested over number of workers from Tables 3-7 and 3-8.

1982): the pattern of population; the short history of manufacturing; the long distance between cities; the high transportation costs; and the remote of country's ports.

The distribution of the workforce by region shows that the Central region also has almost the highest number in this area. However, in terms of total capital invested, the eastern region was ranked the highest due to SABIC's investments. The percentage, in terms of number of workers, for each region: central, western, eastern, west southern and northern to total is 34.6, 34, 27.5, 3.4 and 0.5 respectively. Similarly, the percentage, in terms of total capital invested, for each of the above regions to total is 15.6, 36.6, 43.9, 3.7 and 0.20 respectively.

The development of new plants in the kingdom has grown slowly after 1986. As on August 24th, 1987 (i.e., the end of the 1407 Hijra year), the number of plants rose to only 2061 (Ministry of Industry and Electricity, 1987). This represents an increase of 39 plants or 1.9 per cent as compared to last year. This increase is prominent in the industry of metal (1.6 per cent), food (2.5 per cent), paper and printing (2.5 per cent), and Chemical (3.8 per cent). Generally, the slow growth in all industrial sectors is attributed to several factors. The most important among them are: the completion of the kingdom's infrastructure (it mostly affects the building and metal industries); the saturation of some subsectors (e.g., dairy and plastic products, soft drinks industries); the small markets as a result of small population (affects the capacity of the industry);

Table 3-10: Distribution of plants by region up to September 5th, 1986

Ind.	Sector	Cent.R	West R	East R	W.S.R	North.R
31	Food	100	130	61	21	9
32	Textile	13	22	3	1	-
32	Leather	4	3	3	-	-
33	Wood	35	18	14	1	-
34	Paper	50	43	23	5	1
35	Chemical	79	111	90	5	6
36	Non Const.	4	1	1	-	-
36	Building	226	116	121	58	9
37&38	Metal	246	164	141	15	6
39	Other	17	14	2	1	-
71	Storage	10	9	7	1	2
Total		784	631	466	108	33
% of each region to total		38.8	31.2	23.1	5.3	1.6

Source: Ministry of Industry and Electricity (1986a:16), Industrial Statistical Report, Saudi Arabia.

the open markets to foreign products; and the risky industries as a result of lack of materials (e.g., leather, forest).

As indicated by the small growth rate of plants in 1987, issuing licenses for new plants will be restricted to new projects in the well developed industries / subindustries to ensure security to industrial investors as pointed out by the industrial policy (discussions with the Deputy Minister of Industrial Affairs in 1989).

SUMMARY

The purpose of this Chapter was to provide a background to several features of the Saudi Context in which the research was undertaken. The factors discussed in the Chapter were demographic characteristics of the population, educational system, development plans, workforce, economic context and the industrial sector.

Among the main demographic features of the kingdom of Saudi Arabia were the domination of the working age group (54.1 per cent) followed by the under age group (43.1 per cent) and that the male population outnumbered that of the female. The high growth of population is expected to overcome the kingdom's problem concerning small size of population in the near future. In education, Saudi Arabia has shown significant achievements in both the general education (up to secondary stage) and in the higher education (post secondary stage). However, significant improvements in technical education and vocational training are required. The above factors (i.e., education and vocational training) are expected to have a positive effect on the labour force in the near future. Currently, the kingdom is highly dependent on non-Saudi workforce which accounted for almost 60 per cent of the total labour force in 1985. This percentage is expected to be reduced to nearly 50 per cent in 1990, which is a major feature of the Fourth Development Plan (1985-1990). Due to cultural values, the contribution of females in the Saudi workforce is very small (3.1 per cent in 1985). Slightly above fifty per cent of the labour force was employed by the services sectors. The manufacturing sector employed 9.3 per cent of the workforce in 1985 and it is expected to rise to almost 13 per cent by 1990.

Although the economy of Saudi Arabia is highly dependent on one single-commodity, oil, other producing sectors have shown high growth. In real rates of GDP, the oil sector has shown positive high growth, on the average, in the First and Second Development Plans, then a negative growth (-14.5 per cent) was witnessed in the Third Development Plan due to slump in oil demand. Furthermore, the negative growth continued in 1985 and 1987; however, a positive high growth was observed in 1986 in spite of sharp decline in oil prices. In contrast, the non-oil sector has witnessed positive growth during the three development plans, which stopped in 1986 to continue up to 1987. Prominent industries with positive growth in the non-oil sector are agriculture and manufacturing.

The industrial sector has experienced a high level of development due to huge investments generated from oil revenues. The number of plants had risen from 473, in 1975, to 2022 in 1986. By 1986, the total workforce (including management) employed in these plants amounted to 130494 with a total capital invested of $24447.7 million. On the basis of the above three dimensions (i.e., number of plants, number of workers and capital) four potential industries have been pointed out; Chemical, metal, building materials and food. The first three industries ranked first in terms of total capital invested, number of plants, and number of workers respectively. These four industries, in particular, have begun to contribute positively to the national economy.

CHAPTER FOUR

RESEARCH METHODOLOGY

INTRODUCTION

The main purpose of this research is to investigate the manufacturing strategy issue within the Saudi business environment. Without proper methodology, a research can not achieve its objectives. Thus, this Chapter explains how this study was carried out.

In the first two sections of this Chapter, types of research design and research methods are reviewed from a theoretical point of view. Then, a research design for the study is described. In the fourth section the population and the achieved sample are discussed, this is followed by a presentation of the variables and instruments of the study. The last two sections introduce the statistical methods used in the analysis and discuss the validity as well as the reliability of the study.

4.1 TYPES OF RESEARCH DESIGN

Prior to presenting the types of research design, it is necessary to define the term "research design". Zikmund (1984:40) defines research design as "a master plan specifying the methods and procedures for collecting and analysing the needed information, and a framework of the research plan of action". Research design is further defined as "the plan and structure of investigation so conceived as to obtain answers to research questions" (Kerlinger, 1986:279). It is very clear that the foregoing definitions have certain common ground in representing research design as a master plan or a programme for collecting, analysing, and interpreting data. On the basis of these definitions, the key differences among the types of design must be briefly considered in order to understand the reasons lying behind choices and practicalities of the design of the present study, which will be discussed later in this Chapter.

Research design can be classified into three major types: Experimental, Quasi-experimental, and Non-experimental (Stone, 1978; Nachmias and Nachmias, 1981). In the following subsections each one of these types of design will be examined.

4.1.1 Experimental Design

This type of design is mainly used by researchers in the natural sciences. Its most significant feature is the ability to control and manipulate variables. Experimental design allows " the manipulation of a study's independent variable and the subsequent assessment of the impact, if any, such manipulation has had on the study's dependent variable" (Stone, 1978:92). Therefore, experimental design is strong on control (internal validity).

The major advantages of the experimental design as stated by Stone (1978:119) are: measurement is generally more precise ... than with other research strategies because ... (it) takes place under highly controlled conditions; causality can be inferred from the results ... since threats to internal validity can be reduced or eliminated through the use of control groups; the independent variable(s) of a study can be precisely and unambiguously defined by the experimenter through the manipulations used to produce them; and laboratory experiments can be replicated.

However, this design has its own drawbacks (Stone, 1978:119). Some of them are: some phenomena can not be studied in the laboratory (e.g., studies of social sciences); the generality (i.e., external validity) of results produced ... may be restricted; a number of variables can not be manipulated by experimenters; and Laboratory settings may lack "realism" in that conditions of laboratory experiments may not reflect the realities of the case under investigation.

4.1.2 Quasi-Experimental Design

This type of design is conducted in real world organisational settings. An example of a quasi-experimental design is the one-shot case study. The main advantages of the case study are summarised as follows (Stone, 1978; Zikmund, 1984): the researcher thoroughly investigates one or more units of analysis (e.g., person, group or company); data are collected by a variety of unstructured means (e.g., observations, interviews, documents and records); no attempt is made to exercise experimental or statistical controls; and the case study is suited more to the generation of the hypotheses than their testing.

In contrast, the major disadvantages for the case study (Stone, 1978; Nachmias and Nachmias, 1981) are: causal inferences are impossible because there is no control over confounding variables; hypothesis testing is not possible; results are expected to have ample amounts of bias due to nonsystematic collection of data; generalisation from case study results is not possible; and the case study is time-consuming than other type of design. Thus, the above disadvantages indicate that the case study is weak in both internal and external validities.

4.1.3 Non-Experimental Design

In the non-experimental design (a survey) the investigator has practically no control over the independent variables of the study. This is due to two factors. First, "the independent variable(s) may act upon a study's subjects before the investigator is in a position to determine who will get the treatment and when they will get it. Second, the study's independent variable may not be manipulable" (Stone, 1978:104). In the social sciences studies, survey is the most commonly used design. A survey can be defined as:

> A form of planned collection of data for the purpose of description or prediction as a guide to action or for the purpose of analysing the relationships between certain variables (Oppenheim, 1966:1).

In line with the above definition surveys are of two types; descriptive and analytical. The descriptive survey focuses upon describing the phenomenon rather than explaining relationships between variables. Conversely, the analytical survey focuses upon finding and explaining relationships between variables.

The major advantages of the survey design (Stone, 1978; McNeill, 1985) are: results allow for generalisations because the sample is representative of the population; results are accurate because of large sample size as well as "generally" low sampling error; personal influence is minimised; the survey design produces a large amount of standardised data that can be easily utilised via statistical techniques, which allow testing the hypothesis (i.e., answering research questions); and the survey design has various methods of systematic data collection (e.g., questionnaire). Consequently, these advantages indicate that the survey study has strong external validity.

However, the survey design also has its own disadvantages. These are: the data tend to be superficial (breadth of information is typically obtained at the expense of the depth); and the answers that respondents provide to a sensitive question may not reflect their views.

4.2 RESEARCH METHODS

In the previous section, three types of design were presented. In this section, research methods will be introduced as techniques for collecting data. The most common methods in the social sciences for collecting data are observation, questionnaire, interview and archival records.

4.2.1 Observation

Observation means watching a case very carefully (people or things) to record what can be observed.

There are some advantages and disadvantages for the observation technique as a method of data collection (Stone, 1978; Nachmias and Nachmias, 1981). Among the advantages are: the ability to obtain data concerning behaviour that the observees (subjects) may be either unable or unwilling to report themselves; and the ability to make inferences (with varying degrees of accuracy) to explain the behaviour. In contrast, the disadvantages for the observation include: observers may produce incomplete reports of what they observe; observers may be subjected to fatigue during the progress of the study which affects the reliability and validity of the data; observers often need considerable training; and the observation technique is costly because the observers must be present all times (if audio -visual means are not used).

4.2.2 Questionnaire

Questionnaire is another technique for collecting data. It is the most frequent method in the social sciences fields (Stone, 1978). Questionnaire is simply a list of questions that take the form of "closed" (fixed alternative) and "open-ended". Usually the "closed" questions are dominant.

Like any other technique for data collection, the questionnaire has its advantages and disadvantages (Selltiz et al., 1959). Among the advantages are: it is somewhat inexpensive; it can be administered by a relatively unskilled person; it can be distributed in person or by mail; it provides uniformity of stimulus to all subjects; and it generally coexists with anonymity that may lead subjects to be more open and truthful. As for the disadvantages, the following ones are noteworthy: missing data may be a problem especially if many subjects did not respond as a result of unclear questions; low rate of response in the case of mailed questionnaire; inapplicability of the questionnaire to illiterates or individuals who have difficulties in reading; and inflexibility of the questionnaire because subjects are to respond to relatively structured formats.

4.2.3 Interview

The interview is a third method of collecting data. An interview is a face-to-face meeting between the interviewee and interviewer where the latter asks questions to the former and records his responses. The interview may range from the most informal chat to the most well structured sets of questions and answers.

Among the advantages or benefits associated with this technique are (Selltiz et al., 1959): a higher rate of response as compared to mailed questionnaire; applicability to illiterates as well as individuals who have reading difficulties; and flexibility especially in the case of unstructured interview. However, the disadvantages of the interview include (Stone, 1978): it is generally costly especially in terms of time for both the interviewee and the interviewer; it has the potential of being a "reactive" technique due to the interpersonal nature which affects responses; it requires training of interviewer; and it affects the validity and the reliability, if the interviewer, subjected to fatigue, alters the manner of questioning.

4.2.4 Archival Records

This final method of collecting data for research is through documents and records. As pointed out by Nachmias and Nachmias (1981), documents and records are two forms: public and private records. Public records include political and judicial records, governmental documents, and the mass media reports. On the other hand, private records subsume organisational records. It is worth mentioning in this section that governmental documents as a form of annual reports were heavily utilised in this study as a primary research data (see Chapter 3).

The major advantages of using records are the low cost incurred as well as the accessibility to the data in most cases (e.g., governmental reports). As for the limitations involved in this method, it must be pointed out that the researcher should be aware of the possibility that the data may be unavailable.

4.3 RESEARCH DESIGN FOR THE PRESENT STUDY

The first two sections of this Chapter examined, from a theoretical point of view, the different types of research design as well as the various research methods available to the researcher. Moreover, the advantages and disadvantages of each type and method of research were examined. In this section, the research design for the present study and the data collecting techniques will be discussed.

In the literature of research methodology, it is argued that there is no one single best research design that can be used to treat a research problem. An eminent researcher in the social sciences has stated this viewpoint quite eloquently:

> There is never a single, standard, correct method of carrying out a piece of research. Do not wait to start your research until you find out the proper approach, because there are many ways to tackle a problem - some good, some bad, but probably several good ways. There is no single perfect design. A research method for a given problem is not like the solution to a problem in algebra. It is more like a recipe for beef stroganoff; there is no one best recipe (Simon, 1969:4).

According to the objectives of this study (see Chapter one), a decision has been made to use a survey design for the following considerations:

1. This study attempts to find out the manufacturing strategy for Saudi plants in the last two years (i.e., 1987 and 1988) as well as for the next two years (i.e., 1990 and 1991). Therefore, a research survey design investigating a large number of plants is preferred to a case study bearing on a small number of plants.
2. The study intends to detect the manufacturing strategy for the Saudi plants by examining the influence of a wide range of variables. Therefore, survey is the most appropriate design.
3. In the literature of manufacturing management, there exists

quite a few empirical studies on manufacturing strategy (as it is a new field) which are based on this type of research design (Roth, 1987; Ferdows and De Meyer, 1989; Roth et al., 1989). Using the survey approach would allow the researcher to compare, to a certain extent, the results of the present study with the those of previous studies.

4. The non-experimental study (survey) is highly heuristic (Kerlinger, 1986). It is understandable by the researcher that one of the difficulties in research is to distance oneself of the problem under investigation. Therefore, this kind of design has investigation potential.

Similarly a decision has been made to use questionnaire as a method of data collection although interviews also will be used, if required, based on the structured questionnaire. The following are considerations for using the questionnaire:

1. The most common method of data collection in survey approach is the questionnaire. Using questionnaire as a main data collection technique assures the anonymity of respondents.
2. The questionnaire as a technique for collecting data is suitable for an individual researcher who is limited in terms of time, effort, and money.
3. Most of the objectives of this study (detecting strategies and testing hypotheses) will be accomplished through the utilisation of several statistical techniques. Thus, questionnaire is the most appropriate technique.

4. Self-administered questionnaire instead of mail questionnaire will be used to avoid a low rate of response.

5. Open-ended questions in addition to closed ones will be used to overcome the weaknesses of the latter. Furthermore, informal chat with the respondents will be sought as a source to complement and support the survey data.

4.4 POPULATION AND THE ACHIEVED SAMPLE

Sampling is very important for researchers engaged in field work. Zikmund (1984:44) defines sampling as "any procedure that uses a small number of items or that uses parts of the population to make a conclusion regarding the whole population." To achieve proper sampling, three dimensions must be addressed: the definition of the population, the size of the sample, and the representativeness of the sample (Nachmias and Nachmias, 1981). These three dimensions were highly considered in selecting the sample of this study.

The population for this study is the Saudi industrial sector. It was chosen for two principal reasons: its importance to the national economy as a means of diversification (see Chapter Three); and its potential for investigating the issue of manufacturing strategy (e.g., tangible products).

Within the industrial sectors, the manufacturing private sector was chosen (see Figure 3-2) on the basis of the following criteria:

1. The examination of the literature indicates that the

manufacturing private sector lacks studies of this kind with the exception of one study by Yaghmour (1985) on the metal industry only.

2. The existence of a variety of industries. As mentioned in Chapter Three, SABIC and Petromin have limited industrial activities; the former concentrates on the chemical and metal industries whilst the latter focuses only on the chemical industry.

3. The existence of similar capabilities among plants. SABIC Companies are giant projects, highly supported by the government. Similarly, Petromin refineries are large but totally supported by the government.

4. The existence of a large number of plants in most of the private industries, which allows for wider range of selection. In SABIC and Petromin, there are respectively 15 and 6 companies only (see sections 3.8.2 and 3.8.3).

Since the Saudi manufacturing private sector consists mainly of eight producing industries (excluding storage), a decision was made to select four industries (see Table 3-6) for two reasons: to minimise time and effort for the researcher; and to examine the manufacturing strategy dimensions in more than one industry (e.g., quality, cost). The selection criteria concerning the four industries is based on the following factors as priorities in decreasing order:

1. The highest total invested capital.
2. The highest number of employees.
3. The highest amount of sales.

The previous are three important factors to the national economy. Thus, the first four industries that met these criteria are: chemical, metal, building materials, and food industries (see Tables 3-7, 3-8 and 4-1; for more details, see sections 3.8.5.2 and 3.8.5.3). It is also worth mentioning that these four industries count the highest number of plants (see Table 3-6 and section 3.8.5.1), which means that they are industries with good potential.

However, after consulting a guide of "A List of Licensed Factories" provided by the Ministry of Industry and Electricity (1986b), and after visiting some of the operating plants in these four industries during the pre-field work trip, it was concluded that plants in the building materials industry do not lend themselves well to the application of the manufacturing strategy survey. This is because the highest percentage of the plants in this industry represents brick manufacturers, while the rest are concrete manufacturers. In the case of brick manufacture, the majority of the plants is labour intensive (i.e., using simple tools, a group of workers perform repeated manual work) and the remainder of the plants is mechanically operated. Furthermore, the Kingdom's infrastructure is now completed therefore, the building materials industry is likely to remain stable or decline. For the reasons mentioned above, the building materials industry was excluded from the sampling industry selection. Thus, the next industry that met the selection criteria is the paper and printing industry (see Tables 3-7, 3-8 and 4-1). Therefore, plants for this study will be selected from the following industries: Chemical, Metal, Food, and Paper.

Before starting to select plants of these four industries, two important points were addressed: the targeted subjects in the plants, and the total number of plants that should be selected of all industries. Since manufacturing strategy is formed in the corporate level strategy with the active participation of the manufacturing function (e.g., Skinner, 1978; Hayes and Wheelwright, 1984; Hill, 1985; Southern and Al-Shuaibi, 1990), two types of managers were targeted from each plant; general manager and production manager. Moreover, another functional manager of each plant (e.g., marketing or sales) was sought to participate in order to support or disagree with the general manager's view regarding the position of the production manager. Since there were only three targeted subjects in each plant, the researcher preferred to survey a large sample of plants because of the relationship between the sample size and the error as suggested by Kerlinger (1986) (e.g., the larger the sample, the smaller the error is). Accordingly, a decision was made to survey a total of 160 plants of the four industries, because distributing questionnaire in person is time demanding. The 160 plants represent 12.4 per cent of the total number of plants in the four industries.

Selecting 160 plants of four industries requires choosing one of two approaches; either equal or unequal quota of plants of each industry. The second approach was taken in order to select plants according to their actual existence (disproportional stratified sampling). This approach allows presenting the influence of each industry in this study as in the practical situation. Based on the total number of plants in these four industries (see Table 3-6), Figure 4-1 shows the

Table 4-1: Sales by industrial sector (1986)

(million U.S dollars)

Sector		Amount
31	Food	1147.0
32	Textile	53.9
32	Leather products	8.5
33	Wood	74.4
34	Paper and Printing	330.4
35	Chemical*	5206.1
36	Non Const. Mat.	20.3
36	Building Mat.	1171.7
37&38	Metal*	1361.0
39	Other industries	246.5
71	Storage	101.0

*: Sales for SABIC and Petromin were included

Source: The Consulting Center for Finance and Investment (1988:4), Survey Industries - 1987, (Saudi Arabia).

percentage of plants that should be selected out of each industry. Thus, the number of food, paper, chemical, and metal plants selected in the sample are 40, 15, 35 and 70 respectively.

Since each of the selected industries consists of several subindustries, strata, (see Tables 4.1.1 to 4.1.4 in Appendix A), the

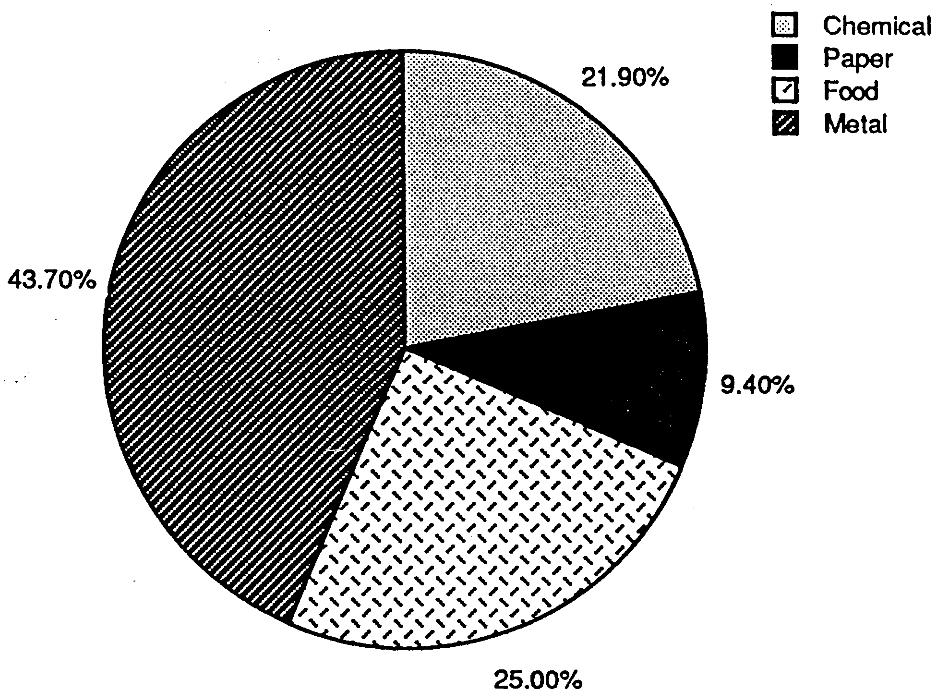

Figure 4-1 : Planned Sample by Industrial Sector

best sampling procedure for selecting plants of each industry is disproportional stratified sampling. This procedure (i.e., unequal quota of plants of each subindustry) allows the presentation of plants according to their actual existence. The major advantages of stratified sampling are (Zikmund, 1984): that it saves time and cost; it reduces sampling error because the categories are internally homogeneous; it produces a smaller standard error because the groups are adequately represented when strata are combined; it is very helpful in comparative studies; and it gives a reasonable degree of accuracy, which allows generalisation.

The following criteria were established to select plants of each subindustry:

1. Plants must be included in the guide of "A List of Licensed Factories" provided by the Ministry of Industry and Electricity (1986b) which ensures industrial license (see section 3.8.1.2, no. 6). By the time this survey is carried out, selected plants from this guide will have a minimum of three years experience in terms of operation, which is considered reasonable.

2. Plants were selected of each subsector through the above mentioned guide according to the following factors as priorities in decreasing order:

   (i) highest in paid up capital.

   (ii) highest in both paid up capital and number of employees.

   (iii) highest in number of employees.

   This in fact represents consistency with the criteria used for selecting the four industries in spite of the following two exceptions: total invested capital was replaced by total paid-up capital as it was not available for all plants; and the amount of sales for individual industries was not published since all plants were privately owned. The researcher was compelled to select plants according to capital and number of employees because plants were not classified in terms of size by the Ministry of Industry and Electricity. Selecting large plants in terms of paid up capital and number of employees is based on the researcher's assumption that manufacturing strategy or professionalism in businesses would be well searched in any firm except very small ones where one person is in charge of every task.

3. Plants in the private sector were selected without any consideration of the type of ownership (i.e., national or joint venture plants, see Table 3-6), as comparison between entirely Saudi and joint venture plants is not the objective of this study.

4. Plants must be located in any of the following regions: central, western and eastern, because they represent almost well balanced regions in terms of industrialisation (see section 3.8.5.4).

Following the above sampling procedures a field work survey was carried out in Saudi Arabia, for a period of three months, i.e., May-July, 1989. A total of 160 plants was approached in three major cities (Riyadh, Jeddah and Dammam), 121 plants returned the questionnaires (3 sets of questionnaires by each plant). After careful examination, the sets of questionnaires of 117 plants were accepted (a total of 351 questionnaires) (due to missing data and unanswered questions), which constituted 73 per cent in terms of rate of response (see Table 4-2). Almost 30 per cent of the respondents were interviewed.

It is worth mentioning that the high rate of response was prompted as a result of three important letters: a letter from the supervisor, a letter from the Dean of the School of Economics and Administration at King Abdulaziz University (Saudi Arabia), and a letter from the Deputy Minister of the Ministry of Industry and Electricity. In addition to the above letters, the researcher phoned the majority of the selected plants to ask for permission to conduct the survey.

Figure 4-2 depicts the achieved sample in the major cities in the three regions. As seen from the Figure, the highest number of the plants surveyed were first in Riyadh then in Jeddah and finally in Dammam. This exactly represents the actual plants distribution in these regions (see section 3.8.5.4), which proves that the majority of the plants in each region were concentrated in the largest city.

The achieved sample by subsector in the food, paper, chemical and metal industries are shown in detail in Tables 4-3, 4-4, 4-5 and 4-6 respectively. In some subsectors of the food and paper industries the "required number of plants that should be included in the sample" was not taken as it is, it was either decreased or increased. In the food industry, for instance, (see Table 4-3), the number of plants that should be included in the sample of the subsector 3117 is 8. However, only 3 plants of that subsector were selected in the sample because the manufacturing strategy is not much applicable to the activities of these plants (e.g., bakeries with modern equipments and blue-collar workers, see Table 4.1.1 in Appendix A). This figure (i.e., the extra 5 plants of the subsector 3117) was added to the

Table 4-2: Distribution of planned and achieved sample by industrial sector

Industry	No. of plants Planned	Achieved	Rate of response
Food	40	26	65.0
Paper	15	11	73.3
Chemical	35	32	91.4
Metal	70	48	68.6
Total	160	117	73.0

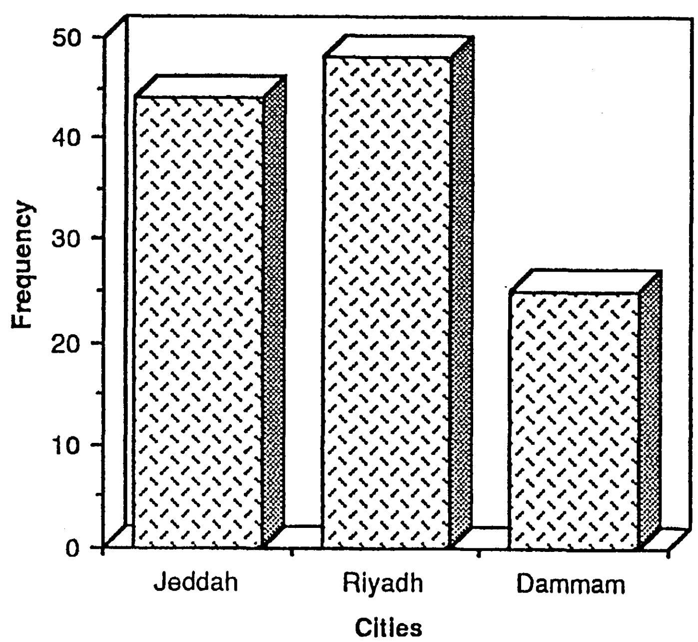

Figure 4-2 : Distribution of Plants by City

Table 4-3: Distribution of planned and achieved sample in the food industry by subsector

Subsector*	% Actual	No. of plants Planned		Achieved
3111	3.8	1		1
3112	17.4	8	(+1)	7
3113	12.8	7	(+2)	2
3114	0.6	0		-
3115	0.6	1		1
3117	20.6	3	(-5)	1
3118	0.6	1	(+1)	1
3119	5.0	3	(+1)	3
3121	18.7	3	(-5)	3
3122	8.4	1	(-2)	0
3134	11.5	12	(+7)	7
Total	100	40		26

For description see Table 4.1.1 in Appendix A.

Table 4-4: Distribution of planned and achieved sample in the paper industry by subsector

Subsector	% Actual	No. of plants Planned		Achieved
3411	4.1	2	(+2)	2
3412	17.2	3		2
3419	18.9	3		2
3421	59.8	7	(-2)	5
Total	100	15		11

For description see Table 4.1.2 in Appendix A.

Table 4-5: Distribution of planned and achieved sample in the chemical industry by subsector

Subsector*	% Actual	No. of plants Planned	Achieved
3511	13.4	5	3
3512	4.5	2	2
3513	2.4	0	-
3521	10.7	4	4
3522	1.0	1	1
3523	5.8	2	2
3529	3.4	2	2
3530 @	1.7	0	-
3540 @	5.2	0	-
3551	1.4	1	1
3559	1.4	1	1
3560	49.1	17	16
Total	100	35	32

@ : Belong to SABIC and Petromin companies.
For description see Table 4.1.3 in Appendix A.

Table 4-6: Distribution of planned and achieved sample in the metal industry by subsector

Subsector*	% Actual	No. of plants Planned	Achieved
3710 @	0.7	0	-
3720	0.7	1	1
3811	4.5	3	1
3812	10.8	8	2
3813	44.1	31	24
3819	9.1	7	7
3822	2.6	2	1
3824	1.7	1	1
3826	5.1	4	3
3827	2.1	2	1
3829	1.0	0	-
3831	4.9	3	0
3832	0.2	0	-
3839	3.8	3	3
3841	0.5	0	-
3843	7.0	5	4
3844	0.2	0	-
3852	1.0	0	-
Total	100	70	48

@ : Belongs to SABIC companies.
For description see Table 4.1.4 in Appendix A.

subsector 3134 with 2 more plants taken from the subsector 3122. Such manipulations are marked in these Tables by (-) and (+) which indicate taking a certain number of plants and adding them to other subsectors, according to the size of the subsector. In fact, this decrease and increase of plants in these subsectors were compensated in the achieved sample. In the same example mentioned above (i.e., subsector 3117), only one plant responded successfully (see Table 4-3).

4.5 VARIABLES AND INSTRUMENTS

As indicated in the previous section three types of managers were targeted from each plant. Therefore, questionnaires were designed for general managers (GMs), production managers (PMs), and sales managers (SMs). These were coded A, B, and C respectively (see Appendix A).

This study has six major variables (see Chapter Two). These are:

1. Manufacturing Task
2. Perceived Environmental uncertainty
3. Production Manager's role in Strategic Decision making
4. Competitive priorities
5. Performance
6. Manufacturing Infrastructure

Of the above variables, questionnaire A (general managers) measured items 1, 2, 3, 4 and 5; questionnaire B (production managers) measured items 1, 3, and 6; and questionnaire C (sales managers) measured item 3 only. In addition, questionnaire A covered five open-ended questions and several short questions as well as 15 questions related to "Type of business and products". Questionnaire B, similarly, covered some short questions.

The following are discussions of the instruments used to measure these variables. The expressions "Instrument" and "measure" will be used interchangeably in this study.

4.5.1 Manufacturing Task

Skinner and Associates (1982) measured manufacturing task (MT) by asking respondents to rank five items (low cost, quality, new products, flexibility, and delivery) according to their importance. Other researchers have used Likert scales to measure manufacturing task (e.g., Swamidass, 1983; De Meyer, 1986; Ferdows et al., 1986).

In this study, manufacturing task was measured using a Likert scale. The respondents (i.e., GMs & PMs) were asked to rate a 14-item instrument about cost, quality, flexibility, and delivery on a five point scale according to their plant's goals over the last two years (1987 and 1988) (Appendix A: questionnaire A, section II-A; questionnaire B, section I-A). Time (i.e., 1987 and 1988) was used in this and other questions because it represents one of the characteristics of strategy (Hayes and Wheelwright, 1984). In the five point scale used, a higher rating indicates high importance and a lower rating means low importance (exception made for items 1 and 12).

The instrument used in the present study is similar to the one used by Swamidass (1983), but with some modifications. Firstly, there are 14 task items in this study whereas Swamidass's study had 11 tasks. The new tasks (high performance design, volume flexibility, and fast delivery) were included according to the refined list of competitive priorities (see Figure 2-3). It should be noted that Kerlinger (1986) and Churchill (1979) recommended the use of a large number of items in an instrument to improve the reliability of the measure. Secondly, this study used a five point scale while Swamidass's study employed a ten point scale. In the opinion of the researcher such a long scale is not appropriate for the present study as it is too difficult for instance to tell the difference between number 6 and 7 on the scale.

4.5.2 Perceived Environmental Uncertainty

The controversies surrounding environmental uncertainty and its measures have been discussed in Chapter Two. The perceived measure has been strongly advocated over the objective measure by various researchers (e.g., Miles et al., 1974; Weick, 1977; Manning, 1982). The perceived measure of environmental uncertainty by Duncan (1972) has been replicated in several studies (e.g., Bourgeois, 1978; Jamison, 1981; Boulton et al., 1982; and Swamidass, 1983).

This study uses Duncan's approach for measuring environmental uncertainty with some modifications made to adopt to the Saudi environment. Duncan's approach consists of 13 items; one of them linked to "unionism" was dropped and replaced by an item related to "supervising Ministeries and Chambers of Commerce and Industry", which is more applicable to the Saudi business environment. Moreover, three items borrowed from Hill's (1983) external environment dimensions were added to the thirteen items; two of them are related to the economy and the third is linked to the "source of financial resources".

As a result, general managers were asked to rate a 16-item instrument on a five point scale in two questions; in the first question (A), according to the importance of the items when making decisions; and in the second question (B), according to general managers' ability in predicting these items when making decisions (Appendix A: questionnaire A, sections III-A and B). According to the scale in the first question, the higher the score the greater the importance of the item. As for the scale in the second question, a lower score indicates higher uncertainty and a higher score means lower uncertainty .

4.5.3 Production Manager's Role in Strategic Decision Making

In the "Manufacturing Management Survey", Skinner and Associates (1982) developed an instrument consisting of 4 statements in order to assess the manufacturing managers perception of their role in strategic decision making. The same instrument was adopted by Swamidass (1983). In addition to this instrument, Swamidass developed a corresponding instrument to measure the chief executives perception of the role of manufacturing managers in strategic decision making.

The present study adopted both instruments with some modifications. It accepted the four statements of each instrument and added a new statement to both instruments. This new statement: which is "whether the production manager is given an equivalent role among the functional managers in the formulation of corporate strategy or not" represents the critical issue in manufacturing strategy (see section 2.4.4). Also, another statement was added to the general managers' instrument only (i.e., questionnaire A). It is concerned with "the attendance of the production managers to top management meetings". Both statements were meant to verify if the manufacturing function as represented by the production manager is still separated from the corporate level strategy. In other words, the new statements were meant to investigate if the missing link between the corporate level and the manufacturing function still exists as reported by Skinner (1969).

Furthermore, a third corresponding instrument to measure the sales managers' perception of the role of the production manager was developed in this study. It contained the same five statements that were used with the general and production managers. As mentioned in the previous section, the purpose of developing the sales managers' instrument is to support or disagree with the general managers' view regarding the role of the production manager in strategic decision making.

All managers were asked to rate the statements (i.e., GMs a 6-item instrument, while PMs and SMs each a 5-item instrument) on a five point scale (Appendix A: questionnaire A, section IV-A; questionnaire B, section II-A; questionnaire C). In the scale used, a higher rating means a greater role for the production manager in strategic decision making.

4.5.4 Competitive Priorities

Competitive priorities were measured in several studies by the refined list of competitive priorities (e.g., De Meyer, 1986; Roth, 1987).

In this study, the competitive priorities variable was measured, also, by the refined list of competitive priorities (see Figure 2-3). Only general managers were asked to participate in this question. This is because the researcher anticipated that GMs are the most knowledgeable about competitive priorities as a result of their access to information inside and outside the organisation. This turned to be right as it will be seen in section 6.4. Thus, general managers were asked to rate a 8-item instrument on a five point scale according to their importance at that time (i.e., towards the end of 1989) and for the next two years (1990 and 1991) (Appendix A: questionnaire A, section IV-B). In the scale used, the higher the score, the greater the importance of the priority.

4.5.5 Performance

The performance approaches as well as their measures were discussed in detail in Chapter 2. It was mentioned that researchers on organisational performance are currently shifting away from focusing on a single measure and are concentrating on multiple measures. This is due to the difficulty in selecting one measure to represent the overall performance of the company (Bedeian, 1984). Accordingly, this study adopted the multiple measures approach to performance.

Growth in profitability and sales are usually used to measure organisational performance (Dess and Beard, 1984). In this study, growth in return on investment (GROI), growth in sales (GS), and growth in return on sales (GROS) during the last three years (1986-1988) were used to measure the financial performance of the Saudi plants (Appendix A: questionnaire A, section V-D Q4). For the purpose of this study, the researcher believed that a three-year span is appropriate because of the short history of the Saudi plants in manufacturing (see Chapter 3).

Because the selected plants in this survey are privately owned, the researcher anticipated that a large number of general managers will refuse to supply "objective data" for the aforementioned measures. Therefore, the approach of using "subjective data" for these three measures was employed as a precautionary step. This approach has been used successfully by several researchers. After comparing objective and subjective performance measures, Bourgeois (1980b) reported that a reasonable degree of similarity between the two approaches exists.

General managers were asked to rate a three-item instrument on a three point likert scale (i.e., below industry average, industry average, and above industry average) (Appendix A: questionnaire A, section V-B). For the purpose of this study, it was suggested by the researcher and advocated by his supervisor as well as those who examined the questionnaire (i.e., pilot study) that the industry average on the scale be considered slightly above the "break-even point". This step was taken in order to avoid confusion among respondents as such data was not published by the Ministry of Industry and Electricity. Similarly, to avoid confusion, all respondents were asked to report financial data according to the Gregorian calendar (see Chapter 3).

In addition to the above three subjective measures of performance, general managers were asked to respond to a question rating their plants chances of survival. The idea of this question was borrowed from Yaghmour (1985), but with a different scale of measure. Hence, GMs were asked to rate on a three point likert scale the chances of their plants survival today (i.e., refers to the period of the survey, May-July, 1989) as compared to three years ago. The purpose of this question was to find out the effect of oil prices decline as well as the completion of the kingdom infrastructure on the movement of industrialisation in Saudi Arabia.

Finally, two new questions related to benchmarking were incorporated in the study (Appendix A: questionnaire A, section V-A Q1 & 2). As mentioned in Chapter 2, the idea of benchmarking was to measure the plant's performance against the best in the industry.

4.5.6 Manufacturing Infrastructure

The manufacturing infrastructure variable was measured by enormous number of programmes (i.e., activities) in several studies (De Meyer, 1986; De Meyer and Ferdows, 1987; Roth, 1987; Roth et al., 1989). In these studies, the manufacturing infrastructure variable was measured by 37 programmes, all related to the activities in the manufacturing function. Manufacturing Managers were asked to rate these 37 programmes on a five point scale according to the degree of emphasis on each programmme over the next five years (or 2 years for some studies).

In this study, the manufacturing infrastructure variable was measured by 57 programmes. These programmes were adopted from a 64-item list from Swamidass (1983) with some modifications. Of the 57 programmes, 8 of them were added to this study to improve the instrument. The new 8 programmes are: 11, 12, 38, 42, 43, 45, 46 and 48 (see Appendix A: questionnaire B, section III-BQ3). These 57 programmes were grouped under eight major infrastructure areas: Inventory, Planning, Scheduling and control, Purchasing, Process and product design, Labour and quality, Miscellaneous, and Foreign production. In this question, Production Managers were asked to rate a 57-item instrument on a five point scale according to time, effort, and resources devoted to each programme currently (i.e., towards the end of 1989) and for the next two years (1990 and 1991). A two year period (rather than a five year period) was selected to provide more accuracy in planning since the Saudi industries have limited experience. In the scale used, the higher the rating, the greater the time, effort, and resources devoted to the programme is.

The next paragraphs will discuss briefly the other questions that were covered by both types of the questionnaires; A and B.

Questionnaire A

The first section of this questionnaire covered 15 short questions, aiming at providing a good background about the Saudi manufacturing industries. These questions are mainly related to type of plant, number of employees, years of operation, product and its major technological change, foreign and Saudi competition, and exporting obstacles.

Five open-ended questions were formed for this study to overcome the weaknesses of the fixed format (Appendix A: questionnaire A, sections II-Q15; IV-D Q 1 & 2; V-C Q 1&2). Four of these questions inquired about the Saudi plants in terms of strengths, weaknesses, opportunities, and threats (i.e., SWOT analysis). Several researchers have included only "strengths" in their manufacturing strategy studies; however, the researcher believes that the other dimensions of SWOT analysis are equally important. Threats, for example, could be decreased or turned into opportunities. The fifth open-ended question was related to the business strategy of the plant (i.e., what elements of your manufacturing and technology are vital to your plant's competitiveness). This question is similar to the one used by Swamidass (1986). The researcher expects that these open-ended questions will serve to support or contradict the findings of the fixed format questions.

Both GMs and PMs were asked to rank the manufacturing areas (competitive priorities) from 1 to 8 according to the plant's needs for improvements; 1 indicates the most needed improvements and 8 indicates the least needed improvements (see Appendix A: questionnaire A, section IV-C; questionnaire B, section II-B). As it is clear from the question, the purpose is to find out the areas that need the most improvement as well as those which require the least improvement.

General Managers were also asked to provide percentages for the following: aspects of total unit cost (materials, labour, transportation, other); source of raw materials (locally & imported); allocation on Research and Development; and finally investment on process and equipment (Appendix A: questionnaire A, section V-D Q 1, 2 & 3). These percentages will be used in support of other findings.

Questionnaire B

In addition to the question related to manufacturing areas, production managers were asked to respond to a variety of other questions. These questions related to: type of process; future demand; peak capacity requirements; decreased capacity requirements; maintenance; and forecasting (Appendix A: questionnaire B, section III-A Q 1, 3, 4, 5, 6, and B-Q2). All these questions were derived from the production management literature (e.g., Hayes and Wheelwright, 1984; Fine and Hax, 1985).

Production managers were, also, asked to supply percentages for the following: capacity (growing or declining); rework products; customer rectification; scrap; products with new design; and rejected rate in production (Appendix A: questionnaire B, section III-A Q2, B-Q1). These percentages will be utilised in support of other findings.

4.6 STATISTICAL METHODS

In this study, different statistical techniques were used via the "Statistical Package for the Social Sciences" (SPSSX). Descriptive statistics was used throughout the dissertation such as frequency distribution, percentages and mean. The mean value was used intensively in this study for two reasons: it provides a standard approach for comparisons between items; and it shows differences between items (better than the median value), which is utilised in ranking. The Mann-Whitney test was used to find out if highly significant differences exist, on the total sample level, between the ratings of general and production managers. For the sake of double accuracy, the T-test of the Parametric techniques was used to detect differences between general and production managers'ratings. Similarly, Kruskal Wallis as well as One Way Analysis of Variance (ANOVA) were used to find out if highly significant differences exist among the ratings of the four industries by each type of managers. Cronbach's alpha coefficient was employed to indicate the reliability of the instruments in this study (see Chapter 6).

Pearson product moment correlation was used for testing the hypotheses. This type of correlation was used rather than "spearman rank correlation" because the data were weighted and it was suggested that Pearson product moment correction is more appropriate. Furthermore, using this type of correlation permits comparisons to take place between the findings of the present study and those of Swamidass' (1983) study. The T-test was also employed in the testing.

The principal components of factor analysis were used to find out the manufacturing strategy components as well as the focused sets of competitive priorities. This technique was used in several studies of the same nature (e.g., De Meyer and Ferdows, 1987; Roth, 1987).

Canonical correlation analysis was employed to facilitate the study of interrelationships among the components of manufacturing strategy (sets of criterion variables) and the focused sets of competitive priorities (sets of predictor variables) in order to find out the expected manufacturing strategy. This technique suits the ordinal level of data in the study because "canonical correlation places the fewest restrictions on the types of data (metric or nonmetric) on which it operates" (Hair et al., 1987: 188). Moreover, all data were weighted (i.e., constructing indices) in order to ensure meeting the criteria of the study subject and to improve the level of data. This technique, with the same level of data, was used by Roth (1987).

Along with the preceding statistical techniques, three levels of significance were used: 0.001, 0.05, and 0.10 (Daniel and Terrell, 1983). The first level of significance (0.001) or better was used to judge the differences in ratings between and among managers. This level is set up to be very high because the researcher is searching for genuine differences among respondents. The second level (0.05) or better was used in canonical correlation analysis. The final level (0.10) or better was used to judge the results of the hypothesis testing. This level of significance was extended to 0.10 because the hypotheses are almost new.

4.7 VALIDITY AND RELIABILITY OF THE STUDY

Validity and reliability are very important in Social Science Studies. Unlike physical studies, the social science studies deal with human subjects and human measurements; therefore, it is difficult to control human behaviour (Sanders and Pinhey, 1983). Validity addresses the problem of whether an instrument measures what it is supposed to measure (Zikmund, 1984). Reliability, on the other hand,is defined as "the degree to which measures are free from error and therefore yield consistent results" (Peter, 1979:6). Both validity and reliability were taken into account in this study.

One of the related approaches for establishing validity for this study is called "face or content validity" (Churchill, 1979; Zikmund, 1984). This approach refers to the "subjective agreement among professionals that a scale logically appears to accurately reflect what it purports to measure" (Zikmund, 1984: 253). As referred to by Churchill, if the sampling of items in the instrument is appropriate and the items "look right" then the instrument is said to have face or content validity. All the items in the instruments of this study were perused by Dr Geoff Southern and reviewed by some members of the management studies department at Glasgow Business School.In addition, the instruments were re-examined by 17 managers (GMs, PMs, SMs) of the Saudi business environment to ensure their validity for the Saudi environment as well as to clarify their ambiguity.

On the other hand, according to the above definition, measurement error is the major source of unreliability in measures. Since errors in a study of this type are caused by: inability of respondents to communicate; failure to remember; and reluctance to report true data (Bedeian, 1984). All these causes of errors were considered when the questionnaires were prepared. All questions were made very clear to avoid ambiguity. During the field work, the researcher distributed the questionnaires in person and assured every manager (i.e., GMs, PMs, & SMs) that their answers will be considered highly confidential besides the fact that the data will be entirely processed by the computer. Moreover, replication of measurements is the essence of reliable research (Sanders and Pinhey, 1983; Zikmund, 1984). Eventhough manufacturing strategy is still a new field, the researcher was able to replicate some instruments with some modifications (see section 4.5).

Furthermore, after collecting the data, the instruments were examined by Cronbach's alpha coefficient which is a widely accepted index to indicate the reliability of the instruments and they were found to be reliable (see Chapter 6).

Translation of the questionnaires was another factor of reliability in this study. Because this study was conducted in Saudi Arabia where Arabic is the main language, it was of paramount importance that both versions of the questionnaires (i.e., Arabic & English) be identical. Therefore, three competent linguists were asked to translate the English version into Arabic. Then, the Arabic translations of the questionnaires were exchanged between the linguists to be checked for accuracy.

SUMMARY

This Chapter has discussed the research methodology for the present study. Three types of research design (experiment, case study & survey) accompanied with their advantages and disadvantages were presented. As a consequence, the survey design was found suitable for a study of this type. A self administered questionnaire as a major tool for data collection was selected in addition to interview and observation. Governmental documents played also a vital role in supplying primary data for this research.

The survey was conducted on the Saudi manufacturing private sector because it lacks a study of this kind in addition to the availability of several industries and the similarity of plants' capabilities. Four industries (Chemical, Metal, Food and Paper) were selected from the manufacturing private sector on the basis of highest invested capital, highest number of employees, and highest amount of sales. The number of plants for each industry was determined based on the actual existence of the plants in the industry. The plants were then selected from each subindustry using disproportional stratified sampling according to the highest paid up capital, highest in both paid up capital and number of employees, and highest number of employees. Through the above sampling procedures, a sample of 117 plants was achieved during a three month period (May-July, 1989): 26 food plants, 11 paper plants, 32 Chemical plants, and 48 Metal plants. The achieved sample constituted 73 per cent rate of response.

Three types of managers from the areas of strategy, production, and sales were invited to participate in the study. Accordingly, three types of questionnaires were designed. Their major variables are as follows: manufacturing task, environmental uncertainty, production manager role in strategic decision making, competitive priorities, performance, and manufacturing infrastructure.

CHAPTER FIVE

CHARACTERISTICS OF THE SAMPLE

INTRODUCTION

This Chapter presents certain characteristics of the surveyed plants. These cover several important areas relevant to the study of manufacturing strategy in Saudi Arabia. Most of the data presented were furnished by general managers of the first three pages of questionnaire A, and a small portion of the data was provided by production managers of questionnaire B (see Appendix A).

These areas are plant profiles, time of new product development, major technological changes in product, demand on main product, product combinations, nature of foreign and Saudi competition and finally sales to Saudi and foreign markets. The analysis of these areas are summarised in terms of means and frequency. Some of the findings are compared with other findings concerning the Saudi total industrial sectors and, in particular, the Saudi manufacturing private sector. Such comparisons indicate the manufacturing situation in Saudi Arabia and the level of improvement. Data in these areas will be used in later discussion and analysis in the subsequent Chapters.

5.1 PLANT PROFILES

Plants which participated in this survey were classified by industrial sector, ownership, size of plant in terms of number of employees and amount of capital, and finally number of years in operation. The following subsections briefly describe each one of them.

5.1.1 Industrial Sector

Figure 5-1 shows the proportions of participants in the survey by industrial sector (achieved sample). The percentages of the plants in the achieved sample by industrial sector are approximately the same as in the planned sample (see Figure 4-1). 117 plants in total participated in the survey. The number of plants from the food, paper, chemical, and metal private industries are 26 , 11 , 32 and 48 respectively. The next two subsections analyse these plants in terms of type of manufacturing processes and capacity utilisation.

5.1.1.1 Type Of Manufacturing Processes

Figure 5-2 illustrates the type of manufacturing processes for all the participated plants in this survey. Of all types of processes, the continuous has the highest percentage in terms of number of plants and the assembly line has the lowest percentage. As expected, continuous processing is used in all plants in the food industry and in the majority of the plants in the chemical industry. For more details of type of manufacturing processes by industrial sector, see Table 5.1.1 in Appendix B.

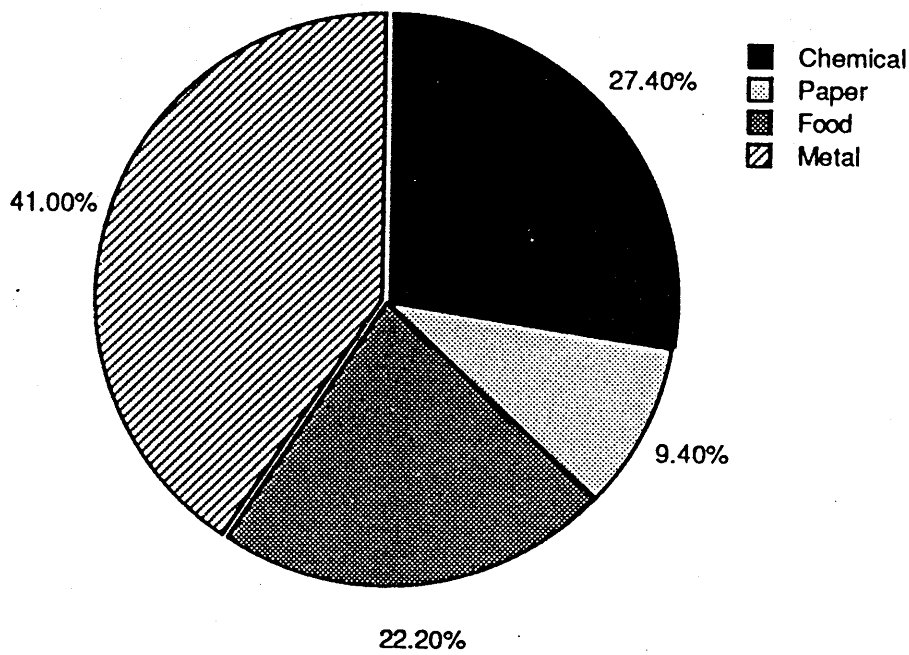

Figure 5-1 : Achieved Sample by Industrial Sector

5.1.1.2 Capacity Utilisation

On a scale of 100 points, general managers (GMs) were asked to indicate the total actual capacity utilisation in their plants in terms of equipment, labour and resources. The average utilisation of the total capacity for the total sample (i.e., food, paper, chemical and metal industries) is 71.3 per cent, with a standard deviation (SD) of 18.3 [SD measures the spread of the data from the mean (Porkess, 1988)]. During the field work discussions most of the general managers pointed out that they were working below full capacity. In general, they attribute the problem of underutilisation to the following reasons:

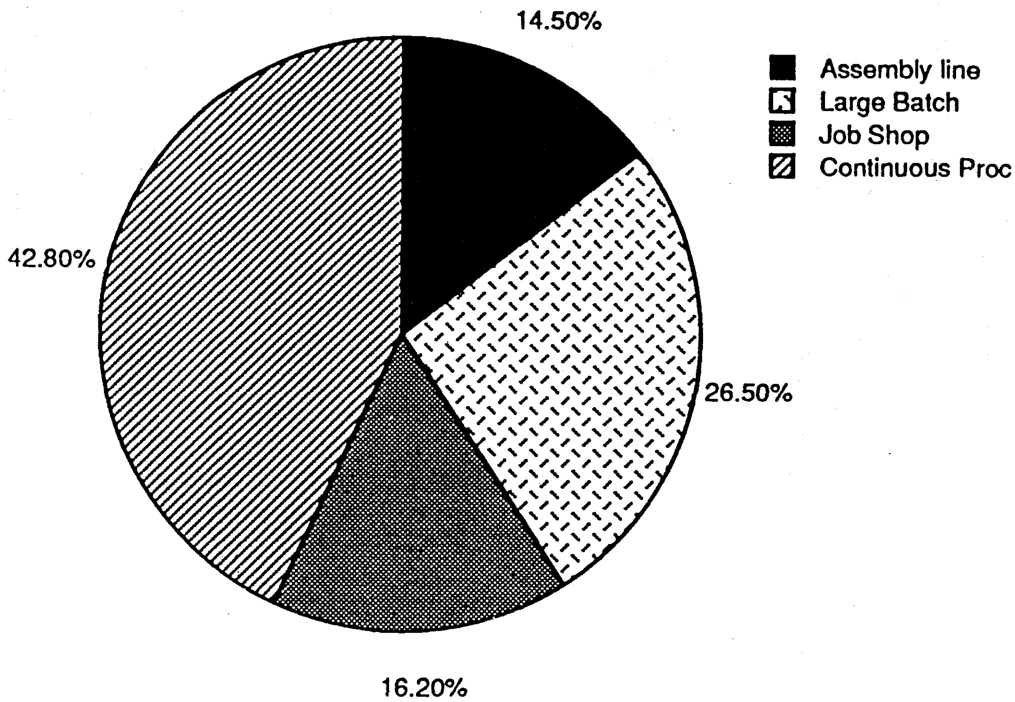

Figure 5-2 : Distribution of Plants by type of process

1. Small markets in the kingdom of Saudi Arabia.
2. Low demand in purchasing from both government and private sectors due to the completion of the Kingdom infrastructure.
3. Overcapacity of plants in some industries, and in particular in some subsectors, which constitutes very hard domestic competition.
4. Foreign competition in Saudi markets, especially unfair competition.
5. Difficulties in exporting.

Almost sixty seven per cent of plants surveyed have indicated that their capacity will increase in the next two years (1990 and 1991). In contrast, only about nine per cent of the plants will reduce their capacity, and the remaining portion of the plants will continue to operate with the current level of capacity for the next two years. This trend clearly shows that more than half of the plants in this survey are not satisfied with the current level of capacity.

An estimate of capacity utilisation was established in 1986 by The Consulting Center for Finance and Investment (1988). In this estimate, the average utilisation of capacity for the private sector (four industries of which are the focus of this study) was found to be 54.2 per cent and it was about the same for the total industrial sectors (55 per cent) [see Figure 3-2]. However, the average capacity utilisation for the other sectors exceeded the highest level: 100.8 per cent for Petromin refineries, and 104.6 per cent for SABIC industries. This does not mean that Petromin refineries as well as SABIC companies did not consider a capacity cushion but it may mean that they had not recently upgraded their licensed capacity. The average utilisation of capacity found in the present survey is higher than that reported by The Consulting Center for Finance and Investment (1988), because these are the largest plants in the surveyed industries and the situation may have improved.

Some of the reasons for underutilisation of capacity reported by The Consulting Center for Finance and Investment (1988) are almost similar to those reported here.

In dealing with future demand on their products, slightly over 60 per cent of the plants in the total sample responded that they usually increase their capacity ahead of time, and almost 40 per cent indicated they usually increase it at the time of the demand. Plants included in the 40 per cent category refer their decision concerning increasing the capacity at the time of the demand to the existence of unexpected fluctuations in demand (discussions with production managers).

For peak capacity requirements, eighty per cent of the plants of the total sample tend to "hire workers" and "schedule overtime" (almost in equal proportion). Slightly over ten per cent pointed out that they were "far from the peak level". Moreover, small percentages of the plants mentioned that they use "subcontracting" and "increase the number of shifts" for peak capacity requirements. Conversely, for decreased capacity requirements, about a quarter of plants of the total sample tend to "lay off workers", and about a quarter "give annual vacation for employees". Almost 22 per cent indicated that they were "far from the decreased level of capacity", and the rest of the plants mentioned that they "reduce the number of work shifts" for decreased capacity requirements.

Among the individual industries, the food has the highest capacity utilisation in terms of equipment, labour and resources, whilst the chemical industry has the lowest capacity. The other two industries utilise about the same capacity (see Table 5.1.2 in Appendix B). Again, of all industries the food has the highest percentage of plants (84.6 per cent) that are planning to increase the capacity for the next two years (1990 and 1991), and the chemical industry has the lowest percentage (50 per cent).

5.1.2 Ownership

Ownership of plants, by capital, is either wholly Saudi or joint venture. The main purposes of the joint venture projects (Saudi and foreign partners) are to share experience with and to learn from foreign partners who have proven themselves in the world of manufacturing (see Chapter 3).

In this survey, almost 60 per cent of the total sample of the plants are wholly Saudi (see Table 5-1). The percentage of the joint venture plants in this survey is twice that in the Saudi manufacturing private sector (see section 3.8.5.1) but has no effect on this study because comparisons of the wholly saudi and joint venture plants is not the objective of this research (see section 4.4).

Of all industries in this survey, plants in the chemical industry show the highest percentage of joint venture projects (62.5 per cent), while those in the food industry show the lowest percentage (26.9 per cent). The chemical industry has the highest percentage of joint venture projects because it requires a high level of expertise. As for the food industry, the Joint venture plants are not as plentiful as in all other industries in the private manufacturing sector (see Table 3-6). For more details about the wholly Saudi and joint venture plants of the single industries, see Table 5.1.3 in Appendix B.

Table 5-1 : Ownership of plants by capital in the total sample

Type Of Plant	No. Of Plants	Perc.
Wholly Saudi	70	59.8
Joint Venture	47	40.2
Total	117	100

5.1.3 Size Of Plant

Because the Ministry of Industry and Electricity did not classify Plants in terms of size, the researcher examined the guide of "A List of Licensed Factories" (Ministry of Industry and Electricity, 1986b) and selected certain criteria to classify the surveyed plants into small, medium and large sizes according to number of employees and capital.

5.1.3.1 Size Of Plant In Terms Of Number Of Employees

As expected, the share of large size plants in terms of number of employees is the highest and those in the small scale are the lowest. This is achieved on the basis of the sampling selection criteria where large size plants in terms of number of employees were targeted following plants with high capital (see section 4.4).

As can be seen from Table 5-2, 55.6 per cent of the surveyed plants are large.

Over 50 per cent of the plants of each industry are large with the exception of the paper industry (see Table 5.2.1 in Appendix B). Most of these plants operate in the following activities: dairy products, soft drinks, plastic products, manufacture of structural metal products, and manufacture of fabricated metal products.

a) Employment

The total number of employees in the surveyed plants of the four manufacturing industries is 18961. This figure represents 15.4 per cent of the total labour in all industries of the manufacturing private sector (see Chapter 3). Of the total number of employees in this survey, only 9 per cent are Saudi (Table 5-3). This clearly shows the shortage of the Saudi employees in these important industries. This value is higher than that reported by The Consulting Center for Finance and Investment (1988) which stated that the private manufacturing sector had 7.5 per cent of Saudi workers. The increase in the Saudi labour percentage could reflect the government's scheme for the replacement of foreigners by Saudis in the private manufacturing sector (saudiisation). However, this slight increase indicates a very slow progress in this direction bearing in mind that the 9 per cent represent four industries only. In the total industrial sectors, Saudi labour reached only 12.8 per cent, but it is much higher in Petromin refineries, and in SABIC: 67.1 per cent and 58.4 per cent respectively (see Figure 3-2).

Table 5-2 : Distribution of plant size according to number of employees in the total sample

Size	No. Of Plants	Perc.
Small	20	17.1
Medium	32	27.3
Large	65	55.6
Total	117	100

small : 49 employees or less

medium : 50 - 99 employees

large : 100 employees and over

Of all industries, the metal industry hires the highest number of employees of the total employment in this survey (46.2 per cent). On the other hand, the paper industry hires the lowest number of employees of the total employment (5.5 per cent) (see Table 5.2.2 in Appendix B).

In terms of Saudi employment, none of the four manufacturing industries exceeds 10 per cent. The highest percentage of saudi employees is found in the metal industry (9.6 per cent), whereas the lowest is found in the paper industry (5.5 per cent) (see Table 5.2.2

Table 5-3 :Distribution of Saudi and non-Saudi employees in the total sample

Category	Cases	No. Of Employees	Perc.
Saudi		1712	9
Non - Saudi		17249	91
Total	117	18961	100

in Appendix B).

In all plants surveyed, the average number of employees (Saudis & Non-Saudis) is 162. The maximum number of employees hired by a plant is 1448 while the minimum number is 15. The high standard deviation (SD =184) reflects the inclusion of all sizes of plants in this sample.

Since Saudi employees constitute only nine per cent of the total employment, their existence in most plants is negligible not including their positions in top and middle management levels. The average number of Saudi employees in all the surveyed plants is 15, The maximum number of Saudi employees hired by a plant is 234, and in some plants Saudi employees are nonexistent. In most cases, the jobs taken by the Saudis in these plants are in the top management and at the administrative level (a head of department). In this survey, Saudi general managers constitute almost 40 per cent of the total general managers (observations during the field work). This result supports previous finding of which it was found that Saudi managers formed 43.1 per cent of total managers at the private manufacturing sector in 1986, and the percentage is slightly higher in the total industrial sectors for the same year (44.6 per cent).

Furthermore, the Saudi percentage of the total employment of each of the following in 1986 was : 15.5 per cent administrative, 4.6 per cent professional, and 4 per cent for each of skilled and unskilled workers (The Consulting Center for Finance and Investment, 1988). This clearly means that the private manufacturing sector is highly dependent on foreign labour force, especially on professional and skilled workers. Corresponding figures for the total industrial sectors are a little bit higher: 25.5 per cent administrative, 11.5 per cent professional, 11.2 per cent skilled workers, and 5.6 unskilled workers. This increase is due to the high percentages recorded at Petromin refineries and SABIC companies.

The average number of employees (Saudi and Non-Saudi) in the food and metal industries is above the average of the total sample (Table 5.2.3, Appendix B) as they employ the highest number of employees.

5.1.3.2 Size Of Plant In Terms Of Capital

As with the number of employees, the share of large plants in terms of capital is the highest and those in the small size are the lowest. Table 5-4 displays that 44.8 per cent of the surveyed plants are large. Again, this is accomplished on the basis of the sampling selection criteria where large size plants in terms of capital are targeted first (see section 4.4).

All the individual industries with the exception of the paper industry have the highest percentage of plants in the large size category (see Table 5.2.4, Appendix B).

By combining the two factors (i.e., number of employees and capital), it was found that the biggest share of the surveyed plants is large.

a) Capital

The capital paid up in the surveyed plants of the four manufacturing industries is estimated at $ 637076 (all figures in thousand U.S dollars). Of all industries, the metal industry consumes the highest capital (35.2 per cent), followed by the food industry (29.2 per cent) and the paper industry consumes the lowest capital (6.9 per cent).

The average amount of capital paid up of all plants surveyed is $5492 (SD = $6645.7). The maximum amount of capital paid up is $42000, and the minimum is $266. Regarding single industries, the average amount of the capital paid up for the food and the chemical

Table 5-4 : Distribution of plant size according to capital in the total sample

Size	No. Of Plants	Perc.
Small	29	25.0
Medium	35	30.2
Large	52	44.8
Total	116	100

small : $ 1333 or less (in thousand U.S. dollars)

medium : over $1333 - $4000

large : over $4000

industries are above the average of the total sample ($7155.2 and 5915 respectively). In contrast, the average amount of the capital paid up for the paper and the metal industries are below the average of the total sample ($3973 and $4666.1 respectively).

The capital paid up per employee in the total sample is $ 33.6 .The same ratio for the food, paper, chemical and metal industries are $ 38.1, $ 42.2, $ 42.8 and $ 25.6 respectively. Thus, the capital paid up per employee is the highest in the chemical industry and the lowest in the metal industry.

The Saudi Industrial Development Fund (SIDF) plays a major role in attracting Saudis to invest in the industrial sector by providing financial loans (see Chapter 3). In this survey, nearly 67 per cent of the plants obtained loans from SIDF. Of the plants which did use the SIDF facility are 80.8 per cent of the food, 81.8 per cent of the paper, 56.3 per cent of the chemical and 62.5 per cent of the metal.

5.1.4 Number Of Years In Operation

Table 5-5 shows that nearly 60 per cent of the plants in this survey have been in operation for 10 years or less, and only 10.3 per cent for 21 years or over. What is interesting here is that this study dealt with 12 out of the 55 plants that reported having over 20 years of operation in the survey conducted by The Consulting Center for Finance and Investment (1988).

When considering individual industries the metal and the food industries have the highest percentage of number of operational plants in the category of 6 to 10 years (52 per cent and 53.9 per cent respectively) (see Table 5.3.1 in Appendix B).

5.2 TIME OF NEW PRODUCT DEVELOPMENT

Nearly 60 per cent of all plants surveyed reported an average time of three years or less for new product development. Examination of Table 5-6 reveals that 25.6 per cent of the plants introduce new products in a period of six months or less. This figure represents the most outstanding plants in Saudi Arabia in terms of effort in research and

Table 5-5 : Distribution of plants according to number of years in operation in the total sample

Years In Operation	No. Of Plants	Perc.	Cumulative Perc.
3 - 5	15	12.8	12.8
6 - 10	53	45.3	58.1
11 - 20	37	31.6	89.7
21 - 35	12	10.3	100
Total	117	100	

development (R & D). It is worth mentioning that the majority of the general managers pointed out that they rely heavily on their foreign partners in performing this task.

In contrast, 27.4 per cent of the plants did not introduce any new products hitherto.

Of all industries, the metal spends the longest period to develop new products whereas the paper industry spends the shortest period due to simplicity in design (see Table 5.4.1 in Appendix B).

Table 5-6 : Average time for product development in the total sample

Time	No. Of Plants	Perc.	Cumulative Perc.
6 Months Or Less	30	25.6	25.6
Over 6 Months To 1 Year	20	17.1	42.7
2 Years	7	6.0	48.7
3 Years	11	9.4	58.1
Over 3 Years	17	14.5	72.6
Did not introduce any Product	32	27.4	100
Total	117	100	

5.3 MAJOR TECHNOLOGICAL CHANGES IN PRODUCT

Of all plants surveyed, 40.1 per cent reported that their competitors offered the recent major technological changes in their product during the last four years, while only 23.1 per cent said it had been five years or over, and just under 10 per cent reported that their industries lack any technological changes (see Table 5-7). These findings reinforce the fact that the Saudi industries are young and equipped with the latest technology. Surprisingly, as much as 30 per cent of the participants mentioned that they were unaware of the last technological changes offered by competitors in the industries.

Table 5-7 : Major technological changes in product offered by competitors in the total sample

Last major Technological Change Occurred	No. Of Plants	Perc.	Cumulative Perc.
None	9	7.7	7.7
1 Year Ago	19	16.2	23.9
2 Years Ago	13	11.1	35.0
3 Years Ago	11	9.4	44.4
4 Years Ago	4	3.4	47.8
5 Years Or Over	27	23.1	70.9
Do Not Know	34	29.1	100
Total	117	100	

Table 5-7 shows that there is a slow of technology introduction in the period of three to four years, and an escalation of its introduction in the period of one to two years. This recent escalation could be a reaction to economic uncertainty, and if this is the case it validates the proposal that technology is a means of beating uncertainty (Woodward, 1970; Miles et al.,1974; Gerwin, 1982). This finding also agrees with that reported by Swamidass (1983) and could mean that technology is updated every two years.

The food and metal industries experience the shortest period of major technological changes in product. Both industries reported an average period of three and a half years since the last major technological changes. The paper industry, however, experiences the longest period since major technological changes (see Table 5.5.1 in Appendix B).

5.4 DEMAND ON MAIN PRODUCT

Nearly 70 per cent of all participating plants reported that they anticipate a growth in demand for their main product, and almost 7 per cent expected a decline in 1990 and 1991 (see Table 5-8).

General managers expect between 3 and 99 per cent growth in demand with an average of 20.3 per cent. As a result, 67 per cent of all the plants surveyed are planning to increase capacity in 1990 and 1991 (see section 5.1.1.2). On the other hand, declining demand is expected by fewer plants and ranges from 1 to 20 per cent, with an average of 7.3 per cent.

Plants which predict a growing demand on their major product are spread in the four industries. The food industry is expected to experience the highest growing demand on its main product (84.6 per cent) followed by the paper industry (72.7 per cent) (see Table 5.6.1 in Appendix B).

Table 5-8 : Demand on main product in the total sample

Demand On Product	No. Of Plants	Perc.
Stable	29	24.8
Growing	80	68.4
Decline	8	6.8
Total	117	100

5.5 PRODUCT COMBINATIONS

Plants surveyed in the Saudi manufacturing private sector tend to have few product lines, a small number of products, and a small number of options. On average, on the total sample level, the plants surveyed have three product lines, four products per line, and three options per product (beyond the standard) as shown in Figure 5-3. The minimum reported number of product line is 1 by 9 plants, and the maximum is "16 or more" product lines also by 9 plants. The minimum reported number of products is 1 by 17 plants, and the maximum is "16 or more" products by 32 plants. Finally, the minimum reported number of options is zero by 25 plants, and the maximum is "16 or more" options by 22 plants.

This means that the plants tend to be small in terms of operations, and this partly reflects the focused factory concept (Skinner, 1974;

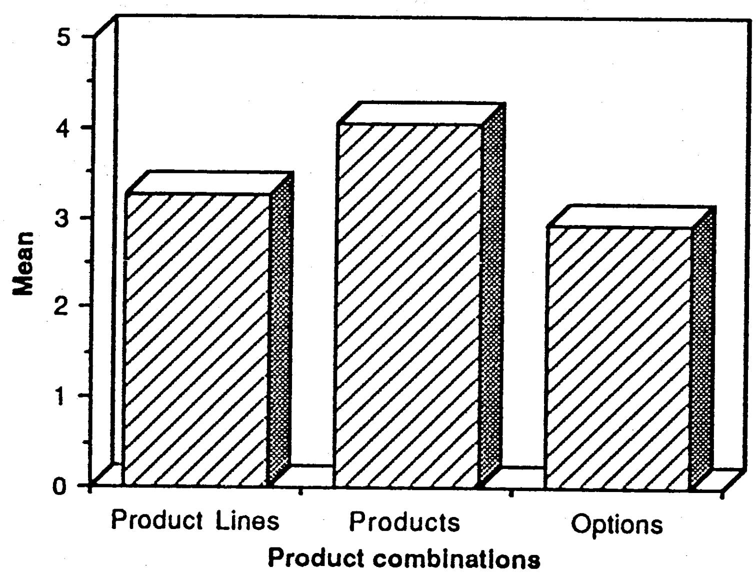

Figure 5-3 : Distribution of Product Combinations in the Total Sample

Hill,1985). The main idea behind "focusing" is to do few tasks and to do them well (see section 2.4.1). If the reported data is representative of the actual situation, a typical plant manages on the average 36 product combinations.

Figure 5-4 highlights the differences in product combinations (product lines, number of products and number of options) based on the means among the four manufacturing sectors. Plants in the chemical industry have the highest number of product lines as opposed to those in the food industry. As for number of products, again the chemical industry offers the highest variety of products per product line and its followed by the metal industry, while the paper industry offers the lowest number of products. Options in the

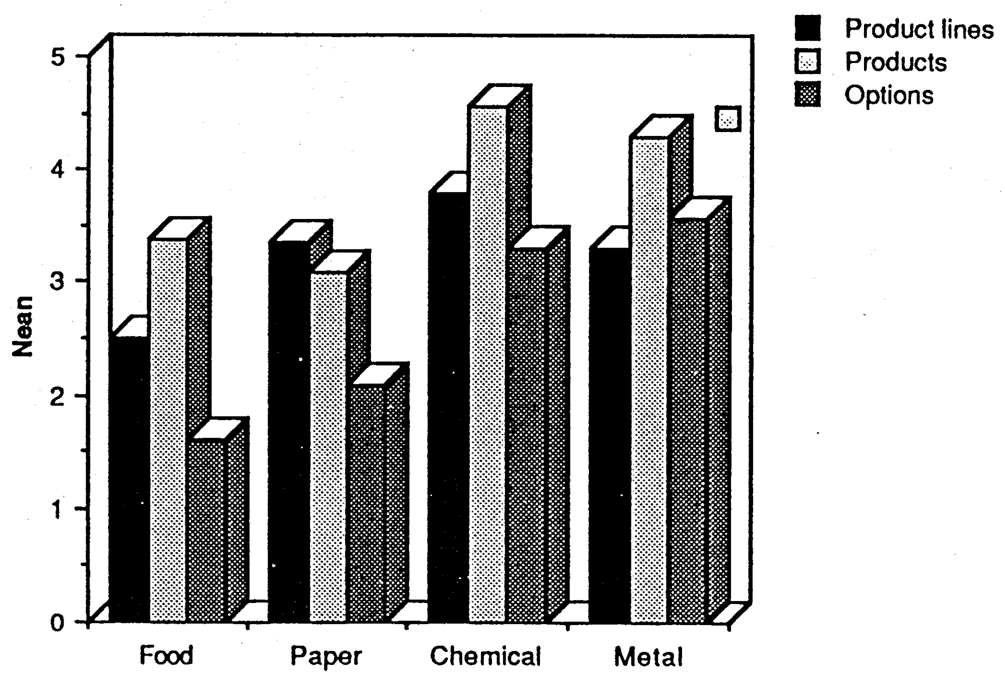

Figure 5-4 : Distribution of Product Combinations by Industrial Sector

product beyond standard are the highest in the metal industry and the lowest in the food industry. This is because the food industry is highly standardised, whereas the metal industry is largely involved in customised product manufacture.

5.6 NATURE OF COMPETITION

Since Saudi market is accessible to all legal foreign products (i.e., according to islamic law) as indicated by the industrial policy (see section 3.8.1.2, no. 3), foreign and Saudi competition are very important dimensions in the study of manufacturing strategy.

5.6.1 Foreign Competition And Market Share

On a scale of one to five, foreign competition for the total sample rated a score of 2.86 (1 = non-existent, 5 = very high competition). This suggests that plants in the surveyed industries experience little to moderate foreign competition in the home markets indicating that foreign competition is not as severe as people think. However, it could be harsh competition for some industry and especially for some subsectors. This survey result appears to be consistent with the average market share for foreign competition of 22.4 per cent in 1988 at the Saudi markets reported by plants of the four manufacturing sectors. The maximum reported market share for foreign competition in the Saudi market for the same year was 75 per cent and the minimum was zero per cent.

The foreign market share in the Saudi market for 1988 was less than the previous years. In 1986, the average foreign market share was 30 per cent, and it was 25.6 per cent in 1987, a reduction between 1986 and 1988 of almost eight per cent. This can be attributed to the following factors: better quality Saudi products, consumers nationalism in buying, and government intervention to prevent inferior foreign products from entering the Saudi market.

Figure 5-5 shows that the chemical industry perceives moderate to slightly high foreign competition which is the strongest of all industries. Conversely, the paper industry faces none to little foreign competition. The foreign market share in the food and metal industries between 1986 and 1988 is similar to the average that for the total sample. In contrast, the foreign market share in the chemical industry is far above the average of the total sample, and

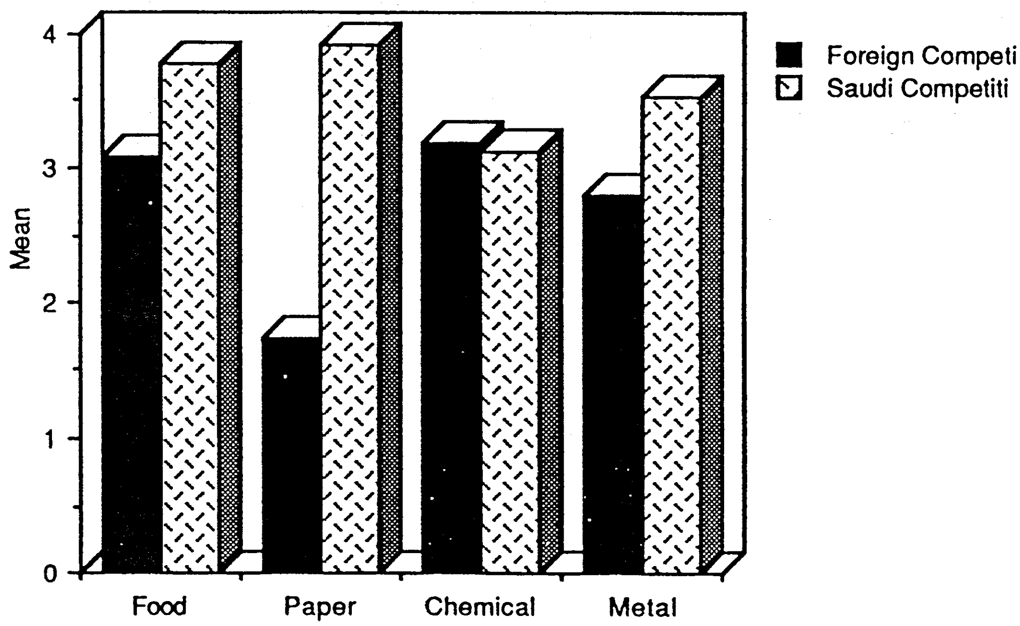

Figure 5-5 : Foreign and Saudi Competition by Industrial Sector

it is far below the average of the total sample in the paper industry during the same period (see Table 5.7.1 in Appendix B).

5.6.2 Saudi Competition

On the same scale used for "foreign competition", the Saudi competition for the total sample rated a score of 3.51. This indicates that Saudi competition among plants in the four industries is perceived to be between moderate and high. Generally, strong national competition indicates that these industries are free of monopoly. As a result, only well managed plants will stay in the market.

Figure 5-5 shows that Saudi competition is perceived to be highest in the paper industry and lowest in the chemical industry. This is exactly the opposite of the situation in the foreign competition.

5.7 SALES TO SAUDI AND FOREIGN MARKETS

In response to the question "sales to Saudi and foreign markets", 73.5 per cent of the plants reported that they sell their products in both Saudi and foreign markets, and the rest deals with Saudi markets only (Figure 5-6). The Figure shows that the number of exporting plants is nearly three times that of the non-exporting plants.

The amount of sales to foreign markets in the total sample on average is almost 8 per cent. The maximum level of sales to foreign markets is 40 per cent, and the minimum is 1 per cent. This percentage of sales to foreign markets is very small and should be increased as the local markets are very small and some plants operate at under capacity.

This survey includes a large number of exporting plants: the number of exporting plants constitutes 44 per cent of all exporting plants in 1986. In that year, the number of exporting plants was 195 in the private manufacturing sector, and 208 plants in the total industrial sectors (The Consulting Center for Finance and Investment, 1988). Exporting is a new and tough activity for Saudi plants and it involves many obstacles. The number of plants in this avenue (i.e., exporting) should be increased year after year to ease plants' difficulties concerning small home markets and underutilisation of

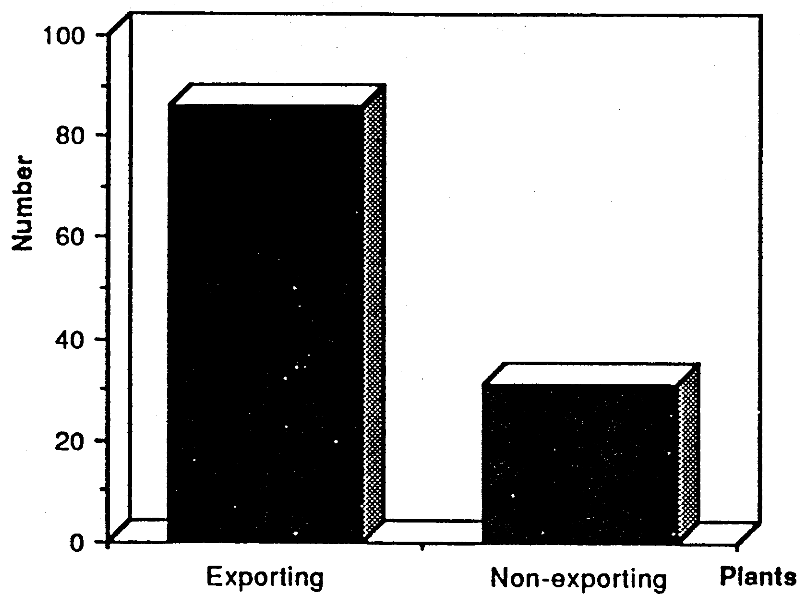

Figure 5-6 : Distribution of Exporting and Non-exporting Plants

capacity. Some of the plants that do not export say it is because:

(i) products are not exportable due to their large size such as polystyrene packs.

(ii) products are widely manufactured outside the kingdom of Saudi Arabia.

(iii) products are not allowed to be exported due to an agreement with foreign partners who have joint venture projects with other plants in other countries with a similar agreement (Discussions with general managers during the field work).

Plants which market their products both nationally and internationally are scattered in all sectors. Of all industries, the food industry has the largest percentage of number of exporting plants and the paper industry has the lowest percentage (see Table

5.8.1 in Appendix B).

The metal industry shows the highest amount of sales to foreign markets (9.9 per cent), and the paper industry shows the lowest (5.3 per cent) (see Table 5.8.2 in Appendix B).

The above four industries export to nearly 30 countries: including Gulf, Arab, European, American, Far Eastern, and African countries (see Table 5.8.3 in Appendix B). Exporting is predominant to Gulf and Arab countries: Kuwait, United Arab Emeritus, and Bahrain. This supports the finding made by The Consulting Center for Finance and Investment (1988). Of all industries, the metal industry is the most frequent exporter, followed by the chemical industry.

In response to the question on obstacles or problems facing exporting, general managers were given seven items to rank. Table 5-9 displays the ranking of the seven items based on means (the lower the mean, the greater difficulty presented). The survey reveals that "high transportation cost", "lack of information about exporting markets", and "uncompetitive price" are the primary obstacles to exporting. This means that price, which is one of the manufacturing competitive priorities is not perceived as currently being favourable to the Saudi manufacturers. However, superior quality, which is one of the competitive priorities, is perceived highly by the Saudi plants (the highest mean). It is worth noting that The Consulting Center for Finance and Investment (1988) has also found that "lack of information about exporting markets" and

Table 5-9 : Ranking of exporting obstacles in the total sample (in increasing order)

Items	Cases	Means	SD
High Transportation Costs	114	2.55	1.97
Lack Of Information	110	2.73	2.25
Uncompetitive price	113	2.88	2.39
Duties On Imported Materials	111	3.46	2.53
Insufficient Subsidy	108	3.48	2.56
Lack Of Finances	112	3.65	2.47
Superior Quality	110	3.67	2.54

"uncompetitive price" were the biggest obstacles to exporting. However, "high transportation costs" was one of the least mentioned exporting obstacles in the 1988 survey.

The ranked values of exporting obstacles for individual industries are slightly different from the ranking of the total sample. For instance, all industries with the exception of the metal industry ranked "high transportation costs" as the most difficult problem (number one). The metal industry ranked it third out of the seven items (see Table 5.8.4 in Appendix B). According to the metal industry, the most difficult problem in exporting is "lack of information". This item is ranked second or third in the other industries. "Uncompetitive price" was ranked second or third by all industries, clearly indicating that production cost is high in all industries.

SUMMARY

This Chapter discussed the major characteristics of the surveyed plants; namely, plant profiles, time of new product development, major technological changes in product, demand on main product, product combinations, nature of foreign and Saudi competition, and finally sales to Saudi and foreign markets. The analysis in this Chapter is presented in terms of means and frequencies.

In the study, 117 plants of four manufacturing industries have been surveyed. These are 26 food plants, 11 paper plants, 32 chemical plants, and 48 metal industry plants. Almost 60 per cent of the plants are wholly Saudi owned and the remaining are joint venture projects. The biggest proportion of the plants were found to be large size in terms of capital paid up and or number of employees. The total number of employees in the plants surveyed is 18961, of which only 1712 or 9 per cent are Saudis. This clearly indicates the paucity of the Saudis in these manufacturing industries. The average number of employees in all plants surveyed (Saudis & Non Saudis) is 162. The maximum number of employees hired by a plant is 1448, and the minimum number is 15. On average, plants in the total sample reported 71.3 per cent utilisation of capacity. Nearly 60 per cent of the plants surveyed has been in operation for 10 years or less, and only 10.3 per cent reported 21 to 35 years of operation. This figure indicates the age of the Saudi manufacturing plants as it was supported by The Consulting Center for Finance and Investment (1988). Almost 60 per cent of the plants reported that it took three years or less to develop new products, and 27.4 per cent mentioned that they did not introduce any new products hitherto. Of all plants surveyed, 40.1 per cent reported that their competitors inspired the recent major technological changes in their product during the last four years, and just under 10 per cent reported that their industries did not introduce any technological changes.

Almost 70 per cent of the plants surveyed anticipate a growing demand on their main product while only 6.8 per cent expect a declining demand for the next two years (1990 and 1991). On average, plants in the total sample have three product lines, four products per line and three options per product beyond the standard. Plants experience little to moderate foreign competition, and the average market share for foreign competition in 1988 was 22.4 per cent which is the lowest of the last years. On the other hand, plants experience moderate to high Saudi competition. 73.5 per cent of the plants surveyed export to foreign markets and the rest serve domestic markets exclusively. The plants surveyed export to nearly 30 countries, most of them of the Arab world with an average sales of 8 per cent. The biggest exporting obstacles plants face are "high transportation cost", "lack of information about exporting markets", and "uncompetitive price".

CHAPTER SIX

PRELIMINARY DATA ANALYSIS

INTRODUCTION

This Chapter presents preliminary analysis of the data collected in support of the manufacturing strategy model which was developed in Chapter Two. The analysis is carried out in terms of frequency and means and covers manufacturing task, environmental uncertainty, the strategic role of the production manager, ranking the manufacturing areas, infrastructure programmes, the importance of the competitive priorities and the plants'performance.

Statistical techniques were used to find out if highly significant differences exist in two cases of ratings: between general and production managers'ratings of the total sample; and among the four industries'rating of each type of managers. In the former case, the Mann - Whitney test and the T-test were used (for double accuracy). In the latter case, Kruskal Wallis and One Way Analysis of Variance (ANOVA) were employed.

Prior to the analysis of the manufacturing strategy model, it is important to find out the reliability of the instruments for this study.

6.1 RELIABILITY TEST OF THE INSTRUMENTS

As mentioned in Chapter 4, all the instruments were examined by Cronbach's alpha which is a widely accepted index to indicate the reliability of the instruments (Peter, 1979). The alpha coefficient values range between zero and one. An alpha value of one means that random errors are totally inexistent. This coefficient as an internal consistency measure "assesses the homogeneity of a set of items."

Table 6-1 presents the values of alpha coefficient for the variables of this study which ranged from 0.68 to 0.94. Since 0.5 is the acceptable level for the Cronbach's alpha index (Nunnally, 1967), all alpha values indicate that the study's instruments are reliable. It is interesting to know that if alpha values did not reach the acceptable level of reliability, some of the items in the instrument with low inter-item correlation should be dropped to improve the reliability of the instruments as suggested by Churchill (1979).

6.2 MANUFACTURING TASK

As stated in Chapter 2, manufacturing task is viewed as a statement of goals (Skinner,1985), and "a consistent set of goals for manufacturing" (Leong et al., 1990:114). Therefore, similarity or analogy of views between general and production managers on manufacturing task items indicate clearly the pursued manufacturing strategy.

Table 6-2 summarises the fourteen manufacturing task items of the total sample rated on a five point scale by general managers (GMs),

Table 6-1: Internal consistency coefficients of the manufacturing strategy variables

Variables	GMs	PMs	SMs
Manufacturing task	0.72	0.70	-
Importance of uncertainty	0.81	-	-
Predictability of uncertainty	0.82	-	-
Production manager's role	0.70	0.70	0.68
Competitive priorities	0.76	-	-
Manufacturing areas	0.73	0.70	-
Performance (subjective data)	0.84	-	-
Performance (objective data)	0.74	-	-
Manufacturing infrastructure	-	0.94	-

where a higher rating indicates high importance and a lower rating indicates low importance. In other words, the higher the mean, the better the situation except for TG1 & TG12. The Table shows that "consistent quality", "on-time delivery" and "high performance design" rated the highest means in descending order. This indicates that general managers place high emphasis on these tasks .

In contrast, "new product introduction", "research and development (R&D) effort", and "introducing new production processes" rated the lowest means by GMs in increasing order. This indicates that general managers devote little attention to these tasks.

Table 6-2: Manufacturing task items of the total sample scored by GMs

	Item	Cases	Mean	SD
TG1	Price	117	2.87	1.06
TG2	High performance design	117	**4.46**	0.70
TG3	Consistent quality	117	**4.84**	0.37
TG4	New product introduction	117	**2.33**	1.65
TG5	Introducing new production processes	117	**2.74**	1.64
TG6	Product range	117	3.53	1.26
TG7	Wide range of product features	117	3.48	1.24
TG8	Rapid changes in product	117	3.75	1.25
TG9	Volume flexibility	117	4.30	0.85
TG10	On - time delivery	117	**4.83**	0.47
TG11	After Sales service	117	4.25	0.52
TG12	Customised product	117	3.30	1.48
TG13	Fast delivery time	117	4.04	0.89
TG14	R & D effort	117	**2.39**	1.31

TG : denotes Task rated by General managers

1= low importance, 5= high importance except for TG1 & TG12

Table 6-3 reports the responses of production managers (PMs) of the total sample, rating the same manufacturing task items. The task items which showed the highest means are very identical to those rated by GMs (see Table 6-2). Although the means of general managers' ratings are higher than those of production managers' ratings, their responses are very similar even in the ranking of items except for "after sales service" and "fast delivery time". Concerning these two items, general managers rated "after sales service" higher than "fast delivery time" and production managers did the opposite. This means that each manager is highly concerned about his responsibilities.

Swamidass (1983), in his survey, found that "high quality" and "customer service" rated the highest means out of eleven manufacturing tasks.

On the other hand, in this study PMs of the total sample place similar emphasis on the same task items which were rated the lowest means by general managers.

To a large extent, this finding is similar to Swamidass' finding (1983). Swamidass found that firms offer relatively lower emphasis on "custom manufacture", "R & D effort", and "introduction of new production processes". With the exception of "custom manufacture", generally most plants / firms in the world rely, to a certain extent, on leaders in the industry or their foreign partners to perform these tasks - as it is the case with some of the Saudi plants. This could be attributed to the fact that these tasks require expertise and huge funding to support intensive research. As for "custom manufacture", some firms follow standard manufacturing to facilitate their production function.

Table 6-3 : Manufacturing task items of the total sample scored by PMs

	Items	Cases	Mean	SD
TP1	Price	116	3.03	0.99
TP2	High performance design	117	**4.37**	0.73
TP3	Consistent quality	117	**4.68**	0.58
TP4	New product introduction	117	**1.48**	1.16
TP5	Introducing new production processes	117	**2.51**	1.67
TP6	Product range	117	3.64	1.14
TP7	Wide range of product features	117	3.60	1.11
TP8	Rapid changes in product	117	3.86	1.05
TP9	Volume flexibility	117	4.27	0.75
TP10	On - time delivery	117	**4.66**	0.63
TP11	After sales service	117	4.16	0.67
TP12	Customised product	117	3.22	1.47
TP13	Fast delivery time	117	4.17	0.78
TP14	R & D effort	117	**1.82**	1.00

TP : denotes Task rated by Production managers

1= low importance, 5= high importance except for TG1 & TG12

From the above analysis it becomes clear that price was not one of the lowest tasks that were rated by both general and production managers. This means that price was not one of the priorities for competition in the majority of the Saudi plants during 1987 and 1988.

It was stated earlier that general managers' ratings for manufacturing tasks are higher than those of production managers. Thus, it is important to find out whether these differences are highly significant or not.

In order to determine these differences, the Mann- Whitney test and the T-test were used (Daniel and Terrell, 1983; Siegel and Castellan, 1988). According to the criterion of significant level that was established in Chapter 4, both tests showed highly significant differences between GMs and PMs ratings in two tasks. These are "new product introduction" and "R & D effort" (see Table 6.1.1 in Appendix C). This means that the difference in ratings of these two tasks are not fortuitous as in the case of the remaining tasks. Because both tasks are a product of R&D, the difference could indicate that production managers are not aware of the ongoing research which is initiated under the guidance of the general managers.

To find out whether highly significant differences do exist among the four industries that were rated by GMs as well as by PMs , Kruskal Wallis and One Way Analysis of Variance (ANOVA) were performed (Daniel and Terrell, 1983; Siegel and Castellan, 1988). Both techniques showed a highly significant difference for both general and production managers among the four industrial sectors in one task only; "product customisation" (see Table 6.1.2 in Appendix C). An examination of Tables 6.1.3 and 6.1.4 (Appendix C), shows a big difference in means for product customisation between the food industry on one hand and the rest of the industries on the other. This difference can be interpreted in light of the fact that the type of the food industry process is highly standardised whereas the other processes are subject to product customisation.

The analysis indicates that in 1987 and 1988 the surveyed plants' goals were to achieve "consistent quality", "on-time delivery", and "high performance design" to the best in the industry. In other words, high quality, in particular, and "on-time delivery" were the manufacturing strategies for all the surveyed plants in 1987 and 1988. This finding will be supported later in Chapter Nine.

6.3 ENVIRONMENTAL UNCERTAINTY

According to the "open system" theory, organisations are affected by their external environments, and organisational theorists stress that "organisations must adapt to their environments if they are to remain viable" (Duncan, 1972:313). The study of environmental uncertainty is the focal point for a firm which tries to adapt to its environment. Managers should not only be able to indicate the importance of the factors that effect the process of strategic decision making but also to display their ability in predicting them.

Table 6-4 exhibits the responses of general managers of the total sample rating the importance of the sixteen items which can cause environmental uncertainty. On the five point scale used, the higher the mean, the greater the importance of the item (1=not important at all, 5=extremely important).

It appears from this Table, that "customers for your products", "the situation of the Saudi economy", and "keeping up with new technological requirements" are the top three important considerations in strategic decision making (in decreasing order). The last item, "keeping up with new technological requirements", supports the claim that the Saudi plants are using the latest technology in manufacturing. They are acquiring the latest technology because of the availability of capital either from owners of plants or through loans from the Saudi Industrial Development Fund. In fact, the Ministry of Industry and Electricity encourages manufacturers to take advantage of technology as much as possible in order to overcome the shortage of Saudi labour (discussions with GMs during the field work).

Swamidass (1983) found that chief executives considered "actual users of your firm's products" the most important item in strategic decision making. This obviously signifies that top managers consider highly this item in strategic decision making.

On the other hand, "competitors for your supply of raw materials and parts", "the suppliers of product parts", and "the suppliers of equipment" are the three least important considerations in strategic decision making (in increasing order).

Table 6-4: Importance of environmental uncertainty items of the total sample as perceived by GMs

	Items	Cases	Mean	SD
I1	The distributors of your products	117	3.57	1.29
I2	Customers for your products	117	**4.53**	0.61
I3	The suppliers of raw materials	117	3.78	1.11
I4	The suppliers of equipment	117	**3.19**	1.13
I5	The suppliers of product parts	117	**2.94**	1.25
I6	The supply of labour	117	3.34	1.21
I7	Competitors for your supply of raw materials and parts	117	**2.92**	1.29
I8	Competitors for your customers	117	3.71	1.22
I9	Government regulations controlling your industry	117	3.75	1.17
I10	The public attitudes toward your industry	117	3.80	1.17
I11	The relationship with your supervising ministries and chambers of commerce & industry	117	3.99	0.99
I12	Keeping up with new technological requirements in your industry in the production of goods	117	**4.27**	0.82
I13	Improving and developing new products by implementing new technological advances in the industry	117	3.82	1.00
I14	Your source of financial resources	116	3.87	0.95
I15	The situation of the Saudi economy	117	**4.33**	0.81
P16	The situation of the world economy	117	3.39	1.01

1=not important at all, 5=extremely important

All the three previous items occurred with no surprise in this study. As for the suppliers of parts and equipment, some general managers expressed dissatisfaction at the request of the Ministry of Industry and Electricity to determine once at the beginning of each year their needs of product parts and equipment so they could be exempt of duties (discussions with GMs during the field work process). By being compelled to follow this procedure, GMs think that they are not getting full advantage of the industrial policy (see section 3.8.1.2, no. 5b). GMs consider this situation very annoying in terms of time and money, because the failure of large parts and big equipments is difficult to predict and in addition, a consumption of huge capital is involved. As for "competitors for your supply of raw materials and parts", Swamidass (1983) also found that managers gave this item the least important consideration in decision making. They conceive that their suppliers' competitors are not important because they are either unknown to them or their distribution is limited to specific regions.

Using Kruskal Wallis and One Way Analysis of Variance (ANOVA), no significant differences were found in the importance of uncertainty items in the food, paper, chemical, and metal industries (see Tables 6.2.1 and 6.2.2 in Appendix C).

Table 6-5 presents the responses of general managers of the total sample rating the predictability of the sixteen items which can create environmental uncertainty. On the five point scale used, lower mean indicates higher uncertainty and higher mean indicates lower uncertainty (1=highly unpredictable, 5=highly predictable).

The Table shows that "your source of financial resources", "customers for your products", and "keeping up with new technology" are the most predictable items (in descending order). In contrast, "the situation of the world economy", "competitors for your supply of raw materials and parts", and "government regulations controlling your industry" are the least predicable items (in increasing order).

Some of the findings of this study with regard to uncertainty are similar to Swamidass' study (1983). Both studies found that top managers could easily predict their source of financial resources, but they have high uncertainty in predicting government regulations controlling their industries.

Kruskal Wallis and One Way Analysis of Variance (ANOVA) failed to show highly significant differences among the four industries with regard to the predictability items (see Tables 6.2.3 and 6.2.4 in Appendix C).

To summarise the results on environmental uncertainty GMs in Saudi plants pay great attention in strategic decision making to "customers for your product", and "keeping up with new technological requirements", and they have low uncertainty in predicting them. On the other hand, "competitors for your supply of raw materials and parts" is one of the least important considerations in decision making, yet it is included as one of the items that has high

Table 6-5: Predictability of environmental uncertainty items of the total sample as perceived by GMs

	Items	Cases	Mean	SD
P1	The distributors of your products	114	3.84	1.10
P2	Customers of your products	117	**4.02**	0.84
P3	The suppliers of raw materials	117	3.75	1.08
P4	The suppliers of equipment	117	3.54	1.16
P5	The suppliers of product parts	115	3.44	1.14
P6	The supply of labour	117	3.61	1.24
P7	Competitors for your supply of raw materials and parts	116	**3.23**	1.07
P8	Competitors for your customer	117	3.50	1.02
P9	Government regulations controlling your industry	117	**3.31**	1.22
P10	The public attitudes toward your industry	117	3.49	1.01
P11	The relationship with your supervising ministries and chambers of commerce & industry	117	3.68	1.04
P12	Keeping up with new technological requirements in your industry in the production of goods	117	**4.00**	0.91
P13	Improving and developing new products by implementing new technological advances in the industry	117	3.80	1.01
P14	Your source of financial resources	117	**4.05**	0.96
P15	The situation of the Saudi economy	117	3.52	0.94
P16	The situation of the world economy	117	**3.03**	1.07

1=highly unpredictable, 5=highly predictable uncertainty.

6.4 THE STRATEGIC ROLE OF THE PRODUCTION MANAGER

The literature indicates that the role played by production managers in the formulation of corporate strategy is passive. Writers in the field call for production managers to adopt a proactive role (Hayes and Wheelwright, 1984; Hill, 1985; Skinner, 1985), that is to be active participants in strategic decision making (see section 2.4.4).

Tables 6-6, 6-7 and 6-8 summarise the respective responses of general, production, and sales managers of the total sample to the statements rating the role of the production manager in strategic decision making. On the five point scale used, the higher the mean, the greater the role of the production manager in strategic decision making.

On the basis of the means for the first five statements displayed in the three Tables, compared with the perceptions of general and sales managers, production managers perceived a greater role for themselves in strategic decision making. It is understandable that production managers would assess themselves higher in such a comparison and this replicates the finding's of Swamidass (1983).

Table 6-7 shows that PMs rated RPM3 the highest mean whereas GMs and SMs rated it the second and the third highest mean respectively (Tables 6-6 & 6-8). This means that some managers in these two areas, strategy and sales, disagree with the statement that production managers know exactly the most important competitive priorities for the manufacturing function.

Statement 4 (RPM4) was rated the lowest mean by both general and sales managers (see Tables 6-6 & 6-8). This result indicates some disagreements between GMs and SMs in one side and PMs in the other. Almost 19 per cent of general managers and 14 per cent of sales managers disagree with the statement that production managers are responsible for initiating and modifying short and long term changes in manufacturing strategy (RPM4). On the other hand, only 3.5 per cent of production managers agree with this. This means that the majority of the production managers see themselves responsible for initiating some changes in manufacturing strategy while not every general and sales managers confirm this.

Agreements among all types of managers (strategy, production, and sales) on statement 5 (RPM5) - a new variable introduced in this study - seem to contradict the literature. Assuming that the production manager is a representative of the manufacturing function, the claim that production manager is given less equivalent role among the other functional managers (Skinner, 1978; Hayes and Wheelwright, 1984; Hill, 1985) has improved. In this study, 72 per cent of the production managers rated (RPM5) between agree and strongly agree that they possess an equivalent role as any functional managers. To verify RPM5 from the other side; i.e., general and sales managers gave almost 70 per cent each to the statement "PM is given an equivalent role among the functional managers".

Table 6-6: Participation of production managers in strategic decision making scored by GMs

Items	Cases	Mean	SD
RPM1	117	3.97	0.72
RPM2	117	4.24	0.65
RPM3	117	4.10	0.81
RPM4	117	3.50	0.95
RPM5	117	3.71	0.82
RPM6	117	4.02	0.85

1= strongly disagree, 5= strongly agree

KEY TO STATEMENTS

RPM1 I feel that production manager(s) (PM) has a good understanding of how the divisional strategy is formed.

RPM2 I feel that PM is an integral part of the strategy formulation process, and that his inputs are part of the divisional (or corporate) strategy.

RPM3 I feel that PM knows exactly what the most important competitive priorities are for our manufacturing function (e.g., low cost, fast delivery, etc.).

RPM4 PM is responsible for initiating and modifying short & long term changes in manufacturing strategy.

RPM5 PM is given an equivalent role or more among the functional managers in the formulation of corporate strategy.

RPM6 PM is one of the members who should be allowed to attend top management meetings.

Table 6-7 : Participation of production managers in strategic decision making scored by PMs

Items	Cases	Mean	SD
RPM1	117	4.14	0.67
RPM2	117	4.13	0.74
RPM3	117	4.50	0.58
RPM4	117	3.97	0.80
RPM5	117	3.84	0.84

1= strongly disagree, 5= strongly agree

KEY TO STATEMENTS

RPM1 I feel that I have a good understanding of how the divisional strategy is formed.

RPM2 I feel that I am an integral part of the strategy formulation process, and that my inputs are part of the divisional (or corporate) strategy.

RPM3 I feel I know exactly what the most important competitive priorities are for our manufacturing function (e.g., low cost, fast delivery, etc.).

RPM4 I am responsible for initiating and modifying short & long term changes in manufacturing strategy.

RPM5 I am given an equivalent role or more among the functional managers in the formulation of corporate strategy.

Table 6-8 : Participation of production managers in strategic decision making scored by SMs

Items	Cases	Mean	SD
RPM1	116	3.92	0.73
RPM2	116	3.96	0.74
RPM3	117	3.83	0.99
RPM4	117	3.56	0.91
RPM5	117	3.63	0.85

1= strongly disagree, 5= strongly agree

KEY TO STATEMENTS

RPM1 I feel that production manager(s) (PM) has a good understanding of how the divisional strategy is formed.

RPM2 I feel that PM is an integral part of the strategy formulation process, and that his inputs are part of the divisional (or corporate) strategy.

RPM3 I feel that PM knows exactly what the most important competitive priorities are for our manufacturing function (e.g., low cost, fast delivery, etc.).

RPM4 PM is responsible for initiating and modifying short & long term changes in manufacturing strategy.

RPM5 PM is given an equivalent role or more among the functional managers in the formulation of corporate strategy.

In response to statement 6 (RPM6), another new variable introduced in this study (see Table 6-6), general managers showed slightly over 80 per cent agree or strongly agree that production managers attend top management meetings. This confirms that "the missing link" between the corporate level and the manufacturing function, as reported by Skinner (1969), no longer exists.

Furthermore, general and sales managers rated RPM2, "I feel that PM is an integral part of the strategy formulation process, and that his inputs are part of the divisional (corporate) strategy", the highest mean (see Tables 6-6 and 6-8), implying attendance of production managers at top management meetings. Sharma (1987) found in his study that manufacturing management is no longer segregated and that manufacturing managers do participate in the strategic planning process.

All in all, does this mean that production managers have a good understanding of how the divisional strategy is formed? (RPM1). This study found that almost 86 per cent, 87 per cent and 82 per cent of GMs, PMs and SMs respectively rated statement RPM1 between agree and strongly agree. This means that general and sales managers support the claim that production managers have a high level of understanding of the formulation of the divisional strategy.

Using Kruskal Wills and One Way Analysis of Variance (ANOVA) differences were found among the ratings of the three types of managers, on the total sample level, in two statements. These are "I feel that PM knows exactly what the most important competitive priorities are for our manufacturing function (e.g. low cost, fast delivery, etc.)", (RPM3), and "PM is responsible for initiating and modifying short & long term changes in manufacturing strategy", (RPM4), (see Table 6.3.1 in Appendix C). The significant difference in RPM3 clearly indicates that GMs and SMs do not agree with the statement that PMs know the most important competitive priorities. This finding may be related to the difference between qualifying and competitive priorities criteria in the market place (Hill, 1985). That is, general and sales managers have greater depth of knowledge about the situation in the market than that of the production managers (see section 2.4.1). In fact, most production managers admitted that they are unaware of the pricing policy when asked to rate price in the manufacturing task items. (PMs received some help from other managers when rating price). This supports the researcher's methodology in asking only general managers to rate the competitive priorities (see section 6.7). As for the response to statement RPM4, because PMs are not the most knowledgeable about the competitive priorities they are not responsible for "initiating and modifying short & long term changes in manufacturing strategy".

Using Kruskal Wallis and One Way Analysis of Variance no significant differences were found among the four industries of each type ratings (see Tables 6.3.2, 6.3.3, and 6.3.4 in Appendix C).

In summary, the findings of this study indicate that production managers have taken a proactive role in the formulation process of corporate strategy. More specifically they are given an equivalent role among the functional managers to participate in the formulation process of corporate strategy. However, general managers as well as sales managers still believe that production managers do not fully understand the most competitive priorities. As a result, PMs are not mainly responsible for initiating and modifying short and long term changes in manufacturing strategy.

6.5 RANKING THE MANUFACTURING AREAS

Making improvements in competitive priorities in order to compete better in the market place is the underlying theme of manufacturing strategy.

Tables 6-9 summarises the manufacturing areas, known as the competitive priorities, ranked according to needs for improvements by both general and production managers of the total sample.

In this Table, the lower the value of the mean the greater the need for improvements. Both managers specify "low price", which is a function of cost, as their first priority for improvement. By comparing the two means, it becomes clear that the mean for general managers is lower than that of the production managers. This suggests that general managers are more motivated than production managers to reduce cost in order to compete effectively. The second priority for improvement is "fast delivery". General and production managers admit that the time between receiving the orders to manufacture products and filling these orders is longer than what they wish.

Table 6-9 : Ranking manufacturing areas according to needs for improvements by GMs and PMs of the total sample

Areas	Cases*	GMs Mean	GMs SD	PMs Mean	PMs SD
Low price	117	**3.46**	2.27	**3.67**	2.17
Fast delivery	117	3.68	2.09	4.37	2.22
Rapid volume changes	117	4.07	2.28	4.52	2.33
Meeting delivery time promises	117	4.40	2.01	4.43	2.12
New products	117	4.54	2.32	4.65	2.47
Rapid design changes in product	117	4.94	2.31	4.80	2.20
High performance design	117	4.98	2.05	4.67	2.08
Consistent quality	117	**5.80**	2.12	**5.72**	2.00

*: the same number of cases for both GMs & PMs

1= the most improvements, 8= the least improvements

Their desirability to provide "faster delivery" is a result of pressure from their customers, as some general managers put it "customers place their orders today and want them to be delivered yesterday" (discussions with GMs during the field work).

Managers disagree on the third priority for improvement. GMs wish to work on "rapid volume changes in the rate of production" to cope with the large fluctuations in demand, whereas PMs want to improve "meeting delivery time promises" (which could be eased as a result of improvements in fast delivery).

On the other hand, managers of both levels, strategy & production, absolutely agree on the areas of their manufacturing facilities strength. They ranked "consistent quality", "high performance design", and "rapid design changes in the product", the highest means. This indicates that Saudi plants generally produce top quality products thanks to high technology and high standard of raw materials (see Chapter 9 for details).

Introducing "new products" was ranked fifth among all the eight priorities by both managers and was perceived as being only moderately important. This supports earlier findings where "introducing new products" and "R&D" were found of the lowest three manufacturing tasks during 1987 and 1988 (see section 6.2). Furthermore, it was found that 27.4 per cent of the plants surveyed did not introduce any new products yet, and 14.5 per cent of the plants require over three years to develop new products (see Table 5-6).

It is important to find out if highly significant differences exist between general and production managers on needed improvements of manufacturing areas. Both tests (i.e., Mann-Whitney test and T-test) indicated no significant differences between these two types of ranking (see Table 6.4.1 in Appendix C).

Similarly, highly significant differences were not found, using Kruskal Wallis and One Way Analysis of Variance (ANOVA), among the four industries of each type of ranking (i.e., GMs & PMs) (see Tables 6.4.2, 6.4.3, 6.4.4 and 6.4.5 in Appendix C).

6.6 INFRASTRUCTURE PROGRAMMES

As mentioned in Chapter Two, infrastructure-programmes are the means to implement manufacturing strategy. Therefore, devoting all resources to certain priorities are indications of efforts to win them.

Table 6-10 summarises the 57 infrastructure-programmes (activities) rated on a five point scale by production managers of the total sample. On the five point scale used, the higher the mean, the greater the time, effort, and resources devoted to the programme for the next two years (1990 and 1991), and vice versa (the lower the mean, the lesser the time, effort, and resources devoted to that programme in the mentioned period).

On the basis of the mean values, the study reveals that the top ten programmes that received the highest attention in terms of time, effort, and resources for the next two years (1990 and 1991) are (in decreasing order):

1. Reducing production costs. (INFR 38)
2. Reducing raw materials costs. (INFR 18)
3. Developing a better master

production schedule. (INFR 14)

4. Improving labour productivity. (INFR 46)

5. Product standardisation. (INFR 28)

6. Worker skills diversification. (INFR 39)

7. Developing high quality suppliers. (INFR 23)

8. Development or improvement of quality control programmes. (INFR 47)

9. Reducing manufacturing lead time. (INFR 12)

10. Developing reliable timely suppliers. (INFR 24)

The above list shows that the top two programmes to which most attention is devoted for the next two years are related to cost reduction. This gives a good indication about Saudi industries and their struggle with such programmes. In addition, the fourth, fifth and sixth programmes are sources of cost reduction. On the other hand, high attention was paid to the last four programmes in the above list as they are credible tools to improve the total quality. The master production schedule is considered as a total plan for all these programmes.

Conversely, the five programmes that received the least attention with regard to time, effort, and resources for the same period are (in increasing order):

1. Developing facilities abroad for assembly of major product lines where most of the production factors are cheap.
INFR 57

2. Developing facilities abroad for manufacturing of components for use in Saudi assembly plants where labours are cheap. (INFR 56)

3. Finding reliable subcontractors. (INFR 9)

4. Removal of inspectors. (INFR 45)

5. Automatic inspection. (INFR 34)

What is interesting here is that the first three programmes in the above list received the lowest attention in terms of resources devoted. This indicates that manufacturers in Saudi Arabia seem pleased with performing all tasks within their plants. However, what is surprising is that the last two programmes in this list indicate that the majority of the plants are short of these two types of inspection system. This contradicts somehow the claim that Saudi plants have high technology and high quality products.

As with the previous items, it is important to find out if highly significant differences in responses exist among the four manufacturing sectors. Using Kruskal Wallis and One Way Analysis of Variance (ANOVA), none of the sector responses on the 57 infrastructure-programmes appeared to be highly significant according to the criterion of significant level that was established in Chapter 4. It should be mentioned that even if the significant level was at (.05), two programmes only, through both tests, would indicate high significant differences (see Tables 6.5.1 and 6.5.2 in Appendix C).

Table 6-10 : Infrastructure programmes of the total sample rated by PMs

	Programmes	Cases	Mean	SD
	INVENTORY			
INFR1	Reducing inventory costs	116	3.30	0.91
INFR2	Increasing inventory turnover	113	3.40	0.90
INFR3	Reducing raw materials and component inventories	115	3.29	1.04
INFR4	Reducing work-in-process inventories	108	2.83	1.13
INFR5	Reducing finished goods inventories	115	3.42	1.19
INFR6	Achieving larger production lots	116	3.58	0.95
	PLANNING			
INFR7	Hiring and lay-off system	114	2.82	0.97
INFR8	Reducing idle time	116	3.64	0.99
INFR9	Finding reliable subcontractors	108	2.14	1.18
INFR10	Stabilising workforce numbers	114	3.50	0.99
INFR11	Designing policies to motivate employees to work as a team	116	3.60	0.96
INFR12	Reducing lead time manufacturing	116	3.70	0.97
INFR13	Increasing warehouse space	116	3.15	1.23
	SCHEDULING / CONTROL			
INFR14	Developing a better master production schedule	117	3.95	0.79
INFR15	Close order progress control system	116	3.60	1.02
INFR16	Frequent work centre rescheduling capacity	117	3.46	0.97
INFR17	Order status reporting system	116	3.46	0.76

Table 6-10 (continued)

Programmes	Cases	Mean	SD
PURCHASING			
INFR18 Reducing raw material costs	116	4.03	0.87
INFR19 Obtaining long-term supply contracts	115	3.24	1.19
INFR20 Reducing the number of purchase orders per year	115	3.14	1.11
INFR21 Obtaining quantity discounts from suppliers	117	3.50	1.01
INFR22 Obtaining quantity discounts from shippers	116	3.25	1.14
INFR23 Developing high quality suppliers	117	3.76	1.02
INFR24 Developing reliable timely suppliers	117	3.69	1.01
INFR25 Diversifying suppliers	116	3.37	1.08
INFR26 Achieving independence from suppliers	115	3.37	1.23
PROCESS AND PRODUCT DESIGN			
INFR27 Substitution of labour by machines	117	3.23	1.22
INFR28 Product standardisation	117	3.86	0.88
INFR29 Product modularisation	113	3.32	1.05
INFR30 Product simplification	113	3.37	1.02
INFR31 Substitution of inexpensive materials or components	113	3.20	1.19
INFR32 Mechanised materials handling	117	3.18	1.19
INFR33 Automation of production lines	117	3.38	1.24
INFR34 Automatic inspection	116	2.67	1.28
INFR35 Acquiring the latest in production equipment	115	3.64	1.25

Table 6-10 (continued)

	Programmes	Cases	Mean	SD
	PROCESS AND PRODUCT DESIGN			
INFR36	Development of new features for older product lines	117	3.43	1.20
	LABOUR / QUALITY			
INFR37	Reducing direct labour costs	117	3.77	0.89
INFR38	Reducing production costs	117	4.09	0.81
INFR39	Worker skills diversification	117	3.84	0.88
INFR40	Worker training	117	3.59	0.89
INFR41	Worker specialisation	115	3.38	0.87
INFR42	Increasing worker responsibility in work planning	116	3.35	1.04
INFR43	Increasing worker control over work pace	117	3.48	0.98
INFR44	Inspectors training	114	3.03	1.11
INFR45	Removal of inspectors	113	2.40	1.21
INFR46	Improving labour productivity	117	3.91	0.73
INFR47	Development or improvement of quality control programmes	117	3.71	1.03
INFR48	Acquiring a Saudi quality mark	112	3.46	1.31
INFR49	Monetary incentive system	115	2.94	1.15
INFR50	Development or improvement of quality circle programmes	114	3.21	1.09
	MISCELLANEOUS			
INFR51	Development of high volume products	115	3.24	1.11
INFR52	Development of products with high economics of scale	115	3.33	1.13
INFR53	Development of products with high economics of scope	114	3.40	1.18

Table 6-10 (continued)

	Programmes	Cases	Mean	SD
	MISCELLANEOUS			
INFR54	Improving co-ordination among engineering, manufacturing,& marketing	117	3.52	0.78
	FOREIGN PRODUCTION			
INFR55	Developing reliable foreign suppliers for components, where materials are cheap	117	2.69	1.44
INFR56	Developing facilities abroad for manufacture of components for use in Saudi assembly plants where labours are cheap	117	1.81	1.28
INFR57	Developing facilities abroad for assembly of major product lines, where most of the production factors are cheap	117	1.57	1.11

1= no effort, 5= well above average effort

6.7 THE IMPORTANCE OF THE COMPETITIVE PRIORITIES

Table 6-11 presents the responses of the general managers of the total sample rating the importance of the eight competitive priorities. On the five point scale used, the higher the mean the greater the importance of the priority.

The Table shows that "on-time delivery" was rated the most important priority, followed by "consistent quality", "fast delivery" and "high performance design". This means that the most important priorities for manufacturers in Saudi Arabia for the next two years (1990 and 1991) are quality and delivery. This endorses the earlier findings where both types of quality and "on-time delivery" were rated the highest means out of fourteen manufacturing tasks for 1987 and 1988 (see section 6.2). The above indicates that manufacturers in Saudi Arabia have already won quality and "on-time delivery" and they will continue winning them in addition to "fast delivery priority" for 1990 and 1991. If these priorities continue to be accomplished, then this will be a major support for the "Sandcone model" and the Japanese cumulative model (see section 2.4.1), both of which suggest that the pursuit of competitive priorities must start with quality then challenge both quality and delivery.

On the other hand, "new product introduction" was rated the least important priority for the same period. It is surprising that manufacturers in Saudi Arabia have continued to neglect this priority which is an important dimension of product flexibility (see sections 6.2 and 6.5). From discussions with most of the general managers it appears that their efforts with regard to strategic directions (i.e., diversification patterns) are to concentrate on expanding market share in existing markets, and entering new markets with existing products. This inference is supported by the above finding. In other words, "developing new products" is not a potential strategic direction for either current or new markets.

Both Kruskal Wallis and One Way Analysis of Variance (ANOVA) indicated no significant differences among the four manufacturing sectors which were rated by general managers (see Tables 6.6.1 and 6.6.2 in Appendix C).

Table 6-11: The importance of the competitive priorities of the total sample rated by GMs

Items	Cases	Means	SD
Low price	117	3.72	1.08
High performance design	117	**4.03**	0.91
Consistent quality	117	**4.39**	0.77
Rapid design changes in the product	117	3.80	0.99
Rapid volume changes in the rate of the production to handle large fluctuations in demand	117	3.97	0.83
New products introduction	117	**3.47**	1.06
On - time delivery	117	**4.54**	0.60
Fast delivery	117	**4.12**	0.78

1= not important at all, 5= extremely important

6.8 PERFORMANCE

The following subsections present an approach to improve manufacturing performance (i.e., benchmarking) as well as measures of performance. The latter is discussed in the form of subjective and objective data.

6.8.1 Benchmarking

Benchmarking is an approach for improving performance. The approach requires comparing the company's performance against that of the best companies in the industry. Benchmarking is highly related to manufacturing strategy, because it improves the capabilities of the manufacturing function with respect to cost, quality, flexibility and delivery (see section 2.4.6).

In response to the question "making business visits to some of the high performance firms / plants", 73.5 per cent, GMs pointed out, do make business visits to such firms or plants to gain strength in specific issues of manufacturing. On the contrary, 26.5 per cent of the plants surveyed mentioned that they had not yet carried out any business visit.

It is a good sign that almost three-fourth of the plants in this sample have contacts with other plants whether in the kingdom of Saudi Arabia or outside the nation. Such contacts ease their manufacturing problems or provide an answer to their inquiries and give them a broad view of their position in the world of manufacturing. The benchmarking approach is very helpful in establishing competitive priorities because it indicates the kind of operating capabilities that make a difference in the market place (Hayes et al., 1988).

On the individual industries, the largest number of business visits to high performance firms are made by the metal industry and the lowest number of these visits are made by the paper industry (see Table 6.7.1 in Appendix C).

The issues that these plants target in their business visits are very broad. These are grouped under seven categories as shown in Figure 6-1, and are directly or indirectly related to enhancing competitive priorities. These seven categories of benchmarking's issues exist approximately in all industries except for the paper industry where attention is mainly devoted to the first three categories only.

Since making business visits is undoubtedly costly, the same question (i.e., making a business visit) is rephrased to see whether general managers set up some manufacturing issues of high performance plants as their plant's objectives. The percentage of the responses to this question is slightly higher than that about making business visits. General managers who set up some of their plant's objectives to catch up with high performance plants totaled to 75.8 per cent. On the other hand, those who set up their plant's objectives according to their own standards totaled to 24.2 per cent. The distribution of plants by industrial sector concerning this question is almost similar to the content of Table 6.7.1 in Appendix C.

Figure 6-1 : Targeted issues in business visits for the total sample (in descending order)

	Category	Description
1.	Technology	- adopting latest Technology
2.	Cost	- reducing production costs
3.	Quality	- adopting high standard quality
		- introducing new products
		- finding new sources for raw materials
4.	Process	- adopting modern production methods
5.	Training	- training employees
6.	Marketing	- adopting modern marketing methods
		- making marketing agreement
		- exploring new exporting outlets
7.	Miscellaneous:	
	a) exchange information & expertise	
	b) better use of resources	
	c) new business ventures	
	d) new management style in manufacturing	
	e) implement ideas	

6.8.2 Subjective Measures

This section presents the analysis of the data with respect to subjective financial measures, and chances of plants survival.

6.8.2.1 Subjective Financial Measures

The subjective measures of performance were requested as a precautionary step if objective data of performance measures were denied.

Table 6-12 shows three types of subjective measures of performance rated by general managers of the total sample for the period running from 1986 to 1988. These measures are growth in return on investment (GROI), growth in sales (GS), and growth in return on sales (GROS).

On the three point scale used, higher score of mean denotes better performance. According to this scale, the mean ratings for all the three performance measures ranged from 2.24 to 2.46. This indicates that the majority of the plants surveyed are within the industry average or above in terms of these three performance measures. It also appears from this Table that growth in sales (GS) for the Saudi plants is the highest compared to the other performance measures (GROI & GROS), and growth in return on investment (GROI) is the lowest. There are three possible explanations for this. First, these industries are young by nature, So they are more concerned with sales. Second, these industries generate small profits or sometimes reach only the break-even point on sales (during the field work, some GMs mentioned that they are selling at a point to cover their costs

Table 6-12 : Subjective performance measures of the total sample scored by GMs (1986-1988)

Items	Cases	Mean	SD
GROI	115	2.24	0.60
GS	115	2.46	0.61
GROS	115	2.32	0.64

GROI : Average Annual Rate Of Growth In Return On Investment

GS : Average Annual Rate Of Growth In Sales

GROS : Average Annual Rate Of Growth In Return On Sales

1= below industry average, 3= above industry average

only). Finally, these industries could be continuously extending their capabilities and buying equipment which results in more capital employment and effects return on investment.

Unlike the rest of the industries, the majority of the plants in the chemical sector have the highest growth in return on investment, and the lowest growth in return on sales (see Table 6.7.2, Appendix C). By comparing "growth in sales" and "growth in return on sales" for the chemical industry with the same measures of the total sample, one can conclude from Table 6.7.2 that these two measures for the chemical industry are below the average. Since some of the products in this industry are durable, which means low turnover and high profit margin, the below average measures for the chemical industry could be attributed to the following three reasons. First, low local market share as a result of strong foreign competition as mentioned in Chapter 5. Second, low sales volume (no exporting). Finally, high cost of expertise.

6.8.2.2 Chances Of Plants Survival

Another dimension of the Saudi plants performance is the chances of survival. Of all participating plants, over half of them (55.2 per cent) anticipated higher chances of survival today (May-July, 1989) as compared to three years ago. This means that in 1986 some plants were depressed by the situation of the Saudi economy resulting from a sharp decline in oil prices. Plants in all industries have shown between a fifty and nearly sixty per cent higher chance of survival today as compared to three years ago (see Table 6.7.3, Appendix C).

On the other hand, 43.1 per cent of the plants reported that there had been no change in the situation and that the chances of survival today are the same as three years ago. This figure represents those plants that are either not affected by the decline of oil prices, or are still suffering from this situation and expect it to continue. In discussions, some general managers said that they do not consider the decrease in oil prices, which affects the purchasing power of the public and private sectors, to be the main reason for their present situation. They believe that their current situation is a consequence of the quick development of the country's infrastructure. That is, during the peak of the development period (1975-1979), most plants were operating at almost full capacity to cover the demand of the market. One general manager, for example, pointed out that during one year of the peak period his plant generated a net profit equal to three times the plant's paid up capital. Therefore, general managers who want the same situation to continue as at the peak of the development period may be included in the pessimistic 43.1 per cent. In contrast, those who counted themselves in the optimistic 55.2 per cent, realised the current situation and made the preparations for other channels such as expanding their market share in the Kingdom and exploring new exporting outlets.

Plants which expect lower chances of survival are only under two per cent and represent two plants only: one in the chemical industry and the other in metal industry. This could be attributed to their struggles with competition, especially foreign competition.

Indeed, it is a sign of the strength of Saudi industries that 98 per cent of the surveyed plants expected in 1989 the same or higher chances of survival as compared to three years ago, bearing in mind that their financial performance are on the industry average or above for 1986-1988.

6.8.3 Objective Performance Measures

As mentioned earlier, subjective measures of performance were requested in case objective data for the performance measures were declined. In fact, using subjective performance measures has paid off because only about fifty plants provided objective data. The percentages of responses of individual industries in providing objective data are: 26 per cent for the food industry, 6.4 per cent for the paper industry, 27.6 per cent for the chemical industry, and 40 per cent for the metal industry. This decline is due to the sensitivity of the data. In the researcher's opinion, at least, the data of return on investment and return on sales were exaggerated by some plants.

Table 6-13 displays the three types of objective performance measures of the total sample for the period 1986-1988. The three types of performance measures are return on investment (ROI), sales, and return on sales (ROS). The Table shows the basic statistics of these measures. The mean for ROI ranged from 9 per cent to almost 12 per cent during the three years (1986-1988). Sales ranged from $13.7 million to $17.5 million and ROS ranged from 10.6 per cent to 11.4 per cent for the same period. As with the subjective measures, the growth rate of return on investment was the lowest amongst the three measures (see section 6.7.2.1).

Both types of performance measures (subjective and objective) were used intensively in testing four of the six hypotheses that will be discussed in Chapter Seven.

Table 6-13 : Objective performance measures of the total sample

Indicators	Cases	Mean	SD	Min.	Max.
ROI 86	45	9.09	15.2	-41.8	56.0
ROI 87	46	11.1	9.57	-23.0	33.5
ROI 88	50	11.8	9.17	-0.20	40.0
Sales 86	53	13.7 M	23.6 M	451 T	146 M
Sales 87	53	16.0 M	26.5 M	553 T	154 M
Sales 88	53	17.5 M	30.9 M	601 T	196 M
ROS 86	43	10.6	13.7	-46.2	35.0
ROS 87	47	11.0	11.7	-27.4	39.0
ROS 88	49	11.4	7.7	-0.90	33.0

M: in millions (USA dollars)

T: in thousands (USA dollars)

SUMMARY

This Chapter focused on the analysis of the manufacturing strategy model that was developed in Chapter Two. This analysis is mainly presented in the form of means. It covers manufacturing tasks, environmental uncertainty, the strategic role of the production manager, ranking the manufacturing areas, infrastructure programmes, the importance of the competitive priorities and finally plants'performance. Prior to the analysis, a reliability test was performed to indicate the reliability of the instruments for this study. The test showed that the instruments are reliable. The findings of all aspects of this model are presented below.

The analysis revealed that "consistent quality", "on-time delivery" and "high performance design" received the highest attention out of fourteen manufacturing tasks by both general and production managers during 1987 and 1988. In contrast, "new product introduction", "R & D effort" and "introducing new production processes" received the lowest attention by both types of managers for the same period. This means that "high quality" and "on-time delivery" were the manufacturing strategies for all the plants surveyed in 1987 and 1988.

Concerning environmental uncertainty, general managers pay very high attention to "customers for your product", "keeping up with new technological requirements" and "the situation of the Saudi economy" and have low uncertainty in predicting the first two items. On the other hand, the items "competitors for your supply of raw materials and parts", "the suppliers of product parts", and "the suppliers of equipment" are the three least important considerations in strategic decision making, yet the first item was reported as one of the items that has high uncertainty.

With respect to the role of the production managers, this study found that PMs were given an equivalent role among the functional managers to participate in the formulation process of corporate strategy (i.e., a proactive role). However, in spite of their proactive roles, general managers as well as sales managers still see that production managers do not fully understand the most important competitive priorities. And as a result, they are not mainly responsible for initiating and modifying changes in manufacturing strategy. This is probably due to the fact that production managers are not fully aware of the changes occurring in the market as suggested by Hill(1985).

In ranking the manufacturing areas (i.e., competitive priorities) according to their needs for improvements, both general and production managers indicated that they want the highest improvement in "low price" and "fast delivery" and the least in "quality" (both types) and "rapid design changes in product". This means that manufacturers in Saudi Arabia have already won quality and they are pursuing low price strategy.

Out of 57 infrastructure programmes rated by production managers, the highest ten programmes that received the highest attention in terms of time, effort, and resources for the next two years (1990 and 1991) are related to cost reduction, quality and suppliers. In contrast, the lowest five programmes that were rated by the same managers for the same period are related to foreign production facilities and automatic inspection systems.

Concerning the importance of the competitive priorities, general managers indicated that both types of quality and delivery are the most important priorities presently and for the next two years (1990 and 1991). "New product introduction" is the least important competitive priority possibly because this task requires expertise and huge funding in order to support intensive research. It is worth mentioning that manufacturers in Saudi Arabia rely heavily on their foreign partners to develop new products.

According to general managers, the performance of the Saudi plants is satisfactory. The majority of GMs use benchmarking to improve the capability of the manufacturing function and they expect higher chances of survival in the industrial sector. The Plants'financial performance was measured using subjective and objective data and was found to be satisfactory.

CHAPTER SEVEN

TESTING OF THE HYPOTHESES

INTRODUCTION

The purpose of this Chapter is to test all the six hypotheses which were described in Chapter Two. Each hypothesis was tested five times; first, on the total sample, then on the individual industries (food, paper, chemical and metal). Testing the same hypothesis in more than one industry shows similarities and dissimilarities among industries in finding significant relationships. On the other hand, testing the same hypothesis on the total sample provides the effect of a larger sample in finding significant relationships.

The results of the hypotheses testing were compared with those of Swamidass (1983) whose study covered 30 U.S.A. firms from machinery and machine tool industries.

The variables used in testing these hypotheses are (see Figure 2-8):

- perceived environmental uncertainty
- Manufacturing task
- Manufacturing infrastructure
- Production manager's role in strategic decision making
- Performance

- o Uncertainty-task congruence
- o Task-infrastructure congruence
- o Task congruence

To test the hypotheses, measures were developed for each of the above variables as seen in Appendix D. Figure 7-1 displays the statistical tests that were used in testing the hypotheses (Cohen and Cohen, 1983; Daniel and Terrell, 1983).

Figure 7-1: Statistical tests for testing the hypotheses

Hypotheses	Type of test	Significant level
H1	Correlation (pearson)	
H2	Same as H1	
H3	T-test	.10 or
H4	Same as H3	LESS
H5	Same as H1	
H6	Same as H1	

7.1 HYPOTHESIS 1

A plant's manufacturing task correlates with its environmental uncertainty.

The test of this hypothesis was accomplished by Pearson correlation between the manufacturing task measure MTM, and the environmental uncertainty measure WPEU. The results of testing this hypothesis on the total sample then on the single industries are shown in Table 7-1.

On the total sample, there is a very significant relationship between environmental uncertainty and manufacturing task (p =.002). The correlation coefficient, r, shows it is a positive relationship with almost moderate strength (.6 or above indicates strong association). A similar response was found for all individual sectors except the food industry. The paper industry, in particular, indicates a very strong association between the concerned variables in spite of the few number of cases (r=.8). In the food industry, the researcher failed to come across a relationship between environmental uncertainty and manufacturing task. Therefore, it can be said that the food industry is different from the other industries (paper, chemical and metal), in perceiving environmental uncertainty.

Swamidass (1983) also found a significant relationship between these two variables. Surprisingly, it was a negative moderate correlation (see Table 7-1).

Table 7-1: Relationship between the manufacturing task measure and the environmental uncertainty measure.

(Hypothesis 1)

Total Sample	F	P	C	M
r = 0.2716	-0.0240	0.8096	0.3806	0.4550
n = 117	26	11	32	48
p = **0.002***	0.454**	**0.001***	**0.016***	**0.001***
r = -0.327				
n = 27	Swamidass			
p = 0.048	(1983)			

F: Food Industry C: Chemical Industry

P: Paper Industry M: Metal Industry

*: Statistically significant

**: Not statistically significant.

The fact that, three out of four industries show that there is a significant relationship between environmental uncertainty and manufacturing task clearly supports this hypothesis.

7.2 HYPOTHESIS 2

A plant's manufacturing infrastructure correlates with its manufacturing task.

Similar to hypothesis one, this hypothesis was tested by Pearson correlation. The involved measures are the manufacturing infrastructure measure INFRA, and the manufacturing task measure MTM.

For the total sample, it was found that there is a significant relationship between a plant's manufacturing infrastructure and its manufacturing task as seen in Table 7-2.

When testing this hypothesis on the four individual sectors, two of them showed significant relationships. These are the chemical and the food industries. It is a highly significant relationship between these two measures in the chemical industry (p = .004), whereas it is barely significant at the .10 level in the food industry. In contrast, the value of the correlation coefficient (r) in the paper industry shows almost moderate correlation but it is not significant. That is, the value of p is out of the allowed level of significance, which indicates a non-existing linear relationship between manufacturing infrastructure and manufacturing task in this industry. In examining the metal industry, one can see that there is no relationship between the concerned measures (r = .0) and it would be worthless to justify the negative sign. It is noticeable that the type of process employed in the industry seems to have an effect in this respect. Both the chemical and the food industries use

Table 7-2: Relationship between the manufacturing infrastructure measure and the manufacturing task measure.

(Hypothesis 2)

Total Sample	F@	P@	C@	M@
r = 0.1963	0.2595	0.2877	0.4548	-0.0586
n = 117	26	11	32	48
p = **0.017***	**0.100***	0.196**	**0.004***	0.346**
r = 0.21				
n = 28	Swamidass			
p = 0.13	(1983)			

@: For description see Table 7-1 in this Chapter

*: Statistically significant

**: Not statistically significant

"continuous process" systems in their operations (see section 5.1.1.1).

Swamidass (1983) failed to find a significant relationship between the manufacturing infrastructure measure and the manufacturing task measure in the 28 firms in the machinery and machine tool industries.

This hypothesis is clearly supported in two industries (chemical and food) in addition to the overall sample.

7.3 HYPOTHESIS 3

The higher the congruence between environmental uncertainty and manufacturing task, the better the performance.

To test this hypothesis, plants were partitioned into three groups using the binary uncertainty-task congruence measure (UTCONG), as explained in Appendix D. The three groups are:

1. **high congruence plants**: above the mean in the UTCONG measure.
2. **low congruence plants**: below the mean in the UTCONG measure.
3. **plants without congruence**: high and low in the UTCONG measure.

Then the average of performance measures for the classified plants were compared using the "T-test". The purpose of using this statistical technique is to find out whether the difference, if any, in average of performance measures between the two groups is significant or not. Significant difference means better performance.

To achieve the testing of this hypothesis correctly, one should understand its meaning and identify the two required groups of the above classification. Two tests were performed for the classified groups:

Test 1: Comparing the performance of plants with uncertainty-task congruence (i.e., groups 1 & 2) with the performance of plants without uncertainty-task congruence (i.e., group 3 only).

Test 2: Comparing the performance of high congruence plants (i.e., group 1) with the performance of low congruence plants (i.e., group 2).

Both tests were performed on the total sample then on the individual industries using subjective and objective measures.

7.3.1 Testing Hypothesis 3 With The Subjective Performance Measures

Table 7-3 exhibits comparison of subjective performance measures between plants with and without uncertainty-task congruence for the total sample. When comparing the performance of plants with uncertainty-task congruence (groups 1 & 2), with the performance for plants without uncertainty-task congruence (group 3 only), none of the three subjective measures showed any significant result (test 1). However, within the same sample, when comparing plants with high uncertainty-task congruence (group 1) with plants of low uncertainty-task congruence (group 2) in terms of performance (test 2), two measures in addition to the composite showed significant difference in favour of high uncertainty-task congruence plants (Table 7-4). These measures are growth in return on investment (GROI), growth in sales (GS), and the composite measure. All these measures are significant at $p = .06$ or less.

To elaborate on this, one can see from Table 7-4 that the average of performance of all the subjective measures for plants with high uncertainty-task congruence are higher than the those for plants with low uncertainty-task congruence. This difference was found to be

Table 7-3: Comparison of Subjective Performance Measures between Plants with and without uncertainty-task congruence in the total sample

(Hypothesis 3: test 1)

Measure	n	Performance (Means) Plants with congruence (1&2)	n	Plants without congruence (3)	Significance
Composite	65	2.37	50	2.30	0.49**
GROI	65	2.25	50	2.22	0.82**
GS	65	2.51	50	2.40	0.35**
GROS	65	2.35	50	2.28	0.55**

**: Not statistically significant
Composite: averaging GROI, GS & GROS
GROI: growth in return on investment
GS : growth in Sales
GROS: growth in return on Sales

statistically significant for most of the performance measures.

Both tests (1&2) in terms of subjective performance were performed on the individual industries to see whether the results of each test (i.e., significant or not) paralleled its counterpart in the total sample.

The results of test one (comparing the performance of plants with uncertainty-task congruence with the performance of plants without uncertainty-task congruence) were found to be statistically

Table 7-4: Comparison of subjective performance measures between plants with high and low uncertainty-task congruence in the total sample

(Hypothesis 3: test 2)

Measure	n	Performance (Means) Plants with high congruence (1)	n	Plants with low congruence (2)	Significance
Composite	34	2.50	31	2.23	**0.04***
GROI	34	2.38	31	2.10	**0.06***
GS	34	2.65	31	2.35	**0.05***
GROS	34	2.47	31	2.23	0.12**

For measures description, see Table 7-3
*: Statistically significant
**: Not statistically significant

insignificant for all individual industries (Tables 7.1.1 and 7.1.2 in Appendix D).

In contrast, as seen in Table 7-6 the results of test two (comparing the performance of high congruence plants with the performance of low congruence plants), were found to be statistically significant in some measures in the chemical and metal industries. The food and the paper industries did not show statistical significant results in any measure, although almost all the figures of the average performance of plants with high uncertainty-task congruence are higher than those of low uncertainty-task congruence (Table 7-5). Of all measures, the following ones were found to be statistically significant: (i) growth in sales (GS) in the chemical industry; and

Table 7-5: Comparison of subjective performance measures between plants with high and low uncertainty-task congruence in the food and paper industries

(Hypothesis 3: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	Significance
Food					
Composite	8	2.47	5	2.42	0.87**
GROI	8	2.20	5	2.13	0.81**
GS	8	2.80	5	2.63	0.60**
GROS	8	2.40	5	2.50	0.78**
Paper					
Composite	6	2.39	3	2.11	0.26**
GROI	6	2.33	3	2.00	0.18**
GS	6	2.50	3	2.33	0.70**
GROS	6	2.33	3	2.00	0.18**

For measures description, see Table 7-3
**: Not statistically significant

(ii) growth in return on investment (GROI), and growth in sales (GS) besides the composite measure in the metal industry. All the previous significant relationships were found in favour of plants with high uncertainty-task congruence.

The findings of tests one and two using subjective measures can be classified as insignificant results and significant results respectively. The findings of test one whether in the total sample or

Table 7-6: Comparison of subjective performance measures between plants with high and low uncertainty-task congruence in the chemical and metal industries

(Hypothesis 3: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	Significance
Chemical					
Composite	7	2.38	8	1.96	0.22**
GROI	7	2.43	8	2.13	0.34**
GS	7	2.43	8	1.75	**0.10***
GROS	7	2.29	8	2.00	0.48**
Metal					
Composite	16	2.48	13	2.13	**0.06***
GROI	16	2.31	13	1.92	**0.10***
GS	16	2.69	13	2.31	**0.07***
GROS	16	2.44	13	2.15	0.23**

For measures description, see Table 7-3
*: Statistically significant
**: Not statistically significant

in the individual sectors were statistically insignificant. On the other hand, some of the findings of test two were found to be statistically significant in the total sample and in the majority of the single industries. As a result, hypothesis three is supported in only test two in GROI, and GS besides the composite measure. The next section will test hypothesis three with regard to the objective performance measures.

7.3.2 Testing Hypothesis 3 With The Objective Performance Measures

As reported in Chapter Six, most of the plants failed to provide the requested objective data. Therefore, this had an effect on the analysis of all industries, especially those with few cases. With the available objective data, the hypothesis was tested using tests one and two as with the subjective data.

Test one failed to find significant results in any of the objective measures in the total sample as seen in Table 7-7. However, within the same sample, test two showed significant results in two types of the objective measures. These are return on investment (ROI) for 1986, and the amount of sales for 1986 & 1987 as seen in Table 7-8. All the significant results are in favour of plants with high uncertainty-task congruence.

On the individual industries test one, using objective data, failed to find significant results in any measure in all industries (see Tables 7.1.3 and 7.1.4 in Appendix D).

However, test two indicated significant results in some objective measures of all industries except the paper industry as can be seen from Tables 7-9 and 7-10. The absence of significant results of all objective measures in the paper sector may be due to the very small number of cases, between 2 and 3, reported in terms of data as mentioned earlier. In the remaining industries, significant results were scattered in all measures. Of all measures, the following were found to be statistically significant: (i) return on investment (ROI)

Table 7-7: Comparison of objective performance measures between plants with and without uncertainty-task congruence in the total sample

(Hypothesis 3: test 1)

Measure	Performance (Means) Plants with congruence n	(1&2)	Plants without congruence n	(3)	Significance
ROI 86	26	8.40	19	10.04	0.70**
ROI 87	26	11.09	20	11.07	0.99**
ROI 88	28	13.30	22	9.96	0.18**
Sales 86	28	14793499	25	12579927	0.82**
Sales 87	28	18332910	25	13400000	0.71**
Sales 88	28	20173000	25	14763527	0.93**
ROS 86	24	11.42	19	9.47	0.66**
ROS 87	27	11.06	20	10.83	0.95**
ROS 88	27	12.43	22	10.06	0.29**

For measures description, see section 6.8.3 (Chapter 6).
**: Not statistically significant

Table 7-8: Comparison of objective performance measures between plants with high and low uncertainty-task congruence in the total sample

(Hypothesis 3: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	Significance
ROI 86	14	14.60	12	3.09	**0.10***
ROI 87	15	11.75	11	10.20	0.69**
ROI 88	15	16.11	13	10.05	0.12**
Sales 86	16	15493000	12	13445733	**0.05***
Sales 87	16	18974800	12	16097540	**0.06***
Sales 88	16	19580000	12	17491000	0.45**
ROS 86	12	10.19	12	12.66	0.59**
ROS 87	15	10.45	12	11.83	0.74**
ROS 88	15	13.58	12	11.00	0.38**

For measures description, see section 6.8.3 (Chapter 6).
*: Statistically significant
**: Not statistically significant

for 1988, and sales for 1986 and 1987 in the food industry; (ii) return on investment (ROI) for 1987 and 1988, sales for 1986, and return on sales (ROS) for 1988 in the chemical industry; and (iii) return on investment (ROI) for 1986 and sales for 1987 in the metal industry. Again as with the subjective performance measures, all the preceding significant results are in favour of plants with high uncertainty-task congruence.

Using the objective performance measures, the findings of test one were found to be statistically insignificant and the findings of test two were found to be statistically significant. Thus, the findings of each test in terms of insignificant or significant results are the same in the subjective and objective performance measures.

In approaching this hypothesis, Swamidass (1983) divided the firms into two groups only, those with congruence and those without. As seen in Table 7-11, none of his results for the three subjective measures were significant. Comments on the approach of this hypothesis as well as hypothesis four will be mentioned in section 7.4.3

This hypothesis is supported in all industries but the paper using subjective and objective performance measures.

Table 7-9: Comparison of objective performance measures between plants with high and low uncertainty-task congruence in the food and paper industries

(Hypothesis 3: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	Significance
Food					
ROI 86	6	16.75	2	5.84	0.70**
ROI 87	5	11.73	3	6.33	0.65**
ROI 88	5	18.54	3	5.31	**0.08***
Sales 86	5	20753221	4	16411000	**0.03***
Sales 87	5	22873453	4	19733425	**0.04***
Sales 88	5	23087582	4	22997524	0.68**
ROS 86	6	15.90	2	6.32	0.98**
ROS 87	5	16.8	3	10.20	0.72**
ROS 88	5	10.78	3	9.63	0.87**
Paper					
ROI 86	2	14.55	0	-	-
ROI 87	2	11.30	0	-	-
ROI 88	2	11.05	1	5.00	0.63**
Sales 86	2	9440902	0	-	-
Sales 87	2	12057900	0	-	-
Sales 88	2	12977000	0	-	-
ROS 86	3	14.3	0	-	-
ROS 87	3	14.37	0	-	-
ROS 88	3	16.60	0	-	-

For measures description, see section 6.8.3 (Chapter 6).
*: Statistically significant
**: Not statistically significant

Table 7-10: Comparison of objective performance measures between plants with high and low uncertainty-task congruence in the chemical and metal industries

(Hypothesis 3: test 2)

Measure	Plants with high congruence n	Performance (Means) (1)	Plants with low congruence n	(2)	Significance
Chemical					
ROI 86	5	19.14	3	22.63	0.85**
ROI 87	5	18.48	3	7.57	**0.08***
ROI 88	5	19.18	2	0.95	**0.05***
Sales 86	4	11653490	2	6310222	**0.04***
Sales 87	4	12257000	2	6011353	0.12**
Sales 88	4	10211343	2	7092045	0.29**
ROS 86	5	19.92	3	11.43	0.13**
ROS 87	5	19.12	3	11.43	0.13**
ROS 88	5	19.12	2	5.50	**0.07***
Metal					
ROI 86	7	11.55	6	-5.69	**0.07***
ROI 87	8	11.28	5	11.16	0.98**
ROI 88	9	14.62	6	11.70	0.57**
Sales 86	10	13778123	6	11572483	0.53**
Sales 87	10	16335075	6	10827511	**0.05***
Sales 88	10	17887410	6	13521117	0.53**
ROS 86	6	14.02	5	5.00	0.25**
ROS 87	8	12.12	5	7.90	0.27**
ROS 88	9	11.15	6	10.30	0.83**

For measures description, see section 6.8.3 (Chapter 6).
*: Statistically significant
**: Not statistically significant

Table 7-11: Comparison of subjective performance measures between plants with and without uncertainty-task congruence

(Hypothesis 3: Swamidass, 1983)

Measure	Performance (Means) Plants with congruence	Plants without congruence	Significance
Composite	3.82	3.80	0.98**
GROI	3.53	3.83	0.78**
GS	4.40	3.58	0.34**
GROS	3.50	4.00	0.61**
	n = 15	n = 12	

**: Not statistically significant

7.4 HYPOTHESIS 4

The higher the congruence between manufacturing task and manufacturing infrastructure, the better the performance.

The test of this hypothesis was accomplished in the same way of testing hypothesis three. That is, plants were divided into three groups using the binary task-infrastructure congruence measure (TICONG) as described in Appendix D. The three groups are:

1. **high congruence plants:** above the mean in the TICONG measure.
2. **low congruence plants**: below the mean in the TICONG measure.
3. **plants without congruence**: high and low in the TICONG measure.

Then, as with the previous hypothesis, the average of performance measures for the categorised plants were compared using the t-test.

To ensure the correct testing of this hypothesis, two tests were performed for the categorised groups as below:

Test 1: Comparing the performance of plants with task-infrastructure congruence (i.e., groups 1 & 2) with the performance of plants without task-infrastructure congruence (i.e., group 3).

Test 2: Comparing the performance of high congruence plants (i.e., group 1) with the performance of low congruence plants (i.e., group 2).

As with hypothesis three, tests one and two were performed on the total sample then on the single industries using subjective and objective measures.

7.4.1 Testing Hypothesis 4 With The Subjective Performance Measures

Tables 7-12 and 7-13 display the results of tests one and two respectively on the total sample. The comparison of the performance of plants with task-infrastructure congruence (group 1 & 2) with that of plants without task-infrastructure congruence (group 3) showed insignificant results in all the subjective measures (test 1). Test two (comparing plants with high task-infrastructure congruence (group 1) with low task-infrastructure congruence plants (group 2) in terms of performance), showed, surprisingly, insignificant results.

Again, using subjective data, both tests were performed on the single sector level. For all single sectors, the results of test one

Table 7-12: Comparison of subjective performance measures between plants with and without task-infrastructure congruence in the total sample

(Hypothesis 4: test 1)

Measure	Performance (Means) Plants with congruence n	(1&2)	Plants without congruence n	(3)	significance
Composite	64	2.40	51	2.26	0.17**
GROI	64	2.31	51	2.14	0.12**
GS	64	2.50	51	2.41	0.44**
GROS	64	2.39	51	2.23	0.19**

For measures description, see Table 7-3
**: Not statistically significant.

Table 7-13: Comparison of subjective performance measures between plants with high and low task-infrastructure congruence in the total sample

(Hypothesis 4: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	significance
Composite	36	2.43	28	2.37	0.68**
GROI	36	2.36	28	2.25	0.47**
GS	36	2.53	28	2.46	0.68**
GROS	36	2.38	28	2.39	0.98**

For measures description, see Table 7-3
**: Not statistically significant.

(comparing the performance of plants with task-infrastructure congruence with that of plants without task-infrastructure congruence), were statistically not significant (Tables 7.2.1 and 7.2.2 in Appendix D).

As seen from Tables 7-14 and 7-15 of all individual industries, only the metal industry showed a significant result when performing test two (comparing the performance of high congruence plants with the performance of low congruence plants). The significant result was found in the measure growth in sales (GS). The significance measure came in favour of plants with high task-infrastructure congruence.

While test one of hypothesis four failed to find significant results in the total sample as well as in the individual sectors, test two showed significant result in the metal industry only. Therefore, hypothesis four is supported in the metal industry only, using test two, in the GS measure.

Table 7-14: Comparison of subjective performance measures between plants with high and low task-infrastructure congruence in the food and paper industries

(Hypothesis 4: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	significance
Food					
Composite	6	2.39	6	2.33	0.88**
GROI	6	2.17	6	2.11	0.73**
GS	6	2.67	6	2.50	0.17**
GROS	6	2.30	6	2.33	0.68**
Paper					
Composite	3	2.35	3	2.29	0.57**
GROI	3	2.31	3	2.29	0.33**
GS	3	2.40	3	2.27	0.71**
GROS	3	2.35	3	2.30	0.68**

For measures description, see Table 7-3
**: Not statistically significant.

Table 7-15: Comparison of subjective performance measures between plants with high and low task-infrastructure congruence in the chemical and metal industries

(Hypothesis 4: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	significance
Chemical					
Composite	9	2.29	12	2.22	0.82**
GROI	9	2.33	12	2.25	0.81**
GS	9	2.33	12	2.25	0.80**
GROS	9	2.22	12	2.17	0.88**
Metal					
Composite	16	2.52	10	2.33	0.36**
GROI	16	2.38	10	2.20	0.50**
GS	16	2.75	10	2.40	0.09*
GROS	16	2.44	10	2.40	0.89**

For measures description, see Table 7-3
**: Not statistically significant
*: Statistically significant

7.4.2 Testing Hypothesis 4 With The Objective Performance Measures

Test one in this hypothesis revealed insignificant results in all the objective measures of the total sample as can be seen from Table 7-16. On the contrary, within the same sample, test two showed significant results in favour of plants with high task-infrastructure congruence in the sales measure for the two consecutive years; 1986 and 1987 (see Table 7-17).

Again, as with the results of test one on the individual sectors with the subjective data, the test, using objective data, failed to come across significant results in any measure in all industries (Tables 7.2.3 and 7.2.4 in Appendix D).

When applying test two on the single industries only the chemical industry showed that the sales measure for 1987 is significant (Tables 7-18 and 7-19). As with the previous sectors, the significance in the chemical industry came in favour of plants with high task-infrastructure congruence.

As with hypothesis 3, Swamidass in his work divided the firms into two groups only; with congruence and without. None of his results were significant as can be seen from Table 7-20.

Therefore, this hypothesis is supported in both the subjective and objective performance measures.

Table 7-16: Comparison of objective performance measures between plants with and without task-infrastructure congruence in the total sample

(Hypothesis 4: test 1)

Measure	Performance (Means) Plants with congruence n	(1&2)	Plants without congruence n	(3)	Significance
ROI 86	30	7.33	15	12.6	0.18**
ROI 87	30	10.8	16	11.7	0.72**
ROI 88	32	12.8	18	10.2	0.27**
Sales 86	34	16788586	19	11500710	0.63**
Sales 87	34	19201733	19	12240331	0.61**
Sales 88	34	21922532	19	13112470	0.78**
ROS 86	28	7.5	15	16.3	0.12**
ROS 87	30	9.41	17	13.7	0.19**
ROS 88	30	11.4	19	11.3	0.98**

For measures description, see section 6.8.3 (Chapter 6)
**: Not statistically significant

Table 7-17: Comparison of objective performance measures between plants with high and low task-infrastructure congruence in the total sample

(Hypothesis 4: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	Significance
ROI 86	17	10.63	13	4.85	0.36**
ROI 87	17	12.6	13	8.37	0.25**
ROI 88	18	15.1	14	9.7	0.12**
Sales 86	20	23650441	14	7304977	**0.10***
Sales 87	20	32865443	14	8071997	**0.08***
Sales 88	20	32865443	14	9989587	0.16**
ROS 86	15	9.38	13	5.90	0.53**
ROS 87	16	10.4	14	8.57	0.53**
ROS 88	17	12.42	13	9.9	0.38**

For measures description, see section 6.8.3 (Chapter 6).
*: Statistically significant
**: Not statistically significant

Table 7-18: Comparison of objective performance measures between plants with high and low task-infrastructure congruence in the food and paper industries

(Hypothesis 4: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	Significance
Food					
ROI 86	3	3.50	1	1.90	0.89**
ROI 87	4	4.50	1	0.95	0.71**
ROI 88	4	9.75	1	3.60	0.16**
Sales 86	4	18964095	1	15599733	0.19**
Sales 87	4	23619882	1	1606933	0.18**
Sales 88	4	27544390	1	1965490	0.19**
ROS 86	3	4.60	1	3.50	0.91**
ROS 87	4	4.80	1	0.40	0.64**
ROS 88	4	10.1	1	4.1	0.12**
Paper					
ROI 86	1	0.50	0	-	-
ROI 87	1	0.50	0	-	-
ROI 88	1	1.80	2	11.50	0.38**
Sales 86	1	3681804	1	5333000	0.61**
Sales 87	1	3483999	1	6400000	0.58**
Sales 88	1	4251288	1	13329257	0.49**
ROS 86	1	1.80	-	-	-
ROS 87	1	2.2	1	2.0	0.58**
ROS 88	1	5.40	1	15.0	0.43**

For measures description, see section 6.8.3 (Chapter 6).
**: Not statistically significant

Table 7-19: Comparison of objective performance measures between plants with high and low task-infrastructure congruence in the chemical and metal industries

(Hypothesis 4: test 2)

Measure	Performance (Means) Plants with high congruence n	(1)	Plants with low congruence n	(2)	Significance
Chemical					
ROI 86	4	15.9	5	15.0	0.94**
ROI 87	4	16.7	5	8.30	0.36**
ROI 88	5	16.5	4	5.48	0.24**
Sales 86	4	9233256	4	3381952	0.13**
Sales 87	4	9806679	4	3258065	**0.09***
Sales 88	4	9817358	4	4341554	0.12**
ROS 86	4	8.75	5	7.68	0.95**
ROS 87	4	14.3	5	12.5	0.90**
ROS 88	5	15.2	4	8.60	0.37**
Metal					
ROI 86	7	9.68	5	-2.70	0.20**
ROI 87	7	15.3	5	10.8	0.33**
ROI 88	8	16.2	5	14.1	0.69**
Sales 86	10	31690766	6	6997825	0.31**
Sales 87	10	34867089	6	7027307	0.26**
Sales 88	10	39458765	6	8547618	0.24**
ROS 86	5	12.4	5	3.76	0.24**
ROS 87	6	11.1	5	8.38	0.44**
ROS 88	7	12.9	5	10.1	0.49**

For measures description, see section 6.8.3 (Chapter 6).
*: Statistically significant
**: Not statistically significant

Table 7-20: Comparison of subjective performance measures between plants with and without task-infrastructure congruence

(Hypothesis 4: Swamidass, 1983)

Measure	Performance (Means) Plants with congruence	Plants without congruence	significance
Composite	3.96	3.60	0.67**
GROI	3.88	3.63	0.84**
GS	4.05	3.90	0.87**
GROS	3.94	3.27	0.46**
	n = 17	n = 11	

**: Not statistically significant

7.4.3 An Important Approach In Testing Hypotheses 3 And 4

The reason for not finding significant results in hypotheses three and four in Swamidass' study is due, to a large extent, to his failure in understanding the meaning of the hypothesis. That is, the meaning of the hypothesis is "the higher ..., the better the performance" and not "firms with congruence perform better than the ones without". Thus, this study achieved the correct testing of these two hypothesis, because the comparison was made between plants with high congruence and plants with low congruence (test 2), which corresponds exactly to the meaning of these hypotheses. Swamidass testing of theses hypotheses is similar only to test one of this study in which insignificant results along all the measures were shown.

7.5 HYPOTHESIS 5

The higher the top management and production management task congruence, the better the performance.

The test of this hypothesis was accomplished by Pearson correlation between the task congruence measure TCONG, which is defined as the difference of the average ratings between general and production managers on manufacturing task, and the two types of the performance measures (i.e., subjective and objective).

7.5.1 Testing Hypothesis 5 With The Subjective Performance Measures

The results of testing this hypothesis on the total sample then on the individual industries using subjective performance measures are shown in Table 7-21. On the total sample, a significant relationship was found in growth in sales (GS) in addition to the one in the composite index.

When testing this hypothesis on the individual industries, only the metal industry showed significant to highly significant relationships between task congruence and each of: growth in sales (GS) and the composite index.

Thus, using subjective performance measures, the hypothesis was supported in the total and metal industries.

Table 7-21: Relationship between the task congruence measure and the subjective performance measures in all industries

(Hypothesis 5)

		Performance Measures			
Industry		Composite	GROI	GS	GROS
Total sample	r	0.1513	0.1136	0.1686	0.1135
	n	115	115	115	115
	p	**0.053***	0.113	**0.036***	0.114
Food	r	-0.1182	-0.0300	-0.1000	-0.1825
	n	26	26	26	26
	p	0.283	0.442	0.313	0.186
Paper	r	0.1581	0.1264	0.0730	0.2447
	n	11	11	11	11
	p	0.321	0.356	0.416	0.234
Chemical	r	0.1787	0.2168	0.0891	0.1865
	n	32	32	32	32
	p	0.164	0.117	0.314	0.153
Metal	r	0.2654	0.1267	0.3867	0.1630
	n	46	46	46	46
	p	**0.037***	0.201	**0.004***	0.140
Swam. (1983)	r	0.16	0.24	-0.03	0.16
	n	30	30	30	30
	p	0.20	0.10	0.43	0.19

For measures description, see Table 7-3

*: Statistically significant

7.5.2 Testing Hypothesis 5 With The Objective Performance Measures

This hypothesis was highly supported using the objective performance measures as seen in Table 7-22. On the total sample, there were significant relationships between the task congruence measure and each of: return on investment (ROI) for 1986, and sales (GS) for 1986 and 1987. On the individual industries, several significant relationships were found in each industry. These are: (i) return on investment (ROI) for 1986 and 1988 in the food industry; (ii) sales for 1986 and 1987 and return on sales (ROS) for 1987 and 1988 in the paper industry; (iii) return on investment (ROI) for all years, sales for 1988 and return on sales (ROS) for 1986 in the chemical industry; and (iv) return on investment (ROI) for 1986 and 1988, sales for all years, and return on sales (ROS) for 1986 in the metal industry. Clearly it appears from the Table that all objective performance measures showed significant relationships with the task congruence.

Swamidass (1983), however, found a barely significant relationship between task congruence and growth in return on investment (Table 7-21).

The above results indicate that this hypothesis is supported in the subjective as well as in the objective performance measures in all industries.

Table 7-22: Relationship between the task congruence measure and the objective performance measures in all industries (Hypothesis 5)

Measure		Total Sample	Industries: Food	Paper	Chemical	Metal
ROI 86	r	0.3062	0.4737	-	0.4270	0.6522
	n	43	11		13	19
	p	**0.020***	**0.071***		**0.073***	**0.001***
ROI 87	r	-0.0318	-0.3465	-	0.5807	0.0036
	n	44	12		13	19
	p	0.417	0.135		**0.019***	0.494
ROI 88	r	0.1706	0.3930	-0.5173	0.5188	0.2847
	n	50	12	4	12	22
	p	0.118	**0.103***	0.241	**0.042***	**0.100***
Sal. 86	r	0.2377	-0.1740	0.9965	-0.2219	0.3016
	n	53	13	3	12	25
	p	**0.043***	0.285	**0.027***	0.244	**0.071***
Sal. 87	r	0.2508	-0.1724	0.9917	-0.3210	0.2723
	n	53	13	3	12	25
	p	**0.035***	0.287	**0.041***	0.155	**0.094***
Sal. 88	r	-0.1391	-0.1374	-0.8573	0.6115	0.2834
	n	53	13	3	12	25
	p	0.160	0.327	0.172	**0.017***	**0.085***
ROS 86	r	0.0733	-0.0470	-0.8981	0.4771	0.3673
	n	43	11	3	13	16
	p	0.32	0.445	0.145	**0.050***	**0.081***
ROS 87	r	-0.0342	-0.0244	0.9212	0.4091	-0.2696
	n	47	12	4	13	18
	p	0.410	0.470	**0.039***	0.083	0.140
ROS 88	r	-0.0083	-0.2393	0.7869	0.3713	-0.0934
	n	49	12	4	12	21
	p	0.478	0.227	**0.102***	0.117	0.344

*: Statistically significant

7.6 HYPOTHESIS 6

The greater the involvement of production managers in strategic decision making, the better the performance.

The test of this hypothesis was carried out between each one of the two measures: role of production manager rated by general managers (RPMG), and role of production manager rated by themselves (RPMP) and the subjective as well as the objective performance measures.

7.6.1 Testing Hypothesis 6 With The Subjective Performance Measures (general managers ratings)

Table 7-23 presents the results of testing this hypothesis on the total sample then on the single sectors using subjective performance measures with the RPMG measure. On the total sample, none of the subjective measures showed any significant relationship with the measure RPMG. Within the single industries two out of four showed significant relationships. These are the food and the metal industries. The measure RPMG showed significant relationships with each of growth in sales (GS) in the food industry; and with growth in return on investment (GROI) in the metal industry.

Swamidass' findings strongly supported the hypothesis and showed significant relationships with all the subjective performance measures and the role of the manufacturing manager rated by chief executives as seen in Table 7-23.

The above findings of this study support this hypothesis using

Table 7-23: Relationship between the involvement of production managers in strategic decision making and the subjective performance measures in all industries (RPMG rating)

(Hypothesis 6)

Industry		Performance Measures Comp.	GROI	GS	GROS
Total sample	r	0.0206	0.0484	0.0373	-0.0287
	n	115	115	115	115
	p	0.413	0.304	0.346	0.380
Food	r	-0.2468	-0.0684	0.3762	-0.2179
	n	26	26	26	26
	p	0.112	0.370	**0.029***	0.142
Paper	r	-0.0070	-0.1667	0.1514	-0.0224
	n	11	11	11	11
	p	0.424	0.409	0.296	0.383
Chemical	r	-0.0070	-0.1667	0.1514	-0.0224
	n	32	32	32	32
	p	0.485	0.181	0.204	0.452
Metal	r	0.1059	0.2130	0.0721	-0.0226
	n	46	46	46	46
	p	0.242	**0.078***	0.317	0.441
Swam. (1983)	r	0.337	0.22	0.376	0.22
	n	34	34	34	34
	p	0.026	0.10	0.014	0.10

For measures description, see Table 7-3
*: Statistically significant

subjective performance measures with the role of the production manager rated by general managers (RPMG) and lend more support to the findings reported by Swamidass (1983).

7.6.2 Testing Hypothesis 6 With The Objective Performance Measure (general managers ratings)

The results of testing this hypothesis on the total sample then on the individual industries using the objective performance measures with the RPMG measure are shown in Table 7-24. On the total sample, for all years, none of the three objective measures showed any significant relationship with the RPMG measure. On the other hand, of all industries, only the food industry showed significant relationships. These are between sales for all years and the RPMG measure. On the basis of the above significant findings one can say that this hypothesis, using the objective performance measures with the RPMG measure, found support in the food industry only.

7.6.3 Testing Hypothesis 6 With The Subjective Performance Measures (production managers ratings)

By using the RPMP measure, hypothesis six was re-tested with all the subjective performance measures as seen in Table 7-25. On the total sample, the measure RPMP showed a significant relationship with growth in return on investment (GROI), growth in return on sales (GROS), and on the composite index. On the individual industries all except the metal industry showed significant relationships. The measure RPMP was found to be significant with each of (i) growth in sales (GS), growth in return on sales (GROS), and with the

Table 7-24: Relationship between the involvement of production managers in strategic decision making and the objective performance measures in all industries (RPMG rating) (Hypothesis 6)

Measure		Total sample	Industries			
			Food	Paper	Chemical	Metal
ROI 86	r	-0.0074	-0.1406		-0.1179	0.1027
	n	45	11	-	13	19
	p	0.481	0.340		0.351	0.338
ROI 87	r	0.0091	-0.1629		0.1782	0.2010
	n	46	12	-	13	19
	p	0.476	0.306		0.280	0.205
ROI 88	r	-0.0375	-0.2354		-0.0692	0.0439
	n	50	12	-	12	22
	p	0.398	0.231		0.415	0.423
Sal. 86	r	0.0311	0.3778		0.2196	-0.1080
	n	53	13	-	12	25
	p	0.413	**0.102***		0.246	0.304
Sal. 87	r	0.0606	0.3797		0.2652	-0.0877
	n	53	13	-	12	25
	p	0.333	**0.100***		0.202	0.338
Sal. 88	r	0.0250	0.3906		-0.1873	-0.0841
	n	53	13	-	12	25
	p	0.429	**0.093***		0.280	0.345
ROS 86	r	-0.0080	-0.2098	0.1444	0.1276	-0.0284
	n	43	11	3	13	16
	p	0.480	0.268	0.454	0.339	0.458
ROS 87	r	-0.0229	-0.2526	-0.0378	0.0899	0.2585
	n	47	12	4	13	18
	p	0.439	0.214	0.481	0.385	0.150
ROS 88	r	-0.0274	-0.3003	0.1410	-0.1604	0.1510
	n	49	12	4	12	21
	p	0.426	0.171	0.429	0.309	0.257

*: Statistically significant

Table 7-25: Relationship between the involvement of production managers in strategic decision making and the subjective performance measures in all industries (RPMP rating)

(Hypothesis 6)

Industry		Performance Measures: Comp.	GROI	GS	GROS
Total sample	r	0.1273	0.1158	0.0904	0.1255
	n	115	115	115	115
	p	**0.088***	**0.104***	0.168	**0.091***
Food	r	0.2790	0.1828	0.2684	0.2948
	n	26	26	26	26
	p	**0.084***	0.186	**0.092***	**0.072***
Paper	r	0.3881	0.5719	0.0195	0.2115
	n	11	11	11	11
	p	0.119	**0.033***	0.477	0.266
Chemical	r	0.1147	0.2913	-0.1997	-0.1554
	n	32	32	32	32
	p	0.266	**0.053***	0.137	0.198
Metal	r	0.0705	-0.0069	-0.0512	-0.0752
	n	46	48	48	48
	p	0.321	0.481	0.365	0.306
Swamidass (1983)		All measures are not significant (N/A)			

*: Statistically significant

composite index in the food industry; (ii) growth in return on investment (GROI) in the paper industry; and (iii) growth in return on investment (GROI) in the chemical industry.

Swamidass (1983) failed to find any significant results between any of the subjective performance measures and the role of the manufacturing managers rated by themselves (Table 7-25).

As a result of the above findings, this hypothesis is supported using the subjective performance measures with the role of the production managers rated by themselves.

7.6.4 Testing Hypothesis 6 With The Objective Performance Measures (production managers ratings)

Table 7-26 displays the results of testing hypothesis 6 on the total sample, then on the single sectors using the objective performance measures with RPMP measure. On the total sample, only the measure return on sales (ROS) for 1988 showed a significant relationship with the measure RPMP. Of all the individual industries, only the chemical and the metal industries showed significant relationships. The measure RPMP was significant with return on investment (ROI) for 1988 and return on sales (ROS) for the same year in the chemical industry; and with each of return on investment (ROI) for 1986 and 1988, sales for all years (1986-1988) and return on sales (ROS) for 1988.

Table 7-26: Relationship between the involvement of production managers in strategic decision making and the objective performance measures in all industries (RPMP rating) (Hypothesis 6)

Measure		Total sample	Food	Paper	Chemical	Metal
			Industries			
ROI 86	r	-0.1648	0.0331	0.3195	-0.1044	0.4256
	n	45	11	7	12	15
	p	0.140	0.461	0.242	0.373	**0.057***
ROI 87	r	0.0850	0.0083	0.3858	-0.1531	0.2657
	n	46	12	7	13	16
	p	0.287	0.490	0.196	0.309	0.160
ROI 88	r	0.0069	-0.1146	0.0799	0.7024	0.4809
	n	50	12	7	15	18
	p	0.481	0.361	0.432	**0.002***	**0.022***
Sal. 86	r	0.0720	0.2225	-0.1370	0.1077	0.5762
	n	53	13	7	15	18
	p	0.304	0.233	0.385	0.351	**0.006***
Sal. 87	r	0.0981	0.2323	-0.1950	0.0656	0.5895
	n	53	13	7	15	18
	p	0.242	0.222	0.338	0.408	**0.005***
Sal. 88	r	0.0538	0.2412	-0.1825	0.0144	0.5591
	n	53	13	7	15	18
	p	0.351	0.214	0.348	0.480	**0.008***
ROS 86	r	-0.1603	-0.1116	0.4516	-0.3058	0.3066
	n	43	11	7	13	16
	p	0.152	0.372	0.155	0.155	0.124
ROS 87	r	-0.1213	-0.1117	0.4077	-0.2999	0.1182
	n	47	12	7	15	18
	p	0.208	0.365	0.182	0.139	0.320
ROS 88	r	0.2006	-0.3100	-0.1530	0.5275	0.3446
	n	49	12	7	15	18
	p	**0.083***	0.163	0.372	**0.022***	**0.081***

*: Statistically significant

It is clear from the above findings that this hypothesis was supported in the chemical and metal industries using the objective performance measures with the RPMP measure.

The findings of hypothesis six indicate that the rating of role of the production managers, by themselves, in strategic decision making generated more significant relationships than when it was rated by general managers, whether in the subjective or objective performance measures (see Tables 7-23 to 7-26). A possible reason for that could be attributed to their egos in overstating their role. It was stated in chapter six that the ratings of production managers are higher than those of general managers.

The above findings indicate that this hypothesis is supported in the subjective and objective performance measures in both RPMG and RPMP measures collectively in all industries.

SUMMARY

The results of testing the six hypotheses derived from the model (see chapter two), showed a significant relationship in every hypothesis. This could be attributed to the advantage of using multiple measures of performance (see section 2.4.6.1). The results of the testing are summarised below:

Environmental uncertainty, which is an input to manufacturing strategy, influences manufacturing task in the paper, metal and chemical industrial sectors, and in the total sample.

The evidence of correlating manufacturing infrastructure with manufacturing task was not conclusive in all industries. A relationship exists in the chemical as well as in the food industries in addition to the overall sample but not in the paper and metal sectors.

This study validates hypothesis three for the first time. It was found that plants with high uncertainty-task congruence appear to perform better than those with low uncertainty-task congruence. Using the subjective and objective performance measures, this hypothesis was supported in all industries but the paper industry, due to a small number of cases. Also, the hypothesis was supported on the total sample level.

As with the above hypothesis, this study validates hypothesis four for the first time. It was found that plants with high task-infrastructure congruence perform better than those with low task-infrastructure congruence. Using subjective and objective performance measures, this hypothesis was only supported in two industries; the chemical and metal industries. On the total sample, this hypothesis was supported with the objective measures only.

Task congruence between general and production managers on manufacturing tasks influences performance as evident by the findings. This hypothesis was highly supported in all industries with the objective measures, while only in the metal industry with the subjective data. On the total sample both subjective and objective measures have shown significant relationships, although it is very weak association in the subjective measures.

Finally, the role of the production manager in strategic decision making, as perceived by themselves (RPMP) and by general managers (RPMG), associates with performance. Both subjective and objective performance measures have shown significant relationships with the measures RPMG and RPMP collectively in all industries.

CHAPTER EIGHT

COMPONENTS OF MANUFACTURING STRATEGY AND EXPECTED STRATEGY

INTRODUCTION

Selecting one or more of the competitive priorities based on the capabilities of the manufacturing function is an extremely important decision. A good decision could set the firm/plant apart from its competitors. To implement such a decision (i.e., achieve a certain priority) programmes (policies) leading to this priority must be in place.

The aim of this chapter is to detect the manufacturing strategy for the next two years (1990 and 1991) for all the Saudi surveyed plants. This was accomplished by finding the components of the manufacturing strategy as well as the focused sets of competitive priorities through the principal components of factor analysis, and employing a canonical correlation analysis between the components of the manufacturing strategy and the focused sets of competitive priorities.

8.1 AN ANALYSIS ON THE TOTAL SAMPLE

Chapters Five, Six and Seven report on the analysis performed on the total sample as well as on the individual industries. Few differences among these industries were found in some questions.

In this Chapter, analysis was carried out on the total sample only (117 plants) because of the requirement of the statistical technique. By and large, in using statistical techniques, the sample size is a very important element for generating valid results. Kerlinger (1986) encourages researchers to use samples that are as large as possible, which he called "a rough-and-ready rule". The reason behind this arises out of the relationship between the sample size and the error. That is, in Kerlinger's words (p. 117) "the larger the sample, the smaller the error" (deviation). Therefore, the researcher is well advised to use a large sample (100 or above) with advanced statistical techniques as those used in this Chapter.

Prior to establishing analysis on the total sample, checking that the concerned questions have either no or few differences among industries is the only important step in validating the analysis at this stage. In other words, if major differences do exist among the various industries, analysis on the total sample will be invalid. Since the analysis in this Chapter focuses on two questions: the infrastructure-programmes (scored by PMs), and the importance of competitive priorities (scored by GMs), testing differences among industries in these two questions is necessary. Both questions were tested by Kruskal Wallis and One Way Analysis of Variance (ANOVA) earlier in Chapter Six to find out if highly significant differences do exist among industries. As mentioned in that Chapter, none of the items in these two questions showed a very significant difference among the four industries (see Table 6.5.1 and 6.6.1). Therefore, the analysis on the total sample is quite acceptable.

8.2 COMPONENTS OF MANUFACTURING STRATEGY

The activities or the programmes that support competitive priorities can be called components of manufacturing strategy (see Figure 2-7). Each component consists of a set of similar programmes. In order to detect these components, principal components of factor analysis were used on only the 51 infrastructure-programmes which were rated by production managers.

The rest of the infrastructure-programmes (i.e., six) were omitted from this analysis owing to three reasons (see Figure 8-1):

1. These programmes had already been analysed in Chapter Six, where the importance of every programme was noticed.

2. Some of these programmes are collectively represented by another programme or vice versa. That is., (i) the first three programmes in the Figure (Infrs. 1, 18 and 37) are represented by the programme "reducing production costs", (Infr. 38); and (ii) the fourth programme, (Infr. 55), is similar to "developing high quality suppliers", (Infr. 23), and "developing reliable timely suppliers", (Infr. 24).

3. The last three programmes (Infrs. 55, 56 and 57), received the least attention from the respondents in terms of time, effort and resources (see Chapter Six); therefore, they are not directly related to the production operations of all plants surveyed in this study.

Figure 8-1: Excluded programmes of the principal components analysis

Programme	Description
INFR 1	Reducing inventory costs
INFR 18	Reducing raw material costs
INFR 37	Reducing direct labour costs
INFR 55	Developing reliable foreign suppliers for components, where materials are inexpensive.
INFR 56	Developing facilities abroad for the manufacturing of components for use in Saudi assembly plants, where labour is cheap.
INFR 57	Developing facilities abroad for assembly of major product lines, where most of the production factors are low.

8.2.1 Principal Components

The primary purpose of the principal components method of factor analysis is data reduction in order to facilitate the interpretation process (Child, 1979; Hedderson, 1987; Hair et al., 1987). That is, it classifies all variables into groups (factors). This classification is based on the association between the variable and the factor, later this will be called a factor loading (Hair et al., 1987).

To find out the results of applying principal components on the 51 infrastructure-programmes, the following criteria were outlined:

- The number of factors to be extracted
- The significance of factor loadings
- The selection of variables for each factor

8.2.1.1 Criteria For The Number Of Factors To Be Extracted

The criteria for the number of factors to be extracted are based, to a large extent, on the latent roots (eigenvalues) and the total percentage of variance accounted (Hair, Anderson and Tatham, 1987). Factors whose eigenvalues are more than or equal to one are considered significant. Hair et al. argue that "the rationale for the eigenvalue criterion is that any individual factor should account for at least the variance of a single variable if it is to be retained for interpretation" (p. 247). Regarding the second criterion, percentage of variance, the factoring procedure comes to an end when the last factor accounts for a small portion of the variance (less than 5 per cent). Accordingly, fourteen factors with eigenvalue of one or more than one for each, and the last factor accounted for 2.1 per cent of the variance were extracted (see Table 8-1). The cumulative percentage of variance accounted by the extracted factors is 76.4. This percentage is considered highly satisfactory as Hair et al., explain:

> In the social science, where information is often less precise, it is not uncommon for the analyst to consider a solution that accounts for 60 per cent of the total variance (and in some instances even less) as a satisfactory solution" (1987:247).

Table 8-1: Number of factors extracted and the percentage of variance explained (Total sample)

Factor	Eigenvalue	% of variance	Cum. %
1	13.1	26.8	26.8
2	3.58	7.30	34.1
3	3.21	6.60	40.7
4	2.30	4.70	45.4
5	2.16	4.40	49.8
6	1.98	4.00	53.8
7	1.89	3.90	57.7
8	1.75	3.60	61.3
9	1.52	3.10	64.4
10	1.51	3.10	67.5
11	1.17	2.40	69.9
12	1.11	2.30	72.2
13	1.03	2.10	74.3
14	1.01	2.10	76.4

8.2.1.2 Criteria For The Significance Of Factor Loadings

Before the interpretation of the factor matrix, the researcher must decide on which factor loadings are to be considered to represent variables in each factor. Many writers including Child (1979), Kim and Mueller (1983) and Hair et al. (1987) suggest that factor loading greater than $\pm.30$ are considered significant. Loadings of $\pm.40$

are considered more important, and ±.50 or higher are considered very significant. Thus, the higher the factor loading, the more significant the loading is, which in turn indicates the significance of the variable. In this regard, variables with higher loading greatly influence the name or the label for the factor (Hair et al., 1987). On the basis of the above criteria, the considered factor loadings in this study are ±.40 or above. In other words, the cut-off point for the loadings is ±.40.

8.2.1.3 Criteria For The Selection Of Variables For Each Factor

Since the first two steps determined the number of factors to be studied and the cut-off point, the next step defines the interpretation procedure for the factor matrix, that is, the selection of variables for each factor.

Varimax rotation was employed to magnify the factor loadings in order to facilitate the interpretation of the identified factors.

The factor matrix illustrates factor loadings for each variable in each factor (previously called groups). The interpretation procedure is to select for each variable the highest factor loading (only one loading) of all the factors (Child, 1979; Hair et al., 1987). The above procedure classified almost all the variables (50 infrastructure -programmes) into the identified fourteen factors as seen in Table 8-2. A detailed principal components factor loadings matrix is shown in Table 8.1.1, Appendix E).

8.2.2 Results Of The Principal Components

By matching the infrastructure-programmes of each factor in Table 8-2 to their descriptions, Figure 8-2 was produced. The infrastructure -programmes of each factor in Figure 8-2 were used to construct strategic indices to be utilised as components of manufacturing strategy in a subsequent analysis. A high degree of similarities among the infrastructure-programmes in most factors was found. Comparisons were made between some factors of this study and those of De Meyer and Ferdows (1987) and of Roth (1987) whenever appropriate. The fourteen extracted factors are discussed below.

FACTOR ONE: Supplier Chain Management

Six infrastructure-programmes out of 50 loaded very significantly in this factor (all above .50, see Table 8-2 and Figure 8-2). These infrastructure-programmes are positively highly related to each other (factor loadings are interpreted as the correlation coefficients). All these infrastructure-programmes concern suppliers, starting with "developing high quality suppliers" and ending with "achieving independence from suppliers". Therefore, this factor is interpreted and labelled "Supplier Chain Management". Since the "suppliers management factor" explained the largest percentage of variance (26.8 per cent), it is considered the most important factor for the Saudi industrial sectors indicating two concerns.Firstly, it indicates that the manufacturers in Saudi Arabia encounter some difficulties with suppliers as will be seen in SWOT analysis in the next chapter. Secondly, it means that the manufacturers attempt to achieve improvements in this factor as will be shown in the subsequent analysis.

FACTOR TWO: Automation Management

This factor is identified by the high significant loadings of six infrastructure-programmes which accounted for 7.3 per cent of the total variance. The infrastructure-programmes in this factor call for automation in all its types (i.e. enhancing and replacing labour). Thus, this factor is interpreted and labelled "Automation Management". It is worth mentioning that the last programme in this factor, "increasing worker control over work pace", has also high loading in factor three (see Table 8.1.1 in Appendix E).

Despite the differences in the programmes leading to automation, the findings of this factor are , in general, similar to the findings by De Meyer and Ferdows (1987) and Roth (1987). Roth found two types of automation (each type loaded in a separate factor). The first type serves to enhance the productivity of labour such as computer-aided design (CAD) and computer-aided manufacturing (CAM). The second type serves to substitute labour such as robot and flexible manufacturing system (FMS). The essence of enhancing and replacing labour has been encapsulated within one factor in this study.

Enhancing and replacing labour should be two types of automation that provide a basis for classifying Saudi plants. Such classification would indicate the capacity of plants besides other issues.

Table 8-2: Components of manufacturing strategy factor loadings (Total sample)

	Factors							Communality
Programmes	1	2	3	4	5	6	7	
Infr 23	0.82							.81
Infr 25	0.82							.82
Infr 24	0.80							.84
Infr 21	0.72							.74
Infr 22	0.70							.74
Infr 26	0.51							.77
Infr 33		0.87						.82
Infr 34		0.77						.73
Infr 35		0.66						.75
Infr 32		0.61						.84
Infr 27		0.56						.70
Infr 43		0.49						.79
Infr 41			0.75					.79
Infr 40			0.74					.75
Infr 45			0.56					.76
Infr 36			0.51					.76
Infr 42			0.50					.69
Infr 44			0.44					.76
Infr 30				0.78				.76
Infr 29				0.77				.86
Infr 15				0.57				.79
Infr 31				0.51				.73
Infr 14				0.47				.81
Infr 51					0.79			.81
Infr 52					0.78			.83
Infr 53					0.74			.78
Infr 48						0.80		.79
Infr 50						0.70		.79
Infr 49						0.62		.76
Infr 47						0.48		.71
Infr 3							0.84	.79
Infr 5							0.79	.76
Infr 8							0.45	.72
Infr 10							0.40	.67

Table 8-2 : (Continued)

	Factors							Communality
Programmes	8	9	10	11	12	13	14	
Infr 38	0.78							.81
Infr 39	0.60							.71
Infr 46	0.53							.78
Infr 12	0.50							.70
Infr 17		0.77						.75
Infr 16		0.46						.71
Infr 19			0.72					.68
Infr 20			0.60					.79
Infr 28			0.44					.75
Infr 11				0.80				.81
Infr 7				0.80				.82
Infr 9				0.66				.78
Infr 2					0.74			.72
Infr 54						0.56		.67
Infr 13						0.51		.67
Infr 4							0.82	.75

FACTOR THREE: Improving Workforce Skills Management

This factor includes six infrastructure-programmes which explained 6.6 per cent of the total variance, making the cumulative percentage of variance slightly over 40 per cent. Programmes in this factor stress the necessity to continue worker specialisation and training. Since all these programmes indicate specific attention to the workforce, this factor is interpreted and labelled "Improving Workforce Skills Management".

Two programmes in this factor, "Development of new features for older product lines" and "increasing worker responsibility in work planning", have relatively high loadings in factors two (Automation Management) and four respectively.

FACTOR FOUR: Product Control Management

This factor is loaded with five infrastructure-programmes which accounted for 4.7 per cent of total variance. Programmes in this factor call for product control whether in terms of design (i.e. simplification and modularisation) or in terms of progress system and replacement of inexpensive materials which all facilitate a better master production schedule. Therefore, this factor is interpreted and labelled "Product Control Management". In the product control management factor, two programmes, "close order progress control system" and "substitution of inexpensive materials or components", have also high loadings in factors six and twelve respectively.

FACTOR FIVE: High Volume Products

Three infrastructure-programmes are loaded very significantly in this factor and accounted for 4.4 per cent of the total variance. These programmes deal with the issue of high volume products as a result of economies of scale or economies of scope. Thus, this factor is interpreted and called "High Volume Products".

FACTOR SIX: Quality Management

This factor is identified by four infrastructure-programmes which explained 4 per cent of the cumulative variance (see Figure 8-2). All these programmes are concerned with product quality. Therefore, this factor is interpreted and labelled "Quality Management". In respect of "monetary incentive system", it is obvious that the Saudi and non-saudi managers who are in charge of the Saudi plants follow the approach of the firms that connect monetary incentive system directly to quality improvements (Krajewski and Ritzman, 1987). In this regard, it is worth noting that both studies which were conducted by De Meyer and Ferdows (1987) and Roth (1987) failed to include such a programme in their studies. Apart from this, both studies included programmes concerning quality circle and quality control in the "quality factor". Workers' safety, which is not considered in this study, was found to be in the "quality factor" in the study conducted by De Meyer and Ferdows (1987).

FACTOR SEVEN: Inventory Management

Four infrastructure-programmes are loaded highly in this factor and accounted for 3.9 per cent of the total variance. These programmes call for reduction in raw materials, finished goods, idle time and workforce stabilisation. Thus, this factor is interpreted and labelled "Inventory Management", according to the highest two loadings (Hair et al.,1987).

The last two programmes in this factor, "reducing idle time" and "stabilising the workforce numbers", may appear less indicative of the inventory management. However, knowing that inventory levels (e.g., the first two programmes in this factor) could have a significant influence on profit (Krajewski and Ritzman, 1987), stabilising the workforce numbers and reducing idle time would indicate steady demand.

Figure 8-2 : Components of Manufacturing Strategy (Total Sample)

	Infr
FC 1 : Supplier Chain Management (26.8%)	
1. Developing high quality suppliers	23
2. Diversifying suppliers (multi sources)	25
3. Developing reliable timely suppliers	24
4. Obtaining quantity discounts from suppliers	21
5. Obtaining quantity discounts from shippers	22
6. Achieving independence from suppliers	26
FC 2 : Automation Management (7.3%)	
1. Automation of production lines	33
2. Automation inspection	34
3. Acquiring the latest in production equipment	35
4. Mechanised materials handling	32
5. Substitution of labour by machines	27
6. Increasing worker control over work time	43
FC 3 : Improving Workforce Skills Management (6.6%)	
1. Worker specialisation	41
2. Worker training	40
3. Removal of inspectors	45
4. Development of new features for older product lines	36
5. Increasing worker responsibility in work planning (job enrichment)	42
6. Inspectors training	44
FC 4 : Product Control Management (4.7%)	
1. Product simplification	30
2. Product modularisation	29
3. Close order progress control system	15
4. Substitution of inexpensive materials or components	31
5. Developing better master production schedule	14
FC 5 : High Volume Products Management (4.4%)	
1. Development of high volume products	51
2. Development of products with high economies of scale	52
3. Development of products with high economies of scope	53
FC 6 : Quality Management (4.0%)	
1. Acquiring a Saudi quality mark	48
2. Development or improvement of quality circle programmes	50
3. Monetary incentive system	49
4. Development or improvement of quality control programmes	47

Figure 8-2 : (continued)

Factor / variable	Infr
FC 7 : Inventory Management (3.9%)	
1. Reducing raw materials and component inventories	3
2. Reducing finished goods inventories	5
3. Reducing idle time	8
4. Stabilising workforce numbers	10
FC 8 : Increasing Productivity Management (3.6%)	
1. Reducing production costs	38
2. Worker skills diversification	39
3. Improving labour productivity	46
4. Reducing manufacturing lead time	12
FC 9 : Information System Management (3.1%)	
1. Order status reporting system	17
2. Frequent work centre rescheduling capacity	16
FC 10 : Purchasing Control Management (3.1%)	
1. Obtaining long term purchasing supply contracts	19
2. Reducing the number of purchase orders per year	20
3. Product standardisation	28
FC 11 : Human Resources Management (2.4%)	
1. Designing policies to motivate employees	11
2. Hiring and lay-off system	7
3. Finding reliable subcontractors	9
FC 12 : Turnover Management (2.3%)	
1. Increasing inventory turnover	2
FC 13 : Co-ordination Management (2.1%)	
1. Improving co-ordination among engineering, manufacturing and marketing	54
2. Increasing warehouse space	13
FC 14: Work-In-Process Management (2.1%)	
1. Reducing work-In-process inventories	4

FC : factor
(%) : percent of variance explained by the factor

It is worth noting that factor Six and Seven have almost the same influence because of equal amount of variance explained.

FACTOR EIGHT: Increasing Productivity Management

This factor includes four infrastructure-programmes which accounted for 3.6 per cent out of 76.4 per cent. These are concerned with lowering production costs, diversifying worker skills, improving labour productivity and reducing manufacturing lead time. Therefore, this factor is interpreted and labelled "Increasing Productivity Management". It is important to mention that "worker skills diversification", Infr.39, also has a high loading in factor three (Improving Workforce Skills Management).

FACTOR NINE: Information System Management

Two infrastructure-programmes included in this factor which accounted for 3.1 per cent of the total variance. These programmes are involved with reporting system and rescheduling capacity for the operation production function. Thus, this factor is interpreted and labelled "Information System Management".

FACTOR TEN: Purchasing Control Management

This factor is identified by three infrastructure -programmes which accounted for the same variance as the previous factor (3.1%). These programmes are highly concerned with purchasing in terms of obtaining long term contracts and having a smaller number of orders per year (see Table 8-2 and Figure 8-2). Thus, this factor is interpreted and labelled "Purchasing Control Management". The last two programmes in this factor, "reducing the number of purchase orders per year" and "product standardisation" have also high loadings in "Suppliers Chain Management" and "Product Control Management" respectively.

FACTOR ELEVEN: Human Resources Management

This factor is identified by three infrastructure-programmes which explained 2.4 per cent of the total variance. Because of the very high loadings of the first two infrastructure-programmes, this factor is interpreted and labelled "Human Resources Management".

FACTOR TWELVE: Turnover Management

Only one infrastructure-programme is loaded in this factor. It is accounted for 2.3 per cent of the total variance. Since this programme calls for increasing inventory turnover, it is named "Turnover Management".

FACTOR THIRTEEN: Coordination Management

This factor is identified by two infrastructure-programmes which accounted for 2.1 per cent of the total variance. These are "improving co-ordination among engineering, manufacturing and marketing" and "increasing warehouse space". Since the first programme has the highest loading, it influences the label of the factor (Hair et al., 1987). Thus, this factor is labelled "Coordination Management".

FACTOR FOURTEEN: Work-In-Process Management

This factor is identified by only one infrastructure- programme which accounted for 2.1 per cent of the total variance. Since this programme deals with "work-in-process inventories", this factor is simply labelled "Work-In-Process Management".

From the above analysis, it was noticed that the infrastructure-programme "achieving larger production lots", (Infr. 6), did not load in any of the fourteen factors. Since this programme is related to inventory's costs, it was expected to be loaded with the inventory management factor, or at least in a separate factor. This means that this programme is not important to manufacturers in Saudi Arabia; this is probably due to obtaining financial loans and getting a piece of land with a nominal fee from the government.

8.3 FOCUSED SETS OF COMPETITIVE PRIORITIES

Competitive priorities are expressed by the eight dimensions which relate to cost, quality, flexibility and delivery (see Figure 2-3). In practice, it would be difficult in most cases for manufacturers to pursue each of the eight competitive priorities alone. For instance, "high performance design" and "consistent quality" are expected to be correlated tasks. However, the purpose of having them in this manner (i.e., the eight priorities) is for measurable reasons (see Chapter Two). Theoretically, Skinner (1978, 1985), Hayes and Wheelwright (1984), Hill (1985) and others predicted the existence of four competitive priorities; namely cost, quality, flexibility and delivery (content of manufacturing strategy).

Competitive priorities are achieved when components of each priority are in place. Thus, they are viewed as predictor (independent) variables in the analysis. Since they are viewed as predictor variables, a certain degree of multi-colinearity could be expected among the eight dimensions. Multi-colinearity is said to exist when two or more of the predictor variables are highly correlated with each other (Hair et al., 1987; Hedderson, 1987).

There are two courses of action available for treating multi-colinearity (Hedderson, 1987). The first is to integrate the highly correlated variables into a composite variable. The second course of action for treating multi-colinearity is to drop one of the two highly correlated variables. In this study, the first approach was used, simply because the second approach involves damaging the data by dropping one or two of the important variables.

Therefore, to get rid of multi-colinearity and to check the existence of theoretically derived competitive priorities, principal components of factor analysis were performed. Such a technique was utilised in this situation by several analysts such as Roth (1987), Huete and Roth (1987) and Roth et al. (1989).

As in the previous analysis, this analysis uses the same level of cut-off point, (i.e., $\pm.40$), for the factor loading (for interpretation of the principal components, see section 8.2.1).

The results of the principal components, when applied on the eight dimensions of the competitive priorities, are exhibited in Table 8-3. A detailed principal components factor loadings matrix is exhibited in Table 8.1.2 in Appendix E). Table 8-3 shows three extracted factors with an eigenvalue of one or more than one for each. Regarding the total percentages of variance explained, the three factors accounted for almost 60 percent. According to Hair, Anderson and Tatham (1987), this percentage is considered a satisfactory solution (see section 8.2.1). These factors are as follows:

FACTOR ONE: Quality-Delivery Priority

It is identified by the high significant loadings of four competitive priorities. These are "high performance design", "on-time-delivery", "fast delivery" and "consistent quality". Since these priorities are concerned with quality and delivery, this factor is interpreted and labelled "Quality-Delivery Priority". This factor represents two of the theoretically predicted priorities collectively (i.e., quality and delivery). Placing these two types of priorities in one focused set support the view of Krajewski and Ritzman (1987) of grouping the competitive priorities: they placed "high performance design" with "fast delivery time" under the label "quality level", whilst the remaining priorities of the quality and delivery were grouped and labelled "quality reliability. Krajewski and Ritzman failed to justify such grouping. An interpretation for having both types of quality and delivery in one focused set of priority will be made later on.

FACTOR TWO: Flexibility Priority

It is identified by the very significant loadings of the two competitive priorities: "product flexibility" and "volume flexibility". Since both of these competitive priorities include flexibility, this factor is interpreted and labelled "Flexibility Priority". This factor exactly confirms its counterpart in the theoretically predicted priorities.

FACTOR THREE: Low Price Priority

It is identified by the high loadings of one competitive priority. It is the low price priority. Therefore, this factor is interpreted and labelled "Low Price Priority", which exactly matches its counterpart in the theoretically predicted priorities.

From the above analysis, it was noticed that the "new products introduction" priority did not load in any factor. It was expected to be loaded with the Flexibility priority because new product is part of the product flexibility or at least with the new factor of priority, viz "quality-delivery priority". Thus, not being loaded in any factor means that manufacturers in Saudi Arabia do not view "new product introduction" as an important competitive priority for 1990 and 1991. "New products introduction" was rated the lowest priority in terms of importance on the basis of the mean (see section 6.7). Furthermore, this priority was not one of the important manufacturing tasks for the past two years (1987 and 1988). In fact, the manufacturing task "new product introduction" was rated the lowest out of fourteen tasks on the basis of the mean by both general and

Table 8-3 : Focused sets of competitive priorities (Total sample)

Competitive Priorities	Factor 1	Factor 2	Factor 3	Communality
1. High performance design	0.77			.61
2. On-time delivery	0.75			.58
3. Fast delivery	0.72			.63
4. Consistent quality	0.68			.63
5. Product flexibility		0.84		.72
6. Volume flexibility		0.71		.54
7. Low price			0.86	.74
Eigenvalue	2.47	1.15	1.11	
% of variance	30.9	14.4	13.9	
Cumulative percentage	30.9	45.3	59.2	

production managers (see Tables 6-2 and 6-3). It was found earlier that 27.4 per cent of the surveyed plants have not introduced any new products since they began operation. 14.5 per cent of the plants require over three years for that activity and the rest of the plants (58.1 per cent) requires an average time of three years or less to develop new products (see Table 5-6). In spite of the fact that most of the plants in the 58.1 per cent category mention that they rely heavily on their foreign partners in introducing new products, this finding (i.e., new products being unloaded in any factor) questions the face value of this percentage figure.

For consistency in research, as suggested by Hair et al.(1987), it was preferred to neglect both the infrastructure-programme and the competitive priority which did not load in any factor. Not being loaded in any factor means that they are not important to the manufacturers in Saudi Arabia at least in the prevailing time.

In summary, the above analysis created three focused sets of competitive priorities according to the perspective of the general managers who operate in the Saudi environment. These are:

- o Quality-Delivery Priority
- o Flexibility Priority
- o Low price Priority

Since this study detected three focused sets of competitive priorities, it is important to compare them with their counterparts (i.e., focused sets of competitive priorities) in Europe, North America and Japan to observe the components of each priority. In a survey conducted on these three regions in 1986, executives of 172 European firms, 188 American firms and 168 of Japanese firms were asked to rate the eight competitive priorities (Roth et al., 1989). Through principal components of factor analysis, focused sets of competitive priorities were derived in these three regions. When comparing them in terms of region including those of Saudi Arabia, one could notice the following (see Figure 8-3):

Firstly, the focused sets of competitive priorities for Europe and North America exactly confirm the four theoretically predicted priorities. Secondly, those for Japan do not exactly match the four theoretically predicted priorities. The analysis of the Japanese executives responses shows three focused sets of competitive priorities which are equivalent to the number of focused priorities detected by the analysis of the Saudi data. As the Figure shows, the analysis of the Japanese data places both types of delivery and flexibility in one factor labelled "Response Flexibility". On the other hand, the analysis of the Saudi data, as mentioned earlier, places both types of quality and delivery in one factor labelled "Quality-Delivery". Apart from this, the rest of the focused sets of priorities exactly confirm the theoretically predicted priorities. In another study, Roth (1987) found three focused sets of competitive priorities. These are product focus, delivery/flexibility, and price. Having both types of two priorities in one focused set as shown in the Saudi and the Japanese data as well as in Roth's study (1987), does not reflect major differences as long as all the components in that priority are similar. The difference in the content of the priority set is referred to the fact that strategy is dynamic [It is noticeable that "Product Flexibility" is also placed in the quality factor in addition to it being in the flexibility factor of the Japanese data. Such duplication is due to Roth et al.'s failure in understanding the interpretation procedure of the principal

Figure 8-3: Comparisons of the components of the focused sets of competitive priorities among Saudi Arabia, Europe/North America and Japan.

SAUDI ARABIA (1989)		EUROPE/NORTH AMERICA (1986)		JAPAN (1986)	
Factor Label	Defining priorities	Factor Label	Defining priorities	Factor Label	Defining Priorities
1. Quality -	- high performance design	1. Flexibility	- product flexibility	1. Response/	- speed
Delivery	- on-time delivery		- volume flexibility	Flexibility	- dependability
	- fast delivery				- volume
	- consistent quality	2. Quality	- conformance		flexibility
			- performance		- product
2. Flexibility	- product flexibility		- service		flexibility
	- volume flexibility				
		3. Delivery	- dependability	2. Quality	- conformance
3. Low price	- low price		- speed		- performance
					- product flexibility
		4. Cost	- price		
		efficiency		3. Cost	- price
				efficiency	

components. That is, only the highest factor loading of product flexibility should be chosen (see section 8.2.1.3)].

The next section discusses the development of manufacturing strategy for all the Saudi surveyed plants in the coming two years.

8.4 A MANUFACTURING STRATEGY FOR THE NEXT TWO YEARS

When manufacturers adopt a certain competitive priority, hence selecting a manufacturing strategy, they must devote their time, effort and resources to all programmes (policies) that support it. Therefore, the developed focused sets of competitive priorities along with the components of manufacturing strategy (see sections 8.3 and 8.2), play an important role in determining the manufacturing strategy for the Saudi surveyed plants in the next two years (1990 and 1991). The approach adopted here to determine the strategy is based on the definition of manufacturing strategy where "a series of consistent decisions" are represented by the components of manufacturing strategy, and "a statement of tasks" is represented by the focused sets of competitive priorities (Southern and Al-Shuaibi, 1990). Furthermore, it is based on a framework, suggested by Cool and Schendel (1987), which consists of two sets of elements to determine strategic groups. These two elements are "devoted resources" (programmes) and "the business scope" (competitive priorities). This framework was replicated by several researchers (Roth, 1987; Roth et al., 1989; De Meyer, 1990).

Since the strategic decisions are highly intercorrelated in practice, indices were constructed for the components of manufacturing strategy and for the focused sets of competitive priorities as well. As Roth says "it is not only necessary that each specific decision be congruent with the required capabilities (competitive priorities) but also that the entire pattern of decisions be consistent with each other" (Roth, 1987: 7).

8.4.1 Constructing Indices

Indices were computed by averaging the scores of all programmes within the factor in the case of the components of manufacturing strategy. For example, the score of the supplier chain management index was computed by adding the scores of the six programmes in that factor and dividing them by six (see Table 8-2 and Figure 8-2). The same process was replicated for each of the remainder of the fourteen components of manufacturing strategy (automation management, improving workforce skills management, etc.). Similarly, indices were computed by averaging the scores of competitive priorities within the factor in the case of the three focused sets of competitive priority. In the case where there is only one competitive priority in the factor (as in the "low price"), or one programme in the factor (as in the "turnover management"), the index was constructed for that priority or programme only.

Since the previous analysis developed fourteen components of manufacturing strategy on one side and three focused sets of competitive priorities on the other, indices were constructed for each component and each focused set in order to reflect the real-life situation. Thus, in order to develop a manufacturing strategy (content) for the Saudi surveyed plants for 1990 and 1991, canonical correlation analysis was used. It should be noticed that research in manufacturing strategy content is the first missing theme in this research area as reported by Adam and Swamidass (1989).

8.4.2 Canonical Correlation Analysis

The objective of the canonical correlation analysis (Cohen and Cohen, 1983; Thompson, 1984; Hair et al., 1987) is to study the interrelationships among sets of multiple criterion variables (i.e., components of manufacturing strategy) and sets of multiple predictor variables (i.e., focused sets of competitive priorities). It is a technique that has recently emerged as a result of its availability in computer packages, although canonical correlation analysis has been known in theory for approximately fifty years (Thompson, 1984). In particular, canonical correlation has been exercised in marketing researches (Alpert and Peterson, 1972). Canonical correlation is regarded as the general model of several multivariate techniques such as multiple regression which considers one criterion variable only and several predictor variables (Hair et al., 1987). This technique is utilised to a large extent as multiple correlation, because it displays the overall correlation among the sets of criterion and predictor variables (Green and Tull, 1978).

In this particular case, canonical correlation analysis is used to determine the manufacturing strategy for the Saudi surveyed plants, i.e., which focused set of competitive priority is highly correlated with sets of manufacturing strategy components. To detect the strategy, the following criteria were outlined:

- The number of canonical functions to be extracted.
- The number of canonical functions to be interpreted.

8.4.2.1 Criteria For The Number Of canonical Functions To Be Extracted

The maximum number of canonical functions to be derived out of the sets of variables is equivalent to the number of sets in the smallest side (Thompson, 1984; Hair et al., 1987). Since the smallest side has three sets (i.e., indices), the number of canonical functions that were extracted in this study are three. In describing these functions, Hair et al. say that each function consists of a two of variates. One stands for the criterion variables and the other represents the predictor variables. Accordingly, six variates were extracted, three for the components of manufacturing strategy and the rest of the variates for the focused sets of competitive priorities. Unlike the principal components of factor analysis where the first factor accounts for the maximum variance, the first pair of canonical variates acquire the highest intercorrelation between the two variates, then the successive pairs of variates display lower relationships (Hair et al., 1987).

8.4.2.2 Criteria For The Number Of Canonical Functions To Be Interpreted

There are three criteria to be considered in interpreting the canonical functions. These are level of significance, size of correlation and the squared canonical correlation coefficient (Alpert and Peterson, 1972; Hair et al., 1987).

As with other statistical techniques, in this analysis the most important indicator for accepting a canonical function is the significance level. If the significance level is outside the allowed level, the analysis will be discounted. According to the criterion of significant level that was established in Chapter Four, only the first function out of the three functions was found to be statistically significant as can be seen from Table 8-4. The other two functions which are not significant are exhibited in Appendix E, Table 8.1.3, and will not be interpreted because it is meaningless to do so as suggested by statisticians (Daniel and Terrell, 1983; Hair et al., 1987).

The size of the canonical correlation plays a role in deciding which functions are to be interpreted (i.e., if significance exists). However, "no generally accepted guidelines have been established regarding acceptable sizes for canonical correlations" (Hair et al., 1987: 194). Accordingly, Hair et al. (1987) suggest the use of the guidelines of the factor loadings'significant level (see section 8.2.1.2). Since only one function was found to be significant, the canonical correlation for that function was found to be highly satisfactory according to the guidelines of factor loadings (see Table 8-4).

The squared canonical correlation coefficient exhibits the shared variance between the pair of variates (sets of criterion and predictor variables). Again, as with the size of the canonical correlation, no guidelines have been established for the acceptable level of shared variance between the pair of variates. In dealing with this, Hair et al.(1987) suggest that it should be left to the judgment of the researcher to decide whether to interpret that function or not. In this analysis, the shared variance between the pair of variates in the significant function is 32 per cent (squaring canonical correlation, Table 8-4). This means that 32 per cent of the variance in the sets of the criterion variables are explained by the sets of the predictor variables. This low percentage could be attributed to the variability in the study (fifty infrastructure-programmes were classified into fourteen indices). However, it is considered slightly high when compared with other percentages in a similar study (see Roth, 1987).

Since the decision was made to accept one canonical function according to the previous three criteria, the next task is to decide how to interpret it, or how to evaluate the canonical relationships. Evaluation is based on the type of canonical correlation coefficient and on its significant loading.

From the SPSSX printout, two types of canonical correlation coefficients were produced: standardised and structure canonical coefficients. Of these two, structure canonical coefficient is highly recommended (Thompson, 1984; Hair et al., 1987). If the variables within each set of the criterion or the predictor are somewhat intercorrelated, the likelihood of interpreting the canonical function through the standardised canonical coefficients is virtually nil (Thompson, 1984). Thompson adds that the appeal in employing structure coefficients is due to its "intuitive linkages" with factor loadings of the principal components of factor analysis. For the above reasons, this study uses structure canonical coefficients in interpreting the pair of variates for the significant function.

The coefficients of canonical structure, referred to as canonical loadings, are interpreted in the same manner as in the factor loading (Hair et al., 1987). Accordingly, each canonical loading of each manufacturing strategy component represents its association with the variate. Similarly, each canonical loading of each focused set of competitive priority reflects its bivariate correlation with the variate. Since the level of significance of the canonical loading is the essence in evaluating the canonical relationships, the cut-off point for the canonical loadings remains $\pm.40$, as in both the components of manufacturing strategy and the focused sets of competitive priorities, to ensure consistency in the analysis (see section 8.2.1.2).

8.4.3 Low Price Strategy

A close examination of the canonical loadings in the competitive priorities indices suggests that only one competitive priority index qualified to be related to components of manufacturing strategy. Table 8-4 shows that this index is the low price priority (loadings less than .40 for both competitive priorities and components of manufacturing strategy indices are shown in Table 8.3.1, Appendix E). There is a very high correlation between low price priority and the variate of the competitive priorities indices. This means that 90.3 per cent of the variance in the low price priority is explained by the competitive priorities variate.

Similarly, the criterion of loadings promoted two indices of the components of manufacturing strategy to associate the low price priority. These two indices are "suppliers chain management" and "inventory management". Both show high correlation with the variate of manufacturing strategy indices. This means that 51 per cent (squaring and adding .52 & .49) of the variances in these two indices is explained by the components of manufacturing strategy variate.

The above results indicate that the expected manufacturing strategy for the Saudi surveyed plants for the next two years (1990 and 1991) is a low price priority. This study finds that such a strategy could be achieved through programmes related to suppliers and inventory management in particular (see the contents of these two programmes in Figure 8-2).In other words, the only possible advantage for the Saudi

Table 8-4: Relationships between focused sets of competitive priorities and components of manufacturing strategy (Total sample)

	Canonical Functions		
Canonical correlation between pair of variates	**1***	**2****	**3****
	0.57		
	Canonical loadings		
Predictor variables (Competitive priorities indices)			
Quality-Delivery			
Flexibility			
Low Price	0.95		
Criterion variables (Manufacturing strategy indices)			
Suppliers Management	0.52		
Automation Management			
Improving Workforce Skills Management			
Product Control Management			
High Volume Products			
Quality Management			
Inventory Management	0.49		
Increasing Productivity Management			
Information System Management			
Purchasing Control Management			
Human Resources Management			
Turnover Management			
Co-ordination Management			
Work-in-process Management			

* Statistically significant at P (.025)
** Not statistically significant

plants to win a manufacturing price strategy is through practicing policies on suppliers and inventory management. The literature supports these two factors as instruments to measure cost (Fine and Hax, 1985; Leong et al., 1990). It was found earlier that both general and production managers have set up low price as their first priority for improvement (see section 6.5).

Several policies could be followed in each aspect of these two major programmes. In supplier management, for example, manufacturers could develop one major policy that could probably lead them to compete on price by achieving independence from suppliers (i.e., backward integration). They could also develop various policies which require diversified suppliers with high quality and timely reliable in addition to quantity discounts as an incentive to maintain their relationships. Both factors are either a direct element of the characteristics of the environmental uncertainty (i.e., supplier chain management) or an indirect element of those characteristics (i.e. inventory management).

Because these two factors are related to environmental uncertainty, they are not under the control of the manufacturers in Saudi Arabia. Therefore, it could be difficult for them to achieve a price strategy, unless it is through backward integration. Backward integration indeed could be a comparative advantage for some plants in the chemical industry due to the existence of SABIC Companies (see Chapter 3).

It was expected that some other factors would be found, such as employing automation, improving workforce skill and increasing productivity management, to win a price strategy (Krajewski and Ritzman, 1987; Schmenner, 1987). But it seems obvious that all manufacturers in Saudi Arabia believe that the suppliers-related problems are their major obstacle in reducing cost (this point will be confirmed in SWOT analysis in the next Chapter). The combination of possessing the latest state funded production equipment (see Chapter Six) and employing low cost non-Saudi labour has led manufacturers to concentrate on suppliers-related problems only. This study found that wages for all the participating plants constitute 16.3 per cent of the average of the total unit cost, while materials consume almost 60 per cent on average. Hence the concentration on supplier and materials management.

However, generally one could argue that labour productivity is important in cost reduction. In this regard, one should point out that labour productivity is considered an internal factor, whereas suppliers are regarded as an external factor to the plant. Thus, most plants, if not all, give a great deal of attention to the external factors first and then gradually place emphasis on internal factors to assume control of affecting factors. In other words, internal factors receive more attention when efforts on external factors are exhausted. This, in a way, reflects the degree of industrialisation; that is, plants in the U.K. or U.S.A., for example, are more concerned with internal factors because they have devoted a great amount of effort to external factors.

By comparison, Roth (1987) found that a price strategy could be achieved under programmes such as human resources (e.g., worker planning, broader jobs and motivation), consolidation (e.g. closing plants, reducing manufacturing units and relocation) and under no expansion of capacity. One can notice in the preceding programmes the absence of "vendor relations factor" which is somewhat similar to the "suppliers factor" in this study. This could reflect the degree of industrialisation as mentioned earlier.

In addition to the price strategy, Roth found several programmes (some overlapped) under a product focus strategy, and a delivery/flexibility strategy. This study; however, failed to predict more than a price strategy.

When considering the Sandcone model (Ferdows and De Meyer, 1989) and the Japanese cumulative model (see Chapter 2), why has this study failed to show specifically through canonical correlation analysis quality and delivery strategies in addition to a price strategy since manufacturers had already won the first two strategies ? (see Chapters Six and Nine). One may argue that the scarcity of empirical studies of the developed countries (only one study) on the one hand and the non-existence of empirical studies of the developing countries on the other, make interpretation difficult as far as this study is concerned. There are three possible interpretations for the result of this study.

1. It could be interpreted according to the trade-offs notion (i.e., achieving one competitive priority means trading off the other priorities). That is, in this study, the achieved quality and delivery were traded off with the hope of achieving a price strategy. This seems to be incorrect, because it was found that both types of quality and delivery are the most important priorities for 1987 and 1988 as well as for 1990 and 1991, on the basis of means (see section 6.2 and 6.7).

2. It could be a different model for competitive priorities in the Saudi industrial environment. Although this may come true in the future, at the present time, one can say that the Saudi industrial environment is highly influenced by the western system (e.g., foreign expertise, production systems) Without the full support of the national infrastructure. Accordingly, the Japanese cumulative model or the Sandcone model is more likely to be the model for the competitive priorities in the Saudi environment.

3. It could be that general and production managers'struggles with suppliers-related problems greatly influence their thinking in a way that they neglect to emphasise quality and delivery in addition to price when responding to these questions. In fact, it was found that the top two programmes which received the most attention for the next two years, on the basis of the mean values, are cost-reduction related. Furthermore, quality was not even one of the top five programmes receiving the most

attention for the next two years (see Chapter Six). Out of the three possible interpretations, the researcher believes that this one is the most appropriate.

If canonical correlation were able to detect quality and delivery strategies in addition to the price strategy, this would have been a good support for the Japanese cumulative model over the Sandcone model.

SUMMARY

The main purpose of the analysis in this chapter was to detect the manufacturing strategy for all the Saudi surveyed plants in the next two years (1990 and 1991). In so doing, components of manufacturing strategy as well as focused sets of competitive priorities were extracted by the principal components of factor analysis.

Out of fifty one infrastructure-programmes, fourteen components of manufacturing strategy have been extracted. These are suppliers chain management, automation management, improving workforce skills management, product control management, high volume products management, quality management, inventory management, increasing productivity management, information system management, purchasing control management, human resources management, turnover management, co-ordination management and finally work-in-process management. The infrastructure-programmes within each factor were highly related to each other in almost all the fourteen factors.

Out of the eight competitive priorities, three focused sets have been extracted. These are quality-delivery priority, flexibility priority and low price priority. These focused sets confirm the theoretically predicted priorities.

Through canonical correlation analysis, a manufacturing strategy was detected using the fourteen components of manufacturing strategy and the three focused sets of competitive priorities. It was found a low price strategy. The manufacturers in Saudi Arabia could achieve a price strategy in 1990 and 1991 via suppliers chain management and inventory management. Specifically, manufacturers in Saudi Arabia consider the suppliers-related problems as their major impediment in winning a price strategy as will be seen in SWOT analysis in the next Chapter.

CHAPTER NINE

SWOT ANALYSIS

INTRODUCTION

This research suggests the implementation of SWOT analysis in studying manufacturing strategy. Since strategy in general and manufacturing strategy in particular are constructed on a competitive advantage basis (i.e., strength), employing a SWOT analysis should be useful in the detailed investigation of the manufacturing situation.

SWOT analysis, also known as "TOWS Matrix" (Weihrich, 1982), stands for strengths, weaknesses, opportunities and threats (David, 1986; Macbeth, 1989). By using this technique in manufacturing strategy, strengths and weaknesses will be defined within the firm (internal environment) as well as opportunities and threats will be highlighted in the industry sector (external environment). Avoiding a problem or a threat in an industry could be an advantage especially when other competitors failed to recognise it. Such an approach will enable a company to adopt a proactive rather than reactive stance.

It is worth noting that the adopted definition of manufacturing strategy in this study was based on SWOT analysis (see section 2.1). Thus, the broader meaning of manufacturing strategy is adopted in this Chapter.

The purpose of this Chapter is to find out in detail, using SWOT analysis, the manufacturing strengths, weaknesses, opportunities and threats (problems) in Saudi industries. This technique will confirm and enrich the previous findings. All the data in this Chapter were provided by the general managers.

9.1 MANUFACTURING STRENGTHS

Table 9-1 presents the manufacturing strengths for all the surveyed plants. Strong unanimity on the top four items of manufacturing strengths among general managers of each of the four industries (i.e., food, paper, chemical and metal) is noticed. The Table shows that general managers postulated "top quality" to be their first manufacturing strength. This confirms earlier findings where consistent quality and high performance design were rated the highest manufacturing goals by both general and production managers (see section 6.2). Moreover, both managers indicated that quality as a manufacturing area needs the least improvement which means that they are pleased with the level of quality (see section 6.5). GMs, also, rated quality as one of the most important factor of all competitive priorities (see section 6.7). The percentage of rework products, customer rectification and scrap is on average 2.33, 2.26, 3.73 respectively for the total sample. In addition, the actual defective or rejected rate in production is lower than what general managers expected; 2.04 % and 2.60 % respectively. These percentages are not considered high when considering the little experience of the Saudi nation in the World of industrialisation. The second manufacturing strength in the Saudi plants, as pointed out by general managers, is "high technology and new equipment". This, also, confirms previous findings (see sections 6.3 and 6.8.1). In this regard, the Saudi Industrial Development Fund plays a vital role as a loan provider (see section 3.8.5.3). General managers mentioned that they spent, on average, 13.2 per cent of the plant's income on buying new equipment. It is worth mentioning that access to modern technology is a major manufacturing objective (see section 3.8.1.1., no. 3). The Table also shows that "skilled workforce" is a strength for Saudi plants. However, Saudi Arabia is highly dependent on foreign manpower (see sections 3.6 and 5.1.3.1a). The fourth item of the manufacturing strengths that the majority of the plants enjoy is "on-time delivery". This supports previous findings where "on-time delivery" was rated next to quality in importance.

"Low price","high capacity" and "national and international standard" are currently manufacturing strengths for only a small number of plants (see Table 9-1). Using canonical correlation it was demonstrated in Chapter 8 that low price is expected to be the manufacturing strategy of Saudi plants during the next two years (see section 8.4.3). Therefore, low price is envisaged to be a manufacturing strength for the majority of the plants during 1990 and 1991 (Capacity and standardisation will be discussed in section 9.3).

When this open-ended question (i.e., manufacturing strengths) was rephrased, the same answers were provided. General managers were

Table 9-1: Distribution of manufacturing strengths by industrial sector

Factors	F	P	C	M	Total
1. Top quality	21*	7*	25*	34*	87*
2. Technology/equipment	18	6	15	23	62
3. Skilled workforce	14	7	15	20	56
4. On-time delivery	11	5	14	17	47
5. Low price	5	2	7	8	22
6. High capacity	3	-	3	6	12
7. National and international standards	4	-	2	3	9
Missing cases	4	2	2	3	11

F : Food industry P : Paper industry

C : Chemical industry M : Metal industry

* : number of times the item was mentioned

asked: "What elements of your manufacturing and technology are vital to your plant's competitiveness?" In response to this question, General managers emphasised quality and technology as tools for competitive advantage.

9.2 MANUFACTURING WEAKNESSES

Table 9-2 exhibits the perceived manufacturing weaknesses for all the Saudi surveyed plants. Due to sensitivity only a small number of general managers were willing to mention their plants' weaknesses. Foremost weaknesses in Saudi plants are "unstable foreign labour" and "foreign expertise changing continuously". Other weaknesses seem to be as expected, except for "communications" which is related to the existence of different foreign nationalities (i.e., language barriers).

The first and the biggest weakness which general managers confront in Saudi Arabia is "unstable foreign labour". It was found earlier that Saudi Arabia is highly dependent on foreign labour. The non-Saudi workforce, within the surveyed sample, constituted 91 per cent (see section 5.1.3.1a). Furthermore, the foreign manpower formed almost 60 per cent of the total employment in Saudi Arabia in 1985 and it was projected to be nearly 50 per cent in 1990 (see Chapter 3). Generally, the attraction of the foreign labour to the Saudi private sector is attributed to several factors. Foremost among them are :

1. Low wages
2. Availability in all areas of specialisation with the required period of experience
3. Unstable Saudi manpower due to their interest in looking for higher wages as well as better jobs
4. Flexibility in transformation to work in any area in Saudi Arabia (Riyadh Chamber of Commerce and Industry, 1989).

As far as the manufacturing function is concerned this high reliance on foreign labour causes instability in employment. During the research field work, a large number of general managers pointed out that by the time they finish training the worker and he becomes familiar with the work, his contract, which normally carries a two year duration, expires. Most likely the high turnover in foreign workforce is ascribed to the difficulty in adopting to the Saudi environment as a closed society with certain values. Moreover, failure in providing recreation facilities to employees has compounded this difficulty. It should be stressed, as pointed out by GMs, that the high turnover in labour is largely restricted to blue collar and non arab nationalities (e.g., South East Asia).

The fact that "foreign expertise changes continuously" (e.g., GMs & PMs), impinges on plant's performance. In a case where the plant's financial performance is not satisfactory, the owner or the management company (i.e., some plants under the supervision of specialised management firms) changes the manager. Such a case was observed by the researcher when he handed out the questionnaire to some general managers but at the time of collection other managers or acting managers had been appointed. To decrease the rate of changing foreign expertise, full information concerning the Saudi business and social environment must be provided to intended managers. Furthermore, the criteria for selecting new managers must be examined carefully especially by the owners who make the choice.

"Low productivity of labour" as a manufacturing weakness in some of the Saudi plants could be mainly attributed to low wages. Some general managers mentioned indirectly that they try to offer the lowest wages to employees. This attitude explains why foreign labour is attracted to the private sector as mentioned earlier. As a result, only low skilled employees will be attracted to the general manager's offer. Using low wages to reduce costs is a traditional strategy (Stalk, 1988). This study found that the cost of labour is on average 16.3 per cent of the produced unit. To improve labour productivity, managers as well as plants' owners should not be influenced by low wages strategy because a small increase in wages is easily compensated by slight improvement in performance. Furthermore, some systems should be implemented to improve labour productivity.

Another weak manufacturing factor is "planning difficulties". General managers referred these difficulties to customer rush orders and fluctuations of demand. As for "rush orders", it was pointed earlier that both types of managers (GMs & PMs) want to provide "faster delivery" to ease the pressure received from their customers, as some general managers put it, "customers place their orders today and want them to be delivered yesterday" (see section 6.5). Thus, improving "fast delivery" will ease the difficulties in planning regarding "rush orders". The "fluctuations of demand" as a cause of inaccuracy in planning was confirmed in the findings of this study. The study found that the difference between actual and forecasted time of demand on a five point scale is 2.53 (1 means no difference and 2 indicates little difference). Moreover, it was found that the difference between actual and forecasted demand on product quantity,

Table 9-2: Distribution of manufacturing weaknesses by industrial sector

Factors	F	P	C	M	Total
1. Unstable foreign labour	6*	2*	9*	12*	29
2. Low productivity of labour	3	2	6	10	21
3. Planning difficulties	3	1	7	8	19
4. High production costs	2	-	6	9	17
5. Long time design for new products	2	-	5	7	14
6. foreign expertise changing continuously	2	-	5	6	13
7. Small plant's area	2	1	3	4	10
8. Experience	2	-	3	3	8
9. Communications	1	-	3	4	8
10. Inappropriate location	1	1	1	-	3
11. Do not exist	3	-	4	6	13
Missing cases	9	2	6	8	25

F : Food industry P : Paper industry

C : Chemical industry M : Metal industry

* : number of times the item was mentioned

on the same scale, represents 2.42. It can be said that a better study of the Saudi market as well as more improvement on fast delivery reduce planning difficulties.

The fourth manufacturing weakness that the Saudi manufacturing industries face is "high production costs". Since production costs mainly consist of the cost of raw materials, labour and overhead (energy), the highest of the three in terms of cost is raw materials as will be seen later. This is because Saudi plants rely heavily on foreign labour with low wages and the country is rich in energy (i.e., oil). It is surprising that not many general managers have mentioned this manufacturing weakness, although it does exist on a large scale. It was reported earlier that both managers rated low price (as a function of cost) to be the manufacturing area that needs the highest improvement (see section 6.5). Furthermore, uncompetitive price was ranked the third obstacle which Saudi exporting plants encounter (see section 5.7).

The next manufacturing weakness to high production costs is "Long time in design for new products" (Table 9-2). This weakness was found on a large scale in more than one area of the analysis. Manufacturers in Saudi Arabia not only take a long time to produce new products, but also neglect new products as a potential competitive priority. It was found earlier that 32.5 per cent, of the total sample, spent a period of over 6 months to 3 years to develop new products, and 14.5 per cent required over 3 years for the same activity (see Table 5.6). Moreover, the study found that "introducing new product" was one of the three lowest tasks that received little emphasis by both general managers and production managers; the other two were "R&D effort" and "introducing new production processes" (see section 6.2). Similarly, "new products introduction" was rated the least important factor out of eight priorities for the next two years (1990 and 1991) (see section 6.7). This supports the finding that 27.4 per cent of the total surveyed sample indicated that they did not introduce any new products from the time of operation (see Table 5.6). It should be noted that the "long time in designing new products" is ascribed to the small effort in "research and development". Nearly three-quarters of the surveyed general managers mentioned that they spent, on average, only 3.87 per cent of the plant's income on research and development. Such a percentage, if not spent on a regular and short term basis, is considered very small. Saudi plants should give more attention to R&D which would result in a strengthening of new products development. Expertise as well as substantial funds should be allocated to support intensive research.

The remaining perceived weaknesses, small plant's area, inappropriate location, and experience, are of little consequence. Such weaknesses with the exception of experience are the result of inaccurate planning on the part of both the Ministry of Industry and Electricity and the owners of plants. As for small plant's area, the second stage of plant development should be taken into consideration when approving the first stage. Regarding inappropriate locations, the Ministry should not provide certain types of plants a site in the industrial city (e.g., salt plants should be accommodated near the sea). Concerning "short experience", it is a fact that Saudi plants are of recent origin (mean in years of operation is 11.6; see Table 5.5). However, manufacturers in the Kingdom should be able to compete on the basis of other qualifications (e.g., technology).

9.3 MANUFACTURING PROBLEMS AND SOLUTIONS

Table 9-3 displays the manufacturing problems or threats for the participating plants. These problems will be first discussed briefly, then suggested solutions will be presented (see Figures 9-1 and 9-2).

The first and the biggest problem these plants encounter is "importing raw materials". This is supported in more than one area of the analysis. This study found that, on average for the total sample, 63 per cent of raw materials are imported. Moreover, the cost of materials constituted almost 60 per cent of the total cost unit. Although, the share of materials of the total cost unit is usually the highest (De Meyer, 1986), it is further increased in the case of imported raw materials. Figure 9-1 shows problems associated with importing raw materials. The problem that is highly stressed by GMs is "continuous increase in raw materials prices year after year", due to inflation. This increase rises production costs which in turn result in high selling prices. Some general managers also mentioned that they were manipulated by distributors of raw materials.

Solutions were suggested by some general managers to problems associated with importing raw materials (see Figure 9-2). Some GMs suggested a unified purchasing policy for raw materials so as to impose pressures on suppliers as well as distributors. This can be implemented by establishing a management firm to import raw materials for all plants (or for each industry) at fixed times with fewer orders. The main advantages of such a policy are:

1. Assurance of fixed prices.
2. Attractive quantity discounts due to large purchase.
3. Standardizing materials.
4. Less effort and time expenditure on the part of the manufacturers.

Along these lines, some general managers have also proposed the idea of buying materials through the government (e.g., SABIC). Other suggestions to overcome the raw materials' problems call for serious efforts to find national resources with the participation of the current plants under government supervision; and duty tax exemptions to help reduce high costs. Some general managers suggested that the exemption from customs duties should not only be restricted to primary raw materials, it should also include all other types of materials (see section 3.8.1.2., no. 5b).

It is important to note that good supply chains are a very significant factor for Saudi plants to win a price manufacturing strategy in the next two years (1990 and 1991) (see section 8.4.3). Indeed, getting discounts from suppliers on large quantity purchase (i.e., through a specialised firm) could help Saudi plants enjoy a price strategy. Due to their importance, suppliers have been called "the life blood" of manufacturers (Macbeth, 1989).

The second major problem which participating Saudi plants face is "underutilisation of capacity". Again, this supports previous findings. This study found that the average utilisation of the actual total capacity for the total sample in terms of equipment, labour and resources is 71.3 per cent (see section 5.1.1.2). Figure 9-1 presents four main causes of underutilisation of capacity reported by the respondents:

1. Industry wide over capacity in terms of number of plants, resulting in reducing market share and making the industry very competitive. This indicates that either the principle of licensing industrial projects is not effective, or the Ministry of Industry and Electricity has overestimated market demand (see section 3.8.1.2, no. 6).
2. Products which are manufactured locally are also imported, this leads to war-price competition. This could indicate that the "protective custom tariffs" on competing imports are not effective enough (see section 3.8.1.2, no. 5e). It should be noted that the trend is to reduce protectionism world wide.
3. Declining in governmental projects, due to completion of the Kingdom's infrastructure, causes underutilisation of capacity for the majority of the Saudi plants.
4. Existence of small markets owing to the small size of the population (see section 3.3).

The underutilisation of capacity was also found to be the major problem for Saudi plants in the survey conducted by The Consulting Center for Finance and Investment (1988). It is worth noting that large scale capacity was mentioned as a manufacturing strength for a few plants (see Table 9-1).

All suggested solutions to the underutilisation of capacity require the intensive participation of the Saudi government (see Figure 9-2). The most important suggestion calls for **the introduction of the Saudi manufactured products as a part of the Kingdom's foreign aid programme (subsidy)**. It has been suggested by general managers that half of the subsidy or at least 30 per cent should be in Saudi products rather than all of it in cash. For, as GMs pointed out, all aid receivers are third world countries needing all types of products manufactured in Saudi Arabia. This suggestion, if implemented, will decrease fluctuations in demand. The second solution proposed requires an actual application of the Royal decree to the purchase of local producers for governmental projects (Saudi Consulting House, 1986). Some GMs mentioned that there is no strong control from the government in this area. As one general manager put it "foreign companies have their own ways to escape from it". If this is the case, there is an ineffective application of both the Royal decree and the guideline of the industrial policy (see section 3.8.1.2, no. 5d). The third solution calls for the government to sign agreements with foreign countries so Saudi firms can gain access to their markets with reasonable duties. This could be hard to accept unless such countries express real interest in dual agreements. Other solutions want the government through the Ministry of Industry and Electricity to stop or reduce issuing licenses for the saturated industries and provide financial help for exporting purposes.

The third problem that the manufacturers in Saudi Arabia face, as seen from Table 9-3, is "high dependence on foreign labour". As mentioned earlier in different aspects of this study, there exists a clear shortage of national manpower in the Kingdom (see section 9.2).

Figure 9-1 shows that the use of foreign workforce makes it difficult for GMs to discharge unnecessary number of foreign employees during low demand periods because of the long process involved in getting visas when demand increases again.

Solutions suggested for "high reliance on foreign labour" centred around decreasing the associated problems with foreign employment (see Figure 9-2). As unstable foreign labour is a major manufacturing weakness for Saudi plants (see section 9.2), **general managers suggested a central firm(s) to be in charge of supplying employees.** That is, establishing a firm to provide a central labour pool for all plants (or for each industry) as well as to make some employees available for short term employment, corresponding to management firms. The foremost advantages of such a firm include:

1. Employees will be selected to work in Saudi Arabia on the basis of certain criteria (e.g., national traits related to ease of adjustment).
2. Employees will be provided for seasonal production periods.
3. Employees will be well trained.
4. Employees will be able to socialise by getting to know large numbers of people in the labour pool (e.g., recreational

facilities).

However, the difficulties associated with the establishment of such a firm involve big losses for the firm if employees are not hired especially during seasonal period; and difficulties in managing a large number of employees with variety of skills. Another solution for the problem of "high dependence on foreign labour" is to make serious efforts to train Saudis, and make greater use of government grants for training Saudis (see section 3.8.1.2, no. 5g). Moreover, general managers as well as owners of plants should offer more incentives to Saudi employees to attract them to stay in the job (see section 9.2).

The fourth problem which the Saudi manufacturing industries encounter is "unfair competition" (i.e., dumping). Figure 9-1 indicates that one source of "unfair competition" is the import of inferior products. This indicates ineffective control made by the government to prevent harmful foreign competition (see section 3.8.1.2, no. 3). Another source of "unfair competition" is the provision of low quality products by unlicensed national plants. These low quality products, GMs pointed out, are offered at low prices. It should be noted here that the same finding was reported by The Consulting Center for Finance and Investment (1988).

Suggested solutions for "unfair competition", as pointed out by GMs, call for the government through, the Ministry of Industry and Electricity, to prevent or reduce access for inferior products to the

Table 9-3: Distribution of manufacturing problems by industrial sector

Factors	F	P	C	M	Total
1. Importing raw materials	12*	10*	14*	25*	61
2. Underutilisation of capacity	9	4	21	17	51
3. High dependence on foreign workforce	10	3	14	20	47
4. Unfair competition	4	-	18	17	39
5. Very competitive industry	7	2	15	15	39
6. Difficulties in exporting	5	2	14	11	32
7. Standardisation	-	-	9	12	21
8. Unavailability of quick supply of spare parts & maintenance	6	1	8	4	19
9. Marketing problems	3	1	5	7	16
10. Lack of local expertise	2	1	4	6	13
Missing cases	5	1	4	4	14

F : Food industry　　P : Paper industry

C : Chemical industry　　M : Metal industry

* : number of times the item was mentioned

Details of the above factors are displayed in Figure 9-1

Figure 9-1: Details of problems

Raw materials: imported; remote resources; continuous increase in prices, high prices set by distributors, exchange rates; duties; not standard; and delay in delivery.

Underutilisation of capacity: over capacity industries; import the same manufactured products; decline in government's projects; and small markets.

Foreign workforce: heavily dependent on foreign labour; difficulty in discharging unnecessary number of workforce during low demand periods because of the long process involved in getting visas when demand increases again.

Unfair competition: import inferior products; and low quality products from unlicensed small national plants.

Difficulties in exporting: Lack of information; and lack of finances.

Standardisation: Lack of standardisation for some products.

Figure 9-2: Problems and solutions

Imported raw materials: a unified purchasing policy; buying through the government; effort to find national substitutions; and free duties.

Underutilisation of capacity: introduce the products as a part of the Kingdom's foreign aid programme; apply the Royal decree as regards purchasing in the framework of governmental projects; sign agreements with foreign countries to be allowed access to their markets with reasonable duties; stop or reduce the issuing of licenses; and exporting.

High dependence on foreign workforce: establish a firm to be in charge of providing as well as lending employees to plants; and train Saudis.

Unfair competition: prevent inferior quality products; and meet the Saudi standards.

Very competitive industry: classify plants according to quality and capacity; call for plants to co-operate; stop issuing industrial licenses; increase duties on imported products; decrease importing; unify duties in the Gulf countries; and incorporate weak plants.

Difficulties in exporting: establish governmental offices to provide information; and establish an export bank.

Lack of standardisation: more effort is needed from SASO; and adopt international standards.

Unavailability and long lead times for spare parts and maintenance: review the current policy; and establish maintenance companies in Saudi Arabia.

Marketing problems: merge plants; and increase consumers' awareness.

Lack of local expertise: establish a strong link between plants and universities as well as other institutions.

Saudi markets; and the strict imposition of Saudi standards on foreign products. In other words, general managers are looking for more protection from the government.

The most significant problem, yet not ranked high in the list (see Table 9-3), is the claim that the Saudi environment is "very competitive". Almost every manager (GM & PM) mentioned this fact during the field work, and attributed this toughness to the fact that the Saudi industries are accessible to all foreign legal products (i.e., according to the Islamic law). This is because the Saudi government believes, as pointed out in the industrial policy, in strong competition as being in the best interests of consumers (see section 3.8.1.2., no. 3). This supports earlier findings that the surveyed industries experienced little to moderate foreign competition within the Saudi market. Furthermore, Saudi competition against these industries ranged between moderate and high (see section 5.6 and Figure 5-5). The combination of these two types of competition (foreign and Saudi) really makes Saudi markets tough to compete in.

To reduce the high level of competition in the Saudi industries, general managers offered several suggestions (see Figure 9-2). These are:

1. Classification of plants according to quality and capacity to ensure fair competition.
2. Calling for plants to co-operate and co-ordinate between

themselves as it is the case in the developed countries (e.g., dividing regions with regard to service).

3. Stopping the issue of industrial licenses.
4. Increasing duties on imported products.
5. Decreasing imports.
6. Unifying duties within the Gulf countries (economic co-operation among Gulf countries was encouraged in the Fourth Development Plan (see section 3.5)).
7. Urging weak plants to combine to form strong plants in order to overcome problems.

The sixth of the ten specified problems which Saudi industries face is "difficulties in exporting". As seen from Figure 9-1, these difficulties are caused by a lack of information on available exporting outlets as well as by a lack of finance. It is worth indicating that the present study found "Lack of information" and "Lack of finance" to constitute the second and the sixth obstacles respectively for exporting plants (see section 5.7).

To overwhelm difficulties associated with exporting, general managers suggested: the establishment of governmental offices to provide information concerning exporting outlets, besides plants own efforts in this area; and the establishment of an export bank to finance plants. It is worth noting that the establishment of an export bank is in its final stage (discussion with the Deputy Minister of the Ministry of Industry and Electricity during the field work). The establishment of this bank, the Deputy Minister pointed out, is according to the industrial policy guidelines (see section 3.8.1.2, no. 5h).

The next problem that some Saudi industries are confronting is "standardisation" (Table 9-3). This problem exists only in the chemical and metal industries, and is probably because in the food industry the type of process is highly standardised, and in the paper industries it is highly customised. As shown in Figure 9-1, the problem stems from a lack of standardisation of some products. General managers revealed that a lack of industry standards leads to the definition of customer specific standards resulting in complex tasks. "Standardisation" is seen as a manufacturing strength for a small number of plants (see Table 9-1).

Concerning "standardisation", GMs suggested that the Saudi Arabian Standards Organisation (SASO) should put more effort into the provision of standards for all the products or, at least, the majority of them. When the provision of sufficient standards is difficult for SASO, GMs pointed out, it should adopt international standards.

Unavailability and long lead times for spare parts and maintenance are other problems faced by the Saudi industries. It was found earlier that "the suppliers of product parts" and "the suppliers of equipment" are two of the three least important considerations in strategic decision making (see section 6.3). As mentioned in Chapter Six, this is due to request made by the Ministry of Industry and

Electricity that plants should determine once at the beginning of each year their needs of these two items, so they can be exempt of duties. Accordingly, spare parts as well as equipment are not requested at the time of need causing problems for manufacturers. Maintenance is a highly problematic area in developing countries GMs attributed this to the lack of Saudis experts and to unavailability of large numbers of foreigners in this area. It is important to note that this study found that the average number of monthly hours lost per machine due to breakdowns is between 4 and 8 hours. Moreover, the average number of monthly hours spent on preventive maintenance per machine is between 6 and 10 hours. The small number of hours concerning breakdowns is ascribed to the fact that Saudi industries are well equipped with modern technology and new equipment.

General managers suggested reviewing the current policy with regard to spare parts and equipment. That is, allow manufacturers to buy spare parts and equipment when needed or at least more than once a year. As for the problem of "maintenance", general managers recommended a large scale establishment of maintenance companies in the kingdom.

Marketing problems are also among the problems that the Saudi plants face. Some general managers declared that lack of professionalism, limited resources and lack of consumer awareness are factors attributed to their marketing problems.

To overcome their marketing problems, general managers suggested merging plants so as to create professionalism in business, increase resources substantially, develop marketing programmes, and awaken consumers' awareness concerning "buying national products" with high quality.

Finally, what Saudi industries are faced with is a lack of local expertise. In this context, GMs pointed out that due to the fact that all Saudi plants are new in the world of industrialisation, this makes it difficult to seek immediate technical assistance.

They proposed the establishment of a strong collaboration between plants and universities as well as other institutions (e.g., research). Such a suggestion is highly encouraged because Saudis are getting higher standards in education (see section 3.4).

9.4 MANUFACTURING OPPORTUNITIES

Table 9-4 presents the manufacturing opportunities specified by the surveyed managers. Surprisingly, a glance at the Table, reveals that a large number of the respondents (as compared to the highest number in the Table) mentioned that no opportunities exist in Saudi industries. Similarly, the number of missing cases is quite high. This type of response could mean that these general managers are not considering the government's incentives as opportunities.

According to many GMs, the first and foremost opportunity is "governmental encouragement". They said that the provision of loans, free duties, free taxes, nominal fees for accommodation in the

Table 9-4: Distribution of manufacturing opportunities by industrial sector

Factors	F	P	C	M	Total
1. Governmental encouragement	8*	3*	10*	14*	35
2. Freedom to import raw materials & technology	6	4	9	12	31
3. Exporting	4	-	7	9	20
4. Obtaining raw materials from the Gulf countries	-	-	7	8	15
5. Obtaining raw materials from SABIC	-	-	11	3	14
6. Replacing imported products	1	-	6	5	12
7. Increasing government's projects	-	-	4	5	9
8. Free capital movement	1	-	3	3	7
9. No opportunities	4	2	5	7	18
Missing cases	14	4	8	8	34

F : Food industry P : Paper industry

C : Chemical industry M : Metal industry

* : number of times the item was mentioned

industrial cities, and other incentives are incomparably the best in any country of the World (see section 3.8.1.2., no. 5).

Other general managers mentioned that freedom to move capital and to import raw materials and technology from anywhere in the world are great opportunities, which pave the way to joint venture projects.

Some general managers see their opportunities in exporting. They pointed out that owing to the small size of the Saudi markets and the population, the only opportunity is to seek external markets. The study found that 73.5 per cent of the plants surveyed trade in both Saudi and foreign markets (see section 5.7).

A small number of GMs, particulary in the chemical and metal industries, see their opportunities in obtaining some raw materials from SABIC or from some companies in the Gulf countries (see section 3.8.3).

Others consider their opportunities not only replacing imported products which is the usual model in developing countries, but also expecting an increase in governmental projects.

SUMMARY

The Chapter aimed at a detailed investigation of the Saudi manufacturing situation. Using SWOT analysis, strengths and weaknesses were defined within the firm (internal environment) and opportunities and threats (problems) were also highlighted in the industry (external environment).

By means of this technique, it was found that the manufacturing strengths of Saudi plants centred around high quality and modern technology. The acquisition of modern technology was facilitated through loans provided by the Saudi Industrial Development Fund.

Nevertheless, Saudi plants have major weaknesses related to the high turnover of foreign labour (unstable) and the continuous change of foreign expertise (e.g., GMs). The first weakness is attributed to the difficulty of foreign workers to adjust to the Saudi environment of a closed society, whereas the second weakness is ascribed to the dissatisfactory plants' financial performance. High production cost is further another weakness for the Saudi plants eventhough a low wages strategy might be adopted. Such a strategy aimed at reducing costs is traditional.

As for the problems, the Saudi plants are highly dependent on imported raw materials as well as on foreign labour. To minimise these problems, GMs suggested the establishment of a company to be responsible for importing raw materials on the behalf of all plants (or for each industry), to assure fixed prices and to reduce effort and time. Similarly, they favoured setting up a firm to be in charge of providing and lending employees to all plants (or for each industry). The foremost advantages presented by such a firm are as follows: selecting workers from those nationalities whose citizens have proved to adjust in the past to the Saudi environment;

supplying employees for seasonal periods; providing well trained employees; and offering recreational facilities. In addition, the Saudi plants are also facing underutilisation of capacity and operating in the midst of very competitive industries. The underutilisation of capacity is caused mainly by over capacity industry in terms of plants and importing the same products which are manufactured locally. As concerns strong competition, it is related to the accessibility of Saudi markets to all foreign legal products (i.e., according to islamic law). Solutions suggested for underutilisation of capacity involve: the introduction of Saudi products as a part of the Kingdom foreign aid programme; and the requirement of the actual application of the Royal decree to the purchase from national plants in the framework of governmental projects. To ease competition, GMs suggested: the classification of plants according to quality and capacity to ensure fair competition; the division of regions between plants in terms of service; the non-issuing of industrial licenses; and decreasing importing.

Apart from the problems mentioned above, the Saudi plants enjoy enormous opportunities provided by the government. The foremost of them are the provision of loans, free duties, free taxes and nominal fee for the accommodation in the industrial cities.

CHAPTER TEN

SUMMARY AND CONCLUSION

INTRODUCTION

This final Chapter of the thesis presents a summary and a conclusion of the research results, and suggests some avenues for future research. Prior to this, the objectives of the research and the methodology are reviewed.

10.1 RESEARCH OBJECTIVES

The objectives of the study are to develop an understanding of the manufacturing strategy concept and to find out the type of manufacturing strategies that exist among Saudi plants. More specifically, the study is aimed at:

1. Detecting the manufacturing strategy for the Saudi plants in the last two years (i.e., 1987 and 1988) as well as for the next two years (i.e., 1990 and 1991).

2. Testing the following six hypotheses of the model of manufacturing strategy on the Saudi manufacturing private sector:

H1 Environmental uncertainty correlates with manufacturing task.

H2 A plant's manufacturing infrastructure correlates with its manufacturing task.

H3 The higher the congruence between environmental uncertainty and manufacturing task, the better the performance.

H4 The higher the congruence between manufacturing task and manufacturing infrastructure, the better the performance.

H5 The higher the top management and production management task congruence, the better the performance.

H6 The greater the involvement of production managers in strategic decision making, the better the performance.

3. Using SWOT analysis to find out strengths and weaknesses within the plants surveyed as well as opportunities and threats in the environment.

10.2 RESEARCH METHODOLOGY

The research took the form of a field study which analysed data drawn from 117 plants from the Saudi Manufacturing private sector. The plants were selected from the highest four industries in terms of invested capital, number of employees, and sales. The industries are food, paper, chemical and metal. The number of plants for each industry was determined on the basis of the actual existence of such plants in the industry. Plants were then chosen from each sub-industry using disproportional stratified sampling according to the following factors as priorities in decreasing order: highest capital paid up; highest in both capital paid up and number of employees; and highest number of employees. The achieved sample of plants of each industry is: food 26, paper 11, chemical 32, and metal 48. The achieved sample represents 73 per cent of the total number of plants approached.

Three managers from each plant were invited to participate in the study; the general manager, the production manager and the sales/marketing manager. Correspondingly, three types of questionnaire were designed (see Appendix A). The major sections in these types of questionnaire cover:

1. Manufacturing task.
2. Perceived environmental uncertainty.
3. Production manager's role in strategic decision making.
4. Competitive priorities.
5. Performance.
6. Manufacturing infrastructure.

Of the above variables, the questionnaire for general managers measured items 1, 2, 3, 4, and 5; the questionnaire for production managers measured items 1, 3, and 6; and the questionnaire for sales or marketing managers measured item 3 only. All data in these types of questionnaire are of subjective nature except for a small part in the performance section where objective data are used.

10.3 SUMMARY OF THE MAJOR FINDINGS

Prior to the analysis each of the major variables in this study was examined by Cronbach's alpha coefficient, a widely accepted index, to indicate the reliability of the instruments. More precisely, this index indicates the consistency of the responses. The values of alpha coefficient in this study were ranged between 0.68 and 0.94. These values were found to be above the acceptable level. A summary of the main findings of the work will now be provided.

10.3.1 Manufacturing Strategy For 1987 And 1988

Of fourteen manufacturing tasks rated by both general and production managers according to their plants' goal in 1987 and 1988, it was found that "consistent quality", "on-time delivery", and "high performance design" received the highest means (see section 6.2). Furthermore, using SWOT analysis, general managers postulated "top quality" to be their primary manufacturing strength followed by "high technology and new equipment" (see Table 9-1). This evidence indicates that the manufacturing strategies for the plants surveyed during 1987 and 1988 are "high quality" and "on-time delivery".

10.3.2 The Production Manager's Role In Strategic Decision Making

The role of the production manager in strategic decision making was examined from several viewpoints in this study (see section 6.4). It was found that both general and sales managers do not agree that their "production manager knows exactly what are the most important competitive priorities for the manufacturing function". This could be explained in light of the difference between the qualifying and the competitive priorities criteria (Hill, 1985). That is, general and sales managers are usually the most knowledgeable managers in the firm about the market place and they know what is the qualifier for the product to be in the market place, as well as the competitive priority that allows the product to win orders in the market place. Furthermore, both general and sales managers disagree with the statement that their "production manager is responsible for initiating and modifying short and long term changes in manufacturing strategy". The disagreement about this statement is because production manager does not know exactly the most important competitive priorities, hence he is not solely responsible for initiating and modifying changes in the manufacturing strategy.

All types of managers (strategy, production, and sales) indicated that "production manager is given an equivalent role among the functional managers in the formulation of corporate strategy". It was found that 72 per cent of the surveyed production managers pointed out that they possess an equivalent role as any functional managers (summation of "agree" and "strongly agree"). Moreover, general and sales managers gave each almost 70 per cent in support of the equivalent role for the production manager among other functional managers. These findings indicate that the claim that production managers are given less equivalent role among functional managers has improved (Skinner, 1978; Hayes and Wheelwright, 1984; Hill, 1985).

The majority of the general managers (80 per cent) are in support of the production manager's attendance to top management meetings as a representative of the manufacturing function. This finding supports the previous one and both prove that the "missing link" between the corporate level and the manufacturing function as reported by Skinner (1969) does not exist any more, at least in Saudi Arabia.

Both general and sales managers strongly agree that their "production manager is an integral part of the strategy formulation process, and that his inputs are part of the divisional (corporate) strategy". This finding implies the attendance of the production manager to top management meetings. The finding supports that of Sharma (1987) who found that production managers do participate in the strategic planning process.

Finally, do the above findings mean that production manager has a good understanding of how the divisional strategy is formed? This study found that both general and sales managers strongly support production managers in their high level of understanding to the formulation of the divisional strategy.

10.3.3 Manufacturing Strategy For 1990 And 1991

To detect the manufacturing strategy for the Saudi plants in the next two years (1990 and 1991), components of manufacturing strategy as well as focused sets of competitive priorities were extracted by the principal components of factor analysis.

Before using factor analysis, the data of the four industries were tested by Kruskal Wallis and One Way Analysis of Variance (ANOVA) to find out that there were no significant differences among the industries. Both statistical techniques revealed insignificant differences among the four industries (see section 8.1). Thus, the analysis on the total sample was valid.

Out of fifty one infrastructure-programmes, fourteen components of manufacturing strategy were extracted (see Figure 8-2). These are:

1. Supplier Chain Management.
2. Automation Management.
3. Improving Workforce Skills Management.
4. Product Control Management.
5. High Volume Products Management.
6. Quality Management.
7. Inventory Management.
8. Increasing Productivity Management.
9. Information System Management.
10. Purchasing Control Management.
11. Human Resources Management.
12. Turnover Management.
13. Co-ordination Management.
14. Work-In-Process Management.

The cumulative percentage of variance accounted by the 14 factors is 76.4. According to Hair et al. (1987), this percentage is considered highly satisfactory. The first factor (i.e., Supplier Chain Management) explained the largest percentage of variance (26.8 per cent), and the last factor (i.e., Work-In-Process Management) explained only 2.10 per cent of the variance (see Table 8-1). This means that "Supplier Chain Management" is the most important factor for the Saudi plants in this study.

From the eight competitive priorities listed in Table 6-11, three focused sets were extracted. These are:

(i) Quality-Delivery Priority.

(ii) Flexibility Priority.

(iii) Low Price Priority.

The cumulative percentage of variance explained by the three factors is almost 60 per cent. This percentage is considered satisfactory (Hair et al., 1987). The focused sets of priorities were found to confirm the theoretically predicted priorities (i.e., quality, delivery, flexibility, and cost) with one exception; both types of quality and delivery were loaded in one factor in this study. Two types of priorities encapsulated in one factor is not uncommon and in two other studies, the first related to Japanese data (Roth et al., 1989) and the other to American data (Roth, 1987), the researchers extracted three focused sets of competitive priorities. As reported in Chapter 8, the difference in the content of the set of the priority as long as all the components in that priority are similar can be referred to the fact that strategy is dynamic (see section

8.3).

Through canonical correlation analysis, a manufacturing strategy was detected using the fourteen components of manufacturing strategy and the three focused sets of competitive priorities. The manufacturing strategy was found to be that of a low price (p = .025). The manufacturers in Saudi Arabia could achieve a price strategy in the next two years (1990 and 1991) via two factors; supplier chain management and inventory management (see Figure 8-2). The literature corroborates these two factors as instruments to measure cost (Fine and Hax, 1985; Leong et al., 1990).

It is worth pointing out that "suppliers" constitute a major environmental factor which, as far as plants are concerned, uncontrollable. In this context, it is worth suggesting that saudi plants should adopt the "cooperative approach" rather than the "competitive approach" in their relationship with suppliers (see section 2.4.5.1 d).

10.3.4 Testing Of Hypotheses

Six hypotheses of the manufacturing strategy model were tested (see Figures 2-2 and 2-8). Each hypothesis was tested five times; first, on the total sample, then on the individual industries (food, paper, chemical and metal). The testing was carried out, after weighting the instruments, via pearson product moment correlation and the T-test (see Appendix D). The results showed a significant relationship in every hypothesis. These are summarised below:

First, environmental uncertainty, which is an input to manufacturing strategy, influences manufacturing task. Significant relationships were found between environmental uncertainty and manufacturing task in the paper, chemical, and metal industries and in the overall sample. This implies that the manufacturing strategies of these plants in 1987 and 1988 reflected environmental uncertainty to a certain degree. This finding supports Swamidass's (1983) finding.

Second, the evidence of correlating manufacturing infrastructure with manufacturing task was not conclusive in all industries. A significant relationship was found in the food and in the chemical industries, and in the total sample, but not in the paper and the metal industries. As mentioned in Chapter 7, it seems that the type of process influences such a relationship. Both the food and the chemical sectors employ "continuous process" systems in their operations. Swamidass (1983) failed to find a significant relationship between manufacturing infrastructure and manufacturing task. The absence of a significant relationship in the paper and metal industries, in this study, is intriguing because such a relationship was prescribed in the manufacturing management literature by several authors. This finding supports the claim made by Hill (1985), Skinner (1985) and Wheelwright (1978) that most firms fail to employ a manufacturing infrastructure that suits their needs (i.e., corporate strategy or manufacturing task). This conclusion parallels the one reported by Swamidass (1983).

Third, the findings strongly support the need for congruence between environmental uncertainty and manufacturing task to achieve superior performance. This hypothesis is validated for the first time. Significant relationships were found using subjective and objective performance measures in all industries except the paper industry (due to a small number of cases). Moreover, the hypothesis was supported on the overall sample. Swamidass (1983) failed to find significant results in this hypothesis as well as in hypothesis four and this is may be attributed to differences in interpretation of the hypotheses (see section 7.4.3). The hypothesis findings lend support to the contingency theory (see section 2.4.3), Bedeian's (1984) findings (see section 2.5.3) and Skinner's (1978) writings.

Fourth, though not conclusive the findings support the need for congruence between manufacturing task and infrastructure to achieve superior performance. This hypothesis is also validated for the first time. Significant results were found with the sales measure in the metal and chemical industries using subjective and objective performance measures respectively. As for the overall sample, the hypothesis was supported with the objective performance measure only. It was not surprising to find in the rest of the industries that no conclusive influence on performance appears as a result of congruence between manufacturing task and manufacturing infrastructure. This is due to the failure of finding a significant relationship between manufacturing task and infrastructure in all industries surveyed (i.e., H2).

Fifth, task congruence (the difference of the average ratings on manufacturing task) between general and production managers influences performance. This hypothesis was highly supported in all industries by the objective performance measure, but it was backed by the subjective performance measure in the metal sector only. The hypothesis also was supported in the overall sample in both types of performance measures. This finding corroborates those reported by Bourgeois (1980b), Yaghmour (1985), Dess (1987), and Lindman and Callarman (1990).

Finally, the role of the production manager in strategic decision making as perceived by themselves (RPMP) and by general managers (RPMG) associates with performance. The hypothesis has more backing with the RPMP measure in almost all the industries with both subjective and objective performance measures. As mentioned in Chapter Seven, a possible reason for this could be their egos in overstating their role. This provides more support to Swamidass'finding (1983) who only found that the role of the manufacturing manager in strategic decision making as perceived by chief executives correlates with performance. The findings in this study give support to the writings of Skinner (1978), Hayes and Wheelwright (1984), and Hill (1985).

10.3.5 SWOT Analysis

SWOT analysis was used in this study to detect the Saudi manufacturing strengths, weaknesses, opportunities, and threats. The findings of this technique are not totally new. A new approach on the part of the manufacturers would be to understand these findings in light of the manufacturing strategy and to learn to overcome the problems as well as the weaknesses and to derive the advantages from the manufacturing strengths and the industry opportunities. Furthermore, employing the solutions suggested in this study could decrease tremendously the severity of the problems.

The two major manufacturing strengths that the Saudi plants possess are "high quality" and "modern technology" (see section 9.1). The Saudi plants produce high quality products as a result of high quality raw materials and modern technology. Manufacturers in Saudi Arabia use high technology to overcome shortages of national manpower.

When considering weaknesses, Saudi plants suffer from "unstable foreign labour" (see section 9.2). The high turnover in foreign manpower may well be ascribed to the difficulty of newcomers in adapting to the Saudi environment as a closed society with certain values (i.e., islamic law). Furthermore, failing to offer recreational facilities to employees compounds this difficulty. Other weaknesses of the Saudi manufacturing industries are "low productivity labour", "high production costs", and "long time in design for new products". The low productivity of labour may be attributed to the use of a low wages strategy, while the other two weaknesses are imputed to importing raw materials and allocating small effort for research and development respectively.

The Saudi industries encounter several problems (see section 9.3). The foremost among them are importing raw materials, underutilisation of capacity, high dependence on foreign workforce, unfair competition, and very competitive industrial environment. Solutions were suggested to these problems by general managers (see Figures 9-1 and 9-2). These are as follows:

- **Importing Raw Materials**

Establishing a firm to import raw materials for all plants (or for each industry) at fixed times with fewer orders. The major advantages of such a firm are assurance of fixed prices, attractive quantity discounts, standardising materials, and less effort and time expenditure on the part of the manufacturers.

- **Underutilisation Of Capacity**

Introducing the Saudi manufactured products as a part of the kingdom's foreign aid programme (subsidy) to better utilise capacity. That is, half of the subsidy or at least 30 per cent should be in Saudi products rather than all of it in cash. This suggestion, if implemented, will decrease fluctuations in demand. A second solution for utilising capacity requires the application of an existing Royal decree to the purchase of local producers for governmental projects. Other solutions to the underutilisation of capacity require the government through the Ministry of Industry and Electricity to stop or reduce the issuing of licenses to saturated industries and provide financial help for exporting purposes.

o Reliance on foreign Labour

Solutions suggested for "high reliance on foreign manpower" centred around decreasing the associated problems with foreign employment. Because unstable foreign labour is a major manufacturing weakness for the Saudi plants, general managers suggested the establishment of a firm(s) to be in charge of providing a central labour pool for all plants (or for each industry). The foremost advantages presented by such a firm would include: employees will be selected to work in Saudi Arabia on the basis of certain criteria (e.g., national traits related to ease of adjustment); employees will be lent for seasonal production periods; employees will be well trained; and employees will be more able to socialise by getting to know large numbers of people through the firm. However, the disadvantages for such a firm are big losses if employees are not hired, and difficulties in managing large number of employees with an enormous range of specialisation. Another solution in this context, is making serious efforts to train Saudis using the government subsidies granted for this purpose (see section 3.8.1.2. No. 5g).

o Unfair Competition

General managers call for the Ministry of Industry and Electricity to prevent or reduce the access of inferior products to the Saudi markets and that foreign products should be forced to meet Saudi standards.

- **Competitive Industry**

General managers suggested a classification of plants according to quality and capacity to ensure fair competition, calling on plants to co-operate and co-ordinate between themselves as it is the case in the developed countries (e.g., dividing regions in terms of service); and decreasing imports.

Finally, as for opportunities in the Saudi industries, the foremost opportunity that was mentioned by many general managers is "governmental encouragement" (see section 9.4). They pointed out that the provision of loans, free duties, free taxes, nominal fees for accommodation in the industrial cities and a host of other incentives are incomparably the best in any country of the world.

10.4 CONCLUSIONS

This study is devoted to the investigation of two models; the general model of manufacturing strategy and the competitive priorities model. In the course of the study, results concerning the general model were found to corroborate previous results and to generate new findings proven valid in the literature. On the other hand, results regarding the competitive priorities model are awaiting further empirical investigations for corroboration.

Prior to shedding some light on these results, one may wonder how a western concept can be applied and valid in a developing country? As far as this study is concerned, apart from the modifications that were made on the questionnaire to make it fit to the Saudi environment, the consistency of the results with the western findings is probably due to the technological factor as well as to the western expertise factor. Both factors were found to dominate the Saudi business environment. However, the influence of the Saudi culture on the manufacturing sector is expected to develop in the future as a result of workforce replacement.

The results of the study indicate that production manager, as a representative of the manufacturing function, possesses an equivalent role to other functional managers, forms an integral part of the strategy process, attends top management meetings, and overall has a good understanding of strategy formation. This leads us to conclude that production manager is involved in strategic decision making and that he has a proactive role. However, data suggest that production manager's knowledge concerning external environment is limited. This limitation might affect his participation in decision making.

The role of the production manager and the effect of the external environment are very important pillars in forming manufacturing strategy. The study has provided evidence that both production manager and the external environment influence organisation performance. Furthermore, congruence between aspects of manufacturing strategy (i.e., manufacturing task and manufacturing infrastructure) was found to influence the performance of the organisation.

On the other hand, the study had only faint success in validating the competitive priorities model. The study results have validated the first part of both models of competitive priorities; i.e., the Japanese cumulative model and the Sandcone model (Ferdows and De Meyer, 1989). The first part of both models requires achieving quality, then quality and delivery. However, the conflict between these two models is over the second part (price and flexibility), which the findings of this study came short to support one model over the other. Therefore, the results of this study (i.e., price strategy for 1990 and 1991) concerning the second part of the model lead us to conclude that the prevailing model in Saudi Arabia is one of three models: the Trade-offs notion model, a different model entirely, either the Japanese cumulative model or the Sandcone model. The first model (i.e., Trade-offs) is unlikely, because the results support the first part of both the Japanese and the Sandcone models. Similarly, the second model is unforeseeable at the present time because of the western influence. Therefore, the most likely model is either the Japanese or the Sandcone model. If so, why did this study fail to detect quality and delivery strategies in addition to the price strategy? It could be that general and production managers' struggles with the suppliers-related problems influence greatly their thinking in a way that they neglect to emphasis quality and delivery strategies along with price strategy when responding to these questions (see section 8.4.3).

If this study were able to detect quality and delivery strategies in addition to the price strategy, this would have been a good support for the Japanese cumulative model over the Sandcone model (see section 2.4.1).

The results of the present study lead us to conclude that the Saudi plants have won quality and delivery strategies and they may be winning a price strategy as well. A follow up study would indicate whether the Saudi plants have won a price strategy or not.

10.5 IMPLICATIONS

The following are implications of the research for managers and for the Saudi Ministry of Industry and Electricity.

10.5.1 Implication For Managers

The results indicate that manufacturing task is closely related to the external environment in which the firm operates. Furthermore, the better the fit between the manufacturing task of the firm and its external environment, the better the performance. Therefore, managers should incorporate environmental uncertainty factors in the development of manufacturing strategy.

Also, the firm's manufacturing task is closely related to its manufacturing infrastructure. Moreover, the better the match between the firm's manufacturing task and its infrastructure, the better the performance of the firm. Managers should note that such a match is an effective way of managing the "day-to-day" operations of the manufacturing function.

The role of the production manager in strategic decision making is strongly associated with performance. Managers should allow a bigger role for production managers in strategic decision making. One of the significant results of this study is that it found that production manager's knowledge concerning external environment is limited (e.g., product price). This limitation is likely to affect his participation in decision making. Therefore, production managers should be exposed to participation in decision making related to external environment.

The present study indicates further the importance of the suppliers to the Saudi plants in achieving a price strategy. A situational analysis technique such as SWOT analysis is very useful in understanding major factors (e.g., suppliers) and offering some solutions. In general, this technique is very helpful in studying manufacturing strategy.

10.5.2 Implication For The Ministry of Industry and Electricity

The Ministry of Industry and Electricity in behalf of the Saudi government should re-examine the effectiveness of the industrial policy guidelines. The results generated by SWOT analysis indicate an ineffective application of the majority of the guidelines of the industrial policy.

10.6 SUGGESTIONS FOR FUTURE RESEARCH

As pointed out in several aspects of this study, manufacturing strategy is still in its infancy. Therefore, the task is enormous for those interested in this emerging field. To keep the list short, suggestions for future research are limited to topics closely related to this study. The suggested topics are:

1. Replicate the present study in the context of another developing country to compare and contrast the results with those of this study, especially in a country that does not have the wealth of saudi Arabia.
2. Detect manufacturing strategy, using a large sample consisting of several industries, at the industry level as well as at the level of the company size in order to verify the model of the competitive priorities. Such a study is highly recommended in developed and developing countries.
3. Re-test the six hypotheses in different industries in terms of company size.
4. Include further considerations about the corporate and the functional level of strategies of the firm in addition to its external environment in studying manufacturing strategy.
5. Extend the study to the service sector to enrich the field of operations management.
6. Conduct a follow up study for the four industries discussed in this study to find out if they achieved a price strategy.
7. Conduct a somewhat similar study in the remaining types of the Saudi industrial sector (i.e., SABIC and Petromin).
8. Conduct two important studies for the Saudi industries; the first concerning job satisfaction and the other regarding organisation climate. Both studies are strongly related to organisational performance.

APPENDIX A

Table 4.1.1: Distribution of plants in the food industry by subsector

Subsector	Description	No. of plants
3111	Slaughtering of Livestock	12
3112	Dairy products	56
3113	Packing and preservation of Fruits/Vegetables	41
3114	Packing and preservation of Fish	2
3115	Manufacturing of Animal Fat and Vegetable Oil	2
3117	Bread and Bakeries	66
3118	Sugar and Refining Industry	2
3119	Cocoa Chocolate and Sugar Industry	16
3121	Manufacturing of other products (ICE)	60
3122	Manufacturing of Animals and Birds Feed	27
3134	Carbonated Water Industry	37
Total		321

Table 4.1.2: Distribution of plants in the paper industry by subsector

Subsector	Description	No. of plants
3411	Paper Pulp and Paperboard	5
3412	Hardboard and Paper Boxes	21
3419	Products of Paper Pulp	23
3421	Printing and Publishing	73
Total		122

Table 4.1.3: Distribution of plants in the chemical industry by subsector

Subsector	Description	No. of plants
3511	Basic Chemical Industries	39
3512	Fertiliseries and Pesticides Industry	13
3513	Manufacturing of Compounding Materials Plastic	7
3521	Manufacturing of Paints, Varnish	31
3522	Manufacturing of Drugs and Medicines	3
3523	Manufacturing and Packing of Soap, Cleaning Materials, Perfumes and Cosmetics	17
3529	Other Chemical Products	10
3530	Crude Oil Refining Industry	5
3540	Various of Products Petroleum and Coal	15
3551	Manufacturing Tyres and Tubes of Rubber	4
3559	Other Rubber Products	4
3560	Plastic Products (not elsewhere classified)	143
Total		291

Table 4.1.4: Distribution of plants in the metal industry by subsector

Subsector	Description	No. of plants
3710	Iron and Steel Basic Industries	4
3720	Non-Ferrous Metal Basic Industries	4
3811	Manufacturing of Cutlery and Hand Tools	26

Table 4.1.4: (continued)

Subsector	Description	No. of plants
3812	Manufacturing of Furniture and Fixtures Primarily of Metal	62
3813	Manufacturing of Structural Metal Products	252
3819	Manufacturing of Fabricated Metal products	52
3822	Manufacturing and Repairing Agricultural implements and Accessories	15
3824	Manufacturing of Machinery and Equipment	10
3826	Manufacturing and Repair of Cooking Ranges, Heaters, Washing Machines and Refrigerator	29
3827	Manufacturing and Repair of Air Conditioning and Ventilation Equipments	12
3829	Manufacturing and Repair of Machinery and Equipment except Electrical	6
3831	Manufacturing of Electrical Industrial Machinery and Equipment	28
3832	Manufacturing of Radio Sets, T.V. Sets and Communication	1
3839	Manufacturing of Electrical Appliances and Supplies	21
3841	Ship Building and Repair Industry	3
3843	Manufacturing of Motor Vehicles (assembly and modification)	40
3844	Manufacturing of Motor Cycles and Bicycles	1
3852	Manufacturing of Photographic and Optical Lenses	6
Total		572

UNIVERSITY OF GLASGOW

Form A

MANUFACTURING STRATEGY SURVEY

A QUESTIONNAIRE FOR

GENERAL MANAGER

SECTION I : TYPE OF BUSINESS AND PRODUCT

Please place an __X__ for each question or statement unless otherwise specified.

1. This plant is **in the industry of**:

_______ FoodStuffs
_______ Paper & Printing
_______ Chemical
_______ Metal

_______ City
_______ ISIC (if known)

2. Type of plant **with regard to capital**:

_______ Wholly Saudi plant
_______ Joint venture plant

3. Total **paid up capital** [Millions SR] ____________

4. **Number of employees** (including top management)

_______ Saudis
_______ Non-Saudis

5. Number of years in operation _______

6. Please indicate the number of **product lines, products and product options** in your plant.

- Number of **product lines** in your plant (a group of products processed by the same machine) __________

- Average number of **products** in your main product line (products within the product line) __________

- Average number of **options** in the products (alternative features beyond the standard) __________

7. The **average time for your plant to develop a new product** is:

- ________ 6 months or less
- ________ Over 6 months to 1 year
- ________ 2 years
- ________ 3 years
- ________ Over 3 years
- ________ Did not introduce new products until now

8. The last **major technological change** in product offered by your **competitors** occurred within the last :

- ________ None
- ________ 1 year
- ________ 2 years
- ________ 3 years
- ________ 4 years
- ________ 5 years or over
- ________ Do not know

9. Currently and for the next two years (1990 and 1991), **estimate the percentage of the demand for your plant's main product(s)** ?

- ________ Stable
- ________ % Growing
- ________ % Decline

10. In this scale, **100 points means full capacity** in a plant. On the same scale, circle the number which indicates your actual plant's capacity usage (equipment, labour,and resources).

0 10 20 30 40 50 60 70 80 90 100

11. Evaluate the **nature of competition to your plant's production** from **foreign competitors** in the Saudi market.

None existence	Little competition	Moderate	High competition	Very high
1	2	3	4	5

12. Please estimate the **percentage of the market share of foreign competitors** in your industry for the following years ?

______ % for 1988 of the total Saudi market
______ % for 1987 of the total Saudi market
______ % for 1986 of the total Saudi market

13. Please indicate **the extent of the Saudi competition** in your industry.

None existence	Little competition	Moderate	High competition	Very high
______	______	______	______	______
1	2	3	4	5

14. **Estimate the percentage of your plant's sales for Saudi and foreign markets** ?

______ % **of sales to Saudi market** [if you don't export, please **go to the next question**]
______ % **of sales to foreign market**

14a) If part of your plant' sales goes to foreign markets please **name some of the major countries that buy your products**.

____

14 b) The following could be **obstacles or problems** facing exporting. **According to your plant**, rank them 1 to 7:1 is the **most difficult**, 7 is the **least difficult problem** (two items can not be ranked the same number).

______ Uncompetitive price
______ Lack of information about exporting markets
______ Lack of finances
______ High transportation costs
______ High good quality
______ Duties on imported materials are too high
______ Insufficient subsidy
______ Other (use the back of the sheet if necessary)
____

15. Does your plant obtain a loan from the Saudi Industrial Development Fund ?

______ Yes
______ No

SECTION II : MANUFACTURING TASK

A- Please rate the following items according to your **plant's goals** over the **last two years** (1987 and 1988).

Please **circle the number** that indicates your answer

Items	Lowest in the industry				Highest in the industry
1. **Price**	1	2	3	4	5
	Below average in the industry				Among top in the industry
2. **High performance design** (superior features, tolerance,long life)	1	2	3	4	5
3. **Consistent quality** (meeting the design specifications)	1	2	3	4	5
	Least frequent in the Industry				Most frequent in the industry
4. **New product introduction**	1	2	3	4	5
5. **Introducing new production processes**	1	2	3	4	5

	Narrowest range in the industry			Widest range in the industry	
6. **Product range**	1	2	3	4	5
7. **Wide range of product features**	1	2	3	4	5

	Among the slowest in the industry			Among the fastest in the industry	
8. **Rapid design changes in product according to customers' preferences**	1	2	3	4	5
9. **Rapid volume changes in rate of production to handle large fluctuations in demand**	1	2	3	4	5

	Later Delivery	V.Late	Late	**On Time**	Early
10. **On - time delivery** (meeting delivery time promises)	1	2	3	**4**	5

	Below average in the industry			Among the best in the Industry	
11. **After sales service**	1	2	3	4	5

	No custom production			Entirely custom Production	
12. **Customised product**	1	2	3	4	5

	Longest in the industry				Shortest in the Industry
13. **Fast delivery time** (the time between receiving the order and filling it)	1	2	3	4	5

	None				High effort in the industry
14. **Research & development effort**	1	2	3	4	5

15. What elements of your **manufacturing** and **technology** are vital to your plant's competitiveness ?

____

____

SECTION III : ENVIRONMENTAL UNCERTAINTY

A- In formulating strategic plans, **how important** it is to consider each of the following factors that might **influence the outcome** of the strategic decisions that are made by members of top management in your plant.

Please circle one number in each level

NI means Not Important At All
SI means Somewhat Important
QI means Quite Important
VI means Very Important
EI means Extremely Important

Factors	**NI**	**SI**	**QI**	**VI**	**EI**
1. The distributors of your products	1	2	3	4	5
2. Customers of your products	1	2	3	4	5
3. The suppliers of raw materials	1	2	3	4	5
4. The suppliers of equipment	1	2	3	4	5
5. The suppliers of product parts	1	2	3	4	5
6. The supply of labour	1	2	3	4	5
7. Competitors for your supply of raw materials and parts	1	2	3	4	5
8. Competitors for your customers	1	2	3	4	5
9. Government regulations controlling your industry	1	2	3	4	5
10. The public attitudes toward your industry	1	2	3	4	5
11. Your relationship with your supervising ministeries and chambers of commerce and industry	1	2	3	4	5
12. Keeping up with new technological requirements in your industry in the production of goods	1	2	3	4	5

Factors	NI	SI	QI	VI	EI
13. Improving and developing new products by implementing new technological advances in the industry	1	2	3	4	5
14. Your source of financial resources	1	2	3	4	5
15. The situation of the Saudi economy	1	2	3	4	5
16. The situation of world economy	1	2	3	4	5

B- How often do you feel that you are able to **predict** how each of the following factors is going **to react to decisions made** by your plant ?

Please circle one number in each level

HU means Highly unPredictable
S means Seldom
O means Occasionally
FO means Fairly Often
HP means Highly predictable

Factors	HU	S	O	FO	HP
1. The distributors of your products	1	2	3	4	5
2. Customers of your products	1	2	3	4	5
3. The suppliers of raw materials	1	2	3	4	5
4. The suppliers of equipment	1	2	3	4	5
5. The suppliers of product parts	1	2	3	4	5
6. The supply of labour	1	2	3	4	5
7. Competitors for your supply of raw materials and parts	1	2	3	4	5
8. Competitors for your customers	1	2	3	4	5

Factors	HU	S	O	FO	HP
9. Government regulations controlling your industry	1	2	3	4	5
10. The public attitudes toward your industry	1	2	3	4	5
11. Your relationship with your supervising ministeries and chambers of commerce and industry	1	2	3	4	5
12. Keeping up with new technological requirements in your industry in the production of goods	1	2	3	4	5
13. Improving and developing new products by implementing new technological advances in the industry	1	2	3	4	5
14. Your source of financial resources	1	2	3	4	5
15. The situation of the Saudi economy	1	2	3	4	5
16. The situation of world economy	1	2	3	4	5

SECTION IV : THE ROLE OF THE PRODUCTION MANAGER

A- Strategic Decisions

If asked to **evaluate the role of the production manager**, how would you rate the following statements ?

Please circle one number for each level

SD means Strongly Disagree
D means Disagree
N means Neutral
A means Agree
SA means Strongly Agree

	SD	D	N	A	SA
1. I feel that production manager(s) [PM] has a good understanding of how the divisional strategy is formed	1	2	3	4	5
2. I feel that PM is an integral part of the strategy formulation process, and that his inputs are part of the divisional (or corporate) strategy	1	2	3	4	5
3. I feel that PM knows exactly what the most important competitive priorities are for our manufacturing function (e.g., low cost, quality, delivery)	1	2	3	4	5
4. PM is responsible for initiating and modifying short & long term changes in manufacturing strategy	1	2	3	4	5
5. PM is given an equivalent role or more among the functional managers in the formulation of corporate strategy	1	2	3	4	5
6. PM is one of the members who should be allowed to attend the top management meetings	1	2	3	4	5

B- Listed below are **several competitive priorities** that could be used **for competition in an industry**. Please indicate the level of importance for each one of them currently and for the next two years (1990 and 1991). Please circle one number for each level

NI means Not Important At All
SI means Somewhat Important
QI means Quite Important
VI means Very Important
EI means Extremely Important

	NI	SI	QI	VI	EI
1. Low price	1	2	3	4	5
2. High performance design (superior features, tolerance,long life)	1	2	3	4	5
3. Consistent Quality (meeting the design specifications)	1	2	3	4	5
4. Rapid design changes in the product according to customers' preferences	1	2	3	4	5
5. Rapid volume changes in the rate of production to handle large fluctuations in demand	1	2	3	4	5
6. New products introduction	1	2	3	4	5
7. On-time delivery (meeting delivery time promises)	1	2	3	4	5
8. Fast delivery time (the time between receiving the order and filling it)	1	2	3	4	5

C- Rank the following manufacturing areas (1 to 8) according to **your needs for improvements**; 1 is the **most improvements**, 8 is the **least improvements** (two items can not be ranked the same).

_______ Rapid volume changes
_______ High performance design
_______ New products introduction
_______ Rapid design changes in the product
_______ Meeting delivery time promises
_______ Low price
_______ Consistent Quality
_______ Fast delivery time (the time between receiving the order and filling it)

D)

1. What are the **manufacturing strengths** in your plant ?

a)
b)
c)
d)

2. What are the **manufacturing weaknesses** in your plant ?

a)
b)
c)
d)

SECTION V : PERFORMANCE

Please place an **X** for your chosen answer for the following questions

A: Benchmarking

1. Does a team of your plant make **business visits** to some of the **high-performance firms/plants** in order to **improve specific issues in manufacturing** ?

Yes ________
No ________ Go To Question 2

a) Specifically, what are the **issues** that your plant **targets** in such a visit ?

____

____

2. Does your plant make some manufacturing issues of high performance plant **as your plant's objectives** (e.g., certain level of cost).

Yes ________
No ________

B: Subjective Measures

Please circle <u>one number</u> for each of the following questions

	Below Industry Average	Industry* Average	Above Industry Average
1. **Average annual rate of growth in <u>return on total investments</u> during 1986-1988** (ROI = Net profit / Total Assets)	1	2	3
2. **Average annual rate of <u>growth in sales</u> during 1986-1988**	1	2	3
3. **Average annual rate of growth in <u>return on sales</u> during 1986-1988** (ROS = Net profit / sales)	1	2	3

* Slightly above the break even point

	Lower chances	No change	Higher chances
4. **Describe the <u>change</u> in the chances of your plant's survival today as compared to three years ago.**	1	2	3

c /1. What do you think are the **<u>major problems</u> (threats) facing your industry ?**

____

____

____

In your opinion, **how could these problems be solved** ?

____

____

____

2. What are the **opportunities in your industry** that could make you in a better position in manufacturing nationally & internationally ?

____

____

____

D /1. If **100 SR is the total unit cost** of the **Major product** in your plant, **estimate the share** of each one of the following from the total cost.

_______ % Materials

_______ % Labour

_______ % Transportation

_______ % Other ___________

2. Estimate the percentage of **the source of the raw materials** ?

______ % Locally
______ % Imported

3. **Please provide the following percentages:**

% of plant's income spent on Research & Development ......

% of plant's income reinvested in process & equipment ......

4. Would you please provide the following **figures** in **Saudi Riyals** (SR) for the last three years (1986-1988).

	1986	1987	1988
Ratio of = Net Profit / Total Assets	______	______	______
Sales	______	______	______
Ratio of = Net Profit / Sales	______	______	______

THANK YOU VERY MUCH

UNIVERSITY OF GLASGOW

Form B

MANUFACTURING STRATEGY SURVEY

A QUESTIONNAIRE FOR

PRODUCTION MANAGER

SECTION I : MANUFACTURING TASK

A- Please rate the following items according to your **plant's goals** over the **last two years** (1987 and 1988).

Please **circle the number** that indicates your answer

Items	Lowest in the industry				Highest in the industry
1. **Price**	1	2	3	4	5

	Below average in the industry				Among top in the industry
2. **High performance design** (superior features, tolerance, long life)	1	2	3	4	5
3. **Consistent quality** (meeting the design specifications)	1	2	3	4	5

	Least frequent in the Industry				Most frequent in the industry
4. **New product introduction**	1	2	3	4	5
5. **Introducing new production processes**	1	2	3	4	5

	Narrowest range in the industry				Widest range in the industry
6. **Product range**	1	2	3	4	5
7. **Wide range of product features**	1	2	3	4	5

	Among the slowest in the industry				Among the fastest in the industry
8. **Rapid design changes in product according to customers' preferences**	1	2	3	4	5
9. **Rapid volume changes in rate of production to handle large fluctuations in demand**	1	2	3	4	5

	Later Delivery	V.Late	Late	**On Time**	Early
10. **On - time delivery** (meeting delivery time promises)	1	2	3	**4**	5

	Below average in the industry				Among the best in the Industry
11. **After sales service**	1	2	3	4	5

	No custom production				Entirely custom Production
12. **Customised product**	1	2	3	4	5

	Longest in the industry			Shortest in the Industry
13. **Fast delivery time** (the time between receiving the order and filling it)	1	2	3	4	5

	None			High effort in the industry
14. **Research & development effort**	1	2	3	4	5

SECTION II : MANUFACTURING FUNCTION

A- Strategic Decisions

If you were asked to evaluate your relationship to the divisional and group offices and your personal knowledge of how they make certain decisions, how would you rate the following statements ?

Please circle one number for each level

SD means Strongly Disagree
D means Disagree
N means Neutral
A means Agree
SA means Strongly Agree

	SD	**D**	**N**	**A**	**SA**
1. I feel that I have a good understanding of how the divisional strategy is formed	1	2	3	4	5
2. I feel that I am an integral part of the strategy formulation process, and that my inputs are part of the divisional (corporate) strategy	1	2	3	4	5

	SD	D	N	A	SA
3. I feel I know exactly what are the most important competitive priorities are for my manufacturing function (e.g., low cost, quality, delivery)	1	2	3	4	5
4. I am responsible for initiating and modifying short & long term changes in manufacturing strategy	1	2	3	4	5
5. I am given an equivalent role or more among the functional managers in the formulation of corporate strategy	1	2	3	4	5

B- Rank the following manufacturing areas (1 to 8) according to **your needs for improvements**; 1 is the **most improvements**, 8 is the **least improvements** (two items can not be ranked the same).

_______ Rapid volume changes
_______ High performance design
_______ New products introduction
_______ Rapid design changes in the product
_______ Meeting delivery time promises
_______ Low price
_______ Consistent Quality
_______ Fast delivery time (the time between receiving the order and filling it)

SECTION III : STRUCTURE AND INFRASTRUCTURE DECISIONS

Please place an **X** for each question or statement unless otherwise specified.

A- **Structure Decisions**

1. Please use the following definitions to **select one or more of these types that come closests to your plant's process.**

a) **Job shop** : products are produced in small batches. Job shop meets the unique order requirements of customers such as Commercial printing firms and machine tool shops.

b) **Large batch** : similar to job shop products but in large batches and less varieties. Examples of items produced with this process are heavy equipment and electronic devices.

c) **Assembly line** : products are passed through the same sequence of operations and have the nature of standardisation. A product processed by this type is cars.

d) **Continuous process:** basic materials are passed through successive operations and processed into one or more products such as petrochemical and food. Outputs of this process are highly standardised.

____

2. The **capacity** for your plant for the next two years could be described as:

	________	Stable
%	________	Growing
%	________	Decline

3. To deal with **future demand on your products**, the increase in capacity will be added :

______ Ahead of time
______ At the time of demand

4. For **peak capacity requirements**, does your plant use one or more of the following:

______ Hire workers
______ Schedule overtime
______ Increase the number of work shifts
______ Subcontracting
______ Far from the peak level

5. For **decreased capacity requirements**, does your plant use on or more of the following.

______ Lay-off workers
______ Schedule undertime
______ Reduce the number of work shifts
______ Annual vacation for employees
______ Far from the decreased level

6. Listed below are items related to **maintenance**, please answer each item as it relates to the machines in your plant.

	0	1-3	4-5	6-10	11-16	17-25	26-35	36 or more
Average number of **hours per machine per month lost due to breakdowns**	[]	[]	[]	[]	[]	[]	[]	[]
Average number of **hours per machine per month spent on preventive maintenance**	[]	[]	[]	[]	[]	[]	[]	[]

B- **Infrastructure Decisions**

1. **Please provide the following percentages:**

- Defective or rejected rate in production

% ...... **Expected** ; % ...... **Actual**

- % of rework products (or Jobs) ......
- % of customer rectification ......
- % of scrap ......
- % of products incorporating new design ......

2. Listed below are items related to **forecasting**. Please indicate the degree of difference between the **actual and forecasted demand** in terms of product quantity and the time of demand.

	No Difference	Little	Some-What Difference	Large	Very Large Difference
Difference between actual and forecasted demand on **product quantity**	1	2	3	4	5
Difference between actual and forecasted **time of demand**	1	2	3	4	5

3. Please rate the extent of **time, effort, and resources** devoted to the following activities or causes **currently (i.e., towards the end of 1989) and for the next two** years (1990 and 1991), in comparison with the effort devoted to **all other activities in the list**.

IT IS RECOMMENDED TO GLANCE THROUGH THE LIST OF ACTIVITIES BEFORE BEGINNING TO RESPOND TO THIS PART.

Please circle one number of each level

Example: if you spent **somewhat above average** time, effort, and resources on reducing inventory costs, then please **circle " 4 "** against item (1) in the list.

	None		Average		Well Above Average
a) **Inventory**					
1. Reducing inventory costs	1	2	3	4	5
2. Increasing inventory turnover (cost of goods sold /average inventory)	1	2	3	4	5
3. Reducing raw materials and component inventories	1	2	3	4	5
4. Reducing work-in-process inventories	1	2	3	4	5

PLEASE GO TO THE NEXT PAGE

	None		Average		Well Above Average
a) Inventory (contd.)					
5. Reducing finished goods inventories	1	2	3	4	5
6. Achieving larger production lots	1	2	3	4	5
b) Planning					
7. Hiring and lay-off system	1	2	3	4	5
8. Reducing idle time	1	2	3	4	5
9. Finding reliable subcontractors	1	2	3	4	5
10. Stabilising workforce numbers	1	2	3	4	5
11. Designing policies to motivate employees to work as a team	1	2	3	4	5
12. Reducing lead time manufacturing	1	2	3	4	5
13. Increasing warehouse space	1	2	3	4	5
c) Scheduling / Control					
14. Developing better master production schedule	1	2	3	4	5
15. Close order progress control system	1	2	3	4	5
16. Frequent work centre rescheduling capacity	1	2	3	4	5
17. Order status reporting system	1	2	3	4	5
d) Purchasing					
18. Reducing raw material cost	1	2	3	4	5
19. Obtaining long-term supply contracts	1	2	3	4	5
20. Reducing the number of purchase orders per year	1	2	3	4	5
21. Obtaining quantity discounts from suppliers	1	2	3	4	5
22. Obtaining quantity discounts from shippers	1	2	3	4	5

PLEASE GO TO THE NEXT PAGE

	None		Average		Well Above Average
d) Purchasing (contd.)					
23. Developing high quality suppliers	1	2	3	4	5
24. Developing reliable timely suppliers	1	2	3	4	5
25. Diversifying suppliers	1	2	3	4	5
26. Achieving independence from suppliers	1	2	3	4	5
e) Process and Product Design					
27. Substitution of labour by machines	1	2	3	4	5
28. Product standardisation	1	2	3	4	5
29. Product modularisation	1	2	3	4	5
30. Product simplification	1	2	3	4	5
31. Substitution of inexpensive materials or components	1	2	3	4	5
32. Mechanised materials handling	1	2	3	4	5
33. Automation of production lines	1	2	3	4	5
34. Automatic inspection	1	2	3	4	5
35. Acquiring the latest in production equipment	1	2	3	4	5
36. Development of new features for older product lines	1	2	3	4	5
f) Labour / Quality					
37. Reducing direct labour costs	1	2	3	4	5
38. Reducing production costs	1	2	3	4	5
39. Worker skills diversification	1	2	3	4	5
40. Worker training	1	2	3	4	5
41. Worker specialisation	1	2	3	4	5
42. Increasing worker responsibility in work planning	1	2	3	4	5
43. Increasing worker control over work pace	1	2	3	4	5
44. Inspectors training	1	2	3	4	5
45. Removal of Inspectors	1	2	3	4	5

PLEASE GO TO THE NEXT PAGE

	None		Average		Well Above Average
f) Labour / Quality (contd.)					
46. Improving labour productivity	1	2	3	4	5
47. Development or improvement of quality control programmes	1	2	3	4	5
48. Acquiring a Saudi quality mark	1	2	3	4	5
49. Monetary incentive system	1	2	3	4	5
50. Development or improvement of quality circle programmes	1	2	3	4	5
g) Miscellaneous					
51. Development of high volume products	1	2	3	4	5
52. Development of products with high economies of scale	1	2	3	4	5
53. Development of products with high economics of scope	1	2	3	4	5
54. Improving co-ordination among engineering, manufacturing and marketing	1	2	3	4	5
h) Foreign production					
55. Developing reliable foreign suppliers for components, where materials are cheap	1	2	3	4	5
56. Developing facilities abroad for manufacture of components for use in Saudi assembly plants where labour is cheap	1	2	3	4	5
57. Developing facilities for assembly of major product lines abroad where most of the production factors are cheap	1	2	3	4	5

Thank you very much

UNIVERSITY OF GLASGOW

Form C

MANUFACTURING STRATEGY SURVEY

A QUESTIONNAIRE FOR

SALES/MARKETING MANAGER

SECTION I : MANUFACTURING FUNCTION

A - Strategic Decisions

If you or any functional manager were asked **<u>to evaluate the production manager</u>** in your plant, how would you rate the following statements.

Please circle <u>one number</u> for each level

SD means Strongly Disagree
D means Disagree
N means Neutral
A means Agree
SA means Strongly Agree

	SD	D	N	A	SA
1. I feel that production manager(s) [PM] has a good understanding of how the divisional strategy is formed	1	2	3	4	5
2. I feel that PM is an integral part of the strategy formulation process, and that his inputs are part of the divisional (or corporate) strategy	1	2	3	4	5
3. I feel that PM knows exactly what the most important competitive priorities are for our manufacturing function (e.g., low cost, quality, delivery, etc.)	1	2	3	4	5
4. PM is responsible for initiating and modifying short & long term changes in manufacturing strategy	1	2	3	4	5
5. PM is given an equivalent role or more among the functional managers in the formulation of corporate strategy	1	2	3	4	5

APPENDIX B

Table 5.1.1 : Distribution of type of manufacturing processes by industrial sector

Sector Type	F	P	C	M
		No. Of Plants		
	(%)	(%)	(%)	(%)
Job Shop	-	11 (100)	2 (6.30)	6 (12.5)
Large Batch	-	-	6 (18.7)	25 (52.1)
Assembly Line	-	-	4 (12.5)	13 (27.1)
Continuous Processes	26 (100)	- -	20 (62.5)	4 (8.30)
Total	26 (100)	11 (100)	32 (100)	48 (100)

F : food industry
P : paper industry
C : chemical industry
M : metal industry

Table 5.1.2 : Distribution of total actual capacity usage by industrial sector

Industry	Mean	SD
Food	74.8	17.0
Paper	71.8	14.7
Chemical	67.5	21.2
Metal	71.7	17.6
Total	71.3	18.3

Table 5.1.3 : Distribution of type of ownership of plants by industrial sector

Sector Type Of Plant	F No. (%)	P Of (%)	C Plants (%)	M (%)
Wholly Saudi	19 (73.1)	8 (72.7)	12 (37.5)	31 (64.6)
Joint Venture	7 (26.9)	3 (27.3)	20 (62.5)	17 (35.4)
Total	26 (100)	11 (100)	32 (100)	48 (100)

F : food industry C : chemical industry
P : paper industry M : metal industry

Table 5.2.1 : Distribution of plant size according to number of employees by industrial sector

Sector Size Of Plant	F No. (%)	P Of (%)	C Plants (%)	M (%)
Small	6 (23.1)	1 (9)	6 (18.3)	7 (14.6)
Medium	5 (19.2)	5 (45.5)	8 (25)	14 (29.1)
Large	15 (57.7)	5 (45.5)	18 (56.3)	27 (56.3)
Total	26 (100)	11 (100)	32 (100)	48 (100)

F : food industry C : chemical industry
P : paper industry M : metal industry

Table 5.2.2 : Distribution of Saudi and non-Saudi employees by industrial sector

Sector Category	F (%)	P No. Of (%)	C Employees (%)	M (%)
Saudi	410 (8.4)	57 (5.5)	401 (9.4)	844 (9.6)
Non - Saudi	4468 (91.6)	978 (94.5)	3885 (90.6)	7918 (90.4)
Total	4878 (100)	1035 (100)	4286 (100)	8762 (100)

F : food industry
P : paper industry
C : chemical industry
M : metal industry

Table 5.2.3 : Distribution of the total employees by industrial sector

Sector	Mean	S.D	Min.	Max.
Food	187.6	187.8	30	819
Paper	94.1	40.2	33	155
Chemical	133.9	93.9	17	395
Metal	182.5	237.0	15	1448
Total	162.0	184.0	15	1448

Table 5.2.4 : Distribution of plant size according to capital by industrial sector

Sector Size Of Plant	F No. Of Plants (%)	P (%)	C (%)	M (%)
Small	3 (11.5)	2 (18.2)	11 (34.4)	14 (29.2)
Medium	6 (23.1)	5 (45.4)	8 (25)	16 (33.3)
Large	17 (65.4)	4 (36.4)	13 (40.6)	18 (37.5)
Total	26 (100)	11 (100)	32 (100)	48 (100)

F : food industry C : chemical industry
P : paper industry M : metal industry

Table 5.3.1 : Distribution of plants according to number of years in operation by industrial sector

Sector Years	F No. Of Plants (%)	P (%)	C (%)	M (%)
3 - 5	5 (19.2)	3 (27.3)	2 (6.2)	5 (10.4)
6 - 10	14 (53.9)	3 (27.3)	11 (34.4)	25 (52)
11 - 20	4 (15.4)	3 (27.3)	15 (46.9)	15 (31.3)
21 - 35	3 (11.5)	2 (18.1)	4 (12.5)	3 (6.3)
Total	26 (100)	11 (100)	32 (100)	48 (100)

F : food industry C : chemical industry
P : paper industry M : metal industry

Table 5.4.1 : Distribution of average time of new products development by industrial sector

Industry	Mean	SD
Food	2.35	1.13
Paper	1.91	1.47
Chemical	2.13	0.93
Metal	3.02	0.86

Table 5.5.1 : Distribution of last major technological changes in product by industrial sector

Industry	Mean (in years)	SD
Food	3.42	1.16
Paper	4.73	0.85
Chemical	3.97	1.09
Metal	3.44	1.19

Table 5.6.1 : Distribution of demand on main product by industrial sector

Industry	No. G (%)	Of D (%)	Plants S (%)	As % Of Each Industry G	D	S
Food	22 (27.5)	-	4 (13.8)	84.6	-	15.4
Paper	8 (10)	_	3 (10.3)	72.7	-	27.3
Chemical	22 (27.5)	1 (12.5)	9 (31)	68.8	3.1	28.1
Metal	28 (35)	7 (87.5)	13 (44.9)	58.3	14.6	27.1
Total	80 (100)	8 (100)	29 (100)			

G : Growing demand on main product
D : Declining demand on main product
S : Stable demand on main product

Table 5.7.1 : Distribution of perceived foreign competition and market share by industrial sector

Sector	Mean	Market Share % 1988	1987	1986
Food	3.08	21.6	24.1	27.0
Paper	1.73	6.2	8.5	14.3
Chemical	3.19	28.5	31.6	35.8
Metal	2.79	22.4	26.3	31.1
Total	2.86	22.4	25.6	30.0

Table 5.8.1 : Distribution of exporting and non-exporting plants by industrial sector

Sector	No. Of Plants exporting (%)	non-exporting (%)
Food	22 (84.6)	4 (15.4)
Paper	7 (63.6)	4 (36.4)
Chemical	23 (71.9)	9 (28.1)
Metal	34 (70.8)	14 (29.2)
Total	86 (73.5)	31 (26.5)

Table 5.8.2 : Distribution of sales to foreign markets by industrial sector (percentage)

Sector	Mean	Min.	Max.
Food	6.7	3	29
Paper	5.3	1	16
Chemical	5.9	1	30
Metal	9.9	1	40
Total	7.65	1	40

Table 5.8.3 : Distribution of countries importing from Saudi Arabia by industrial sector

Sector Name Of Country	F	P	C	M	Total
Gulf Countries	7	1	11	17	36*
Kuwait	11	3	6	9	29
U.A.E	6	4	9	9	28
Bahrain	9	3	8	6	26
N. Yemen	-	2	5	9	16
Iraq	1	1	6	7	15
Jordan	3	-	5	6	14
Qatar	3	1	4	4	12
Aman	3	1	2	3	9
Sudan	-	1	-	7	8
U.S.A	1	1	1	1	4
Somalia	2	-	-	2	4
U.K.	2	-	-	1	3
Syria	1	-	-	2	3
Arabian Countries	2	-	1	-	3
Egypt	1	-	-	1	2
Japan	-	-	1	1	2
Lebanon	2	-	-	-	2
Far East Countries	-	-	1	1	2
India	-	-	-	2	2
African countries	-	-	1	1	2
Pakistan	-	-	-	2	2
Yugoslavia	-	-	1	-	1
France	-	-	1	-	1
Cyprus	1	-	-	-	1
Morocco	1	-	-	-	1
Ethiopia	-	-	-	1	1
China	-	-	-	1	1
Senegal	-	-	-	1	1
European Countries	-	-	1	-	1
Tunisia	-	-	-	1	1
S. Yemen	-	-	-	1	1
Gabon	-	-	1	-	1
Germany	1	-	-	-	1
Total	57	18	65	96	236

* means number of plants mentioning the name of a country.

N = 116

Table 5.8.4 : Distribution of exporting obstacles by industrial sector

Sector / Items	F	P	C	M
		Means		
High Transportation Costs	2.65	1.50	2.56	2.72
Lack Of Information	3.44	2.40	2.88	2.28
Uncompetitive price	3.58	2.20	2.91	2.60
Duties On Imported Materials	4.08	2.50	3.66	3.18
Insufficient Subsidy	4.16	2.40	3.19	3.56
Lack Of Finances	4.84	2.90	3.88	3.00
Superior Quality	4.00	2.90	3.75	3.61

F : food industry   C : chemical industry
P : paper industry   M : metal industry

APPENDIX C

Table 6.1.1: Significant levels (P value) for the manufacturing task items in the total sample**

Items	M-W	T-test
1. Price	0.15	0.23
2. High performance design	0.28	0.32
3. Consistent quality	0.06	0.07
4. New product introduction	**0.00***	**0.00***
5. Introducing new production processes	0.32	0.29
6. Product range	0.64	0.48
7. Wide range of product features	0.54	0.44
8. Rapid changes in product	0.79	0.46
9. Volume flexibility	0.51	0.81
10. On-time delivery	0.50	0.54
11. After sales service	0.50	0.28
12. Customised product	0.65	0.69
13. Fast delivery time	0.32	0.24
14. R & D effort	**0.00***	**0.00***

* Highly significant
** Using the Mann-Whitney test (M-W) and the T-test

Table 6.1.2: Significant levels (P value) for the manufacturing task items in the individual industries (GMs & PMs ratings)**

	GMs		PMS	
Items	K-W	ANOVA	K-W	ANOVA
1. Price	0.94	0.91	0.72	0.70
2. High performance design	0.72	0.64	0.42	0.41
3. Consistent quality	0.90	0.90	0.16	0.07
4. New product introduction	0.14	0.14	0.02	0.03
5. Introducing new production processes	0.24	0.21	0.06	0.07
6. Product range	0.46	0.36	0.14	0.13
7. Wide range of product features	0.37	0.28	0.11	0.08
8. Rapid changes in product	0.05	0.04	0.43	0.24
9. Volume flexibility	0.87	0.96	0.24	0.28
10. On-time delivery	0.10	0.14	0.78	0.52
11. After sales service	0.04	0.05	0.09	0.13
12. Customised product	**0.00***	**0.00***	**0.00***	**0.00***
13. Fast delivery time	0.18	0.36	0.14	0.11
14. R & D effort	0.53	0.58	0.22	0.23

* Highly significant
** Using Kruskal Wallis (K-W) and One Way Analysis of Variance (ANOVA)

Table 6.1.3: Distribution of the manufacturing task items by industrial sector scored by GMs

Items	Means			
	F	P	C	M
1. Price	2.89	3.09	2.84	2.83
2. High performance design	4.31	4.46	4.50	4.52
3. Consistent quality	4.89	4.82	4.81	4.83
4. New product introduction	1.96	1.64	2.75	2.40
5. Introducing new production processes	3.31	2.46	2.75	2.50
6. Product range	3.23	3.64	3.81	3.48
7. Wide range of product features	3.19	3.46	3.81	3.42
8. Rapid changes in product	3.19	4.18	3.72	3.98
9. Volume flexibility	4.23	4.36	4.34	4.29
10. On-time delivery	5.00	4.64	4.84	4.79
11. After sales service	4.08	4.00	4.34	4.33
12. Customised product	1.92	4.18	3.19	3.92
13. Fast delivery time	4.31	4.09	3.97	3.94
14. R & D effort	2.58	2.00	2.50	2.29

F : food industry P : paper industry

C : chemical industry M : metal industry

Table 6.1.4: Distribution of the manufacturing task items by industrial sector scored by PMs

Items	Means			
	F*	P*	C*	M*
1. Price	3.04	2.82	3.19	2.98
2. High performance design	4.27	4.09	4.47	4.42
3. Consistent quality	4.46	4.55	4.72	4.81
4. New product introduction	1.65	1.09	1.91	1.19
5. Introducing new production processes	2.85	1.73	2.94	2.23
6. Product range	3.31	3.46	4.00	3.63
7. Wide range of product features	3.31	3.36	4.00	3.54
8. Rapid changes in product	3.50	4.09	3.97	3.94
9. Volume flexibility	4.04	4.18	4.34	4.38
10. On-time delivery	4.65	4.46	4.78	4.67
11. After sales service	4.19	4.09	4.38	4.02
12. Product custom	1.69	3.73	3.28	3.90
13. Fast delivery time	4.46	4.18	4.19	4.00
14. R & D effort	1.96	1.36	2.00	1.73

* For description see Table 6.1.3 in this Appendix

Table 6.2.1: Significant levels for the importance of environmental uncertainty items in the individual industries**

Items	K-W	ANOVA
I1 The distributors of your products	0.31	0.16
I2 Customers of your products	0.25	0.20
I3 The suppliers of raw materials	0.92	0.95
I4 The suppliers of equipment	0.12	0.11
I5 The suppliers of product parts	0.37	0.35
I6 The supply of labour	0.99	0.97
I7 Competitors for your supply of raw materials and parts	0.03	0.02
I8 Competitors for your customers	0.26	0.15
I9 Government regulations controlling your industry	0.14	0.06
I10 The public attitudes toward your industry	0.53	0.35
I11 The relationship with your supervising ministries and chambers of commerce & industry	0.47	0.45
I12 Keeping up with new technological requirements in your industry in the production of goods	0.70	0.62
I13 Improving and developing new products by implementing new technological advances in the industry	0.27	0.45
I14 Your source of financial resources	0.87	0.83
I15 The situation of the Saudi economy	0.05	0.04
P16 The situation of world economy	0.56	0.65

** Using Kruskal Wallis (K-W) and One Way Analysis of Variance (ANOVA)

Table 6.2.2: Distribution of the importance of the environmental uncertainty items by industrial sector scored by GMs

Items		Means		
	F*	P*	C*	M*
I1 The distributors of your products	4.00	3.18	3.66	3.38
I2 Customers of your products	4.58	4.55	4.69	4.40
I3 The suppliers of raw materials	3.73	3.64	3.78	3.83
I4 The suppliers of equipment	3.39	3.18	3.47	2.90
I5 The suppliers of product parts	3.15	2.36	3.03	2.92
I6 The supply of labour	3.36	3.36	3.25	3.38
I7 Competitors for your supply of raw materials and parts	2.96	1.91	3.28	2.88
I8 Competitors for your customers	3.81	2.91	3.81	3.77
I9 Government regulations controlling your industry	3.81	2.91	3.69	3.96
I10 The public attitudes toward your industry	4.08	3.46	3.91	3.67
I11 The relationship with your supervising ministries and chambers of commerce & industry	4.08	3.55	3.97	4.06
I12 Keeping up with new technological requirements in your industry in the production of goods	4.31	4.18	4.41	4.17
I13 Improving and developing new products by implementing new technological advances in the industry	3.77	3.73	4.06	3.71
I14 Your source of financial resources	3.81	4.09	3.81	3.90
I15 The situation of the Saudi economy	4.00	4.09	4.41	4.52
P16 The situation of world economy	3.23	3.27	3.34	3.52

* For description see Table 6.1.3 in this Appendix

Table 6.2.3: Significant levels for the predictability of environmental uncertainty items in the individual industries**

Items	K-W	ANOVA
I1 The distributors of your products	0.07	0.11
I2 Customers of your products	0.05	0.05
I3 The suppliers of raw materials	0.54	0.43
I4 The suppliers of equipment	0.64	0.71
I5 The suppliers of product parts	0.31	0.31
I6 The supply of labour	0.68	0.59
I7 Competitors for your supply of raw materials and parts	0.81	0.63
I8 Competitors for your customers	0.17	0.26
I9 Government regulations controlling your industry	0.75	0.77
I10 The public attitudes toward your industry	0.10	0.17
I11 The relationship with your supervising ministries and chambers of commerce & industry	0.93	0.96
I12 Keeping up with new technological requirements in your industry in the production of goods	0.29	0.56
I13 Improving and developing new products by implementing new technological advances in the industry	0.58	0.60
I14 Your source of financial resources	0.45	0.38
I15 The situation of the saudi economy	0.99	0.98
P16 The situation of world economy	0.15	0.28

** Using Kruskal Wallis (K-W) and One Way Analysis of Variance (ANOVA)

Table 6.2.4: Distribution of the predictability of the environmental uncertainty items by industrial sector scored by GMs

Items	Means			
	F*	P*	C*	M*
P1 The distributors of your products	4.31	3.73	3.70	3.70
P2 Customers of your products	4.35	4.27	3.81	3.92
P3 The suppliers of raw materials	4.00	3.46	3.81	3.65
P4 The suppliers of equipment	3.77	3.55	3.47	3.46
P5 The suppliers of product parts	3.73	3.36	3.16	3.47
P6 The supply of labour	3.69	3.91	3.38	3.65
P7 Competitors for your supply of raw materials and parts	3.27	3.18	3.03	3.35
P8 Competitors for your customers	3.85	3.55	3.41	3.38
P9 Government regulations controlling your industry	3.31	3.00	3.25	3.42
P10 The public attitudes toward your industry	3.85	3.64	3.34	3.35
P11 The relationship with your supervising ministries and chambers of commerce & industry	3.65	3.55	3.66	3.73
P12 Keeping up with new technological requirements in your industry in the production of goods	4.08	4.18	3.81	4.04
P13 Improving and developing new new products by implementing new technological advances in the industry	3.81	3.91	3.59	3.90
P14 Your source of financial resources	4.15	4.46	3.91	4.00
P15 The situation of the saudi economy	3.46	3.55	3.56	3.52
P16 The situation of world economy	3.23	3.09	2.72	3.10

* For description see Table 6.1.3 in this Appendix

Table 6.3.1: Significant levels for the items evaluating the role of the production managers in strategic decision making in the total sample**

Items	K-W	ANOVA
RPM1	0.08	0.06
RPM2	0.28	0.22
RPM3	**0.00***	**0.00***
RPM4	**0.00***	**0.00***
RPM5	0.22	0.24

For description of items, see Table 6-6 in Chapter 6
* Highly significant
** Using Kruskal Wallis (K-W) and One Way Way Analysis of Variance (ANOVA)

Table 6.3.2: Participation of production managers in strategic decision making by industrial sector scored by GMs, and the significant levels**

	Means					
Items	F*	P*	C*	M*	K-W	ANOVA
RPM1	4.04	4.18	3.98	3.88	0.65	0.57
RPM2	4.35	4.09	4.25	4.21	0.56	0.71
RPM3	4.31	4.09	3.84	4.17	0.34	0.16
RPM4	3.69	3.73	3.53	3.31	0.29	0.31
RPM5	3.85	3.91	3.66	3.63	0.53	0.57
RPM6	4.27	4.27	3.91	3.90	0.31	0.19

* For description see Table 6.1.3 in this Appendix
For description of items, see Table 6-6 in Chapter 6
** Using Kruskal Wallis (K-W) and One Way Way Analysis of Variance (ANOVA)

Table 6.3.3: Participation of production managers in strategic decision making by industrial sector scored by PMs, and the significant levels**

Items	F*	P*	C*	M*	K-W	ANOVA
	Means					
RPM1	4.31	4.09	4.06	4.10	0.50	0.53
RPM2	4.27	3.91	3.88	4.27	0.12	0.06
RPM3	4.46	4.36	4.38	4.65	0.16	0.16
RPM4	3.92	3.73	4.09	3.96	0.48	0.60
RPM5	4.15	4.00	3.53	3.83	0.04	0.04

* For description see Table 6.1.3 in this Appendix
For description of items, see Table 6-7 in Chapter 6
** Using Kruskal Wallis (K-W) and One Way Way Analysis of Variance (ANOVA)

Table 6.3.4: Participation of production managers in strategic decision making by industrial sector scored by SMs, and the significant levels**

Items	F*	P*	C*	M*	K-W	ANOVA
	Means					
RPM1	3.89	4.18	4.03	3.79	0.22	0.29
RPM2	4.08	3.91	4.03	3.85	0.28	0.58
RPM3	4.04	3.64	3.63	3.90	0.56	0.37
RPM4	3.65	3.09	3.44	3.69	0.23	0.20
RPM5	3.69	3.64	3.88	3.44	0.07	0.15

* For description see Table 6.1.3 in this Appendix
For description of items, see Table 6-8 in Chapter 6
** Using Kruskal Wallis (K-W) and One Way Way Analysis of Variance (ANOVA)

Table 6.4.1: Significant levels for the manufacturing areas in the total sample**

Items	M-W	T-test
Rapid volume changes	0.13	0.13
High performance design	0.25	0.24
New products introduction	0.66	0.72
Rapid design changes in the product	0.59	0.64
Meeting delivery time promises	0.98	0.92
Low price	0.39	0.48
Consistent quality	0.55	0.75
Fast delivery time	0.02	0.02

** Using the Mann-Whitney test (M-W) and the T-test

Table 6.4.2: Significant levels for the manufacturing areas in the individual industries (GMs ratings)**

Items	K-W	ANOVA
Rapid volume changes	0.78	0.76
High performance design	0.92	0.95
New products introduction	0.71	0.71
Rapid design changes in the product	0.05	0.05
Meeting delivery time promises	0.29	0.37
Low price	0.95	0.95
Consistent quality	0.11	0.05
Fast delivery time	0.32	0.24

** Using Kruskal Wallis (K-W) and One Way Analysis of Variance (ANOVA)

Table 6.4.3: Manufacturing areas according to needs for improvements by industrial sector scored by GMs

Items	Means F*	P*	C*	M*
Rapid volume changes	3.92	4.00	3.81	4.33
High performance design	4.77	5.00	5.06	5.04
New products introduction	4.39	4.91	4.22	4.75
Rapid design changes in the product	5.23	5.73	5.47	4.25
Meeting delivery time promises	4.35	3.55	4.78	4.38
Low price	3.39	3.82	3.37	3.48
Consistent quality	5.96	5.09	5.13	6.33
Fast delivery time	3.85	3.91	4.16	3.22

* For description see Table 6.1.3 in this Appendix

Table 6.4.4: Significant levels for the manufacturing areas in the individual industries (PMs ratings)**

Items	K-W	ANOVA
Rapid volume changes	0.65	0.63
High performance design	0.43	0.49
New products introduction	0.69	0.69
Rapid design changes in the product	0.47	0.49
Meeting delivery time promises	0.79	0.85
Low price	0.71	0.85
Consistent quality	0.58	0.75
Fast delivery time	0.08	0.08

** Using Kruskal Wallis (K-W) and One Way Analysis of Variance (ANOVA)

Table 6.4.5: Manufacturing areas according to needs for improvements by industrial sector scored by PMs

Items	Means F*	P*	C*	M*
Rapid volume changes	4.15	4.00	4.66	4.75
High performance design	4.85	5.46	4.38	4.58
New products introduction	4.46	5.46	4.72	4.52
Rapid design changes in the product	5.31	4.82	4.88	4.48
Meeting delivery time promises	4.65	4.18	4.22	4.50
Low price	3.89	4.00	3.47	3.60
Consistent quality	5.85	5.18	5.59	5.85
Fast delivery time	4.73	4.00	5.03	3.81

* For description see Table 6.1.3 in this Appendix

Table 6.5.1: Significant levels for the infrastructure programmes in the individual industries (PMs ratings)**

	Programmes	K-W	ANOVA
INFR1	Reducing inventory costs	0.30	0.14
INFR2	Increasing inventory turnover	0.37	0.33
INFR3	Reducing raw materials and component inventories	0.06	0.04
INFR4	Reducing work-in-process inventories	0.55	0.52
INFR5	Reducing finished goods inventories	0.66	0.64
INFR6	Achieving larger production lots	0.37	0.36
INFR7	Hiring and lay-off system	0.62	0.62
INFR8	Reducing idle time	0.13	0.14
INFR9	Finding reliable subcontractors	0.56	0.60
INFR10	Stabilising workforce numbers	0.28	0.25
INFR11	Designing policies to motivate employees to work as a team	0.31	0.36
INFR12	Reducing lead time manufacturing	0.04	0.02
INFR13	Increasing warehouse space	0.17	0.18
INFR14	Developing a better master production schedule	0.44	0.56
INFR15	Close order progress control system	0.86	0.71
INFR16	Frequent work centre rescheduling capacity	0.38	0.26
INFR17	Order status reporting system	0.34	0.48
INFR18	Reducing raw material costs	0.95	0.95
INFR19	Obtaining long-term supply contracts	0.71	0.75

Table 6.5.1 (continued)

	Programmes	M-W	T-test
INFR20	Reducing the number of purchase orders per year	0.09	0.08
INFR21	Obtaining quantity discounts from suppliers	0.40	0.20
INFR22	Obtaining quantity discounts from shippers	0.14	0.08
INFR23	Developing high quality suppliers	0.38	0.29
INFR24	Developing reliable timely suppliers	0.28	0.14
INFR25	Diversifying suppliers	0.11	0.07
INFR26	Achieving independence from suppliers	0.70	0.67
INFR27	Substitution of labour by machines	0.51	0.53
INFR28	Product standardisation	0.18	0.12
INFR29	Product modularisation	0.11	0.12
INFR30	Product simplification	0.76	0.74
INFR31	Substitution of inexpensive materials or components	0.48	0.23
INFR32	Mechanised materials handling	0.74	0.70
INFR33	Automation of production lines	0.41	0.37
INFR34	Automatic inspection	0.08	0.08
INFR35	Acquiring the latest in production equipment	0.84	0.87
INFR36	Development of new features for older product lines	0.15	0.16
INFR37	Reducing direct labour costs	0.72	0.85

Table 6.5.1 (continued)

	Programmes	K-W	ANOVA
INFR38	Reducing production costs	0.52	0.66
INFR39	Worker skills diversification	0.35	0.47
INFR40	Worker training	0.32	0.44
INFR41	Worker specialisation	0.27	0.18
INFR42	Increasing worker responsibility in work planning	0.37	0.36
INFR43	Increasing worker control over work pace	0.73	0.66
INFR44	Inspectors training	0.13	0.11
INFR45	Removal of inspectors	0.07	0.03
INFR46	Improving labour productivity	0.36	0.39
INFR47	Development or improvement of quality control programmes	0.06	0.03
INFR48	Acquiring a Saudi quality mark	0.07	0.06
INFR49	Monetary incentive system	0.12	0.10
INFR50	Development or improvement of quality circle programmes	0.40	0.47
INFR51	Development of high volume products	0.43	0.53
INFR52	Development of products with high economics of scale	0.56	0.63
INFR53	Development of products with high economics of scope	0.79	0.78
INFR54	Improving co-ordination among engineering, manufacturing,& marketing	0.69	0.73
INFR55	Developing reliable foreign suppliers for components, where materials are cheap	0.04	0.04

Table 6.5.1 (continued)

Programmes	K-W	ANOVA
INFR56 Developing facilities abroad for manufacture of components for use in Saudi assembly plants where labours are cheap	0.80	0.84
INFR57 Developing facilities abroad for assembly of major product lines, where most of the production factors are cheap	0.79	0.75

** Using Kruskal Wallis (K-W) and One Way Analysis of Variance (ANOVA)

Table 6.5.2: Distribution of infrastructure programmes by industrial sector scored by PMs

	Programmes	Means			
		F*	P*	C*	M*
INFR1	Reducing inventory costs	3.35	2.80	3.53	3.23
INFR2	Increasing inventory turnover	3.40	2.90	3.43	3.48
INFR3	Reducing raw materials and component inventories	3.39	2.33	3.34	3.38
INFR4	Reducing work-in-process inventories	2.68	2.38	2.97	2.89
INFR5	Reducing finished goods inventories	3.36	3.00	3.48	3.50
INFR6	Achieving larger production lots	3.81	3.82	3.48	3.46
INFR7	Hiring and lay-off system	3.00	2.91	2.67	2.79
INFR8	Reducing idle time	3.89	3.18	3.45	3.73
INFR9	Finding reliable subcontractors	2.22	1.73	2.07	2.24
INFR10	Stabilising workforce numbers	3.65	3.00	3.37	3.63
INFR11	Designing policies to motivate employees to work as a team	3.85	3.27	3.52	3.60
INFR12	Reducing lead time manufacturing	3.96	3.09	3.94	3.54
INFR13	Increasing warehouse space	3.54	2.73	3.23	2.98
INFR14	Developing a better master production schedule	4.04	3.64	3.97	3.96
INFR15	Close order progress control system	3.69	3.82	3.61	3.48

Table 6.5.2 (continued)

	Programmes	Means			
		F*	P*	C*	M*
INFR16	Frequent work centre rescheduling capacity	3.73	3.46	3.53	3.27
INFR17	Order status reporting system	3.62	3.27	3.52	3.38
INFR18	Reducing raw material costs	4.12	4.00	4.00	4.00
INFR19	Obtaining long-term supply contracts	3.32	3.00	3.39	3.17
INFR20	Reducing the number of purchase orders per year	3.42	3.50	3.25	2.83
INFR21	Obtaining quantity discounts from suppliers	3.69	3.27	3.72	3.31
INFR22	Obtaining quantity discounts from shippers	3.50	3.09	3.55	2.96
INFR23	Developing high quality suppliers	3.85	3.73	4.00	3.56
INFR24	Developing reliable timely suppliers	3.89	3.46	3.94	3.48
INFR25	Diversifying suppliers	3.54	3.00	3.71	3.15
INFR26	Achieving independence from suppliers	3.48	3.18	3.55	3.25
INFR27	Substitution of labour by machines	3.31	3.55	3.34	3.04
INFR28	Product standardisation	4.08	3.64	4.03	3.67
INFR29	Product modularisation	3.67	2.80	3.39	3.21
INFR30	Product simplification	3.57	3.18	3.32	3.35
INFR31	Substitution of inexpensive materials or components	2.92	2.70	3.39	3.31

Table 6.5.2 (continued)

Programmes		Means F*	P*	C*	M*
INFR32	Mechanised materials handling	3.35	3.09	3.28	3.04
INFR33	Automation of production lines	3.62	3.73	3.38	3.17
INFR34	Automatic inspection	3.19	2.82	2.61	2.40
INFR35	Acquiring the latest in production equipment	3.68	3.73	3.74	3.52
INFR36	Development of new features for older product lines	3.81	2.91	3.47	3.31
INFR37	Reducing direct labour costs	3.73	3.64	3.72	3.85
INFR38	Reducing production costs	4.15	3.82	4.16	4.08
INFR39	Worker skills diversification	4.00	3.55	3.91	3.77
INFR40	Worker training	3.62	3.18	3.69	3.60
INFR41	Worker specialisation	3.58	3.09	3.17	3.48
INFR42	Increasing worker responsibility in work planning	3.65	3.46	3.23	3.25
INFR43	Increasing worker control over work pace	3.58	3.73	3.34	3.46
INFR44	Inspectors training	3.46	2.55	2.97	2.96
INFR45	Removal of inspectors	3.00	2.10	2.10	2.33
INFR46	Improving labour productivity	4.08	3.64	3.91	3.88
INFR47	Development or improvement of quality control programmes	4.08	3.27	4.03	3.56
INFR48	Acquiring a Saudi quality mark	3.78	2.60	3.71	3.31

Table 6.5.2 : (continued)

	Programmes	Means F*	P*	C*	M*
INFR49	Monetary incentive system	3.31	2.36	3.03	2.81
INFR50	Development or improvement of quality circle programmes	3.52	3.00	3.19	3.13
INFR51	Development of high volume products	3.24	3.09	3.48	3.13
INFR52	Development of products with high economics of scale	3.42	3.46	3.47	3.17
INFR53	Development of products with high economics of scope	3.29	3.27	3.58	3.35
INFR54	Improving co-ordination among engineering, manufacturing, & marketing	3.62	3.36	3.44	3.56
INFR55	Developing reliable foreign suppliers for components, where materials are cheap	2.23	2.00	2.78	3.04
INFR56	Developing facilities abroad for manufacture of components for use in Saudi assembly plants where labours are cheap	1.62	1.82	1.84	1.90
INFR57	Developing facilities abroad for assembly of major product lines, where most of the production factors are cheap	1.50	1.73	1.72	1.48

* For description see Table 6.1.3 in this Appendix

Table 6.6.1: Significant levels for the competitive priorities in the individual industries (GMs ratings)**

Items	K-W	ANOVA
1. Low price	0.38	0.46
2. High performance design	0.21	0.12
3. Consistent quality	0.14	0.11
4. Rapid design changes in product	0.78	0.82
5. Rapid volume changes	0.24	0.09
6. New products introduction	0.04	0.06
7. On-time delivery	0.74	0.82
8. Fast delivery time	0.31	0.39

** Using Kruskal Wallis (K-W) and One Way Analysis of Variance (ANOVA)

Table 6.6.2: Distribution of the importance of the competitive priorities by industrial sector

Programmes	Means F*	P*	C*	M*
1. Low price	3.81	3.27	3.66	3.81
2. High performance design	4.23	3.64	4.22	3.90
3. Consistent quality	4.35	4.46	4.66	4.23
4. Rapid design changes in product	3.65	3.73	3.88	3.85
5. Rapid volume changes	4.04	3.36	4.03	4.04
6. New products introduction	3.54	3.09	3.84	3.27
7. On-time delivery	4.58	4.64	4.56	4.48
8. Fast delivery time	4.27	4.09	4.22	3.98

* For description see Table 6.1.3 in this Appendix

Table 6.7.1 : Distribution of business visits by industrial sector

Performing business visits	F*	P*	C*	M*
Yes	19	6	22	39
No	7	5	10	9
Total	26	11	32	48

* For description see Table 6.1.3 in this Appendix

Table 6.7.2: Distribution of subjective performance measures by industrial sector (1986-1988)

	Means			
Items	F*	P*	C*	M*
GROI	2.31	2.18	2.25	2.20
GS	2.69	2.46	2.22	2.50
GROS	2.54	2.27	2.16	2.33

GROI: Average Annual of growth in return on investment
GS :Average Annual rate of growth in sales
GROS :Average Annual rate of growth in return on sales
* For description see Table 6.1.3 in this Appendix

Table 6.7.3: Distribution of plants' chances of survival by industrial sector (1986-1988)

	No. of plants (Frequency)				
Chances	F*	P*	C*	M*	Total
Lower chances	-	-	1	1	2
No change	11	5	15	19	50
Higher chances	15	6	16	27	64
Total	26	11	32	47	116

* For description see Table 6.1.3 in this Appendix

APPENDIX D

DEVELOPMENT OF MEASURES

The following sections describe the used procedures to develop measures for testing the hypotheses.

Perceived Environmental Uncertainty

The variable environmental uncertainty was measured by a 16-item instrument on a five point scale in two questions; A and B (see Appendix A, questionnaire A). Both questions were rated by general manager of each plant. In question A, general managers were asked to rate the importance of the 16-item, and in question B they were asked to show their ability in predicting the same items.

To derive the plant's perceived environmental uncertainty measure, the score of each item in the "predictability" question (B) was multiplied by the outcome of **dividing** the average importance score of that item **by** the sum of the average scores for all the items included in the "importance" question (A) as expressed in the next two following equations. This approach was used by Swamidass (1983), and it is more simplified than the one employed by Duncan (1972). Duncan's approach says that the perceived uncertainty score for each item is the sum of the predictability and the adequacy of information scores weighted by the importance assigned to the item.

$$WPEU = \sum_{j=1}^{n} (Pj)\ (Wj)$$

where,

WPEU: the weighted measure for environmental uncertainty.

n : the number of items included in the "predictability" question (16 items).

Pj : the predictability score for the j-th item.

Wj : the weight for the j-th item (see next equation).

j : the item number

$$Wj = \frac{Ij}{\sum_{j=1}^{n} Ij}$$

where,

Wj: the weight for the j-th item (expressed above as the outcome).

n : the number of items included in the "importance" question (16 items).

Ij: the average importance score for the j-th item.

j : item number.

Manufacturing Task

The variable manufacturing task was measured via a 14-item instrument on a five point scale by both general and production managers (see Appendix A, questionnaires A and B). The plant's manufacturing task measure (MTM) was obtained by averaging the ratings of both general and production managers on the 14 items. This is expressed in the following equation:

$$MTM = \frac{(GT1 + \ldots + GT14) + (PT1 + \ldots + PT14)}{28}$$

where,

MTM: the manufacturing task measure.

GT1 to GT14 : manufacturing task items rated by general managers (see Table 6-2).

PT1 to PT14 : manufacturing task items rated by production managers (see Table 6-3).

Manufacturing Infrastructure

This variable, manufacturing infrastructure, was measured via a 57-item instrument on a five point scale by production managers (see Appendix A, questionnaire B). The plant's manufacturing infrastructure measure (INFRA) was computed by averaging the ratings of production managers on the 57 items. This is expressed in the following equation:

$$INFRA = \frac{\sum_{j=1}^{n} INFRj}{57}$$

where,

INFRA: the manufacturing infrastructure measure.

n : the number of items included in the measure (57 items).

INFRj: the infrastructure score for the j-th items.

j : the item number.

The role of the Production Manager

The variable production manager's role was measured via a 5-item instrument on a five point scale by both general and production managers (see Appendix A, questionnaires A and B). The ratings by both managers yielded two independent instruments for the role of the production manager in strategic decision making. The grand average for each instrument was achieved by averaging the rating of each type of manager on the 5 items. This is expressed by the following equations:

$$RPMG = \frac{\sum_{j=1}^{n} RPMj}{5}$$

$$RPMP = \frac{\sum_{j=1}^{n} RPMj}{5}$$

Where,

RPMG: the production manager's role measure (general managers ratings).

RPMP: the production manager's role measure (production managers ratings).

n : the number of items included in the measure (5 items).

RPMj: the score of the instrument for the j-th item.

j : item number.

Performance

As mentioned in the methodology chapter, plant's performance was measured via two instruments by general managers; objective and subjective measures.

A composite measure was derived by averaging the three subjective measures; growth in return on investment (GROI), growth in sales (GS), and growth in return on sales (GROS) as shown below:

$$\text{The composite measure} = \frac{GROI + GS + GROS}{3}$$

Uncertainty-task Congruence

Uncertainty-task measure (UTCONG) was developed as a binary variable. This binary variable was assigned the following values:

- zero: If plants exhibited high congruence.
- one : If plants exhibited low congruence.
- two : If plants exhibited no congruence.

According to the above assigned values, plants were partitioned into three groups:

Group 1: plants above average in both perceived environmental uncertainty and manufacturing task variables, i.e., high congruence.

Group 2: plants below average in both perceived environmental uncertainty and manufacturing task variables, i.e., low congruence.

Group 3: plants above average in perceived environmental uncertainty and below average in manufacturing task variables and vice versa, i.e., without congruence.

Task-Infrastructure Congruence

The task-infrastructure measure (TICONG) was developed as a binary variable. Similar to the previous binary variable UTCONG, after assigning the values 0, 1, 2, plants were divided into three groups as shown below:

Group 1: plants above average in both manufacturing task and infrastructure variables, i.e., high congruence.

Group 2: plants below average in both manufacturing task and infrastructure variables, i.e., low congruence.

Group 3: plants below average in manufacturing task and above average in infrastructure variables or vice versa, i.e., without congruence.

Task Congruence

The task congruence measure (TCONG) was computed as the difference of the average ratings between general and production managers on manufacturing task, as shown below:

$$TCONG = \frac{(GT1+...+GT14)}{14} - \frac{(PT1+...+PT14)}{14}$$

where,

TCONG: the task congruence measure

GT1 to GT14: the rated manufacturing task items by general managers.

PT1 to PT14: the rated manufacturing task items by production managers.

Since TCONG measures the difference and not the congruence between top management and production management, the smaller the value of TCONG, the greater the task congruence. Also, since TCONG is computed by taking the difference of the grand average between general and production managers on manufacturing task, and generally the ratings of general managers are higher than the ones by production managers in this aspect (see Chapter Six), the value of TCONG should be positive.

Table 7.1.1: Comparison of subjective performance measures between plants with and without uncertainty-task congruence in the food and paper industries

(Hypotheses 3: test 1)

Measure	Performance (Means) Plants with congruence n	(1&2)	Plants without congruence n	(3)	significance
Food					
Composite	13	2.44	13	2.59	0.44**
GROI	13	2.15	13	2.46	0.15**
GS	13	2.69	13	2.75	0.57**
GROS	13	2.46	13	2.62	0.51**
Paper					
Composite	9	2.30	2	2.33	0.96**
GROI	9	2.22	2	2.00	0.86**
GS	9	2.44	2	2.50	0.93**
GROS	9	2.22	2	2.50	0.67**

**: Not statistically significant
Composite: averaging GROI, GS & GROS
GS : growth in sales
GROI: growth in return on investment
GROS: growth in return on sales

Table 7.1.2: Comparison of subjective performance measures between plants with and without uncertainty-task congruence in the chemical and metal industries

(Hypotheses 3: test 1)

Measure	Performance (Means) Plants with congruence n	(1&2)	Plants without congruence n	(3)	significance
Chemical					
Composite	15	2.16	17	2.25	0.66**
GROI	15	2.27	17	2.24	0.89**
GS	15	2.07	17	2.35	0.27**
GROS	15	2.13	17	2.18	0.87**
Metal					
Composite	29	2.32	17	2.37	0.74**
GROI	29	2.14	17	2.29	0.40**
GS	29	2.52	17	2.47	0.77**
GROS	29	2.31	17	2.35	0.84**

For measures description see Table 7.1.1 in this Appendix.
**: Not statistically significant.

Table 7.1.3: Comparison of objective performance measures between plants with and without uncertainty-task congruence in the food and paper industries

(Hypotheses 3: test 1)

	Performance (Means)				
Measure	Plants with congruence		Plant without congruence		
	n	(1&2)	n	(3)	significance
Food					
ROI 86	8	12.0	3	-3.46	0.17**
ROI 87	8	12.5	4	-3.25	0.19**
ROI 88	8	13.6	4	6.68	0.14**
Sales 86	9	19810972	4	13247532	0.49**
Sales 87	9	23521760	4	16990411	0.58**
Sales 88	9	24975072	4	21873514	0.64**
ROS 86	8	13.9	3	-0.20	0.17**
ROS 87	8	14.2	4	-2.80	0.15**
ROS 88	8	11.7	4	6.73	0.19**
Paper					
ROI 86	2	14.6	0	-	-
ROI 87	2	11.3	0	-	-
ROI 88	3	9.03	1	18.0	0.25**
Sales 86	2	9440902	1	5333000	0.60**
Sales 87	2	12057900	1	6400000	0.64**
Sales 88	2	1297700	1	10549000	0.92**
ROS 86	3	14.3	0	-	-
ROS 87	3	14.4	1	2.0	0.25**
ROS 88	3	16.6	1	15.0	0.84**

For measures description see section 6.8.3 (Chapter 6).
**: Not statistically significant.

Table 7.1.4: Comparison of objective performance measures between plants with and without uncertainty-task congruence in the chemical and metal industries

(Hypotheses 3: test 1)

Measure	Performance (Means) Plants with congruence n	(1&2)	Plants without congruence n	(3)	significance
Chemical					
ROI 86	8	20.5	5	5.24	0.13**
ROI 87	8	14.4	5	10.7	0.52**
ROI 88	7	13.9	5	5.34	0.19**
Sales 86	6	13722430	6	8935297	0.51**
Sales 87	6	12972774	6	9733035	0.43**
Sales 88	6	8929719	6	6732652	0.37**
ROS 86	8	16.7	5	-1.52	0.21**
ROS 87	8	17.7	5	7.84	0.36**
ROS 88	7	15.2	5	6.38	0.11**
Metal					
ROI 86	13	12.5	6	2.26	0.57**
ROI 87	13	11.2	6	14.3	0.30**
ROI 88	15	13.5	7	12.1	0.65**
Sales 86	16	14395973	9	6878179	0.33**
Sales 87	16	15470500	9	8408201	0.33**
Sales 88	16	18690533	9	13577344	0.36**
ROS 86	11	9.92	5	13.1	0.46**
ROS 87	13	9.50	5	12.7	0.46**
ROS 88	15	10.6	6	12.3	0.62**

For measures description see section 6.8.3 (Chapter 6).
**: Not statistically significant.

Table 7.2.1: Comparison of subjective performance measures between plants with and without task-infrastructure congruence in the food and paper industries

(Hypothesis 4: test 1)

Measure	Performance (Means) Plants with congruence n	(1&2)	Plants without congruence n	(3)	Significance
Food					
Composite	12	2.36	14	2.64	0.17**
GROI	12	2.17	14	2.43	0.23**
GS	12	2.58	14	2.79	0.37**
GROS	12	2.33	14	2.71	0.13**
Paper					
Composite	6	2.33	5	2.27	0.83**
GROI	6	2.33	5	2.00	0.40**
GS	6	2.33	5	2.60	0.43**
GROS	6	2.33	5	2.20	0.65**

For measures description see Table 7.1.1 in this Appendix.
**: Not statistically significant.

Table 7.2.2: Comparison of subjective performance measures between plants with and without task-infrastructure congruence in the chemical and metal industries

(Hypothesis 4: test 1)

Measure	Performance (Means) Plants with congruence n	(1&2)	Plants without congruence n	(3)	Significance
Chemical					
Composite	21	2.25	11	2.12	0.52**
GROI	21	2.28	11	2.18	0.60**
GS	21	2.29	11	2.09	0.47**
GROS	21	2.19	11	2.09	0.71**
Metal					
Composite	26	2.45	20	2.20	0.13**
GROI	26	2.31	20	2.05	0.16**
GS	26	2.62	20	2.35	0.11**
GROS	26	2.40	20	2.20	0.23**

For measures description see Table 7.1.1 in this Appendix.
**: Not statistically significant.

Table 7.2.3: Comparison of objective performance measures between plants with and without task-infrastructure congruence in the food and paper industries

(Hypothesis 4: test 1)

Measure	Performance (Means) Plants with congruence n	(1&2)	Plants without congruence n	(3)	Significance
Food					
ROI 86	4	2.30	7	10.9	0.35**
ROI 87	5	1.66	7	11.2	0.24**
ROI 88	5	8.50	7	13.2	0.28**
Sales 86	5	102677366	8	26462550	0.53**
Sales 87	5	12611244	8	28922531	0.51**
Sales 88	5	14750330	8	34389278	0.48**
ROS 86	4	4.33	7	13.3	0.29**
ROS 87	5	1.28	7	13.7	0.16**
ROS 88	5	8.86	7	10.8	0.58**
Paper					
ROI 86	1	0.50	1	28.6	0.15**
ROI 87	1	0.50	1	22.1	0.19**
ROI 88	3	8.27	1	20.3	0.13**
Sales 86	2	4507402	1	11687000	0.14**
Sales 87	2	4941999	1	13957980	0.16**
Sales 88	2	8792144	1	16620940	0.23**
ROS 86	1	1.80	2	20.6	0.27**
ROS 87	2	2.1	2	20.6	0.29**
ROS 88	2	10.2	2	22.2	0.35**

For measures description see Table 6.8.3 (Chapter 6)
**: Not statistically significant.

Table 7.2.4: Comparison of objective performance measures between plants with and without task-infrastructure congruence in the chemical and metal industries

(Hypothesis 4: test 1)

Measure	Plants with congruence n	(1&2)	Plants without congruence n	(3)	Significance
Chemical					
ROI 86	9	15.4	4	12.8	0.74**
ROI 87	9	12.0	4	15.0	0.54**
ROI 88	9	11.6	3	6.7	0.38**
Sales 86	8	6307604	4	17893660	0.22**
Sales 87	8	6532372	4	22577615	0.29**
Sales 88	8	7079456	4	9334645	0.30**
ROS 86	9	8.16	4	13.2	0.56**
ROS 87	9	13.5	4	14.9	0.85**
ROS 88	9	12.3	3	9.40	0.68**
Metal					
ROI 86	12	2.45	7	10.7	0.21**
ROI 87	12	13.4	7	10.1	0.33**
ROI 88	13	15.4	9	9.7	0.19**
Sales 86	16	19388544	9	6292939	0.28**
Sales 87	16	20941902	9	8820024	0.35**
Sales 88	16	24044210	9	14339759	0.36**
ROS 86	10	8.08	6	15.6	0.29**
ROS 87	11	9.61	7	11.7	0.45**
ROS 88	12	11.3	9	10.9	0.89**

Performance (Means)

For measures description see Table 6.8.3 (Chapter 6)
**: Not statistically significant.

APPENDIX E

Table 8.1.1: A detailed principal components factor loadings matrix for the infrastructure programmes (Total sample)

Infr	FC1	FC2	FC3	FC4	FC5	F C 6	F C 7
2	.05	.03	.01	.11	-.01	.09	.34
3	.01	-.05	.12	-.01	.15	.04	**.84**
4	.16	-.01	.10	-.01	-.02	-.02	.16
5	.01	.03	-.03	.01	-.23	.09	**.79**
6	.38	.30	.19	.15	.23	-.14	.20
7	.23	.15	.07	.04	-.03	.05	.23
8	.24	.39	.09	-.08	-.08	.09	**.45**
9	.07	-.18	-.06	.14	.06	.02	-.12
10	.29	.04	.20	.16	.09	.11	**.40**
11	.01	.07	.15	.11	.14	.20	.08
12	.12	.32	.02	.05	-.09	.01	-.14
13	.18	.28	.14	.22	.07	.19	.10
14	.10	.24	.26	**.47**	.29	.36	.29
15	.01	.16	.30	**.57**	.09	.44	-.12
16	.15	.24	.17	.19	-.02	.33	-.11
17	.15	.08	.12	.22	.02	.05	.13
19	.21	.09	.04	.12	.25	.08	-.05
20	.40	.24	.25	.03	.22	.10	-.02
21	**.72**	-.02	.13	.19	.01	-.06	-.10
22	**.70**	.08	.11	.18	-.05	-.08	-.07
23	**.82**	.11	.02	.02	.18	.11	.07
24	**.80**	-.01	-.18	.09	.21	.13	.11
25	**.82**	.04	.12	-.03	.01	.21	.06
26	**.51**	.19	.37	.26	-.10	.16	.08
27	.25	**.56**	.31	.26	.20	-.02	-.08
28	.16	.30	.03	.41	-.03	.26	.20
29	.27	.22	.05	**.77**	.12	.11	.02
30	.05	.07	.00	**.78**	.12	-.03	-.02
31	.31	.19	.08	**.51**	.14	-.11	.06
32	.40	**.61**	-.07	.05	.26	.03	-.01
33	.03	**.87**	.03	.08	.13	.04	.10
34	.03	**.77**	.12	.12	.06	.25	-.11
35	-.02	**.66**	.18	.20	.28	.11	.10
36	.06	.48	**.51**	.20	.35	.11	.16
38	.21	.14	.15	.16	.11	.20	.02
39	.12	.12	.45	.12	.10	.09	.17
40	.17	.01	**.74**	.03	.21	.11	.09
41	-.07	.22	**.75**	.10	-.06	.10	.12
42	-.01	.33	**.50**	.45	.22	.05	-.01
43	-.06	**.49**	.43	.05	-.12	.12	-.14
44	.28	.05	**.44**	-.11	.34	.25	.10
45	.12	.04	**.56**	-.02	.17	.22	-.27
46	.23	.06	.34	.20	.22	.25	.18
47	.09	.05	.23	.30	.21	**.48**	.08
48	.22	.18	-.04	.01	.08	**.80**	.12

Table 8.1.1: (continued)

Infr	FC8	FC9	FC10	FC11	FC12	FC13	FC14
2	.04	.02	.04	.01	**.74**	-.16	.07
3	-.01	-.07	-.05	.09	.14	.04	.05
4	.07	-.01	-.05	-.03	.03	-.04	**.82**
5	.11	.21	.04	-.02	.04	.05	.12
6	-.01	.31	-.33	.11	-.27	-.10	.09
7	.04	-.01	-.08	**.80**	-.01	-.02	-.19
8	.21	-.09	-.41	.22	.11	.01	-.05
9	-.07	.26	.10	**.66**	.01	.28	.32
10	.04	.16	-.33	.37	.21	-.01	.13
11	.22	.33	.15	**.80**	.03	.32	.11
12	**.50**	-.10	.16	.22	.12	.00	.13
13	-.28	.04	.12	.11	-.12	**.51**	.05
14	-.02	.32	-.16	.06	.03	-.05	-.16
15	.13	.16	.17	.03	-.20	-.05	.10
16	.04	**.46**	.27	-.02	-.16	.34	-.15
17	.14	**.77**	.01	.16	.01	-.06	.06
19	-.00	.04	**.72**	-.02	.07	-.03	-.10
20	.14	.00	**.60**	-.03	-.06	.16	.20
21	.30	-.17	-.06	.08	-.17	-.07	.02
22	.29	-.08	.20	.07	-.10	-.20	-.06
23	-.01	.19	-.05	.12	.06	.06	.10
24	.00	.21	.14	.00	.12	-.03	.11
25	.01	.09	.16	.09	.16	.08	.00
26	-.13	.12	.26	.15	-.06	-.31	.03
27	.06	.19	.18	.05	.18	-.08	.04
28	.21	.19	**.44**	.24	.06	-.13	-.04
29	.10	-.10	.26	.07	-.04	.17	.03
30	.11	.27	-.02	.10	.15	.12	.01
31	.15	.15	-.11	-.12	.41	.04	-.24
32	.15	.37	.05	.04	.12	.19	-.14
33	.12	.08	.03	-.02	-.03	.05	.06
34	-.14	.01	-.02	-.01	.00	-.01	-.09
35	.25	-.05	.19	.11	-.06	.17	-.03
36	.16	.16	.06	-.11	.02	.00	-.05
38	**.78**	.11	.05	.00	.11	.06	.08
39	**.60**	.06	.14	.01	-.01	-.11	.15
40	.24	.20	-.01	.06	-.00	-.07	.07
41	.18	.07	.01	-.07	.02	.28	.12
42	.04	-.23	-.05	.05	.06	.04	.12
43	.04	-.29	.06	.11	.36	.21	.19
44	.12	.38	.07	-.05	.21	.19	-.19
45	-.04	-.07	.28	.36	.01	.07	-.22
46	**.53**	.20	-.21	-.03	.12	.02	-.21
47	.28	.34	.16	-.15	.03	.14	-.08
48	.09	.10	.13	-.01	.07	-.02	.06

Table 8.1.1: (continued)

Infr	FC1	FC2	FC3	FC4	FC5	FC6	FC7
49	.01	.05	.16	.01	.12	**.62**	-.10
50	.04	.15	.40	.08	.17	**.70**	.19
51	.13	.27	.04	-.04	**.79**	.16	.00
52	.08	.23	.25	.19	**.78**	.18	.10
53	.09	.06	.08	.30	.74	.01	.00
54	.11	.12	.26	.22	.05	.08	.14

Table 8.1.1: (continued)

Infr	FC8	FC9	FC10	FC11	FC12	FC13	FC14
49	.26	-.09	-.03	.14	.46	.10	-.07
50	.03	-.02	-.02	.13	-.07	.13	-.04
51	.07	-.06	.17	.04	-.11	-.13	-.05
52	.11	.06	.04	.04	-.03	.02	.07
53	.05	.13	.15	-.03	.17	.22	-.03
54	.29	.06	-.16	.27	-.10	**.56**	-.19

Table 8.1.2: A detailed principal components factor loadings matrix for the competitive priorities (Total sample)

Competitive Priorities	Factor 1	Factor 2	Factor 3
1. High performance design	**0.77**	0.12	0.07
2. On-time delivery	**0.75**	0.11	-0.04
3. Fast delivery	**0.72**	-0.08	0.32
4. Consistent quality	**0.68**	0.19	-0.36
5. Product flexibility	0.04	**0.84**	-0.02
6. Volume flexibility	0.14	**0.71**	0.10
7. Low price	-0.06	0.03	**0.86**
Eigenvalue	2.47	1.15	1.11
% of variance	30.9	14.4	13.9
Cumulative percentage	30.9	45.3	59.2

Table 8.1.3 : Relationships between focused sets of competitive priorities and components of manufacturing strategy (Total sample)

	Canonical Functions		
	1*	2**	3**
Canonical correlation between pair of variates	0.57		
(significance)	(.025)	(.166)	(.330)
	Canonical loadings		
Predictor variables (Competitive priorities indices)			
Quality-Delivery	0.08	-0.97	-0.22
Flexibility	0.30	0.06	-0.95
Low Price	**0.95**	-0.02	0.30
Criterion variables (Manufacturing strategy indices)			
Suppliers Management	**0.52**	-0.19	-0.48
Automation Management	-0.14	0.04	-0.40
Improving Workforce Skills Management	-0.09	-0.40	-0.38
Product Control Management	0.10	-0.27	-0.62
High Volume Products	-0.20	0.01	-0.33
Quality Management	0.19	-0.54	-0.27
Inventory Management	**0.49**	-0.10	-0.39
Increasing Productivity Management	0.23	-0.33	-0.48
Information System Management	-0.01	-0.57	-0.39
Purchasing Control Management	0.20	-0.28	-0.04
Human Resources Management	0.19	0.13	-0.39
Turnover Management	0.02	-0.16	-0.18
Co-ordination Management	0.35	0.18	-0.37
Work-in-process Management	-0.14	0.02	-0.55

* Statistically significant
** Not statistically significant

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