CRANFIELD UNIVERSITY

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A METHODOLOGY OF MANUFACTURING STRATEGY ANALYSIS FOR THE MANUFACTURING INDUSTRIES IN SAUDI ARABIA

SCHOOL OF INDUSTRIAL AND
MANUFACTURING SCIENCE

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A Methodology of Manufacturing Strategy Analysis for the Manufacturing Industries in Saudi Arabia

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ABSTRACT

To further enhance the progress made by its manufacturing industries during the last two decades, the Sixth Development Plan of Saudi Arabia has stressed the importance of diversifying the country's economic base, reducing its dependence on the production and export of crude oil, and increasing the industrial sector's contribution to GDP. Since national level industrial policies cannot succeed without the full participation and support of the individual companies, it is necessary for its manufacturing organisations to adopt appropriate methods for increasing their overall competitiveness.

This research is concerned with the development of a methodology for manufacturing strategy formulation to help Saudi companies achieve competitiveness in both the local and the international market environment. The work has resulted in a prototype methodology known as MSAMSA - a Methodology of Manufacturing Strategy Analysis for the Manufacturing Industries in Saudi Arabia. The basic concepts of MSAMSA is based on a framework developed previously by the CAMSD research team at Cranfield University, UK. However, the structure and procedures have been further developed to reflect Saudi-specific requirements, and to help link the country's long-term industrial policy to the medium-term strategic direction of the individual companies. In particular, MSAMSA adopts a generic, extended scheme of manufacturing strategy evaluation, tackling a number of key requirements such as: the need for a more structured way to coherently link strategic policies at different levels, and the need to provide both local-level (internal) and global-level (external) measures to prioritise and evaluate strategic concerns.

Industrial case studies have shown that MSAMSA's approach and compatibility with the current national level policies are both timely and conceptually logical. In addition, these have also highlighted issues which may be of value to the authorities' future decision-making. Therefore the methodology's further enhancement and application are anticipated to be of national importance.

Due to its generic nature, it should be possible to adopt the extended scheme to satisfy the needs of manufacturing companies within different industrial sectors or even in different countries.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 INTRODUCTION

1.1 Background

This research is concerned with the development of a methodology for manufacturing strategy formulation, specifically structured to help manufacturing companies in Saudi Arabia to achieve competitiveness in both the local and the international market environment. The work reported in this thesis has resulted in a relatively well structured prototype methodology which, once further enhancement is carried out, may be adopted as the official Saudi Arabia government approach to help the manufacturing companies in the country to link the government's long-term, national industrial policy to the medium-term strategic direction of the individual companies.

Manufacturing is the organised activity devoted to the transformation of raw materials into marketable goods. Therefore it is also called a **secondary industry**, because this is the sector of a nation's economy that is concerned with the processing of raw materials supplied by the **primary industry** (agriculture, forestry, fishing, mining, extraction of minerals and oil, etc.) into the end products. It has been claimed that, due to their importance related to many aspects of life, the very nature of manufacturing industries can be viewed as the backbone of the society.

It is a well known fact that the primary industries (particularly those related to the production of crude oil) in the country have been well developed. However, the country's successive development plans have been focused around the following objectives:

- to diversify its economic base
- to reduce its dependence on the production and export of crude oil

- to increase the private sector's participation in the development process
- to create new job opportunities
- to develop the national manpower resources
- to establish a solid technological base

As a result, the country's manufacturing industries have made remarkable progress during 1970 (total number of factories: 199) to 1995 (total number of factories: 2234) period. The capital investment in the factories amounted to SR 151.2 billion (approximate current rate 1 UKP = 6 SR), and total manpower employment over 196,000, both increased significantly compared to the 1970s levels of SR. 2.8 billion in capital investment and around 14,000 employees respectively.

To continue this overall direction of industrial development, the country's current (the Sixth) development plan has again stressed the importance of increasing the industrial sector's contribution to GDP. The most important issues identified include:

- *Specialization and Diversification.*
- *Petrochemicals Industry and International Competition.*
- *Industry and the Environment.*
- *Ability to Develop Industrial Technology.*
- *Industrial Marketing.*
- *Industrial Information and Data Bases.*
- *Role of Incentives in Industrial Development.*
- *Support for Small Industry.*
- *Promotion of Industrial Exports.*

It was also recognised that in the case of some manufacturing industries, companies are not operating at full capacity because of their manufacturing and marketing deficiencies.

There for it would be necessary to review the performance of such industries and to study the main factors constraining productive growth, so that appropriate methods for overcoming marketing obstacles to be adopted and overall competitiveness improved.

1.2 Objectives

It is a widely accepted view that both the means and the structures of manufacturing and the environment within which manufacturing systems operate have changed radically. This new environment is generally characterised by:

- *Rapid development and application of advanced manufacturing technologies.*
- *Increasing international competition.*

Like in any other industrial country, therefore, the Saudi manufacturing companies can no longer confine themselves to short-term/local-level concerns. The companies must aim to transform their manufacturing organisations into sources of competitive advantage in the international scene, achieving the level of performance globally expected by today's customers.

Typical obstacles to achieving and maintaining a high competitiveness include the following (Wu 1994):

- *Failure to invest in new plant and equipment.*
- *Inefficient management practice.*
- *Lack of a coherent manufacturing strategy.*
- *Inadequate educational and professional training systems.*
- *Lack of awareness of the importance of manufacturing.*
- *High cost of materials and labour.*
- *Failings of economy.*
- *Culture background and social attitudes, etc.*

Amongst the above, the ability for Saudi manufacturing companies to develop effective and coherent manufacturing strategies, which are compatible with the current national policies on the country's industrial development, is clearly of vital importance. This is because national level industrial policies cannot succeed without the full participation and support of the individual companies, and vise versa. Therefore, an investigation into the concepts and structure of an effective approach of manufacturing strategy formulation for the manufacturing companies in the country, and the specification of its operational procedures, appear to be both logical and timely. It is anticipated that, once

validated, such an approach's adaptation within the relevant manufacturing sectors in the country will be of national importance.

In short, the nature of manufacturing strategy formulation approaches can be summarised as a method to help a company analyse its products, market and operations so as to identify areas of concern, and set objectives for these to be improved. In the case of Saudi manufacturing companies of today, it is particularly important to realise that any manufacturing system will inevitably be part of a business organisation which in turn operates within a macro-environment influenced by the national level policies and international market conditions. Hence there will be a hierarchy of strategies which will lead back to the decisions and strategies adopted at the higher levels. Therefore, a manufacturing system's objectives must integrate with the aims of other parts of the enterprise and of the society.

Following the above, the main objectives of this research can be summarised as:

1. To establish the conceptual framework of an effective methodology of manufacturing strategy formulation for Saudi manufacturing industries, with the aim of helping companies to develop their manufacturing strategy, which should be of an international standard and in the same time "Sixth Development Plan compatible".
2. Through case studies, to validate this framework. In addition, the case study results should also be analysed to highlight issues which may be of value to the authorities' high level decision-making regarding the future support and development of the manufacturing industries within the country.

1.3 Research Approach

This section aims to describe, explain and justify the research approach adopted throughout the project. The aim of research may be summarised as to achieve insight, understanding or knowledge that may or may not be useful and/or applicable. The scientific research approaches, typified by the "physics" approach, traditionally consist of five steps (Reich, 1994):

- Observations or preliminary studies.

- Hypothesis formation.
- Hypothesis testing.
- Hypothesis evaluation.
- Hypothesis acceptance or rejection.

Although extremely valuable in certain areas, the "pure" scientific approach may not be appropriate for managerial problems encountered in the organisational or manufacturing fields. For example, Checkland (1981) argues that it is frequently impossible to construct meaningful, rigorously controlled scientific experiments in real-world situations that adhere to the fundamental principles of replication, reductionism, and reliability. In addition, because a more rigorous 'scientific' approach can only be achieved at the expense of relevance by putting more constraints on the problem formulation, the research and its results can become further removed from the real-world context (Grant, 1996). Since the traditional goal of science is creating knowledge for the sake of knowing, but not necessarily knowledge that is relevant to practice, the "pure" scientific methodologies may hinder improving practice, because they may distance the products of the research from actual practice.

Voss (1984) has classified production and operations management research areas into four fields:

- Policy/Technology
- Priorities/Systems
- Production Functions/Engineering
- Operations research/Quantitative Approaches

Strategy/policy research in particular, whether focused on business or manufacturing strategy, can be both qualitative and quantitative in nature. It has been argued that these problems require an holistic and integrated approach, particularly with respect to how sub-systems fit together. The traditional scientific methods not only fail to provide such an holistic and integrated approach, due to their reliance on reductionism to manage complexity, but they also rely too heavily on repeatability of experimental results which

is difficult, if not impossible, to achieve within the domains of production and operations management (Wu 1994, Westbrook1995). A number of research approaches have been suggested in the literature, with the following being particularly relevant:

- ***Case Studies***. Case studies are a research method of finding out some aspects of the reality by taking a small number of examples of something and examining them in detail (Langrish, 1993). By nature, they usually involve an empirical investigation of a phenomenon within its real life context, often using multiple sources of evidence. This approach offers an advantage when the researcher has little or no control over the events being studied within the research domain, and is suitable both for studying cause/effect relationships and for describing situations. Other advantages of this approach include (Hinnells, 1993):

  ⇒ Useful for exploratory studies in relatively new areas of research.

  ⇒ Cases do not have to be representative of a larger sample.

  ⇒ Useful in their ability to trace changes over time.

  ⇒ A variety of theoretical arguments can be explored in relation to the detailed evidence of a case.

  Case studies can either be undertaken in depth in a single situation or across several sites. A criticism of multiple case studies is that, whilst they might provide more generalised conclusions than those provided by a single case, they suffer from the number of variables that change from case to case and hence from a difficulty in interpretation (Westbrook, 1995).

- ***Action Research***. An action research normally has the parallel aims of practical problem-solving and expanding scientific knowledge. It is therefore a collaborative process which involves the analysis of a problem, the construction of plans for intervening in the problem domain and the execution of such plans. The learning will occur at both the theoretical level and the practical level. Since this falls midway in the spectrum between pure basic research and pure action, it is often seen as a variant of case research (Grant, 1996). Since the strength of action research lies in its ability to deal with the emergent nature of human systems, this approach is particularly

useful to provide a theoretical frame of reference for intervention within an organisation and to guide systematic investigation and critical analysis of the problem situation. Therefore, this can be viewed as a more suitable approach for investigating manufacturing strategy methodologies, because it is not only concerned with the practical success of the case under investigation, but also with the addition to knowledge.

A particular feature of this approach is that the researcher involved needs to adapt the approach to the situation factors present in the case. In order to ensure a rigorous approach, elements of subjectivity by the researcher need to be reduced as much as possible, and both the framework and method of the researcher's intervention in the problem situation have to be defined prior to the intervention. Therefore, it has been suggested that researchers should be directly involved in the research application and not merely as observers in order to: define and understand the events through involvement; bring knowledge which they have applied and not just acquired; advise on the relevance of approaches, their application and their evaluation; and to create new knowledge and concepts from the work undertaken (Hill 1987).

Following the reasoning given above, this project adopted primarily an action research approach, and dependent on the issues being addressed, the type of information being retrieved, the models being developed and the context within which the research was being carried out, a number of different methods were used throughout the project. The various stages of the project and the methods used are as listed in Table 1.1.

1.4 Structure Of Thesis

Following Table 1.1, this thesis adopts a logical structure of discussion and presentation as outlined below:

- Review of current techniques of manufacturing strategy formulation.
- Identification of Saudi-specific requirements.
- Suggestion of an extended scheme of manufacturing strategy evaluation, taking specific requirements into consideration.

Table 1.1 The "Action Research" Approach Adopted Throughout The Project.

STAGE	OBJECTIVES	METHODS	ACTIONS & RESULTS	COMMENTS
Initial Analysis	To survey current practice.	Survey of published literature.	Review of current techniques of manufacturing strategy formulation.	These activities were carried out both at Cranfield, UK, and in Saudi Arabia.
Require-ments Specification	To identify Saudi-specific requirements.	Literature search, interviews, meetings and discussions.	•Review of both public and government documents. •Interviews and discussions with both policy-makers and factory management. •Analysis of data. •Identification of key issues.	For this purpose, the researcher managed to obtain access to relevant government information sources, and to secure meetings and interviews with some top-level personnel responsible for the industrial development in the country. These proved to be valuable.
Specific Analysis/ Hypothesis Formation	To identify gaps and suggest techniques or methods to march the requirements.	Literature review, analysis of existing methods and suggestions of further development	Initial ideas generated by the author, and then over a period of approx. 2 years continuously refined. The results were primarily the theoretical development of an extended theme of evaluation for the purpose of manufacturing strategy formulation. This to a large extent reflects the originality of the research work.	As part of the overall research being carried out by the Cranfield team, frequent research meetings, seminars and discussions were curried out at this stage, involving the project supervisor and other researchers of the team. The proposed techniques are generic, and fit into the general framework of the team's research scope.
Conceptual Design of Methodology	To specify the structure and procedures of the proposed methodology.	Same as above, but also involving meetings and discussions with Saudi companies.	Specification of a complete prototype methodology, incorporating the extended techniques into the procedures and taking Saudi-specific requirements into consideration.	As an action research project, from this stage onwards this researcher became a participant. The justification of this approach here is mainly related to action research's ability to allow the researcher to define and understand the events through involvement; to bring knowledge which he has applied (not just acquired); to advise on the relevance of the proposed approaches, their application and their evaluation; and to create new knowledge and concepts from the work undertaken.
Testing/	To validate	Case studies,	Application of the proposed	In addition to ensuring a rigorous approach, elements of subjectivity by the researcher

Evaluation of Methodology	/refine the proposed method, and to improve practice	action research.	approach on site with the researcher's active participation involving: •Training of company management •Collection of data and analysis •Regular discussion •Suggestions for improvement •Monitoring of results. •Based on the results, validate and improve the proposed methodology.	needed to be reduced as much as possible, and it was important to define and meet standards of appropriate rigour without sacrificing relevance. In order to test the approach's general applicability, therefore, the case companies covered a wide range of businesses, and were chosen due to a number of factors such as the type of products involved, the nature of the manufacturing systems and the size of their operations. These have allowed an empirical investigation of the proposed methodology in a real life context using multiple sources of evidence, and to a quite large extent they proved extremely useful for both testing the overall approach and for demonstrating the relevance of the new techniques proposed. However, it must be pointed out that: (1) Due to the limitations such as time and resources available, only a certain number of case studies could be carried out within the scope of this project (ten companies in total). Consequently one CANNOT claim that the proposed methodology and its new techniques have been completely proven. The positive results thus obtained have only demonstrated their usefulness in a practical sense. (2) Due to the nature of multiple case studies and the fact that companies differed from case to case, certain aspects of the results were difficult to interpret in a general sense. Only a few features of the new approach could be validated with relative confidence. In summary, the ten case companies have generally given a positive feedback to the proposed methodology, with a significant amount of suggestions already implemented in practice. These do provide a very positive indication about the methodology's validity and practical value.

Table 1.1 Continued.

- Specification of a complete prototype methodology.
- Case studies and validation.

Following this order, Chapter 2 aims to provide a basis for the development of the suggested framework, by reviewing the ideas and current thinking in the field of manufacturing strategy analysis. It first provides an overview of manufacturing organisation in general, and then reviews the relevant techniques of manufacturing strategy formulation. Their nature, aims, context, structure, procedures and key issues are outlined, and the approaches of a number of current techniques are discussed in more detail.

Chapter 3 then provides a relatively comprehensive overview of the past, current and future development of the manufacturing sectors in the country. Information provided here will give a clearly indication about the future direction for the Saudi manufacturing companies as a whole, and will also help establish overall guidelines to link the industrial policies at a national level to the manufacturing strategy formulation for the individual companies. The information sources of this chapter are mainly from relevant government documents.

Having clarified the issues regarding the current techniques of manufacturing strategy formulation and identified Saudi Arabia specific requirements, Chapter 4 attempts to combine these logically together to suggest a generic, extended scheme of manufacturing strategy evaluation. In particular, this generic framework provide a number of measures as well as related techniques to tackle the following key requirements:

- The need for a more structured way of linking higher level policies to the process of manufacturing strategy formulation.
- The need to provide a mechanism for both system-wide and product-group related method for evaluating manufacturing requirements.
- The need to provide both local-level (internal) and global-level (external) measures, to both qualitatively and quantitatively prioritise and evaluate manufacturing strategic concerns.

Based on the national policy of the Saudi government on the long-term development of Saudi industry, as discussed in Chapter 3, Saudi specific issues regarding its manufacturing industry's strength/weakness and threats/opportunities, are identified and incorporated into the framework in the form of a "The Sixth Development Plan Influences Table".

In addition, manufacturing performance evaluation according to both local and global expectation is particularly important for Saudi manufacturing companies. This is due to the government's policy at the macro-economic level to develop its manufacturing industry, and to expand the industry's level of export. Therefore, for a Saudi manufacturing company to be successful in the long term, it must be competitive both locally and internationally, with its performance achieving the level of expectation from both its own customer group and that of the global market. A set of generic manufacturing strategy priority profiles are developed here in an attempt to provide a guidance to help a company cross-check, qualitatively, its local requirement profile against the general global expectation.

The above are then logically integrated into an overall framework through a structured procedure for SWOT (Strength/Weakness, Opportunities/Threats) analysis. This aims to provide an effective mechanism to link the government's long-term, national industrial policy to the medium-term strategic direction of the individual manufacturing companies.

Integrating all the key issues and requirements as presented in the previous chapters, Chapter 5 presents the structure and procedures of MSAMSA - a Methodology of Manufacturing Strategy Analysis for the Manufacturing Industry in Saudi Arabia. The basic structure of MSAMSA is based on a prototype manufacturing strategy formulation and capture framework developed previously by the CAMSD (Computer-Aided Manufacturing Systems Design) research team at Cranfield University, under the leadership of Dr. B. Wu (Wu 1997a). However, the structure and procedures have been further developed to reflect the specific requirement for Saudi manufacturing industries, as discussed previously.

To evaluate the structure and procedures of MSAMSA, a number of case studies were carried out, involving ten Saudi manufacturing companies. These are reported in

Chapter 6. The case companies covered a wide range of businesses, and were chosen due to a number of factors such as the type of products involved, the nature of the manufacturing systems and the size of their operations. As an example of MSAMSA's application in practice, a relatively detailed account of one case study is provided to illustrated its key features. The results from the rest of the companies are summarised in the subsequent sections.

Finally, conclusions and further recommendations are presented in Chapter 7.

CHAPTER 2 MANUFACTURING STRATEGY FORMULATION - CONTEXT AND TECHNIQUES

This chapter provides an overview of manufacturing organisation in general, and reviews the relevant and current techniques of manufacturing strategy formulation, including their aims, context, structure, procedures and key issues. The aim of the chapter is to provide a basis for the development of the concepts of a framework to be suggested, using the ideas and current thinking in the field of manufacturing strategy analysis. In particular, the approaches of a number of current techniques for manufacturing strategy formulation are assessed.

2.1 Manufacturing Background

Nature and Significance of Manufacturing Industries

Manufacturing is the organised activity devoted to the transformation of raw materials into marketable goods. In economics terminology, these marketable goods are known as **economic goods** which cannot be obtained without expenditure (Wu 1994). This is in contrast to **free goods** which are available in unlimited quantities at no cost. Manufacturing industry is also called a **secondary industry**, because this is the sector of a nation's economy that is concerned with the processing of raw materials supplied by the **primary industry** (agriculture, forestry, fishing, mining, extraction of minerals and oil, etc.) into the end products. It is one of the most basic and important functions of human activities in modern industrial societies. A **manufacturing system** usually employs a series of value-adding **manufacturing processes** to covert the raw materials into more useful forms and eventually into finished products. The outputs from one

manufacturing system may be utilised as the inputs to another. In reality, the actual manufacturing activities are in fact highly diversified - more than 450 separate manufacturing industries have been identified with their products classified into about 20 major groups, which in turn belong to two principal categories, **consumer** and **capital goods**. Some examples of typical manufacturing industries are listed bellow:-

INDUSTRY	PRODUCT CATEGORY
Aerospace industry	capital
Ship building industry	capital
Machine tool manufacture	capital
Automotive industry	consumer & capital
Electronics industry	consumer & capital
Computer manufacture	consumer & capital
Computer software industry	consumer & capital
Metal, coal, oil	consumer & capital
Chemical industry	consumer & capital
Textile industry	consumer
Leather and fur	consumer
Clothing & footwear	consumer
Toy making industry	consumer
Wood and timber production	consumer
Paper, printing and publishing	consumer
Building materials	consumer & capital
Furniture industry	consumer
Food processing	consumer
Drink and tobacco	consumer

In an industrialised country, manufacturing industries may be viewed as the backbone of the nation's economy, because it is mainly through their activities that the real wealth is created. To any industrialised country, manufacturing is important externally as well as internally. A few of the internally and externally significant factors are listed in Table 2.1.

Internal Factors	External Factors
• Continued employment • Quality of live • Creation and preservation of skills	• National defence • Position of strength in world affairs

Table 2.1 Manufacturing Industries' Significant Factors (source: Wu 1994)

The internal significance of manufacturing in a society may be visualised by a pyramid to represent the various aspects of social structure. The upper structure of the society, representing the quality aspects of life, must be built up on the economic base of the society. Since the height of a pyramid is determined by the size and strength of its base, the quality of life (the height of the pyramid) depends upon the economic strength (the base of the pyramid). The greater the economic strength, the higher the quality of life may reach. The important thing is that the strength of manufacturing in an industrialised society to a great extent determines the strength and scale of its economic base.

The Current Environment

Both the means and the structures of manufacturing and the environment within which manufacturing systems operate have changed radically. This new environment is characterised by:

- ***Rapid development and application of computers and other advanced technologies.*** Significant changes in the techniques of manufacturing have been a dominant feature in today's manufacturing environment. It has been claimed that the manufacturing industries are in the middle of an age of radical technological change via computerisation and automation, with typical development and application including the following:

  Computer-controlled work centers (CNC, etc.)
  Robotics and other automation schemes
  Computer Aided Design (CAD)
  Computer Aided Manufacturing (CAM)
  Computer Aided Production Management (CAPM)
  Flexible Manufacturing Systems (FMS)
  Computer Integrated Manufacturing (CIM)
  Artificial Intelligence in manufacturing, etc.

  The hardware system is concerned with the actual handling and processing of production materials on the shop floor, whilst the software system is concerned with the handling and processing of manufacturing and management information, and thus the planning and control of the manufacturing systems (Price et al 1992, 1994).

- ***International competition***. Another feature of today's manufacturing environment is the customers' ever-increasing demand for variety, and hence the tough international competition. To survive, a manufacturing company in today's market must be efficient and competitive. As a result, it is a prerequisite for today's manufacturing companies to adapt advanced techniques and methodologies to maintain and increase manufacturing competitiveness.

The Systems Approach to Manufacturing Operation

Under these circumstances, efficiency and flexibility are of vital importance to the survival of a manufacturing industry, which has to operate under much more complex and difficult conditions than ever before. As the result of a new approach to manufacturing modernisation, a recent multidisciplinary engineering function called Manufacturing Systems Engineering (MSE) has been recognised as an logical and sensible way to approach the complexity involved. Unlike traditional forms of engineering concerned with production, Manufacturing Systems Engineering adopts systems approach to the design and operation of modern manufacturing systems. It incorporates the new manufacturing technologies and techniques into the manufacturing processes, so that **manufacturing systems** can efficiently support the wider company objectives.

In particular, Wu (1994) suggested an overall framework of manufacturing systems design and evaluation, with particular emphasis on systems analysis, systems design, and systems methodology. The aim is to help companies to adopt structured, systematic approaches in the design and evaluation of modern manufacturing plant, with the purpose of optimising the performance of the factory as a whole. Wu's framework is constructed around a number of concepts and techniques that help engineers and managers deal with the complicated manufacturing problems in a logical and coherent way. It consists of the following key words which relate to the main areas of concern:

- *Systems*. It is suggested that a modern manufacturing operation and its associated organisational and operational problems can be best dealt with from a systems perspective. Therefore a sound understanding of systems concepts are a prerequisite to being able to adopt such an approach for the design and operation of manufacturing systems.

- ***Manufacturing (Structures, Technologies, and Operations)***. To be able to adopt the right types of manufacturing structure, unitilise the right technologies and identify the right techniques for effective operations management are the three key requirements at the technical level regarding the success of a manufacturing system.

- ***Systems Engineering***. Systems engineering techniques provide a logical way to tackle various problems associated to a manufacturing systems design and evaluation project, providing tools to deal with both the physical structure and the information system involved, and to analyse both the static and dynamic characteristic of the manufacturing system of concern.

- ***Manufacturing Systems (Design and Evaluation)***. Finally, the systems concept, the analytical methodologies, and the technical aspects of manufacturing elements can be brought into an overall framework for manufacturing systems analysis and design. It is stressed that to achieve competitiveness, a manufacturing company must have a coherent manufacturing strategy which corresponds to its market and match its corporate strategy. The right choice of a manufacturing system for a particular application largely depends on the manufacturing task which the firm has set for itself. The following are the key steps and tools involved to help achieve this:

    - *Manufacturing strategy analysis (including business systems interface).*
    - *Conceptual system design and evaluation.*
    - *Detailed system design and evaluation.*

2.2 Manufacturing Systems Life Cycle and Manufacturing Strategy

As a result of these new requirements, many manufacturing companies are having to re-design or re-structure their manufacturing systems so that a set of coherent manufacturing strategies can be effectively supported. Since this is necessary whenever new manufacturing technologies are introduced into the organisation, or a new set of demands need to be satisfied, manufacturing systems design (MSD) projects are being carried out much more frequently than before (Wu 1994, 1997b). Therefore, similar to what is known as a *product-life-cycle*, a manufacturing system also possesses a life

cycle, and in reality a manufacturing system passes through a series of stages as shown in Figure 2.1. As shown, greenfield type MSD projects are required when a completely new system is introduced, designed and implemented to satisfy manufacturing requirements. The subsequent MSD activities, brought about by continuous improvement initiatives and projects responding to new market requirements, can be referred to as *continuous improvement* or *brownfield* type MSD projects. In both cases it is generally necessary to carry out a redesign project, requiring the utilisation of existing resources and being subject to constraints related to the existing system. This concept of *manufacturing-system-life-cycle* provides an insight into the reason why today's manufacturing organisations have to become more agile, and highlight the need for tools to help manufacturing companies restructure their organisational arrangement.

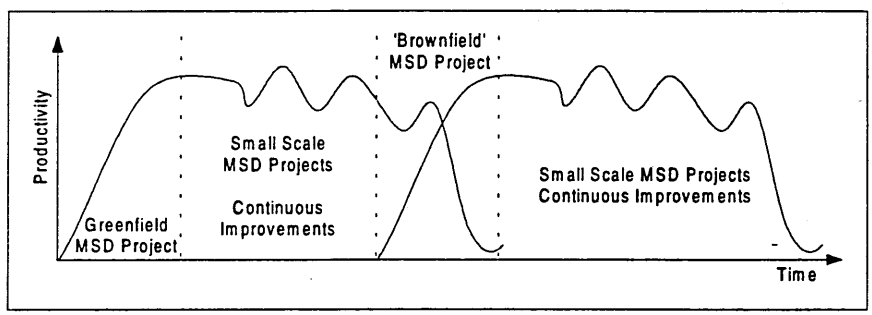


Figure 2.1 Manufacturing Systems Life Cycle (Wu 1997b)

Inevitably, the system which is being designed or redesigned will be part of a business organisation so that there will be a hierarchy of strategies which will lead back to the decisions and strategies adopted at the higher levels. Therefore, a manufacturing system's objectives must integrate with the aims of other parts of the enterprise. It is nowadays a widely accepted view that successful firms must concentrate on one or two aspects of their performance in order to achieve a competitive advantage. To achieve this, there should be a knowledge throughout a firm of what must be achieved and the priorities attached to these. Therefore, regardless of the type of MSD projects concerned, these activities should be strategically driven so that they are carried out following a coherent frame of objectives to guarantee the level of fitness-for-purpose from the resultant systems.

2.3 Nature of Manufacturing Strategy Analysis

Definition of Manufacturing Strategy

The previous sections have clearly indicated that manufacturing companies can no longer confine themselves to short-term concerns such as machine utilisation or metal cutting speeds. Long term success requires that a company continually seeks new ways to increase its overall efficiency, and to differentiate itself from competitors so as to increase its particular competitiveness. However, simply attempting to improve manufacturing practice through JIT, TQM, MRP, etc., is not generally an effective strategy for achieving competitive advantage. The companies that are able to transform their manufacturing organisations into sources of competitive advantage are those that can harness various improvement programmes to the broader goal of selecting and developing unique operating capabilities.

In summary, the nature of manufacturing strategy formulation approaches can be summarised as a method to help a company analyse its products, market and operations so as to identify areas of concern, and set objectives for these to be improved (Hayes and Wheelwright 1984, Hill 1985, Skinner 1985, Platts and Gregory 1992, Voss 1995).

A general definition of strategy proposed by Mintzberg and Quinn (1991) is:

> *"A strategy is the pattern or plan that integrates an organization's major goals, policies, and action sequences into a cohesive whole. A well-formulated strategy helps to marshal and allocate an organization's resources into a unique and viable posture based on its relative internal competencies and shortcomings, anticipated changes in the environment, and contingent moves by intelligent opponents."*

In particular, manufacturing strategy has been defined by many authors. Usually such definitions include some mention of building or positioning resources in a way which enhances a firm's position in the marketplace. For example, manufacturing strategy has been defined as:

> *"Decisions and plans affecting resources and policies directly related to the sourcing, production and delivery of tangible products* (Swink and Way, 1995)".

"Manufacturing strategy is about creating operating capabilities a company needs for the future (Hayes and Pisano 1994)".

To create such a strategy:

- A company must start with the idea that the primary way manufacturing adds value to an enterprise is by enabling it to do certain things better than its competitors can, and
- The company must develop a plan for building the capabilities it wants to acquire.

The underlying logic and process of a typical approach for manufacturing strategy formulation follow closely to that of a generic problem-solving model (Wu 1994). These may be best illustrated by the situation where one wishes to reach geographically from location **A** to **B**. Therefore, it helps to first examine what tasks are involved for one to sensibly plan a journey, and what kind of questions one should ask in order to reach the desired end in the most effective manner:

- **Where should we be ?** First of all, the starting point and the destination of the journey must be known if the best route is to be selected. The answer to this quest will identify the destination location **B**. However, for such a journey to take place a logical reason has to exist - one will not normally spend time and effort to take a journey without purpose. In searching for the location of destination, the underlying reason(s) as to why one should wish to take such a journey must first be outlined, and then background and environmental information must be gathered regarding the feasibility and constraints of the journey.
- **Where are we now ?** In order to reach the destination, one must know from where one starts the journey, as it is not of much use finding the location of where we want to go without knowing precisely our present location. Generally speaking, by comparing the desired and current positions/states, we will have identified a gap that needed to be filled.
- **What are the possible routes and means ?** There may exist a number of alternative means to reach **B** from **A**, including for example: driving or by rail, sea or air travel (each again with a number of possible routes). In order to make a choice, one must

first gather as much information as one possibly can. Aids such as route planners, time tables, information packages and previous experiences can be of great help.

- **Which route to take ?** We should now be in a position to analyse the possible consequences of each of the alternative routes, and choose the best to satisfy our particular requirements.

From a systems engineering's point of view, the nature of manufacturing strategy analysis techniques, and the processes involved, are very similar to the above. That is, to accomplish the best system changes in manufacturing, both the starting point and the desired state should be known. This requires the understanding of the current manufacturing system and the competitive requirements put on this system by its customers. It is then necessary to understand how the current system fails to achieve the current or future requirements, by identifying the reasons for the problems and the most effective route and means to fill this gap.

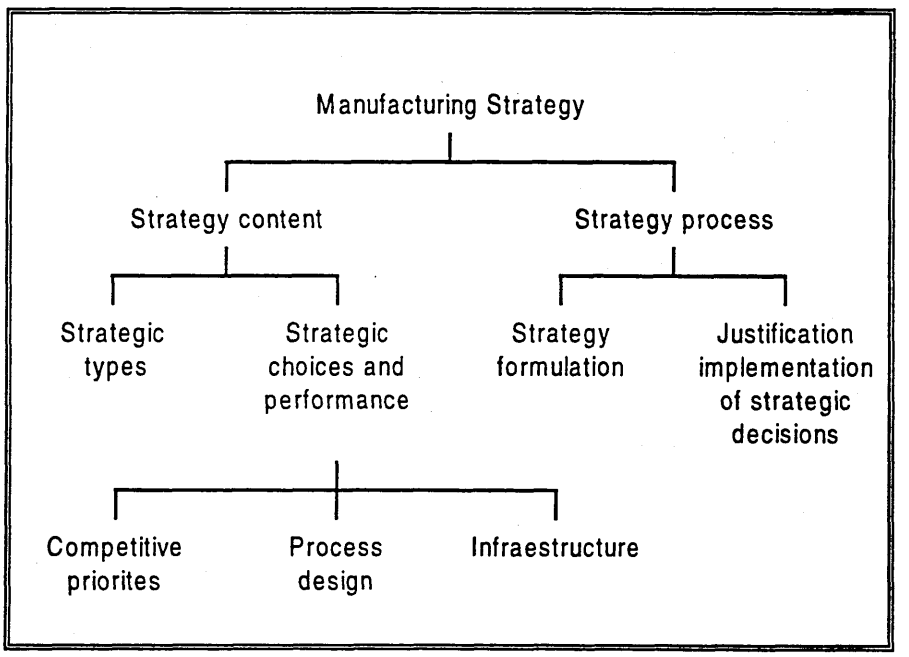


Figure 2.2 A Model of Manufacturing Strategy Research (Swink and Way 1995)

A general model of the manufacturing strategy research is usually followed as shown in Figure 2.2. The model broadly divides manufacturing strategy into the separate domains of process and content. "Process" refers to the process of formulating and implementing

strategy and "content" refers to the choices, plans, and actions that make up a strategic direction (Swink and Way, 1995).

Manufacturing Strategy Hierarchy

In the overall context of a firm and its environment the concept of strategy is commonly used at three levels (Figure 2.3). The degree to which each will impact will depend on different factors, for instance, industrial sector involved, and the level of competition (Wu 1994):

- ***Corporate level strategy*** - this concerns the market sectors in which the company, as a whole, decides to compete.
- ***Business level strategy*** - of concern here are to identify the markets in which each of the several businesses, of a company, compete and the dimension of competition involved.
- ***Functional level strategy*** - at this level, different functions have the principal or shared responsibility for supporting those factors in a company's markets on which it competes. As shown in Figure 2.3, the typical functional areas of concern at this level involve those of research and development, marketing, engineering (design, etc.) and manufacturing.

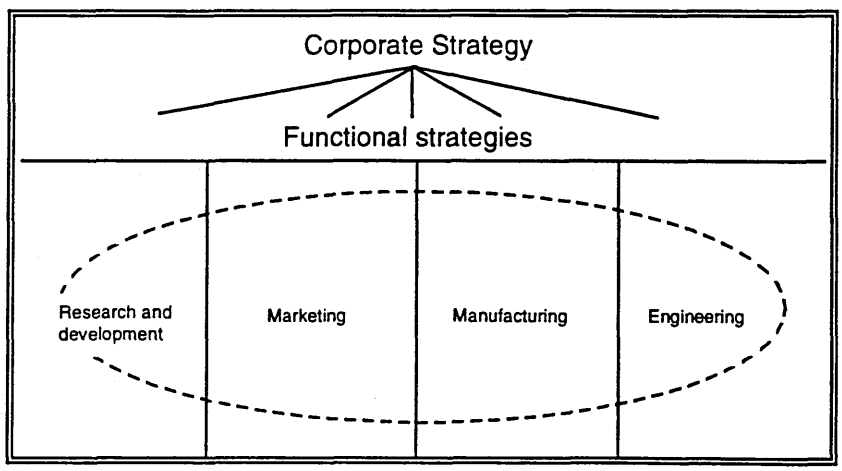


Figure 2.3 Hierarchy of Strategies

A company will compete in several markets and each function will need to develop a strategy appropriate to each of these markets. Functional strategies are concerned with investing in and developing the necessary capabilities to bring this about. Although the general point of view is the three-levels perspective, it is also possible to find authors that consider four levels. Hill (1995) considers that the first level is:

- ***Industrial level strategy*** - of concern here are issues which affect an industrial sector or reflect the level and nature of government intervention.

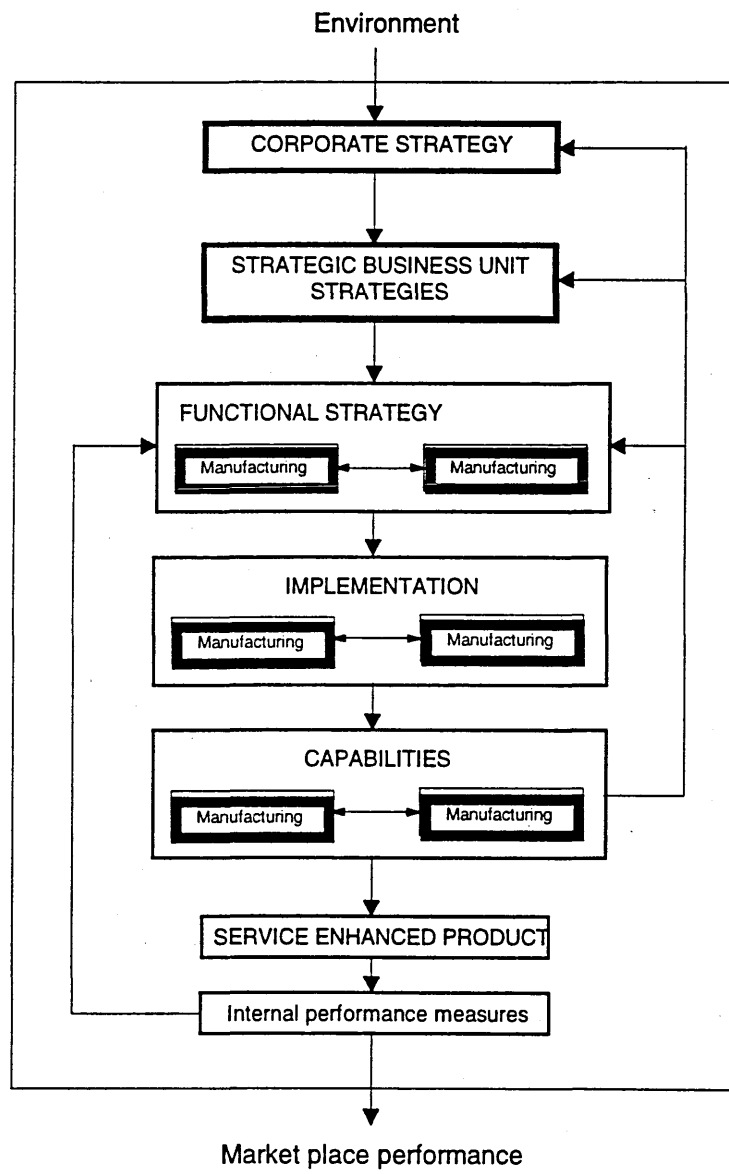


Figure 2.4 Example of A Manufacturing Strategy Planning Process (Source: Ward, Leong and Snyder, 1990)

In both perspectives, manufacturing strategy is included at the functional level, which should also be consistent with R&D, marketing, and engineering strategies:

- R&D strategic inputs may concern issues such as product design and material substitution.
- Marketing strategy issues may include branding, pricing and customer relations.
- Manufacturing strategy may include delivery reliability, price and quality conformance.
- Engineering strategy may include process development and technical support.

The first phase of the strategy process is the formulation. This develops an internal and an external analysis. This analysis allows an assessment of the current situation of the company and the strengths and weaknesses. The second phase is the implementation. After formulating the manufacturing strategy the next step is to implement it. The implementation is not only the action of purchasing and installing any advanced manufacturing technology, but also includes issues such as strategic planning for the adoption of advanced manufacturing technologies, monitoring of these technologies, pre-installation planning and justification. An example of a manufacturing strategy planning process is shown in Figure 2.4.

2.4 Current Techniques of Manufacturing Strategy Formulation

Several approaches to the formulation of manufacturing strategy have been published. An early conceptual approach was proposed by Skinner (1969). Ever since this work, which identified the absence of manufacturing in the corporate strategic planning process, the idea of formulating a manufacturing strategy tied to overall strategy has gained momentum. More recently, many approaches have developed strategic frameworks around strategic decision categories similar to those proposed by Hayes and Wheelwright (1984, 1988) including, for example, those proposed respectively by Platts and Gregory (1988, 1992), Hax and Majluf (1991) and Samson (1991). Table 2.2 provides a summary of these, indicating the main strategy contents dealt with by each.

SKINNER (1969)	HAYES AND WHEELWRIGHT (1984)	BUFFA (1984)	HAYES, WHEELWRIGHT AND CLARK (1988)	PLATTS AND GREGORY (1988)	GIFFI, ROTH AND SEAL (1990)	HAX AND MAJLUF (1991)	SAMSON (1991)
	Capacity	Capacity / location	Capacity	Capacity		Capacity	Capacity
	Facilities		Facilities	Facilities	Manufacturing capabilities	Facilities	Location
Plant and equipment	Technology	Product / process technology	Production equipment and systems	Processes	Technology	Process technologies	Technology
	Vertical integration	Position of production system		Span of process		Vertical integration	
		Strategy wrt suppliers vertical integration	Internal / external sourcing	Suppliers		Supplier relations	Supplier interface
Labour and staffing	Workforce	Workforce and job design	Human resource policies	Human resources	Human assets	Human resources	Human resources
	Quality		Quality systems	Quality	Quality and customer	Quality management	Quality
Production planning and control	Production planning and control	Strategic implications of operating decisions	Production planning	Control policies			Production control Material control
Product design / engineering			New product development	New products		Product scope and new products	Product span New products
			Performance measurement systems		Performance measurement		
Organisation and management	Organisation		Organisation		Organisation	Manufacturing organisation	
					Management approach		
					Manufacturing strategy		

Table 2.2 A Summary of Current Techniques and Their Key Contents (Wu and Hull, 1997)

In addition, Table 2.3 represents Adam and Swamidass's (1989) summary of the manufacturing strategy content variables identified in the manufacturing strategy literature. It can be seen that there is a degree of agreement, with respect to the content variable, amongst the approaches reviewed.

So far as the steps are concerned, Voss (1992) proposed a process of formulation of manufacturing strategy that is fairly typical of the current techniques. This is shown in Figure 2.5.

Content Variables	Authors					
	Hill (1985)	Miller and Roth (1988)	Schroeder *et al* (1986)	Skinner (1978)	Swamidass (1986)	Wheelwright (1984)
Capacity			Yes			Yes
Cost/Price/Productivity	Yes	Yes	Yes	Yes	Yes	
Delivery	Yes	Yes		Yes	Yes	
Product Design	Yes				Yes	
Distribution		Yes				
Employee relations			Yes			
Facilities						Yes
Flexibility	Yes	Yes	Yes	Yes	Yes	
Focus	Yes			Yes		
Infrastructure	Yes					
Quality		Yes	Yes	Yes	Yes	Yes
Return on Investment				Yes		
Service		Yes	Yes	Yes		
Standardisation	Yes					
Technology-Process	Yes		Yes	Yes	Yes	Yes
Vertical integration						Yes

Table 2.3 Manufacturing Strategy Content Variables in the Literature (Source: Adam and Swamidass, 1989)

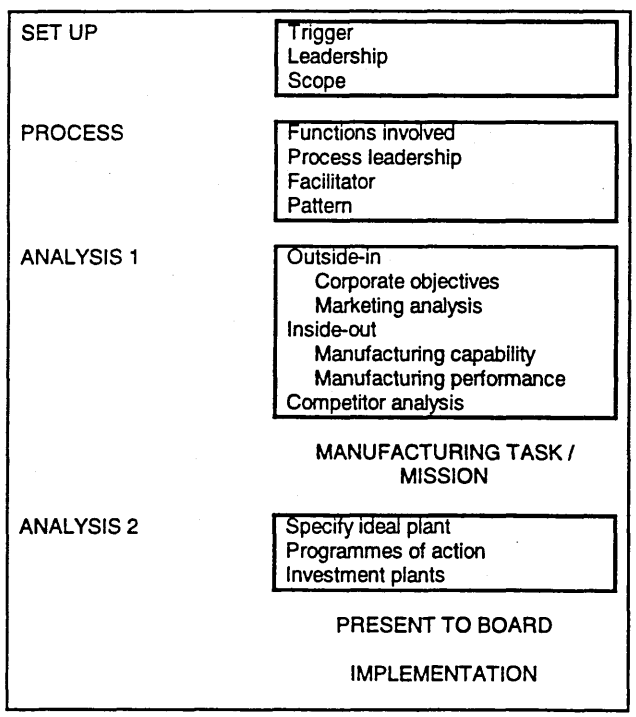


Figure 2.5 Formulating Manufacturing Strategy (Voss 1993)

However, although the need for a procedure is accepted the different stages vary. For example, Table 2.4 shows the structure of another proposal which consist of seven stages for strategy formulation (Hofer and Schendel 1978).

• Strategy identification	assessment of current strategy
• Environmental analysis	identification of opportunities and threats
• Resource analysis	assessment of principal skills and resources available to close gaps identified in the next step
• Gap analysis	comparison of the organisation's objectives, strategy and resources against the environmental opportunities and threats to determine the extent of change required in current strategy
• Strategic alternatives	identification of the options upon which a new strategy may be built
• Strategy evaluation	evaluation of the strategic options to identify those that best meet the values and objectives of all stakeholders, taking into account the environmental opportunities and threats and the resources available
• Strategic choice	selection of the options for implementation

Table 2.4 Seven Stages of Prescriptive Strategy Formulation

(Source: Hofer and Schendel, 1978)

A few of the current approaches are reviewed in more detail below.

Skinner

Skinner (1969) observed that few companies tailored their production systems to perform the tasks vital to corporate success. In addition, instead of focusing on strategy, and then designing the manufacturing systems to reflect manufacturing policies, companies tended to utilise their production systems through a 'total productivity' or 'efficiency' viewpoint. This often results in seriously non-competitive production systems.

The link between manufacturing and the corporate strategy is seen as a two-way influence. Even as early as this time it was recognised that in order to be effective, an effective link is required between manufacturing and corporate strategy. A typical observation was that a production system inevitably involved trade-offs (Table 2.5) and

compromises and hence has to be designed to perform a limited task well, with the task being defined by corporate strategic objectives. Typical variables to be traded include cost, time, quality, technological constraints and customer satisfaction.

Decision Area	Decision	Alternatives
Plant and Equipment	• Span of process • Plant size • Plant location • Investment decisions • Equipment choice • Tooling selection	• Make or buy • Big plant or several small plants • Locate near markets or near materials • Invest mainly in buildings, equipment, inventories or research • General purpose or specific equipment • Temporary, minimum tooling or 'Production' tooling
Production Planning and Control	• Frequency of inventory taking • Inventory size • Degree of inventory control • What to control • Quality control • Use of standards	• Few or many breaks in production for buffer stocks • Higher inventory or lower inventory • Control in greater or lesser detail • Controls designed to minimise downtime, labour cost or time in process, or maximise particular product output or material usage • High reliability and quality or low costs • Formal, or informal, or not at all
Labour and Staffing	• Job specialisation • Supervision • Wage system • Industrial engineers	• Highly specialised or not highly specialised • Technically trained or not technically trained first-line supervisors • Close supervision or loose supervision • Many or few job grades • Incentive wages or hourly wages • Many or few
Product Design / Engineering	• Product line Size • Design stability • technological risk • Engineering • Use of manufacturing engineering	• Many customer specials, few specials, or none at all • Frozen design or many engineering changes • Use of new processes unproved by competition or follow the leader policy • Complete packaged design or design as you go approach • Few or many manufacturing engineers
Organisation and Management	• Kind of organisation • Executive use of time • Assumed degree of risk • Use of staff • Executive style	• Functional or product focus or geographical or other • High involvement in investment or production planning or cost control or quality control or other activities • Decisions based on much or little information • Large or small staff group • Much or little involvement in detail • Authoritarian or non-directive style • Much or little contact with organisation

Table 2.5 Manufacturing Trade-off Decisions (Source: Skinner, 1969)

Skinner proposed a fifteen-step approach to manufacturing policy determination. A concise summary is provided in Figure 2.6. The sequence begins with an analysis of the competitive situation followed by a critical appraisal of the company's skills and resources and of its present facilities and approaches. The third step concerns the formulation of company competitive strategy and the fourth step defines the implications of the company strategy in terms of specific manufacturing tasks. The fifth and sixth steps analyse the constraints or limitations imposed by the economics and the technology of the industry. The seventh and eighth steps integrate and synthesize the first six steps into a broad manufacturing policy. In effect this concerns the decisions about what the company is going to make and what it will buy; how many plants to have, how big they should be and where to place them, what processes and equipment to use, what the key elements are, and what kind of management organisation would be most appropriate.

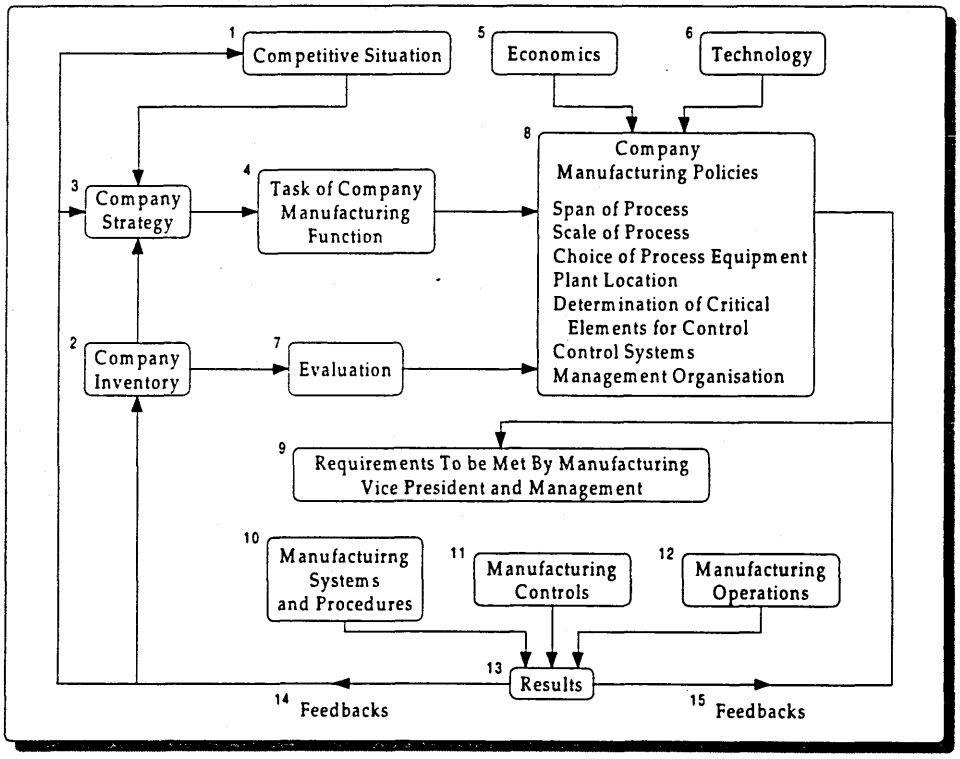


Figure 2.6 Manufacturing Policy Determination Process (Source: Skinner, 1969)

Platts and Gregory

The Platts and Gregory approach (1988, 1992) is described as a guide to auditing the manufacturing activities in order to identify the current strengths and weaknesses. There are three stages to the approach:

Stage 1: ***Understanding the market position*** - establishment of competitive requirements and evaluation of capabilities against the same criteria.

Stage 2: ***Assessing the manufacturing operation*** - establishment of what is the existing structure of the manufacturing operation and identification of the strengths and weaknesses against the competitive criteria.

Stage 3: ***Developing the new strategy*** - review of manufacturing options, determination of improvements and review of manufacturing strategy.

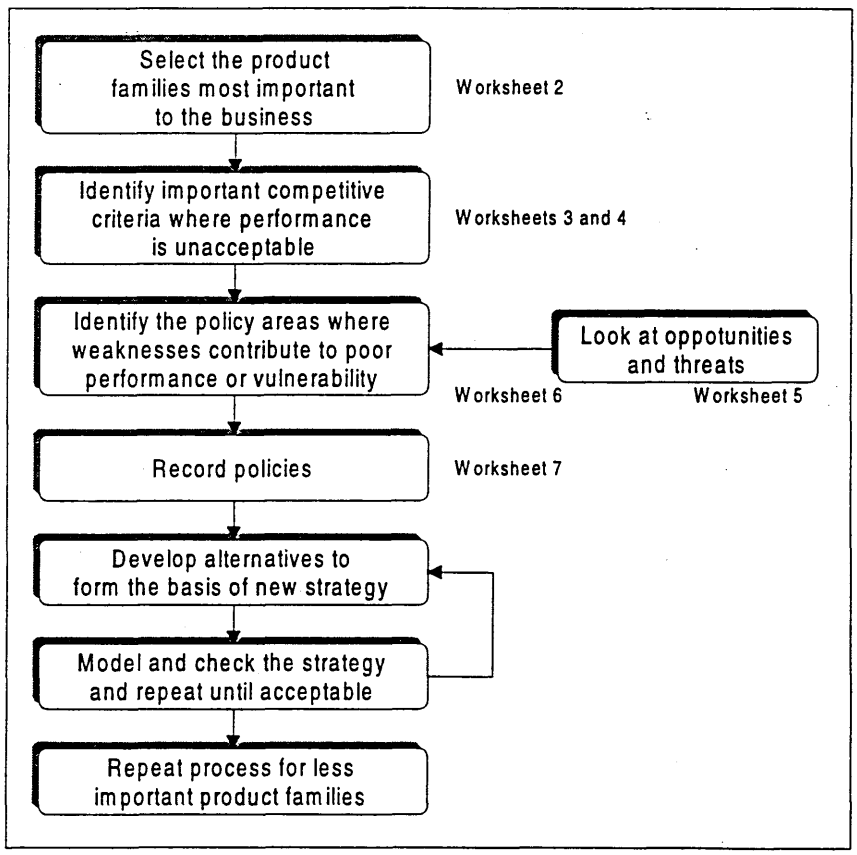


Figure 2.7 Flowchart of the Platts and Gregory Approach .

The overall development approach is presented in the flowchart diagram of Figure 2.7. The main feature of the approach is the application of worksheets to audit the current

operations and analyse the operating environment. The first worksheet simply gives the users a quick profile of the business operations, comparing market requirements and achieved performance for seven strategic criteria. It is seen as a means of graphically illustrating the need for a strategic review of manufacturing. The second worksheet is a more comprehensive analysis based on product families. The product life cycle (PLC) is used as an analytical framework for considering manufacturing requirements. Then, each product family is assessed against the following criteria:

- Percentage sales
- Percentage contribution
- Market share and competitors
- Growth and vulnerability
- Market growth and PLC stage

The aim of this worksheet is to provide a single detailed illustration of the company's products and markets in order to facilitate the identification of the important families upon which to initially focus the audit. The subsequent worksheets help identify the competitive criteria to be used and assess the current performance. The main competitive criteria are presented as being:

- Product features
- Quality
- Delivery lead-time
- Delivery reliability
- Design flexibility
- Volume flexibility
- Price

Worksheet 3 records for each product family a share allocation, indicating how each family competes or whether a criteria is an order qualifier. Worksheet 4 then uses the same criteria and rates how well the organisation performs against competitors. Data collection guidelines are suggested, such as the use of Pareto analysis and activity sampling, and typical measures for each of the criteria are presented. The choice of which measure to use is dependent upon its appropriateness to the industry. Histograms, cost stacks and ranking tables are suggested as simple tools to assist the analysis. Methods of obtaining information about competitors are also presented, though reports of applying the approach in practice have indicated that the companies tended to use

existing data or subjective assessments. Worksheet 5 attempts to look into the future in order to identify possible opportunities and threats for the organisation. Porter's concepts (1980) are presented for threats from suppliers, customers, new entrants, substitute products and existing competitors. Various analysis criteria are then suggested and the worksheet is used to record the results identified for the main product families, those under development and those at the concept stage. This worksheet was designed as a 'catch all' and as such is less structured. The application of this worksheet has been reported to be the least well used, with companies tending to concentrate on the products and markets rather than the role of manufacturing.

The sixth worksheet represents Stage Two of the approach. Its aim is to identify *'how well the existing policies support the achievement of a strong competitive position'*. Nine key policy areas are presented. Empirical evidence has suggested that each of these policy areas will contain between three and nine specific practices that shape the way in which manufacturing is performed. The aim is to identify the current practice in each of the areas and then to determine the strengths and weaknesses of this practice compared to the competitive criteria previously defined. A simple five-level ranking system is used. The nine key policy areas comprise:

- Facilities
- Processes
- Control policies
- Capacity
- Human resources
- Suppliers
- Span of process
- Quality

The results of the analyses from stage 1 and stage 2 are then combined in stage 3, using worksheet 7, to develop a new manufacturing strategy. The final stage involves checking the strategy to ensure that it is consistent with the overall business strategy; that the decisions are consistent throughout the manufacturing strategy; and that it is consistent with the business environment. It is also assessed with respect to its contribution to competitive advantage and whether it will help the organisation avoid problems encountered in production units.

The result of the analysis is a final worksheet for each product family group identified. On each final worksheet there should be entered:

a) The key competitive factors for the particular product group, recorded as *Priorities*.

b) Manufacturing policy areas contributing to weak performance with respect to market competitive criteria together with the reasons for these weaknesses.

c) Manufacturing policy areas which are not strong enough to exploit identified opportunities or negate identified threats.

d) Ideas for possible actions and strategic choices from which to develop a new strategy for each manufacturing policy area.

At each stage in the methodology, the key criteria are explained, although the criteria presented are not always a comprehensive list of what could or should be applied. Where this is the case, it is suggested that the user extend the worksheets to apply their more appropriate criteria. A number of graphical tools are suggested, with the key features of the analysis from such tools being transferred to the worksheets.

A team approach, consisting of members from a variety of departments within the organisation, is advocated for the analysis and development of the manufacturing strategy. It is suggested that the process should be completed in a series of workshops, under the supervision of a 'facilitator'. The most successful approach with respect to company participation was seen to encompass individual assessments of the worksheet, followed by group workshops to collectively complete the worksheet. A high level 'sponsor' is reported to be an important factor in the success of the process.

The justification for its audit approach is that manufacturing systems have evolved which do not satisfactorily contribute to the competitive position of companies. As such, the companies also do not possess an explicit strategy for manufacturing. It is assumed that such companies do not know how to formulate a manufacturing strategy. One reason suggested is that most of the published work in the field has tended to concentrate on the content of manufacturing strategy rather than the process by which it is formulated.

Empirical assessment of the process has revealed that the majority of the companies studied did not have clear views of their position in the market, did not appear to have adequate information on market size and growth and did not have much factual information on competitors. However, use of the process did enable the companies to identify manufacturing priorities and to define the manufacturing task.

The approach is presented as producing a starting point where the development of more competitive manufacturing systems can begin. Criticism of the methodology (Bennett and Forrester, 1993) has been targeted at its top down approach and 'market-deterministic view of manufacturing system development'. In addition, human resource management and organisation issues are not considered to be covered in adequate detail. At a more detailed level, the approach jumps from worksheets based upon the analysis of the manufacturing strategy and system with respect to product families (sheets 1 to 5) to a worksheet based upon the analysis of the manufacturing strategy policy areas with respect to the system as a whole (worksheet 6). Whilst there is a degree of continuity with respect to the competitive criteria and performance ratings, the inconsistency in the approach and the lack of instructions with respect to the assessment of the system as a whole could be considered to be a potential weakness.

Hayes and Wheelwright

Hayes and Wheelwright (1984) provide guidelines with which to achieve 'world class' levels of corporate effectiveness and competitiveness through the exploitation of the manufacturing function. A framework for analysing manufacturing effectiveness is presented. Its aim is to assist the evolution of manufacturing strategies and operations.

They propose eight major manufacturing strategy decision categories for identifying and planning an organisation's manufacturing strategy:

- Capacity
- Facilities
- Technology
- Vertical Integration
- Workforce
- Quality
- Production Planning / Materials Control
- Organisation

The first four categories (capacity, facilities, technology and vertical integration) are considered to be 'structural' decisions and to be long term in nature. The other four are considered to be tactical in nature and to represent 'infrastructure' decisions.

The development of a strategy is considered to be an interactive process involving planning and execution at various levels and in a variety of areas. It is seen as a hierarchical process (see Figure 2.8), beginning with the corporate strategy, progressing to business strategy and then to the various functional strategies of which manufacturing strategy is seen as one of several. It is the patterns of decisions made at this lower level, and the degree to which the pattern of decisions supports the business strategy, which constitute the functional strategy. Due to the interdependencies of the decisions, the activities ensuing can be classified as vertical activities or horizontal activities. Vertical activities relate a single function to the business-level strategy, or a sub-function to the overall functional-level strategy. Horizontal activities are related to multiple functions, usually at low levels. Typically these would include activities such as quality improvement, product development/manufacturing start-up or large scale engineering projects.

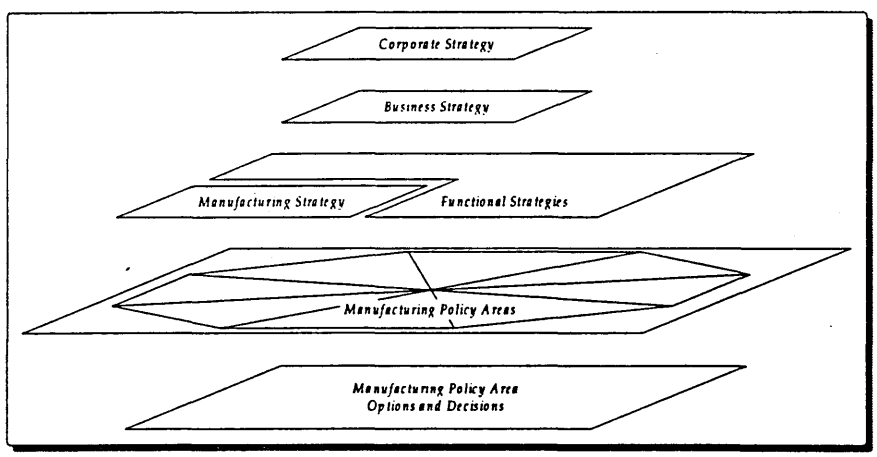


Figure 2.8 The Strategy Hierarchy and Manufacturing Strategy

As well as developing the eight decisional categories for formulating a manufacturing strategy, Hayes and Wheelwright suggest that manufacturing can play at least four major roles in a firm's competitive strategy. These roles are considered to be stages of

development through which the organisation progresses step by step. Each progression through the stages therefore represents an enhancement of the manufacturing function's capabilities and effectiveness. The four major stages are presented as a framework, which is both descriptive and a means of guiding managers when they attempt to formulate manufacturing strategies and operation:

Stage 1 - Minimise manufacturing's negative potential: INTERNALLY NEUTRAL

Stage 2 - Achieve Parity with competitors: EXTERNALLY NEUTRAL

Stage 3 - Provide credible support to the business strategy: INTERNALLY SUPPORTIVE

Stage 4 - Pursue a manufacturing-based competitive advantage: EXTERNALLY SUPPORTIVE

	STRUCTURE	INFRASTRUCTURE
Macro	• Fiscal / tax policies • Monetary Policies • Trade Policies • Industrial Policies • Capital Markets • Political Structure • Organised Labour	• Culture • Traditions • Religion • Values • Social Behaviour
Micro	• Business market selection • Plan and Equipment Decisions • Capacity / Facilities/Location specialisation • Process Technology • Vertical Integration	• Measurement and Control Systems • Workforce Policies • Vendor Relationships • Management Selection and Development Policies • Capital Budgeting / Allocation Systems • Organisation Structure

Table 2.6 Key Elements on Manufacturing Competitiveness
(Source: Hayes and Wheelwright, 1984)

The first step in the manufacturing strategy formulation process is therefore to identify at which stage in the framework the organisation, the manufacturing function in particular, is represented and the factors that have led it to be at that stage. Once this is achieved, it should

be possible to identify the changes that need to be made in order to progress to the next stage. The movements between stages 1, 2 and 3 are considered to be evolutionary in nature, involving the progress along a broad range of manufacturing 'fronts'. However, the progression from stage 3 to stage 4 is considered to be more holistic and organisation wide and as such can not be achieved solely within the manufacturing function. It concerns how the rest of the organisation views manufacturing and how it interacts with manufacturing. Two additional ingredients, which it is stressed should be present if the role of manufacturing in the business is to be strategically placed, are the need for management vision and leadership and the need to consider the implications of the *macro/micro structure/infrastructure* quadrants, particularly the micro/infrastructure aspects of manufacturing. These 'quadrants' (see Table 2.6) relate national based issues (macro) and company based issues (micro) to structural decisions or institutional relationships (structure) and human behaviour, management policies, etc. (infrastructure). Hayes and Wheelwright consider that the micro/structural elements are the appropriate starting point for most companies, but once these decisions are made correctly they must be supported by the appropriate infrastructure. Typically, this infrastructure would include among its elements: quality control systems, workforce management, production planning and materials control, organisational structure, manufacturing systems and performance measurement systems.

Hax and Majluf

Hax and Majluf (1991) also discussed the concept of manufacturing strategy within the overall framework of a hierarchical strategy. Functional strategy is seen as the lower of three strategic levels, below corporate and business strategy, although an enterprise's manufacturing strategy should be designed at all three levels. The functional strategy is viewed as comprising six strategic functional units:

- Financial strategy
- Human resources strategy
- Technology strategy
- Manufacturing strategy
- Procurement strategy
- Marketing strategy

The process of defining a functional strategy is outlined in Figure 2.9. It should be carried beyond the boundaries of the enterprise's manufacturing organisation, such that there are inputs from the corporate and business strategies and other functional units. Equally several tasks are required to be executed, covering the internal environment and the external environment. The internal environment is analysed with respect to the recognition of overall strengths and weaknesses and the determination of the specific skills required for each individual function in order to gain competitive advantage. These distinctive functional competencies are grouped as strategic categories of decisions. The external environment is analysed with respect to obtaining an understanding of the critical industrial trends and the present and future standings of key competitors. Functional intelligence is considered, which covers the current and future state of each individual function.

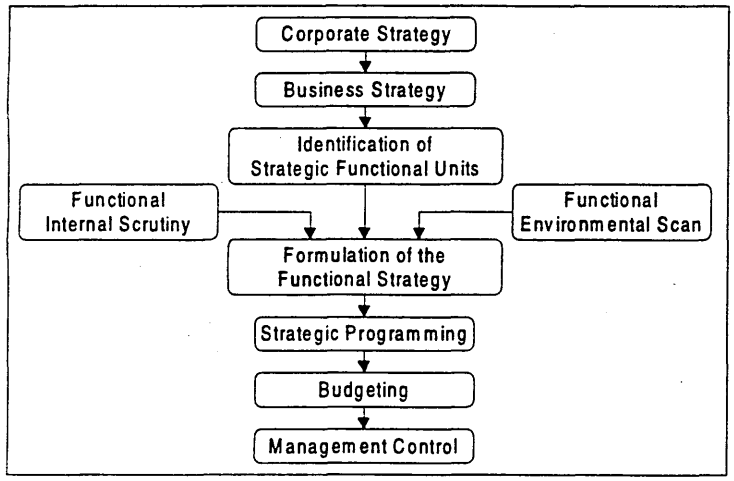


Figure 2.9 Strategy Formulation (Source: Hax & Majluf, 1991)

For each function unit, major strategic decision categories are presented together with strategic performance measures. Two decision categories are common to all the functions: the capturing of external intelligence, and the development of appropriate managerial infrastructure. The methodological approach for the development of functional strategies is presented in a similar fashion to that of Platts and Gregory (1988). The forms presented by Hax and Majluf should not be interpreted as a set of structured and mechanistic instructions but as conceptual frameworks to assist the analysis of the central issues affecting the formulation of functional strategies.

As with Platts and Gregory's approach, Hax and Majluf identify strategic manufacturing decision categories corresponding to the manufacturing policy areas:

- Facilities
- Capacity
- Vertical Integration
- Process Technologies
- Human Resources
- Quality Management
- Manufacturing Organisation
- Supplier Relations
- Product Scope and New Products

The basic approach has six steps:

a) Provide a framework for strategic decision making in manufacturing. This framework, for organising and articulating the strategy, is largely based on Wheelwright's framework (1984). It uses the above nine decision categories as well as four performance measures to address the objectives of the manufacturing strategy. These are: cost (unit cost, total cost, life-cycle cost), delivery (percentage on time, delivery date prediction, response time to demand changes), quality (return rate, product reliability, cost and rate of field repairs, cost of quality) and flexibility (product substitutability, product options and variants, response to product and volume changes).

b) Assure that business strategies and manufacturing strategy are linked.

c) Conduct an initial manufacturing strategic audit to detect strengths and weaknesses in the current manufacturing strategy by each decision category and to assess the relative standing of each product line against those of the most relevant competitors.

d) Group products by positioning the product lines in the product or process life cycle and by assessing commonality of performance objectives and product family missions.

e) Examine the degree of focus existing at each plant or manufacturing unit.

f) Develop manufacturing strategies and suggest allocation of product lines to plants or manufacturing units.

The results of the Hax and Majluf manufacturing strategy development process are:

- Long term objectives concerning the decision categories.
- Short term objectives concerning the decision categories.
- Broad action programs targeted at one or more product groups for each decision category.
- Detailed definitions of the broad action programs.

Hill

Hill (1995) pointed out that the reason for poor manufacturing effectiveness lies in the lack of effective processes for linking manufacturing strategies to corporate strategies. The manufacturing function tends to have a reactive role in the corporate strategy due to:

- The production manager's view of himself.
- The company's view of the production manager's role.
- The fact that production managers are too late in the corporate debate.
- The "can't say no" syndrome.
- The lack of functional goals and measures.
- Functional support for manufacturing being weak.
- Top management's view of strategy.

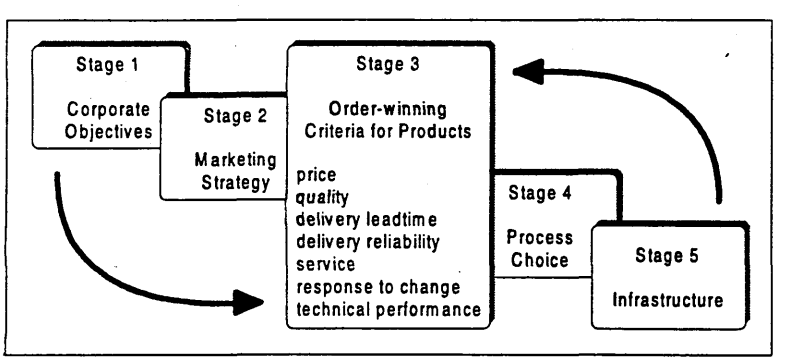


Figure 2.10 Hill's Framework (Source: Bennett & Forrester, 1993)

He proposes a process of manufacturing strategy formulation that is intended to overcome these weaknesses. He views the formulation of manufacturing strategy as a

series of discrete and sequential steps. These steps are embodied in his manufacturing strategy framework, which consists of the following five stages (Figure 2.10):

a) Defining corporate objectives.
b) Determining marketing strategies.
c) Identifying how products win orders.
d) Establishing the most appropriate mode of manufacture for the sets of products (process choice).
e) Determining the appropriate manufacturing infrastructure to support production.

The Hill framework mainly concerns the strategic management of the operations function. However, manufacturing strategy is not considered to be owned by the manufacturing function, but by the corporate level of the enterprise. Process choice and the installation of an appropriate manufacturing infrastructure are considered to be the two essential elements of manufacturing systems design within the framework. The framework has two basic applications: assessing and evaluating the effectiveness of the manufacturing operations in relation to corporate objectives and product markets, and providing guidance for the development of market-focused strategies and manufacturing systems.

Typical corporate objectives consider growth, profit, return on investment and other financial measures. Marketing strategy is defined with respect to product markets and segments, range, mix, volumes, standardisation and customisation, innovation and leader-follower approaches. Process choice involves statement of the choice of alternative processes, the trade-offs considered and the role of inventory in the process configuration. Finally, the infrastructure considers function support, the manufacturing systems, the controls and procedures, the structuring of work and the organisational structure.

The last two steps, stages (d) and (e), are seen as representing manufacturing strategy. The framework presents the concept that the manufacturing strategy should interact in an iterative manner with the corporate policies as defined in stages (a) to (d). In addition it shows how the manufacturing system can provide order winning characteristics for

products. It is perhaps these concepts which are the most important developments of the framework, i.e. that there is a need to develop a strategic difference in the operation functions of manufacturing as well as in the marketing strategy, and that there is a need to link marketing and manufacturing so that the strategies complement and interrelate.

As with the Platts and Gregory framework, the Hill framework is criticised for being top-down and overly market deterministic, and for not considering human resource management and organisation issues in adequate detail.

2.5 Open And Integrated Decision Support for Computer-Aided Manufacturing Systems Design (I/O-CAMSD)

Wu (1995) observed that, despite the obvious needs and potential advantages offered by structured MSA approaches it is quite rare for a company to actually carry out such an exercise, and carry this through to the subsequent MSD stages, mainly due to the following reasons:

- ***Time and effort required to complete a MSA process.*** Although structured and detailed, it usually takes a significant amount of time and effort for a company to follow a complete MSA procedure and produce a meaningful plan, because of the quantity and quality of data required.
- ***Missing MSA/MSD link.*** Very little is available on how to translate a set of manufacturing strategic policies into actual MSD actions.
- ***Lack of integrated computer-aided tools.*** Although previous and current projects have resulted in a better understanding of the processes involved, up to date little computer-aided support is available for manufacturing strategy formulation. Also, the available computer-aided MSD tools, although potentially powerful, are only intended for solving problems associated with individual design tasks, and again strategic linking/guidance are generally lacking.

To overcome these difficulties, a prototype of an open and integrated decision support framework for computer-aided manufacturing systems design, known as I/O-CAMSD, has been produced by Wu and his research team at Cranfield University, UK (Wu 1997a). This aims to provide manufacturing companies with a practical system which

should be capable of supporting the major MSD tasks and coordinating the individual tools. In addition, the system also provides an interface to link MSA and MSD activities. The three key stages involved are (Figure 2.11):

- Manufacturing strategy formulation and capture.
- Manufacturing strategy/manufacturing systems design interface.
- Task-centred, computer-aided manufacturing systems design.

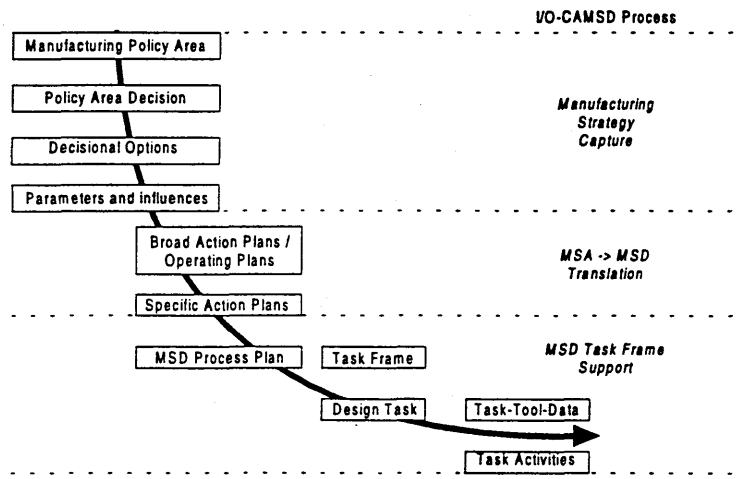


Figure 2.11 The Key I/O-CAMSD Stages (source: Wu 1997a)

The purpose of the first stage, supported by a generic frame of policy areas concerning manufacturing strategy, is to help the user to develop and capture a company's future manufacturing strategy. This is then linked to an overall task frame of MSD activities in order to identify the relevant actions needed to achieve the improvement required.

Manufacturing Strategy Policy Area	Current Practice	Competitive Criteria					
		Quality	Delivery Lead-time	Delivery Reliability	Design Flexibility	Volume Flexibility	Cost
Capacity							
Facilities							
Processes and Technology							
Vertical Integration							
Supplier relationship							
Human Resources							
Quality Systems							
Planning and Control							
Scope and New Products							
Performance Measurement							
Organisation							

Figure 2.12 The Generic MSA Frame (source: Wu 1997a)

Since there is a substantial degree of agreement amongst the different approaches to manufacturing strategy formulation, a generic manufacturing strategies frame has been developed (Figure 2.12). This provides a basis for strategy capture and the subsequent selection of MSD activities. In order to establish a MSA/MSD link, a workbook approach for the initial stages of the MSA/MSD interface has been produced. It is assumed that the users of the I/O-CAMSD framework should carry out a manufacturing strategy audit exercise and capture the decisions using the generic frame shown in Figure 2.12.

A number of MSA/MSD link-tables have been produced, and relevant MSA/MSD cause-effects relationships are embedded in these tables (Wu 1997b, see Figure 2.13). At one side of this MSA/MSD chain, the MSA contents as captured through the previous steps are used as inputs to the selecting process. The other side of the chain relates to an I/O-CAMSD Task Frame. Intermediate steps are included to guide the user through the process by presenting the user with logical options.

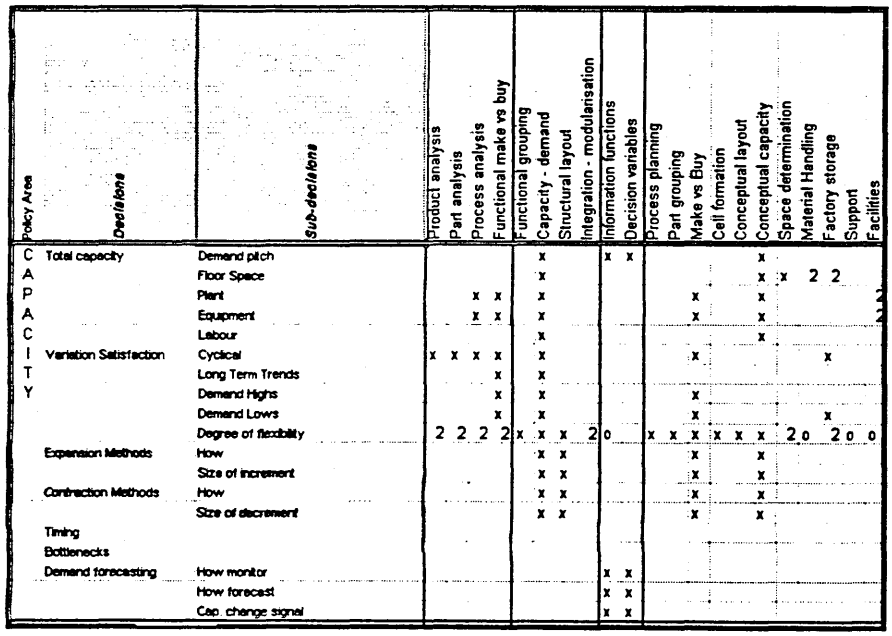


Figure 2.13. Sample MSA/MSD Linking Table (source: Wu 1997b).

Compared with the existing approaches that leave the users almost entirely on their own at this stage to identify feasible options and carry out the necessary actions, this facility will equip the users with a structured guide to enable them to make more informed decision. The I/O-CAMSD prototype has been presented to a number of UK industrial companies, and tests carried out both at the MSA/MSD linking level and the MSD task level. Feedback from these cases was reported to be positive (Wu 1997b).

2.6 The Scope of Current Research

General Requirements

So far as the techniques of manufacturing strategy formulation are concerned, it is evident that a substantial amount of relevant research has been carried out with structured approaches, tools and techniques developed to help the tasks involved. Theoretically, the nature of these approaches can be summarised as a method to help a company analyse its products, market and operations so as to identify areas of concern, and to set objectives for these to be improved.

Despite the fact that the procedures are generally logical and well document, the current approaches seem to be weak in providing specific guidance or techniques to aid the analysis involved. In other words, information packs and route planners are generally lacking which would aid a company's route planning process. This is particular true at the gap analysis stage, when a company is expected to carry out a valid SWOT (strength/weakness, opportunities/threats) analysis.

A number of key questions need to be addressed, such as: How does a company know what is the level of performance to aim for (This is of particular importance for manufacturing companies in a country like Saudi Arabia, where the macro-economical environment, the infrastructure and the current government policy on industrial development are very much different from that in the Western countries)? In an attempt to improve the situation in general, and to find an effective approach to adopt such techniques in Saudi Arabia in particular, an extended evaluation scheme of manufacturing evaluation needs to be developed and the following issues addressed:

- The need for a more structured way to link higher level policies to the process of manufacturing strategy formulation.

- The need to provide a mechanism for both system-wide and product-group related method for evaluating manufacturing requirements.

- The need to provide both local-level (internal) and global-level (external) measures, to both qualitatively and quantitatively prioritise and evaluate manufacturing strategic concerns.

Project Contribution

Following the above, the research and development activities of this particular project were centred around the first stage of the overall I/O-CAMSD cycle (According to the three stages involved, the overall research of the Cranfield team are divided into three task groups: MSA methodology development, MSA/MSD interface development, MSD task module development and I/O-CAMSD software development). As a member of the MSA methodology task group, the contribution of this researcher to the overall research effort include the following:

- Involvement with the development of I/O-CAMSD's basic MSA formulation/capture module. As a core element of I/O-CAMSD, the initial module was developed jointly by the team members involved.

- Whilst the author only partially contributed to the above, he is entirely responsible for the development of an extended evaluation scheme for the purpose of manufacturing strategy formulation, and its incorporation into the basic MSA module to form an advanced method of manufacturing strategy analysis/formulation (Wu and Al-Metary, 1998). This involves: a structured way of providing a link between manufacturing strategy formulation and higher level strategies, a unified method of manufacturing requirements/performance comparison, and the use of a set of generic priority profiles (which are based on previous work reported in the literature, involving the analysis of a few hundred manufacturing companies) as the basis of carrying out external evaluation of manufacturing strategic concerns. These to a large extent represent this particular Ph.D. project's generic originality. The structure of

this evaluation scheme is presented in detail in Chapter 4. It should be pointed out that a particular technique of data visualisation involved here, that of production requirement profiling, is a well established method in the field. However, the way in which it is used here to carry out a unified, system-wide analysis is original (see Section 4.2 - *Requirement Profiling*).

- Evaluation/enhancement of the above through action research activities: the initial specification of MSAMSA whose logical structure is fundamentally based on the proposed techniques, and its actual application, continuous development and refinement through case studies.

CHAPTER 3 DEVELOPMENT OF MANUFACTURING INDUSTRIES IN SAUDI ARABIA

This chapter provides an overview of the past, current and future development of the manufacturing sectors in Saudi Arabia. The information source of this chapter is mainly from The Sixth Development Plan produced by the Ministry of Planning, The 1997 Annual Report of The Saudi Arabian Monetary Agency, and The 1996 Annual Report of The Saudi Industrial Development Fund. Information provided here, together with data gathered through interviews with industrialists in the country, will be analysed to evaluate the effects of government policies on manufacturing industries, to provide indication about the future direction for the Saudi manufacturing companies as a whole, and to help establish overall guidelines to link the industrial policies at the national level to the manufacturing strategy formulation for the individual companies.

3.1 Industrial Development

Overview

The current structural features of the country's industrial sector were shaped in the earlier stages of development, which saw the emergence of three distinct sub-sectors: the *petrochemical industry*; the *oil refining* sector that adds value to the crude oil resources; and the *other manufacturing* sub-sector which is composed of a large number of factories that produce a broad range of products. While most industrial activity is undertaken by the private sector, a number of government agencies are responsible for implementing industrial development policies and programs: The Ministry of Industry

and Electricity (MIE), the Saudi Consulting House, the Royal Commission for Jubail and Yanbu, and the Saudi Industrial Fund (SIDF).

During 1996, for example, the Ministry of Industry and Electricity of the country issued licenses for establishing 533 new industrial factories with a total capital of SR 12.6 billion (current exchange rate 1 Pound equals approximately 6 SR). A breakdown of licensed industrial factories by type of activity indicated that chemical and plastic products, for which 159 licenses were issued during the year, accounting for 40.1 percent of the total factories, followed by metal products and machines (15 percent) and food and beverage (13.8%). These three segments accounted for 68.9 percent of the total capital of the factories for which licenses were issued during the year (Table 3.1)

Industrial activity	1996 Figure		Accumulative Industrial Factories		
	Number of unit	Total Capital	Total Number	Total Capital	Employment
Food and beverage	99	1,737.3	391	11,294.0	31,405
Textiles, ready-made garment and leather products	46	953.4	108	2,592.5	12,905
Wood products	28	369.3	109	1,492.5	12,905
Paper products and printing materials	29	1,012.3	163	4,599.1	12,242
Chemical and plastic products	159	5,051.5	463	100,874.8	51,937
Ceramic, glass products and Construction materials	41	492.9	464	21,169.1	40,758
Basic metal products	12	1,056.8	15	4,371.9	3,727
Manufactured metal products and machines	113	1,886	685	15,457.6	56,251
Other industries	6	45.9	59	933.7	4,455
Transport and storage	--	0.0	19	391.4	1,956
Total	533	12,605.4	2,476	163,179.7	224,877

Table 3.1 Number of Industrial Licenses and the Total Capital Involved

The cumulative number of operating industrial factories reached 2,476 at the end of 1996, with a capital investment of SR 163.2 billion. These factories employed about 225,000 workers. A breakdown of these factories by type of industrial activity indicated that 463 factories, or about 19 percent, belonged to the chemical and plastic products segments and accounted for the bulk (61.8 percent) of the total capital of all operating factories. Construction materials, ceramics and glass industries segments accounted for 464 factories or 19 percent of the total; 391 factories or about 16 percent of the total belonged to the food and beverage segment and 15 factories (0.6 percent) belonged to

basic metal products and machine industries segments. These four industrial segments accounted for 80.9 percent of the total number of industrial factories operating in the country and for 91.2 percent of their total capital.

Therefore, significant investments have been made in the manufacturing during the 1970 to 1995 period. Total number of factories in operation has increased from 199 in 1970 to 2234 in 1995, the capital investment in these factories amounted to SR 151.2 billion, and total manpower employment is over 196,000. These figures reflect a big step of increase from the 1970 level of SR. 2.8 billion in capital investment and around 14,000 employees.

Industrial Cities and Industrial Development Fund

In an effort to stimulate the industrial sector, the country has established eight industrial cities at Riyadh, Jeddah, Dammam, Qassim, Al Hassa, Makkah Al Mukarramah, Jubail and Yanbu. Up to 1995, these industrial cities encompassed a total area of 32.2 million square meters, with a total cost of about SR. 1.9 billion. Currently, phase 3 of the second industrial cities in Riyadh, Qassim and Al-Hassa is being implemented. The location of these industrial cities are illustrated in Figure 3.1.

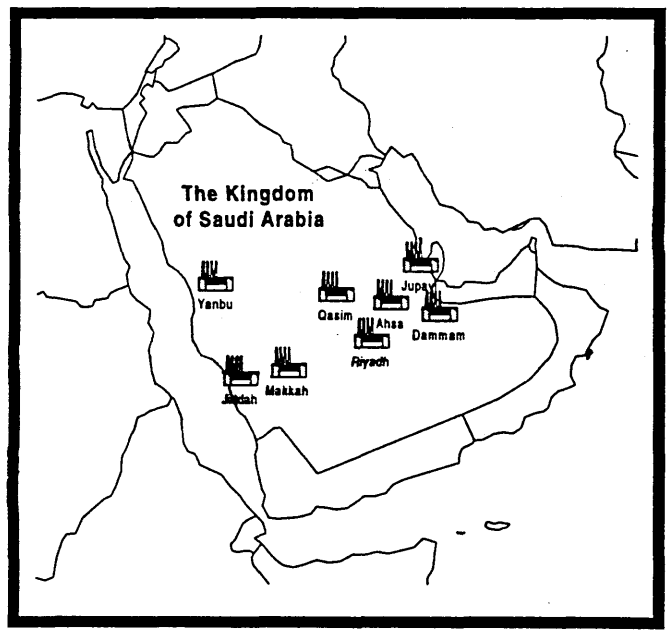


Figure 3.1 Location of Industrial Cities

The creation of a viable industrial base, which will reduce the country's reliance on oil revenues as the main source of income, has been regarded as of vital importance in the economic development of Saudi Arabia. In particular, the twin cities - Jubail and Yanbu - planed to be the strategic sites for hydrocarbon based and energy intensive primary industries, are exploiting the country's natural resource. It is hoped that the economic impact of the established primary industries will set in motion the development of a chain of secondary and downstream industries which would use the primary outputs as their raw material. Through their activities Saudi Arabia is expected to meet 5-6 percent of the world demand for petrochemicals.

For example, the infrastructure of the industrial city of Jubail is established on a site covering 1030 square kms and its population is estimated to 87,000 people by the end of 1995. It is envisaged that by the year 2010 the city will accommodate 290,000 people. There are 16 basic industrial plants at Jubail in the operating phase by the end of 1995. All of these plants are capital intensive in nature. It is estimated that by the year 2010, these industries will create 107,000 new jobs and utilise natural gas which was being flared up without any economic return. The gas will be utilised as fuel and as a primary input in the steel, aluminum, plastic and fertilizer industries. The industries at Jubail Complex could be divided into three categories:

- *Basic Industries.* These are undertaken by SABIC (Saudi Basic Industries Corporation), PETROMIN (General Organisation for Petroleum and Minerals), and SAUDI ARAMCO. Sixteen basic industrial plants have already been completed and are currently in operation.

- *Secondary Industries.* These industries depend on products from basic industries. Five plants are currently in operation, 5 other projects are under construction and another 7 projects are under study and planning.

- *Supporting & Light Industries.* These plants manufacture products which are needed by other industries or by housing projects during the construction stage or for operations and maintenance activities. These plants are established and operated by the private sector. Currently there are 77 such plants in production at Jubail, 27 plants are under construction and another 28 plants are under study and planning phase.

In addition to the infrastructure provided by these industrial cities, financial supports are also available to individual manufacturing companies. Since its establishment until the close of the fiscal year 1996, Saudi Industrial Development Fund (SIDF) has approved 1,959 loans with a total amount of SR 30,680 million. They were extended in support of establishing 1,515 industrial projects located in all of the regions of the country, of which SR 21,494 million have been disbursed, and SR 13,121 million repaid. A review of the main industrial sector in terms of performance and value of loan approved is given in Figure 3.2.

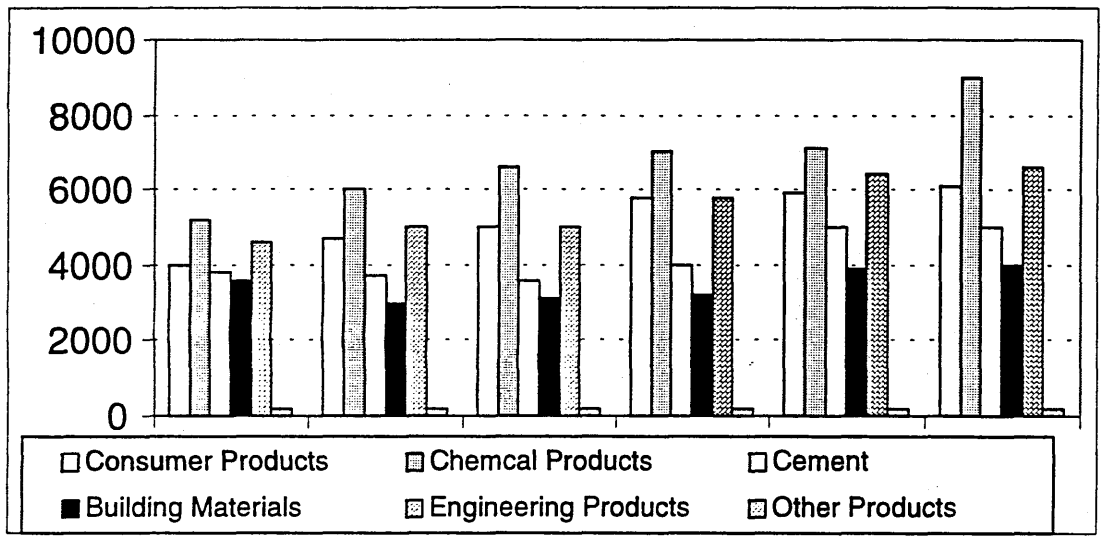


Figure 3.2 SIDF Loans By Major Industrial Sectors (SR Millions) From 1991- 96

3.2 The Sixth Development Plan (1995 – 2000)

The major objectives for industrial development in the country during the sixth development plan are:

- To increase the industrial sector's contribution to GNP and the diversification of the national economy;
- To expand industrialisation based on locally available raw materials and to diversity the industrial structure through more intensive development of upstream and downstream industries;

- To increase the industrial sector's contribution towards meeting the local demand for consumer and capital goods through developing economically feasible import-substitution industries;
- To increase the industrial sector's contribution to the diversification of exports;
- To create new job opportunities and develop the national manpower resources.

The overall growth target is an average annual rate of 4.9% for the industrial sectors as a whole, with petrochemical industries growing at an average annual rate of 8.3%, oil refining at 3.9% and other manufacturing at 4.9%.

The Key Issues

It is recognised that the industrial sector in the country faces a number of key issues which need to be addressed in order to achieve the industrial development objectives and to increase the sector's contribution to GNP. The most important of these issues are identified as:

- ***Specialisation and Diversification*** The structure of industry in the country is characterised by specialisation in the oil refining and petrochemicals industries. These industries have large production capacities and together they account for about half of the industrial sector's GNP contribution and more than 60 percent of industrial investment. Notwithstanding the comparative advantages enjoyed by these industries, the country's progress towards a more advanced stage of industrialisation will require a more diversified industrial structure.
- ***Petrochemicals Industry and International Competition.*** With several new producers entering the petrochemicals industry (particularly in the developing countries), the likelihood of continued surplus production capacity, sharp competition in the international market can be expected in the Sixth Plan period. Thus, SABIC must continue to study local and world market conditions closely and to adopt flexible marketing strategies that are consistent with market needs and are supported by its high production capacity and wide range of products.
- ***Industry and the Environment.*** Industry is often linked with its adverse impact on the environment, as it consumes and depletes natural resources, particularly non-

renewable resources, to meet its need for energy and raw materials. Furthermore, industrial activities are normally associated with air and water pollution from gas emissions and industrial waste. Such waste is often generated from the use of technologies that have little consideration for the environment and its absorptive capacity, and because appropriate environmental regulations either do not exist or cannot be enforced. In the country, positive steps should be taken to control the relationship between the environmental industrial growth. The Sixth Development Plan emphasizes the fact that industrial growth targets will be pursued without prejudice to the rights of future generations to a clean environment and the availability of natural resources.

- ***Ability to Develop Industrial Technology***. In the next stage of development, the capacity of national industries to assimilate new technology and production techniques should be further developed. So that they can use their accumulated experience to create and develop their own technologies and thereby reduce their dependence on imported technology on the one hand, and overcome the difficulties in obtaining such technology, on the other.

- ***Industrial Marketing***. National industrial products are encountering severe competition in both domestic and international markets. It is evident that marketing activities in some industrial establishments are not given as much attention as production activities. In the coming stage of development, greater attention to the marketing of industrial products will be necessary.

- ***Industrial Information and Data Bases***. The success of industrial projects, either at the preliminary planning and study stage or at the actual production stage, depends on the availability of information and statistics on markets, technologies, labour, production capacities, investments and costs of production. The development of industrial information systems will become increasingly important in the next stage of development.

- ***Role of Incentives in Industrial Development***. The progressive liberalisation of international trade, combined with the need to maintain an effective system of incentives for industrial development, mean that an extensive review of the existing

incentive system may now be needed. Furthermore, priorities need to be established so that incentives are directed more specifically towards those industrial projects where support and protection may be needed in the short to medium term, but whose longer term economic potential is firmly established, and is based on the existence of comparative advantage, the manufacture of high quality products, the utilisation of advanced technology and the establishment of link with existing industries and other sectors of the national economy.

- ***Support for Small Industry***. At the present, small industries do not enjoy the range of incentives provided by the government to large-scale projects. Furthermore, no single specialised government department or agency is responsible for supporting small industries and alleviating their difficulties in obtaining the necessary finance for expansion. Small industries need further encouragement to play a more effective role in the development of the industrial sector. In this respect, the possibility of establishing specialised institutions to support small industries and to help them overcome their technical, administrative and financial difficulties, should be explored.

- ***Promotion of Industrial Exports***. With the exception of petrochemicals and refined oil products, exports of manufactured goods still account for only a small part of the country's total exports. Intense competition in global markets presents a special challenge to all industrial exporters, entailing considerably increased risks. Thus, it is not surprising that many companies prefer to sell in the home market first, only entering export markets when this is necessary to support their existing business. Specific policies are needed to address this situation, including the design and implementation of institutional measures to encourage the establishment of private companies and organisations specialised in export development and promotion techniques, the expansion of export credit financing facilities for industrial exporters, and more participation at international fairs.

- ***Saudisation***. With the exception of the larger, capital-intensive industries such as petrochemicals, Saudi industry's dependence on foreign manpower is likely to remain a feature of industrial development for some time, mainly due to an insufficient supply of national skilled manpower. The Sixth Development Plan

assigns a high priority to the employment and training of Saudi nationals in private industry, where they now represent only a small percentage of total employment, particularly in production and technical jobs. This will require joint actions by the government and the private sector, and more intensive adoption of measures to encourage Saudi nationals to work in manufacturing industry.

- ***Privatisation***. Although the government is the majority shareholder in SABIC, it is anticipated that conditions prevailing in the Sixth plan period will make the progressive privatisation of SABIC possible. In this respect, initiatives to privatise some government owned industrial companies will be one of the major features of the sixth plan period.

Development Strategy

The development strategy will be implemented through the following policies and programme.

Policies

- Encourage Saudi industries to develop their own capabilities in industrial studies, research and development, particularly in capital intensive industries;
- Continue conducting comprehensive periodical reviews of the institutional policies, administrative measures, incentives, lending policies, licensing and customs duty exemptions, in order to increase industrial investments by the Saudi and GCC private sectors, and adopt the necessary measures to deal with increasing competition;
- Encourage the balanced diversification of industrial actives, with emphasis on horizontal and vertical expansion in petrochemicals and the development of industries with links to other economic sectors;
- Support and encourage the transfer of modern technology in joint venture industrial projects through the foreign capital investment regulation and the offset programs;.
- Continue establishing industrial cities in locations with favorable growth potential, and expand the capacity of existing industrial cities where infrastructure is coming under heavy pressure;

- Continue the completion of infrastructure facilities in the industrial cites of Jubail and Yanbu to meet the expected increase in demand;
- Continue improving the quality and analysis of industrial statistics and information, and the preparation of economic indicators through industrial surveys;
- Conduct studies on investment opportunities for the private sector;
- Continue the development of national manpower particularly with respect to the technical skills needed in modern industry;
- Encourage industrial companies to prepare advanced training programme for periodically upgrading the technical skill of Saudi workers, and adopt necessary measures to support factories in this regard;
- Improve the production capacity utilisation rates of existing factories and raise the economic efficiency of industrial enterprises;
- Develop the necessary measures and regulations to support small companies and study the possibility of establishing an agency with responsibility for supporting their development;
- Encourage greater concentration on marketing and market research through more emphasis on the study of market conditions, competitor behaviour advertising, after sales service and the development of export marketing techniques;
- Deepen the concept of environmentally friendly industrial development and its impact on present and future generations.

Programme

A major program will be implemented during the sixth plan. In particular, the following aims are identified for a number of relevant areas and industrial sectors:

- ***Petrochemical Industries***: Here the program aims at the optimal utilisation of feed stocks and energy for expanding existing production capacities in primary, intermediate and final petrochemical industries and downstream industries. It also aims at the addition of new products to meet local and international market needs, the

development of existing markets and the search for new markets in ordered to generate economic returns;

- ***Basic Metal Industries***: Here the program aims at expanding the existing production lines of the basic iron and steel industries, and studying the feasibility of establishing other energy intensive basic metal industries commensurate with market demand and in coordination with other GCC countries to avoid unnecessary competition.

- ***Industrial Cities and Infrastructure***: In this area the program aims at the completion of infrastructure and the provision of services and utilities in the existing industrial cites, as well as the establishment of new industrial cities and the expansion of some existing ones. Within this program, the Royal Commission for Jubail and Yandbu will expand the capacities of the infrastructure, utilities and services in the two industrial cities, in line with requirements of industrial development and the expected population growth.

- ***Other Manufacturing Industries***: This aims to strengthen the manufacturing sector by offering credit facilities for the establishment and expansion of projects as well as the improvement of existing operations. It also covers the provision of advisory services to factories for the development of production methods and quality improvement techniques. The identification of investment opportunities in small and medium sized industries in the country are also included as part of this program.

- ***Industrial Investment***: In this aspect the program will acquaint investors at local GCC country and international levels, with the investment opportunities available in import substitution and export-oriented industries, through the preparation of initial investment profiles for feasible projects.

- ***Industrial Studies, Research and Development***: This will encourage the research and developments actives of existing industries and carry out industrial research and studies. It will also develop the information systems required for industrial sector development.

- ***Industrial Exports***: This aims at encouraging and developing export-oriented industries though the establishment of more private companies specialised in

international marketing techniques, the preparation of studies for the promotion of Saudi industries in international markets, the study of foreign trade regulations, the adoption of export financing methods and participation at international fairs.

- ***Manpower Development***: This aims at the development of national industrial manpower and improving their efficiency, in all specialist fields through appropriate training.

- ***Privatisation of Industrial Companies***: This will study the possibility of privatising industrial companies owned by the government and will include a specific schedule that takes into account the social and economic impacts of privatisation.

3.3 Effects on Industry

To summarise, the industrial situation in today's Saudi Arabia is characterised by:

- A significant amount of investment in industrial infrastructure.
- Continuous injection of money into the manufacturing sectors.
- The determination to develop the country's industrial base by: diversifying its economic base, reducing its dependence on the production and export of crude oil, increasing the private sector's participation, creating new job opportunities and developing the national manpower resources.

As a result, the industrial sector has been expanded, and the manufacturing industries in particular play a much more important role in the country's economy.

However, the success of any manufacturing industry must depend on a multitude of factors. In particular, it should be realised that investments do not necessarily mean progress and, although important, certainly do not guarantee success. This was clearly demonstrated by some of the manufacturing companies visited during the early stages of this research. The management of these companies, while welcoming and benefiting from the availability of industrial funding, expressed concern relating to the needs to improve the quality of their products, reduce costs and generally enhance their competitiveness. In addition to investment on new production facilities, more efficiency must by achieved by the existing plants.

It is generally true that in the basic industries, the production efficiency (in terms of capacity utilisation rates, sales/production ratios, etc.) of SABIC companies compare relatively well to international standard for these industries. This, however, has been to a large extent the result of relying heavily on advanced technologies from the industrialised countries. In other industries, there seems to be much room for the improvement of efficiency. It is therefore necessary to review the performance of such industries and to study the main factors constraining productive growth, so that appropriate methods for overcoming obstacles to be adopted and overall competitiveness improved.

At the infrastructure level, some industrial cities are at present operating below capacity while others such as those in Riyadh, Jeddah and Dammam are facing capacity constraints. The areas assigned for secondary industries in Jubial and Yandbu are currently under utilised even though many of these industries operate in other locations. It is therefore also necessary to achieve a better balance in the utilisation of space in these industrial cities, so that the manufacturing companies concerned can be better served.

3.4 Conclusion

This chapter has provided an overview of the industrial development in Saudi Arabia. In particular the current five-year development plan (The Sixth) of the country has been discussed in relative detail. The plan seems to provide overall directions, and also lays down certain rules for the Saudi industries' future development.

For any strategies to be effective at the operational level, all of the relevant strategies - national and/or individual must be coherent (Wu 1994). Since the above represent strong environmental influences from a manufacturing company's point of view, it its important that they should be taken into consideration in terms of overall guidelines, so that the strategy and policies followed by the individual organisation are coherent with, and support the higher level policies (Figure 3.3). To this effect, it is proposed that the following key issues should be further analysed to provide overall guidelines that should be incorporated into the framework of strategy formulation, particularly at the SWOT analysis stage to make certain

that a Saudi manufacturing company's strategy is developed in such a way that it is "Sixth Development Plan Compatible":

- Government support (SIDF)
- Exporting/new market
- Research and Development
- Environmental issues
- Saudization

This issue will be discussed in more detail in Chapter 4.

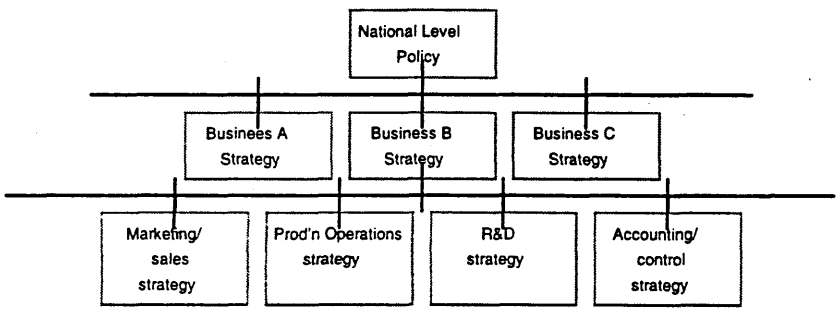


Figure 3.3 The Hierarchy of Strategies Influencing Manufacturing

CHAPTER 4 AN EVALUATION SCHEME FOR THE PURPOSE OF MANUFACTURING STRATEGY FORMULATION

4.1 Introduction

The review of current MSA (Manufacturing Strategy Analysis) approaches given in Chapter 2 has highlighted that despite the fact that the procedures are generally logical and well document, there seems to be a general weakness in providing specific guidance or techniques to aid the analysis involved. This is particular true at the gap analysis stage, and when a company is expected to carry out a valid SWOT (strength/weakness, opportunities/threats) analysis. When this is combined with the overall requirement identified in Chapter 3 regarding the specific current macro environment in the country, it is clear that an extended framework for the purpose of manufacturing strategy formulation will be needed. This chapter suggests an extended evaluation scheme which, compared to the existing approaches, provides a more comprehensive way of analysing market/manufacturing requirements. In particular this chapter discusses the techniques that should be incorporated into the overall process of strategy formulation. These together represent the novel elements of this research and constitute the conceptual structure of MSAMSA- a Manufacturing Strategy Analysis Methodology for Saudi Arabia.

The structure, contents and techniques of the extended evaluation scheme as suggested here are generic. Hence, dependent on the specific macro-economic and environmental conditions, one should be able to adopt and implement it in a flexible way to suite the needs of manufacturing companies within different industrial sectors or even in different countries. In particular, this generic framework recognises the following key requirements as outlined in Chapter 2:

- The need for a more structured way to link higher level policies to the process of manufacturing strategy formulation.
- The need to provide a mechanism for both system-wide and product-group related method for evaluating manufacturing requirements.
- The need to provide help and guidelines which provide an in-depth definition of the content of the manufacturing policy areas with respect to the decisions, sub-decisions, options, parameters and influences.
- The need to provide both local-level (internal) and global-level (external) measures, to both qualitatively and quantitatively prioritise and evaluate manufacturing strategic concerns.

Based on the realisation that, for the purpose of manufacturing strategy formulation, a complete and generic framework should provide a number of measures as shown in Table 4.1, and the overall structure and relationships amongst these measures as summarised in Figure 4.1, it is suggested that the techniques as discussed respectively in the following sections should be developed and incorporated into a strategy formulation process.

	Qualitative	Quantitative	Product-Focused	System-Wide
Internal /Local	gap analysis based on the company's current market needs and factory profile, mismatch level indicated by shape of profile diagrams	gap analysis based on the company's current market needs and factory profile, values calculated to show degree of mismatch for each of the criteria	gap analysis with individual requirement profile of key product groups compared to current system profile - supporting concept of "focused factory"	gap analysis with overall requirement profile, based on utilisation values, compared with overall factory profile to identify system-wide future direction
External /Global	a set of generic priority profiles provided as guidance to help cross-check local requirement profile against general, global expectation	bench-marking against best practice and/or performance	as above, but at global/external level	as above, but at global/external level

Table 4.1 The Complete Framework of Strategy Evaluation

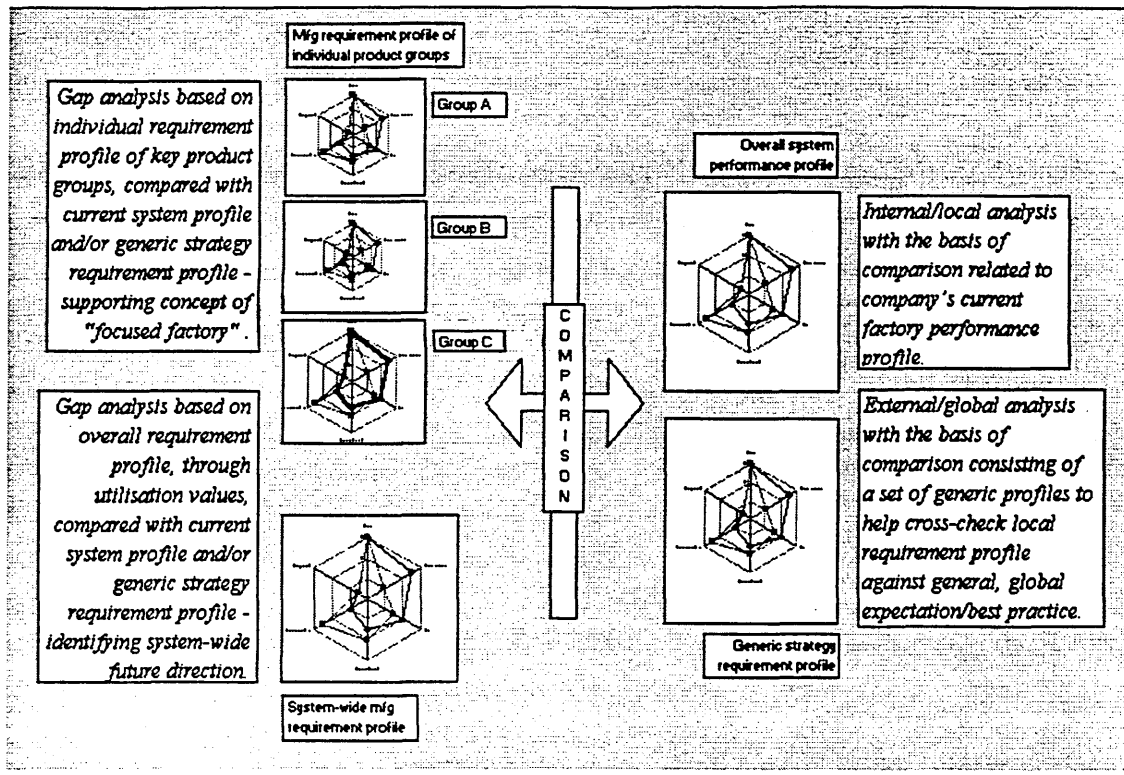


Figure 4.1 Different Measures for Manufacturing Requirement/Performance Comparison

4.2 Algorithms for Unified Strength/Weakness Analysis

At the gap analysis stage, a crucial question is how to logically associate a set of individual requirements, that are related to different product groups, to the overall manufacturing system as a whole in order to measure its effectiveness. A series of algorithms in the form of utility functions were specified to establish a logical match. For instance, a system utility can be defined as: **System Utility** $U_1 = Fn\big(I(\pi), N(\chi,\pi), \theta(\chi,\pi)\big)$, where: I = relative importance, N = requirements, Θ = performance, π = product group, and χ = manufacturing competitive criteria. This allows for a gap analysis to be executed, in the third stage of strategy capture, to identify the areas for improvement. This technique provides a unified way of relating individual product requirement profiles to the overall systems profile. Gap analysis can be conducted in a flexible way dependent on the specific needs:

- *Products-related requirement/system gap analysis.* With this approach the individual requirement profile of the key product groups can be compared to the current system profile to identify future strategic direction of the company. The manufacturing strategy

developed will support the concept of "focused factory" because the resultant system will be geared toward satisfying the manufacturing needs of the company's key products.

- *Factory-wide requirement/system gap analysis.* With this approach the overall requirement profile is compared against the system profile to identify the overall gap, formulating future manufacturing strategies which aim to satisfy system-wide manufacturing requirements.

Within the context of manufacturing strategy analysis, product group analysis represents the first assessment of a company's market place, in terms of the enterprise's position in the market, its products and the competitive requirements of the market. Starting from a basic analysis of the product groups, a series of utility functions and profiles can be constructed to assess the requirements on the manufacturing system and the performance of the existing manufacturing system in meeting those requirements. For this purpose, the system utility is considered to be a function of the level of importance of product groups, the level of importance of the competitive criteria with respect to the individual product groups and the performance of the individual product groups with respect to the manufacturing criteria. The system utility function described below provides a three-step approach to the analysis of the effectiveness of the current manufacturing system in relation to its manufacturing strategic requirements. The first stage ascertains the relative importance of each of the system's product groups. The second stage identifies the relative importance of each of the strategic criteria with respect to these product groups. The final stage repeats this analysis but attempts to identify the actual performance of the system as a whole. A gap analysis can then be executed in order to identify the areas for improvement.

Product Groups

The first step should aim to assist the analysts to define their product groups or families. The parameters used to specify these groups include: markets and customers, cost, profit, volume, resources, processes and materials. The result should be a series of clearly defined product groups. To assist in this process a number of simple tools can be applied such as the ABC analysis technique. This stage should also identify the variants available for each product/product family.

The second step is to allocate a measure of the relative importance of each of these product groups to the operations of the enterprise. Typical parameters to consider include: costs, sales, profit, volume, market share, product-life-cycle stage, growth opportunities, vulnerabilities etc. Once these parameters have been ascertained, the end result should be a table detailing the importance of various criteria for each product group (Table 4.2), and a relative ranking of the product groups (Figure 4.2).

PARAMETER	PRODUCT GROUP A	PRODUCT GROUP B	PRODUCT GROUP C	PRODUCT GROUP D
Cost				
Sales				
Profit				
Volume				
Market share				
PLC Stage				
Manufacturing Capability				
Strengths				
Weaknesses				
Opportunities				
Threats				
Current Relative Importance				
Future Relative Importance				

Table 4.2 Product Group Relative Importance Determination

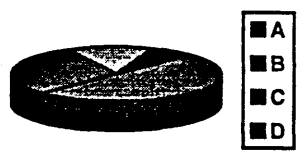


Figure 4.2 Relative Importance of Production Groups

Relative Importance of Strategic Criteria

Next, each product group should be measured in terms of their competitive or order winning criteria. First, for each of the product groups, their competitive criteria requirements are specified, based on customer needs and the market environment. For this purpose, a number of parameters have been suggested as measures for each competitive criteria, as shown in Table 4.3. For each product group, the individual

customer requirements can be assessed, the importance of each criteria to the customers can be specified, together with their current level of satisfaction.

Quality	**Design flexibility**
Conformance to specification	Design changes
Reliability in use	Customised products
Delivery lead-time	**Volume flexibility**
Minimum lead-time requirement	Minimum order size
Maximum lead-time requirement	Maximum order size
Average lead-time requirement	Average order size
Delivery change notice	Seasonality demand
	One-off demands
Delivery reliability	Predictability
Delivery window	Order size change notice
Required delivery lead-time	
Contractual delivery lead-time	**Cost / price**
Products features	Price sensitivity
Unique features	Margins
Superior performance	
	Other criteria

Table 4.3 Criteria and Parameters for Market Analysis

The relative importance of the product groups can be established through a set of utility weightings (Wu 1994), based on a percentage value such that the sum of relative importance is one. Each product group is then assigned requirements ratings out of a hundred (in discrete steps of 5). In order to facilitate this process the intermediate values are assigned textural labels, ranging from 0 - not required to 100 - absolutely essential, as shown in Figure 4.3 (Except for the quarter values where the description has a set value, the users are encouraged to take a more considered judgment about the degree of importance and contribution of the criteria to the competitiveness of each of the product groups). Hence, if quality was considered to be important, the users would still have to quantify the degree of importance as best they could by assigning a value of either 55, 60, 65 or 70.

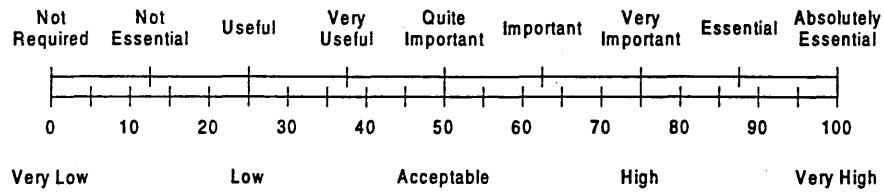


Figure 4.3 Scale for Assessing Competitive Criteria Requirements

PRODUCT GROUP	A	B	C	D
Relative Importance ($\Sigma = 1$)	0.5	0.3	0.13	0.07
Quality	75	80	65	55
Delivery Lead-time	50	65	60	15
Delivery Reliability	80	70	60	50
Design Flexibility	40	90	30	75
Volume Flexibility	20	15	80	10
Cost / Price	80	25	70	40

Table 4.4 Example of product profiles for enterprise with four product groups

Once a table has been completed, a profile for each of the product groups can be specified in terms of the competitive criteria, as illustrated in Table 4.4. Similarly an overall requirement profile can be produced for the enterprise as a whole.

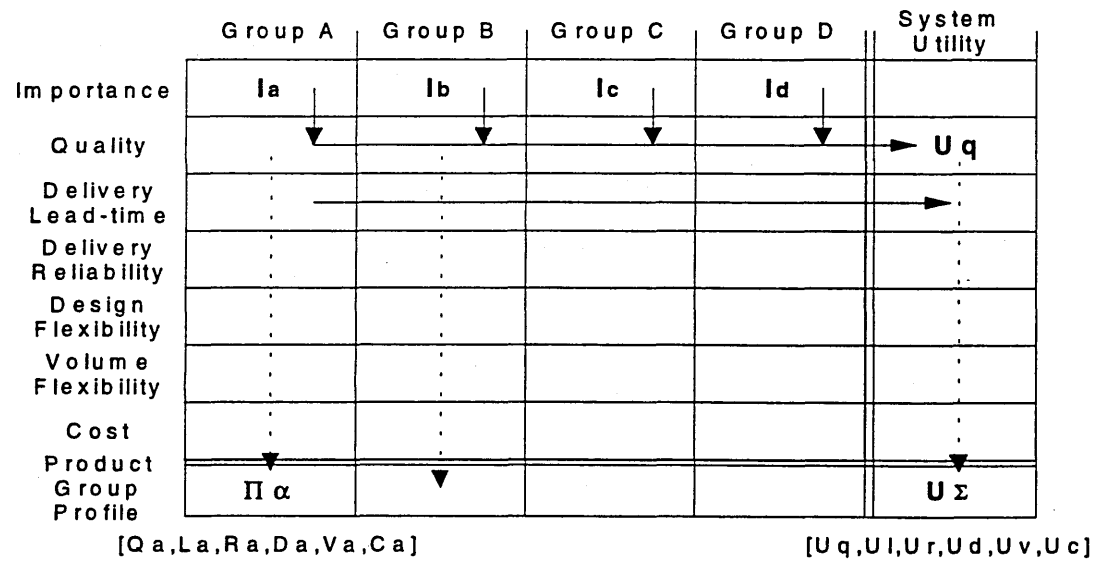


Figure 4.4 Product Group Profiles and System Utility Profile

As shown in Figure 4.4, the product group profile of product x, **Px** can be described using the vector:

$$\mathbf{P_x} = \{Qx, Lx, Rx, Dx, Vx, Cx\}$$

where Qx, Lx, Rx, Dx, Vx, and Cx are respectively the six competitiveness (Quality, Delivery Lead-time, Delivery Reliability, Design Flexibility, Volume Flexibility and Cost / Price) values of product group x. In addition, the competitive criteria utility profile of the overall system ***Ux*** is presented by the vector:

$$\boldsymbol{Ux} = \{Uq, Ul, Ur, Ud, Uv, Uc\}$$

where the system's competitiveness value with respect to criteria *i* is given by:

$$Ui = \sum_{AllGroups} (GroupCompetitivenessValue)_i \times (GroupUtilityValue)$$

For example, according to the above the value of competitiveness with respect to the quality criteria, *Uq,* is given by:

$$Uq = Qa \times Ia + Qb \times Ib \ .....etc.$$

where:

Qa quality competitive criteria requirement for product group A

Ia relative importance for product group A

This leads to the completion of Table 4.5

PRODUCT GROUP	A	B	C	D	SYSTEM
Relative Importance	0.5	0.3	0.13	0.07	1
Quality	75	80	65	55	74
Delivery Lead-time	50	65	60	15	53
Delivery Reliability	80	70	60	50	72
Design Flexibility	40	90	30	75	56
Volume Flexibility	20	15	80	10	26
Cost / Price	80	25	70	40	59

Table 4.5 System Profile for Documented Example

Requirement Profiling

Profiling techniques have been used previously to aid the process of requirement analysis (e.g., Slack 1991). Using these values, it is possible to provide a visual representation indicating the different competitive criteria requirements for each product group. An example is illustrated in Figure 4.5. Similar diagrams can also be developed which take into account the relative importance of each product group. Also, a series of other profile diagrams can be generated from the data to provide additional comparisons within and between product groups. For each product group and competitive criteria pair the following additional parameters can be calculated:

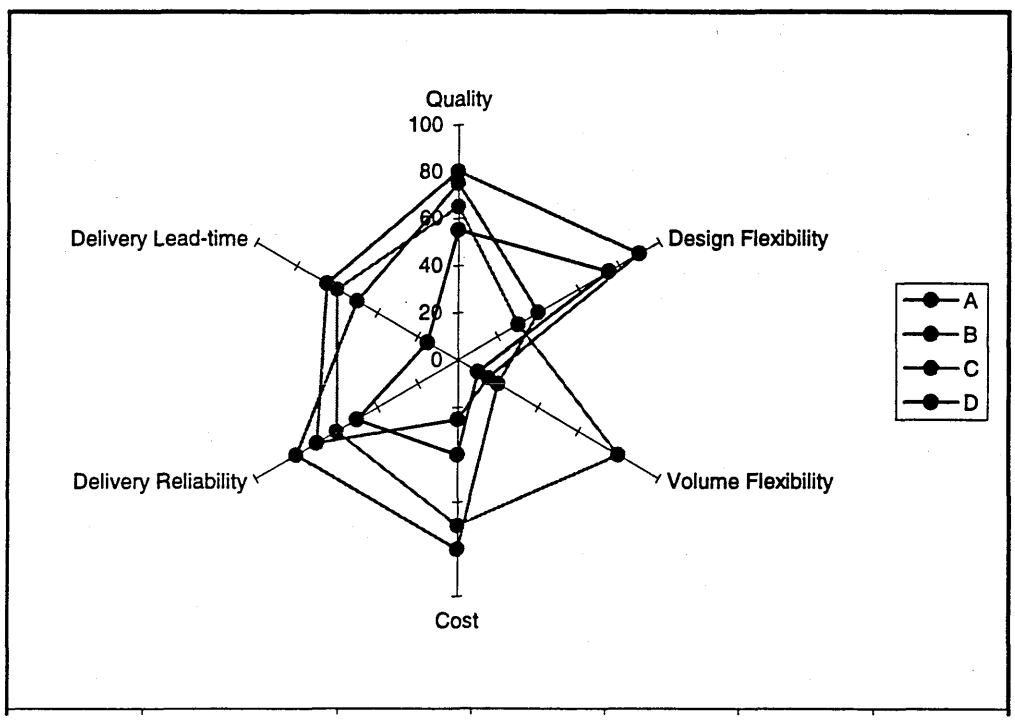


Figure 4.5 Example Product Profiles

Relative importance criteria (Pi) — criteria value for product group based on importance of product group.

Product group normalised criteria (Ω) — criteria value for product group based on ratio of absolute criteria value to sum of all values within same product group.

Absolute system normalised criteria (Ω_{Σ}) criteria value for product group based on ratio of absolute criteria value to sum of all values of all product groups.

Relative system normalised criteria ($\Omega_{I\Sigma}$) criteria value for product group based on ratio of relative importance criteria value to sum of all relative importance criteria values of all product groups.

For the example values previously mentioned, Table 4.6 gives an indication of the values which might be expected for product group A from the previous example. Each can be described by a vector or represented on a diagram.

Parameter	A	Pi	Ω	Ω_{Σ}	Ω_{I}
Quality	75	37.5	0.22	0.06	0.11
Delivery Lead-time	50	25	0.14	0.04	0.07
Delivery Reliability	80	40	0.23	0.06	0.12
Design Flexibility	40	20	0.12	0.03	0.06
Volume Flexibility	20	10	0.06	0.02	0.03
Cost	80	40	0.23	0.06	0.12

Table 4.6 Various Parameter Values for Example Product Group A

The relative importance criteria *Pi* produces the relative product profiles (Figure 4.6). It allows a comparison of product groups and their criteria, taking into account their individual contributions to the system as a whole. The product group normalised criteria Ω provides an alternative indication of the criteria values of the product group relative to each other. The absolute system normalised criteria Ω_{Σ} provides an indication of the criteria values of all the product groups relative to each other. However, the value of this parameter is somewhat limited given that it does not take into account the relative importance of each product group. The relative system normalised criteria $\Omega_{I\Sigma}$ however, does take into account the relative importance of each product group and is therefore a useful alternative parameter for comparisons across product groups.

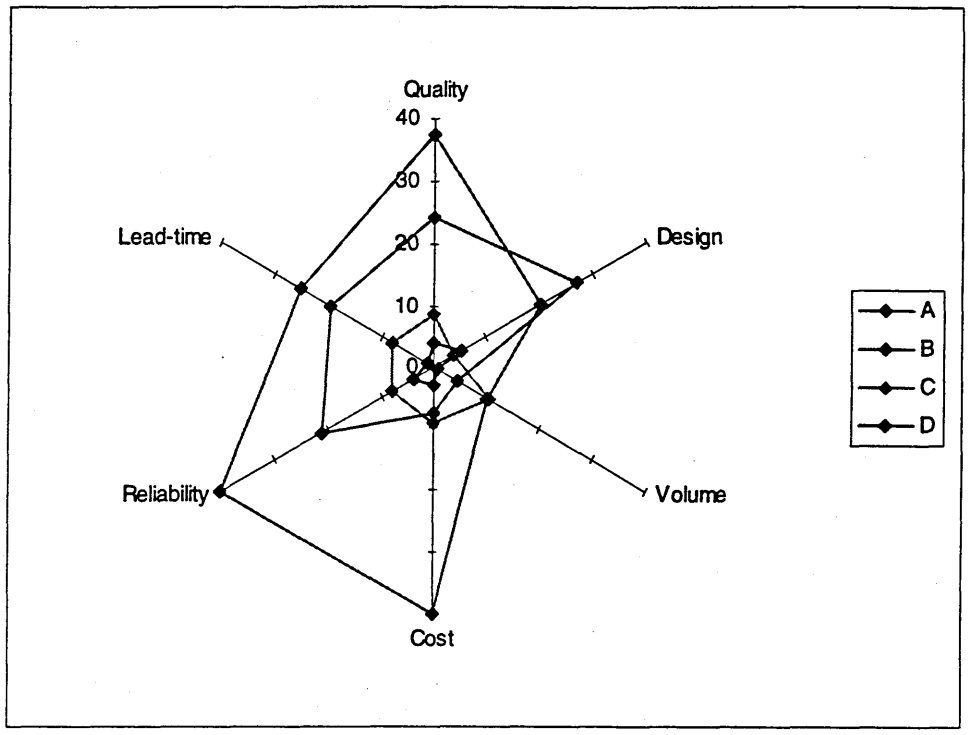


Figure 4.6 Relative Product Profiles

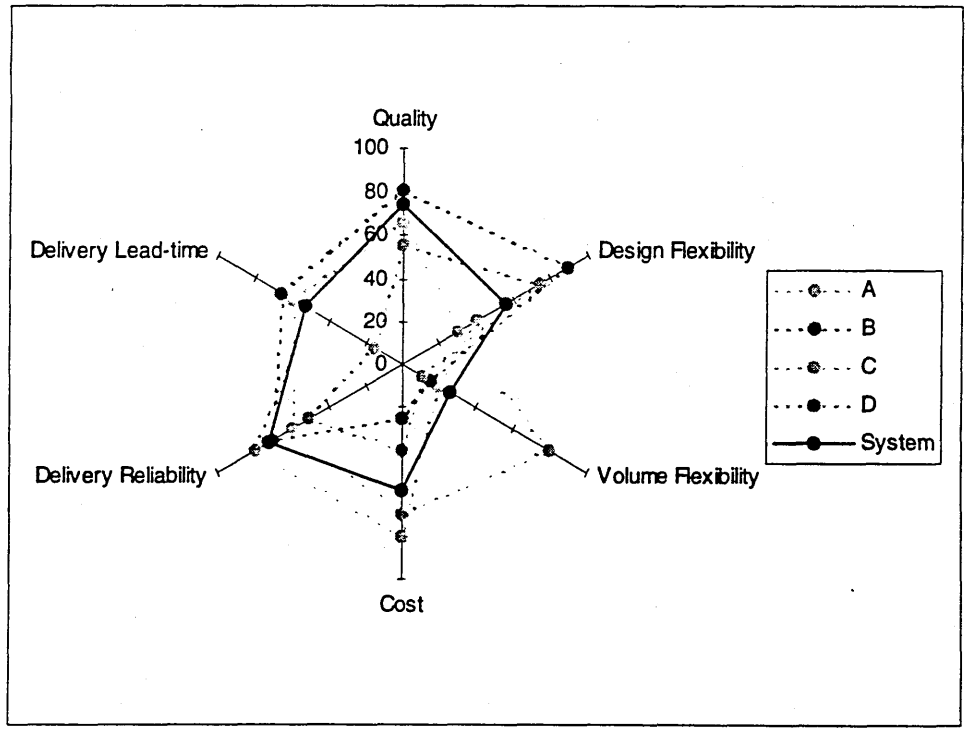


Figure 4.7 Overall System Requirement Profile

In a similar manner, it is proposed that a system profile can also be produced, indicating the combined system requirements with respect to the competitive criteria. There are several

means by which a system profile can be established. For example, the system profile for each of the competitive criteria can be established through the use of an utility function, producing an aggregated utility for each of the criteria based on the relative importance of each of the product groups. The result will be a weighted compromise profile. Figure 4.7 presents the previous product group profiles together with the aggregated system utility profile.

Together these profiles provide a mechanism for both system-wide and product-group related method for evaluating manufacturing requirement. Gap analysis can be conducted in a flexible way dependent on the specific needs:

- *Products-related requirement/system gap analysis.* With this approach the individual requirement profile of the key product groups can be compared to the current system profile to identify future strategic direction of the company. The manufacturing strategy thus developed will support the concept of the "focused factory" because the resultant system will be geared toward satisfying the manufacturing needs of the company's key products. Such that each product family becomes an individual manufacturing entity or unit. The competitive criteria can then be considered and optimised separately for each individual product family.

- *Factory-wide requirement/system gap analysis.* With this approach the overall requirement profile is compared against the system profile to identify the overall gap, formulating future manufacturing strategies which aim to satisfy system-wide manufacturing requirements. It should be remembered, however, that the construction of such utility functions is relatively simplistic, particularly the aggregated system profile, and as such they should be used with caution within the strategy analysis process. In effect, they essentially represent a compromise configuration for the manufacturing system. They should preferably be interpreted as an overview or a guideline of the requirements for the individual product groups and for the system.

- *The maximum-specified-system gap analysis.* A different means of using a system profile is to establish a weighted product profile, again based on the relative importance of each of the product groups. However, instead of accumulating these profiles, this approach

selects the maximum profile of each criteria and then adopts the original product profile for this maximum for this particular criteria only.

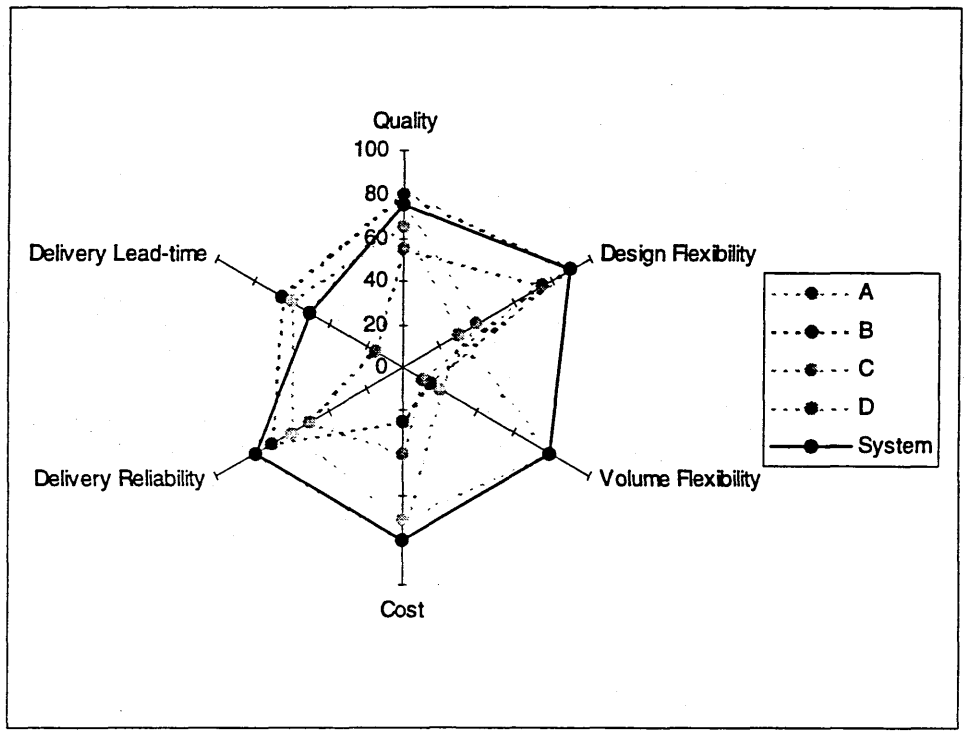


Figure 4.8 System Profile Based on Maximum Relative Profiles

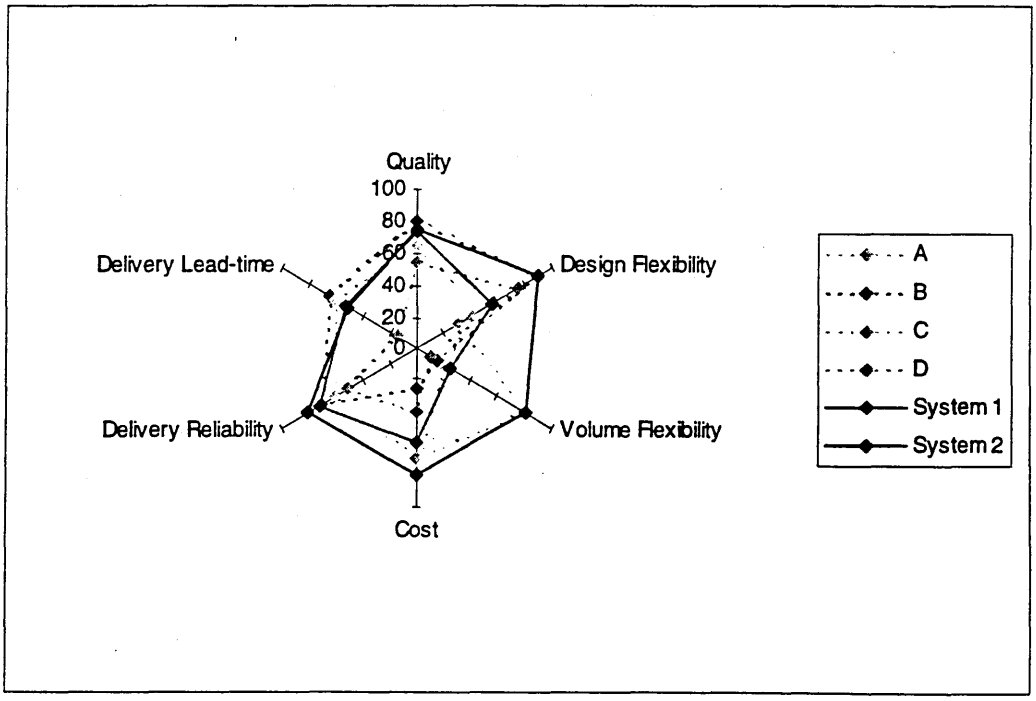


Figure 4.9 Product and System Profiles Comparison

An example can be seen in Figures 4.8. A comparison of the two approaches for the example profiles given indicates, as illustrated in Figure 4.9, the typical differences that may result.

Gap analysis

Although the application of alternative approaches of comparison depends to a great extent upon the actual situation, the relative importance of each product group and the contribution towards the competitive criteria that each product group provides, the procedures that follows are similar involving two major tasks: the establishment of current system performance and the identification of gaps. The system performance stage is similar in detail to that of the competitive criteria stage except that it provides an assessment of how the manufacturing system is performing for each product group with respect to the competitive criteria, rather than the requirements for the system. In addition, similar utility functions can be evaluated. Therefore, a list of parameters can also be specified for this manufacturing performance analysis, as shown in Table 4.7.

Quality	**Delivery reliability**
Actual quality level	Deliveries within specified window
Intermediate scrap rate	Complete orders
Customer reject rate	Error-free orders
Cost of scrap	**Design flexibility**
Final failure rate	Product range ability
Warranty costs	Product change ability
Cost	Design change each year
Actual total cost incurred	Design changes ability
Manufacturing contributions	Proportion customised
Non-manufacturing costs	Customisation ability
Overheads	% increase in lead-time over standard product
Materials	**Volume flexibility**
Direct labour costs	Demand increase response ability
Capital costs	Minimum order size
Delivery lead-time	Maximum order size
Actual delivery lead-time	Seasonal demand variation
Manufacturing lead-time	Random demand variation
Non-manufacturing lead-time	Product shelf life
Op hours required: total factory time	Frequency of schedule changes
Schedule change ability	Size of schedule changes
Inventory investment	Effect on delivery lead-time
Other criteria	Set-up times

Table 4.7 Criteria and Parameters for Manufacturing Analysis

The gap analysis provides a simple comparison of the requirements and competitive performance of the manufacturing system for each of the product groups and of the system as a whole. Both tabular and graphical representations can be used to indicate the result. Simple analysis can be carried out to ascertain an approximate indication of the importance of any particular gap, both within the product group itself and within the system as a whole with respect to a particular criteria:

$$\Delta = R - \theta$$

where:

Δ	the gap
R	required value
θ	performance value

Hence if $\Delta > 0$ then the system is under-performing for the product group for a certain criteria, and if $\Delta < 0$ then the system is over-performing for the product group for a certain criteria.

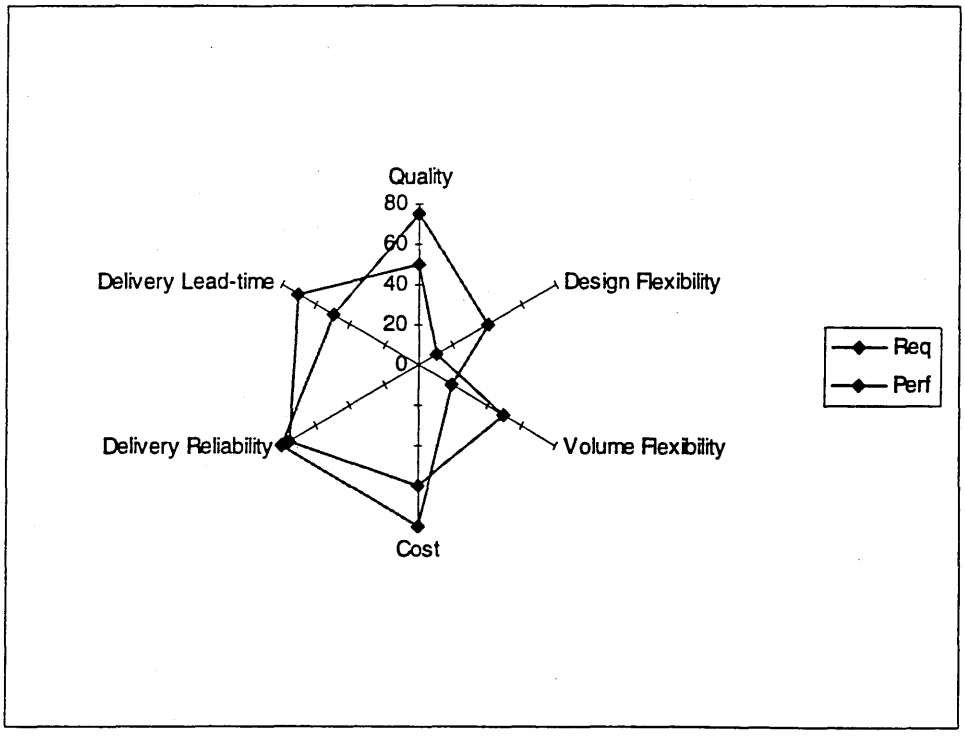


Figure 4.10 Gap Analysis of Product Group A

As with the previous utility function, a gap analysis can be executed to highlight specific directions of change and to assist in the development of action plans. The gap analysis can be applied separately to each product group as a comparison of two matrices (product-group/system performance), producing a series of policy-criteria gap matrices as an output (Figure 4.10). If deemed appropriate, and in the case where adequate system profile matrices exist, then a system strategy gap analysis matrix can be produced.

4.2 Link Between Environmental Influence and Manufacturing Strategy Formulation

Based on the environmental influences (e.g., national policy of a specific government on the long-term development of its industry, available funding schemes and regulations), specific issues regarding a manufacturing industry's strength/weakness and threats/opportunities, should be identified and taken into consideration. Overall guidelines should be incorporated into the framework, particularly at the SWOT analysis stage. This can help to provide an effective mechanism to link, for example, the government's long-term, national industrial policy to the medium-term strategic direction of the individual manufacturing companies.

SWOT Analysis

SWOT analysis is a generic analytical tool. It serves as a means of matching the environmental threats and opportunities with the company's weaknesses as well as its strengths. The analysis refers to both the internal and external environments.

The objective of external analysis is to identify strategic opportunities and threats in the organisation's operating environment. Two interrelated environments should be examined at this stage: the immediate, or industry, environment in which the organisation operates and the wider macro-environment. Analysing the industry environment involves an assessment of the competitive structure of the organisation's industry, including the competitive position of the focal organisation and its major rivals, as well as the stage of industry development. Analysing the macro-environment consists of examining macro-economic, social, government, legal, international, and technological factors that may affect the organisation.

The internal analysis serves to pinpoint the strengths and weaknesses of the organisation/manufacturing function. Such analysis involves identifying the quantity and quality of resources available to the organisation/manufacturing function. The relevant issues and factors are summarised below:

Opportunities and threats	Strengths and weaknesses
Economic factors	**Management and organisation factors**
Interest rates	Management systems
Exchange rates	Industrial relations
Availability of credit	Personnel policies
Level of employment	Morale
Social and political factors	Skills
Government legislation	Employee age
European legislation	**Operations**
International legislation	Quality
Union plans	Lead-times
consumer groups	Performance
Special interest groups	Capacity
Environmental green issues	Flexibility
Demographic factors	Dependability
Demographics	Location
Income levels	Material availability
Age composition	Technology
Market and competition criteria	Equipment age
Customer plans	Implementing change
Competition plans	**Finance factors**
Supplier plans	Capital structure
Customer dependence	Profitability
New competitors	Financial planning
Supplier dependence	Accounting system
Products and technology	Cost structure
New products	**Other factors**
New markets	Patents
New technology	Image of firm
Substitute products	
Other factors	
Availability of raw materials	

Table 4.8 List of sub-headings

- *Strengths*: activities, systems, technologies, procedures, etc., which the manufacturing organisation do uniquely well.
- *Weaknesses*: activities, systems, technologies, procedures, etc., which the organisation does not do at an acceptable standard.

- ***Opportunities***: activities, systems, technologies, procedures, events, potential events, etc., which the organisation may additionally exploit.

- ***Threats***: activities, systems, technologies, procedures, etc., which may prevent the organisation reaching its goals.

Weihrich (1982) pointed out that threats and opportunities relate to the external environment of the manufacturing organisation under analysis, whilst weaknesses and strengths relate to the internal environment. The SWOT analysis is essentially a creative process of qualitative analysis. The external analysis, within an industry, comprises the risk of new entry by potential competitors, the degree of rivalry among established companies within an industry, the bargaining power of buyers, the bargaining power of suppliers, and the closeness of substitution to an industry's products. The macro-economic environment will in general include several elements: the macroeconomic environment, the demographic environment, the political and legal environment, and the global environment. Table 4.8 provides a list of typical sub-headings.

MSAMSA Influence Table

In the case of Saudi manufacturing companies, it is particularly important to take into consideration the influence of national industrial policy to manufacturing strategy formulation. The following key issues are highlighted by Chapter 3.

Saudisation

The purpose of Saudisation is not only to create the job opportunities for the people but also to modernise the country which should be the same policy implemented by both the developing or developed countries. Following this general direction the government recommends companies to hire a certain amount of local employees (5% in each year since 1996), and by law the government takes the responsibility of the training expenses for those people. Also, it is advised that the manufacturing companies should wherever possible switch to automation to decrease the level of requirement on man power. The high skill level needed for these facilities can be achieved by Saudis employees with the government's training support. As a majority of the population of the country are between 20 – 35 and well educated, with the technical training they can readily deal with the automation and

technology. This is being viewed as a prerequisite for Saudi industries to become prosperity and profitable in future. The government policy in this case can be summarised as to increase the Saudis national employee in both the private and public sectors, and the target in this year (97/98) as per the government regulation should be at least 10% of the total in the private sector. The necessary training expenses fore the Saudis employee in the private sector will be met by the government. Because with automation one can minimise the man power to reduce the cost but one needs high skill labour. These together actually presents an ideal combination for the implementation of the current Saudisation policy in the country. The following advantages and disadvantages can be identified:

Advantages

- Decrease the level of unemployment.
- Support the national economy to keep the cash in the country.
- More stabilisation of the national economic.
- To increase quality of life of people in future.

Disadvantages/Threats

- Government enforcement - proportion of Saudi national in a company should be increased by 5% each year.
- One company two salary systems.
- Increased labour cost.

Government Support

Since 1970 the government has conducted 5 year term development plans which provide industry with infrastructure and support infrastructure to increase there opportunity of growth. In addition to the training support mentioned above, the Saudi Government's Sixth Development Plan (1996 –2000) also intends to provide the following support to help the development of manufacturing industries.

- *Industrial Area.* In the country there are 8 industrial cities established by the government with well constricted infrastructure to attract local and foreign investment with convenient utilities, free land, tax free for raw material, machinery and spare parts.

- *Funds.* Long-term loan without interest charge can be arranged from the government through the SIDF (The Saudi Industrial Development Fund). This is available to the new investor in industry, as well as for the existing industry in expansion projects.

Advantages and opportunities from the manufacturing companies' point of view include:

- Free lands.
- Tax free.
- Long. term loan without interest.
- Industrial cities.
- National products preventive policy.
- Relatively high level of consumer spending power.

There is no apparent disadvantages or threats regarding the issue.

Exporting/New Markets

The new market should include both local and oversea markets, because the country has a population of 16 million which represents only a limited local market. Therefore in accordance with the long-term national economic strategy to become an industrialised nation, the country's manufacturing industries must be focused on the fulfillment of both the local consumable products and the exporting market, with the later placing emphasis not only on the expansion of the consumer products but also on industrial goods.

Exporting will be of great importance, especially for those manufacturing sectors with their raw material available from the country itself, such as petrochemicals. To be successful for the Saudi manufacturing companies in exporting, they must be competitive in terms of product quality and price, etc., according to the international expectation. Good advertisement on the international scene, to achieve a higher level of presence in the global

market, through international exhibitions, media, etc., is also important. From the manufacturers' point of view, the following are observed:

Advantages

- Low price of raw materials from local petrochemical industries.
- International loan or support to meet mutual interest.
- Well establish infrastructure.
- Government support to open the new market.

Disadvantages

- Labour costs higher than other countries with the Saudisation policy in force

Research and Development

In order to achieve the prosperity and the wealth in future the country needs specially to focus on Research and Development activities. With the foundation of petrochemical industries, the strong national finance support, the well educated workforce and professional specialists, and comprehensive research institutions such as universities, the King Abduaziz Technical City, the country as a whole is ideally equipped to expand her R&D base in areas such as Electronics , Machinery , Defence , Aeronautics, etc.. For example, in the last few years Saudi Arabia, together with the other GCC (Gulf Community Council) countries, has spent around $150 billion to buy water treatment plants from the overseas suppliers. In the future, part of this money may be much more effectively invested to support R&D projects and technology transfer activities so as to develop and enhance local expertise. The results from these projects will enhance Saudi Arabia's technological capabilities and her chance to become a leading industrialised country in the region.

In this regard, the opportunities to the Saudi manufacturing companies include:

- Existing expertise in petrochemical industry.
- Well educated workforce and experts.
- Utilise the university resource to support the industry.

- Utilise King Abduaziz technical city to support the industry.

Disadvantage

- High cost in technical transfer.

Environmental Issue

This matter requires the generalised implementation of environmental impact evaluations for all industrial projects, from the initial feasibility studies to the selection of technologies that do not pollute the environment or damage natural resources, the improvement of operation and maintenance procedures in the industrial production process, concentration on material-recycling projects, and addressing the adverse environmental impacts from existing industries before they grow any larger.

Generally the environment should be clean and there should be a strict policy to prevent the environment from industry pollution. Accordingly, utilisation of the natural and environmental resource of the country has been ascertained with the purpose to satisfying the current requirements without tampering capabilities and rights of the future generations to fulfill their needs out from the same resource. The basic role of governance of the country has been issued as a culmination of these principle and policies. In Article (32) The Basic Rules stated :

> " The government shall endeavor to conserve , protect and develop the environment as well as to prevent pollution."

Within this framework , Saudi Arabia has adopted the principle of preventive measures which were based on projection of potential environmental damage and seeking to prevent them together with the attempt to avoid depletion and deterioration of the natural resources; hence, the principle of the Environmental Impact Assessment within feasibility studies of proposed projects has been adopted.

From the manufacturing industries point of view, it is desirable to develop and adopt the environmental issues on board due to both moral and financial considerations (e.g., government support and world recognition). The short term disadvantages in this includes, of course, an increased overall cost.

The above are summarised in Table 4.9. This table, although by no means exhaustive, can be used to provide overall guidelines at the appropriate stages during the strategy formulation.

	Advantage	Disadvantage
Saudization	Decrease the rate of unemployed Support the national economy to keep the cash in the country. More stabilisation of the national economy To increase quality of life of people in future	Government enforcement in each year 5% of the total employee should Saudis nationality. One company two salary systems. Increase the labour cost.
Government Support	Free lands Tax Free Long term loan without interest Industrial cities National products preventive policy	Possible WTO intervention
Exporting (new markets)	Low price in petrochemical industries. Through international loan or support to meet mutual interest (monetary) Well establish infrastructure Government support to open new market Consumerability	Production cost are higher than other countries in the Middle East in general.
Research & Development	Specialise in petrochemical industry Well educated workforce Utilise the university resource to support the industry. Utilise king Abdulaziz technical city to support the industry.	High cost technical transfer
Environmental Issue	Government support International recognition	Increase the overall cost

Table 4.9 Influences of Current Government Policies on Manufacturing Development

4.3 General Expectation and Generic Profiles of Strategic Priority

The previous section has also highlighted the long-term need for a manufacturing industry to be able to carry out manufacturing performance evaluation according to both local and global expectation. In particular, for a Saudi manufacturing company to be successful in the long term, it must be competitive both locally and internationally, with its performance achieving the level of expectation from both its own customer group and that of the global market. For example, a set of generic priority profiles may be provided as a guidance to help a company cross-check, qualitatively, its local requirement profile against the general global expectation.

These priority profiles are to be related to specific manufacturing company types according to their organisational and operational characteristics. For quantitative evaluation to be conducted externally, bench-marking techniques should be investigated to provide guidance to measure against international best performance.

In order to develop a set of generic strategy profiles as the basic guide, two key issues must be taken into consideration: classification of manufacturing company types and their associated strategic profile. Manufacturing companies have been traditionally classified by how the work is organised: make-to-order or make-to-stock (Wu 1994). It is also possible to further divide these into high-volume and low-volume production systems (Sweeney and Swejczewsky 1996). Once a scheme of classification is in place, it may then be feasible to develop a set of "generic" strategic profiles to reflect the overall performance requirements as expected from each of the company types.

A literature survey has revealed a number of previous studies of manufacturing strategy practice that identified groups of generic manufacturing strategies. For instance, specific generic strategies for implementation have been suggested by a number of authors (Samson, 1991), all aiming at improving the competitiveness of a manufacturing organisation. A selection of these is summarized in Table 4.10.

HAYES & CLARK (1986)	SCHROEDER & PESCH (1987)	SKINNER (1983)	WALTERS (1989)
Invest capital	Manage operations from a strategic viewpoint	Focus on productivity	Participation of manufacturing in developing business strategies
Reduce waste	Take advantage of new product and process technologies	Develop and use manufacturing strategies	Extension of awareness of corporate goals and individuals contribution to the factory floor level
Remove WIP	Plan and schedule output	Return to quality	Significant cultural change contribution by manufacturing managers
Focus on learning	Keep things simple and action-oriented	Manage new technology and innovation	Optimisation of results of enterprise rather than departments
Focus on improving profitability	Create an environment in which people can excel	Improve ways to effectively use personnel	Partnerships among functional managers
	Emphasise quality assurance	Use operations technology as a strategic weapon	Systems emphasis for standardisation, timeliness, cost control and accuracy
	Be innovative in operations (continual improvement)	Develop and promote the new breed of manufacturing managers	Flexible manufacturing for adjustment of volume and product mix, yet minimising performance losses

Table 4.10 : Generic Strategies for Manufacturing Improvements (Source: Samson, 1991)

Similarly the following set of action plans have been identified by Aggteleky (1987):

- New systems for existing products.
- Modernisation / Innovation / Automation.
- Cost reduction / Rationalisation.
- Capacity expansion / Bottleneck elimination.
- Location change.
- Merging of sites.
- Decentralisation.
- Down sizing.
- Systems synchronisation.
- Systems modification / Diversification.
- New systems for new products.
- Joint ventures / Virtual factories.

Such generic manufacturing strategies provide only an indication of possible directions to take. Whilst the application of generic strategies on their own has been severely criticised (see, for example Judson, 1996), they do sometimes provide an useful starting point from which to derive a strategic direction and a more detailed specification of the manufacturing strategy. It is suggested that they also provide a measure of global expectation against which the manufacturing companies in a specific country/sector may compare their own specific strategies with, in order to highlight issues and identify policy decisions that will enhance their international competitiveness. This is particularly relevant if these companies intend to be successful in the international market, such as in the case of Saudi Arabia.

Generic Strategy	Stobaugh & Telesio (1983)	Roth & Miller (1989)	De Meyer (1990)	Edmundson & Wheelwright (1989)	Sweeney (1990)	Hayes & Wheelwright (1984)
Caretaker	Cost-driven	Caretaker		Quick relief to manufacturing challenges	Quick fix	Internally neutral
Marketeer	Market-driven	Marketeer	Marketing oriented		Stretch	Externally neutral
Reorganiser			High performance product	Applying organisational tools	Catch up	Internally supportive
Innovator	Technology-driven	Innovator	Manufacturing innovators	Develop a competitive edge through manufacturing	Breakthrough	Externally supportive

Table 4.11 Generic Manufacturing Strategies (Source: Sweeney, 1991)

Of particular interests here is the idea of classifying manufacturing organisations, according to their strategic characteristics, into a number of distinct types: 'caretaker', 'marketeer',

'innovator' and 're-organiser' (Sweeney, 1991). These four categories can be related to a certain degree with the four elements of a manufacturing strategy framework, internally neutral, externally neutral, externally supportive and internally supportive respectively, as presented by Hayes & Wheelwright (1984). Table 4.11 presents Sweeney's findings.

	Make for stock	Make for order
	Marketeer	**Innovator**
Low Volume	1.Quality 2.Cost 3.Delivery Reliability 4.Delivery Lead time 5.Design Flexibility	1.Quality 2.Design Flexibility 3.Delivery Reliability 4.Delivery Lead time 5.Cost
	Caretaker	**Reorganisers**
High Volume	1.Cost 2.Quality 3.Delivery Reliability 4.Delivery Lead time 5.Design Flexibility	1.Delivery Reliability 2.Delivery Lead time 3.Quality 4.Cost 5.Design Flexibility

Table 4.12 Classification of Manufacturing Type and Their Generic Strategic Priority

Based on a survey involving a relatively large number of manufacturing companies, a strategic priority list has been suggested. These are listed in Table 4.12. Such generic strategies represent an opportunity with respect to the development of a set of generic priority profiles to provide guidance to help cross-check local requirement profile against general, global expectation. Depending on the particular type of manufacturing operation concerned, certain strategies can be considered to be more appropriate in order that the enterprise might progress and develop in a consistent and logical manner. It is suggested that a number of generic priority profiles to be developed in the format that is consistent with the extended evaluation scheme as presented in Section 4.2. These are illustrated in Figure 4.11.

These profiles are not provided to the companies in a prescriptive manner, but only as suggestions for exploring their own strategic approach. Hence, by considering the corporate and business strategies, the competitive criteria analysis, key issues, SWOT analysis results

and problem definitions a generic approach can be customised. This can then be used to assist the specification of the individual future manufacturing policy decisions. Hence by comparing the generic strategy profiles with those based on the results from a firm's own analysis, the strategy formulation is also taking into account the development of competitive criteria, capabilities, competencies, and as well as international expectations.

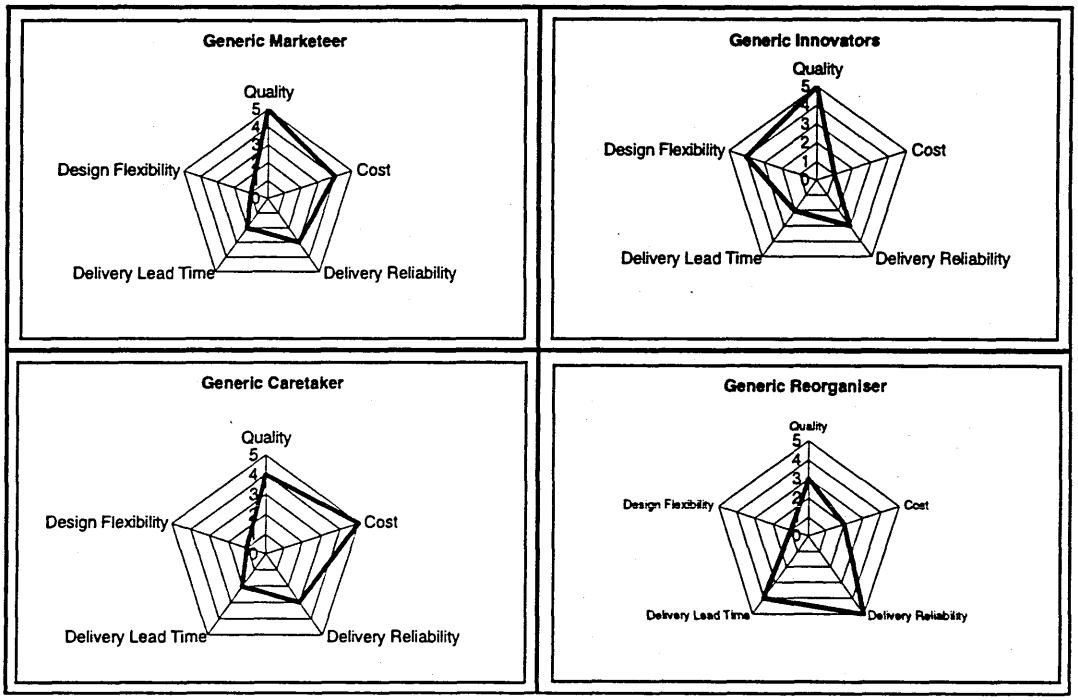


Figure 4.11 Generic Strategic Priority Profiles

4.4 MSAMSA SWOT Procedure

A structured procedure for SWOT analysis is proposed here to take the above issues into consideration (See Figure 4.12). The basic processes are based on that suggested by Greenhalgh (1990) and Weihrich (1982). Each of the SWOT categories as listed in both the generic sub-headings table (Table 4.8), and the Sixth Development Plan influences

table (Table 4.9) and should be taken in turn to complete the analysis by following the following steps:

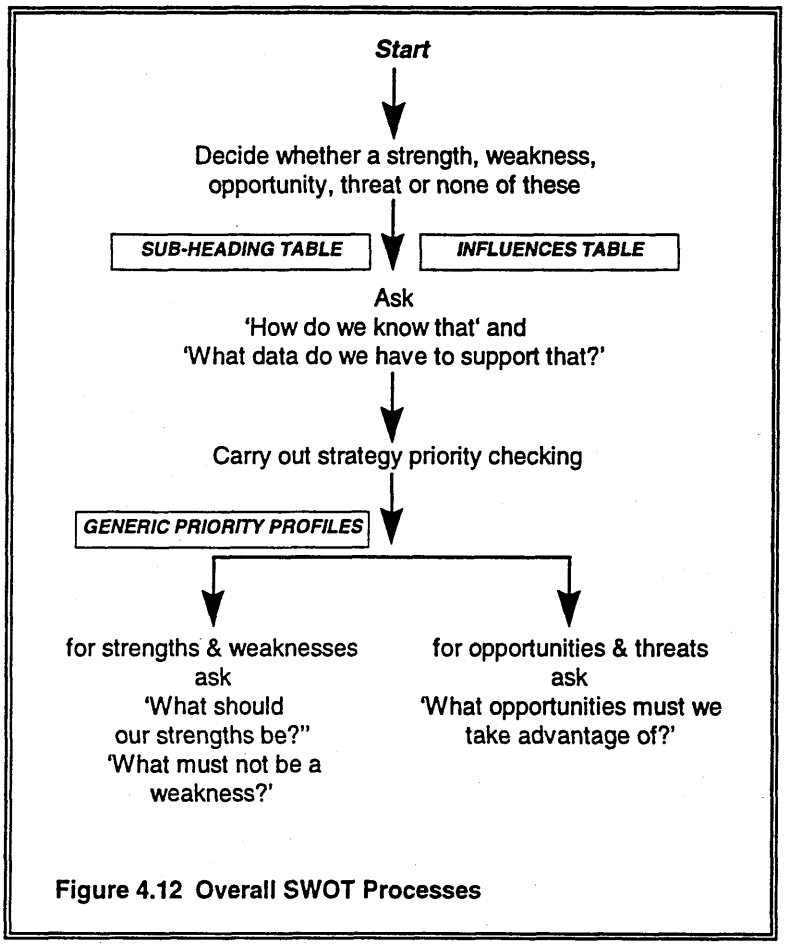


Figure 4.12 Overall SWOT Processes

1. Take each of the headings from the tables, and decide whether these are relevant in the particular situation.
2. Provide explanation or justification for each SWOT assessment, indicating the nature and extent of each SWOT, and provide detailed data to support the justification.
3. Further identify key issues by requirement/performance/generic priority comparison.
4. For strengths and weaknesses: define what the strengths should be and what weaknesses the manufacturing function must not possess.
5. For opportunities and threats: define what opportunities the manufacturing function must take advantage of.

The overall aim in of this exercise is to identify future strategic directions that will effectively direct the organisation in such a way so that the centre of attention is as shown in Figure 4.13.

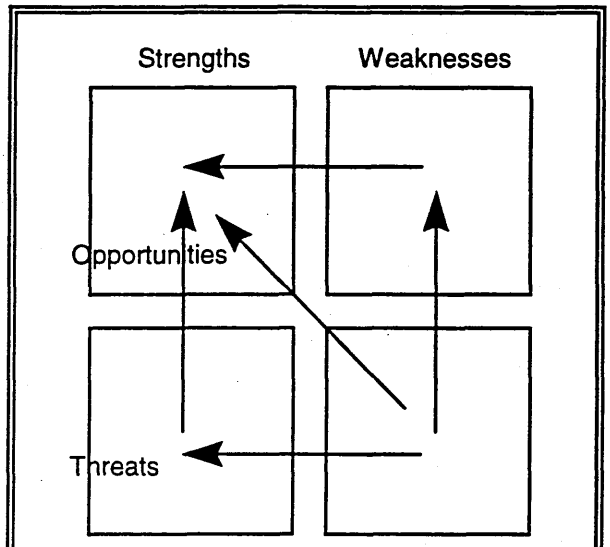


Figure 4.13 SWOT Positioning

CHAPTER 5 STRUCTURE AND PROCEDURES OF MSAMSA

5.1 Introduction

Following the discussions from the previous chapters, this chapter presents the structure and procedures of MSAMSA - A Manufacturing Strategy Analysis Methodology for Saudi Arabia. The basic structure of MSAMSA is based on a prototype manufacturing strategy formulation and capture framework developed previously by the CAMSD (computer-aided manufacturing systems design) research team at Cranfield University (Wu 1995a, 1997a), UK. However, the structure and procedures have been further developed to reflect the specific requirement for Saudi manufacturing industries. This aims to provide Saudi companies with an effective approach to help develop manufacturing strategies particularly suitable within the Saudi industrial environment.

Based on the national policy of the Saudi government on the long-term development of Saudi industry, as discussed in Chapter 3 and 4, Saudi specific issues regarding its manufacturing industry's strength/weakness and threats/opportunities, have been identified and taken into consideration. A number of overall guidelines are incorporated into the framework, particularly at the SWOT analysis stage. The aim is to provide an effective mechanism to link the government's long-term, national industrial policy to the medium-term strategic direction of the individual manufacturing companies. For example, alongside the logical path of strategy development, an extension has been built into the process, in the form of a "road map" to outline the network of agencies and information sources available. These are set up mainly by the Saudi government to

encourage and help local manufacturing industries. The inclusion of this map will provide the user with an useful guide to identify and take advantage of the available support, and hence develop the most suitable strategies in an effective way. More details are provided on this issue later in this chapter.

Manufacturing performance evaluation according to both local and global expectation is particularly important for Saudi manufacturing companies, due to the government's policy at the macro-economic level to develop its manufacturing industry, and to expand the industry's level of export. From within the complete evaluation framework, the measures supported by MSAMSA are shown in Table 5.1.

	Qualitative	Quantitative	Product-Focused	System-Wide
Internal/Local	X	X	X	X
External/Global	X		X	X

Table 5.1 Evaluation Measures Supported by MSAMSA

This chapter provides an overview of MSAMSA's structure, main stages and features. The complete procedures, including individual steps, instructions, forms and worksheets, are described in detail in a self-contained workbook. This workbook is provided in Appendix I.

5.2 Overview of The MSAMSA Structure

The underlying logic and process of MSAMSA closely follows that of the generic problem-solving model of Wu (1994). The manufacturing strategy formulation process of MSAMSA conforms to that of the manufacturing strategy capture/formulation process of Cranfield's I/O-CAMSD Framework (Wu 1997b), with its underlying logic and structure closely following the journey-planning process as described in Chapter 2, but with enhanced functionality and analytical tools. Its first step is to classify a company's products into groups in terms of their market significance. For each product group the key requirements are then assessed with respect to the manufacturing criteria such as cost, quality and delivery performance. Finally the current system's strengths and

weaknesses are analysed to identify gaps and to develop strategies to solve the highlighted problems or to improve the situation.

The whole process is composed of five stages (Figure 5.1):

1. Manufacturing Background

2. Competitive Criteria Profiles

3. Key Issues

4. Strategic Aims

5. Strategic Initiatives

Each stage comprises a number of tasks with a series of questions and data collection methods, in order to develop and assist the capture of the individual manufacturing policy decisions. A number of analytical tools are also provided to aid the analysis and the decision-making process. As with any development process, iterations through the stages are expected, especially at the later stages when the future policies and action plans require evaluation.

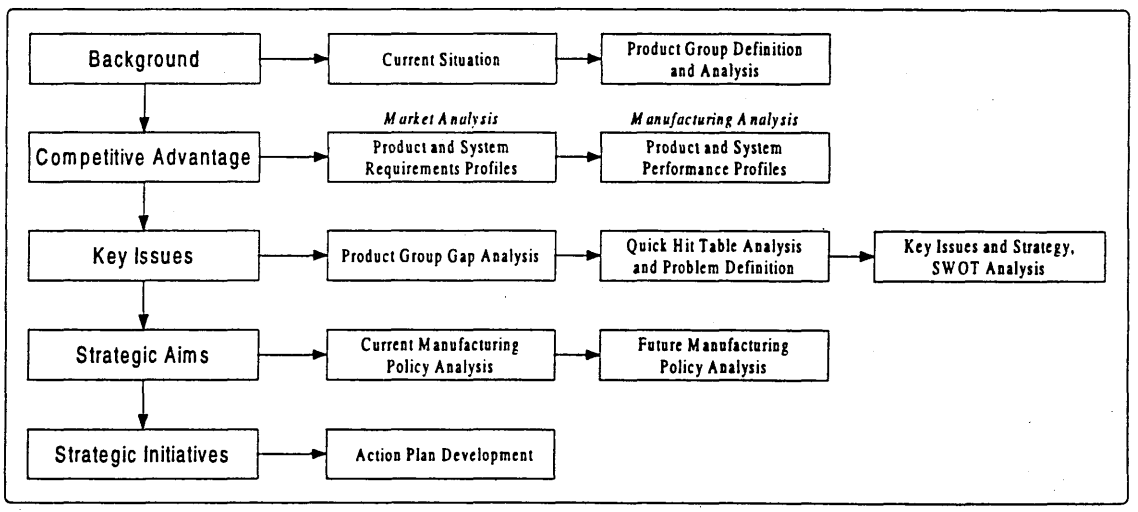


Figure 5.1 Strategy Formulation Process Overview

5.3 The Stages of MSAMSA

As illustrated Figure 5.1, the following are the main stages and their main features.

MSAMSA Stage 1 - Manufacturing Background

Stage 1 produces the first element of the manufacturing strategy document, and is responsible for the initiation or preparation for a strategy or manufacturing system audit. It is designed to gather the relevant background and environmental information at the beginning of journey planning, by classifying the current state of development of the manufacturing system and the role of the manufacturing function within the organisation. In addition, it also attempts to identify the requirements of the manufacturing system, with respect to the products to be manufactured, and assists the analyst later to define appropriate product groups. One of the outcomes of this stage is the identification of the type of manufacturing operation involved, according to a generic classification scheme. This will provide a basis to facilitate the external assessment process for strategic evaluation purposes. The stage comprises a series of questions relating to the organisation and the manufacturing system, and consists of the following four tasks (Figure 5.2):

1.1 Manufacturing function definition

1.2 Current situation specification

1.3 Classification of product groups

1.4 Establishment of product group importance

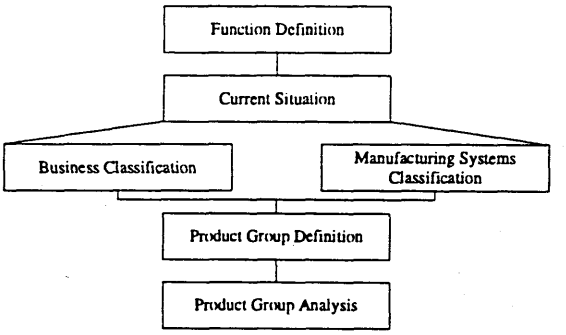


Figure 5.2 Stage1 - Manufacturing Background

Task 1.1 attempts to establish whether a statement of the role of manufacturing in the organisation actually exists. If one does not exist then such a definition should first be formulated before the subsequent analysis. The approach then helps to request a textural input of the manufacturing function definition statement for future reference.

The current situation definition (Task 1.2) is composed of three sections: a statement of the current situation, a classification of the business and a classification of the manufacturing system. The statement of the current situation is similar in format to the definition of the manufacturing function, requesting a textural input. The next two sections are based on a questionnaire approach. A detailed discussion of the concepts behind these sections, including their relevance to the management of change and strategy growth phases, can be found in a previous report (CAMSD Report: Nov96-No.1., 1996, Cranfield, UK). The business is to be classified according to its structure, culture and organisational behaviour:

Business Structure -	*Structural Configuration, Co-ordinating Mechanism, Key Organisational Section, Decentralisation Type.*
Business Culture -	*Culture, Orientation, Organisational Activities.*
Organisational Behaviour -	*Growth, Market, Product Development, New Products and Services, Production, Investment, Concentration, Co-operation, Behaviour to Competitors.*

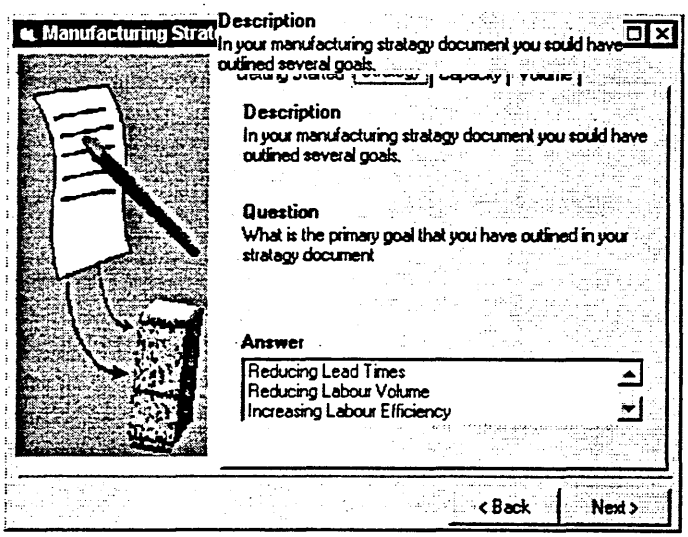


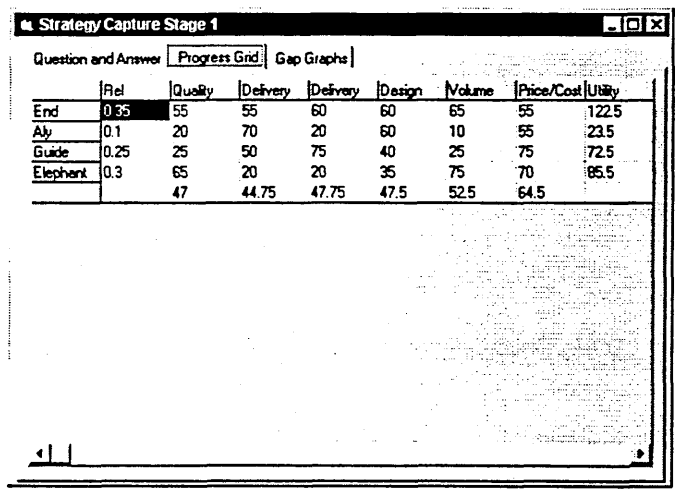
Figure 5.3 Manufacturing Strategy Capture

Figure 5.3 illustrates a computer-aided tool to help an analyst carry out this task. This and the other screenshots in this chapter are the actual user interface display from a generic, prototype I/O-CAMSD implementation that has been developed in Cranfield in accordance with the overall structure as specified. At this stage of development, the use of computer-aided tools is not necessary for MSAMSA's application in practice,

although they are highly desirable for its future development and adaptation. These screenshots are included here merely to help clarify MSAMSA's structure and contents.

Similarly, the manufacturing system is classified with respect to its structure, relationships, state and life cycle:

System Structure -	*Product Process Matrix (Volume, Variety, System Type, Degree of Technology Integration, Degree of Technology Automation, Scale of Capacity Increment), Stock and Order Operating system Structure.*
System Relationships -	*Nature of Business, Customer Influence, Organisational Structure.*
System State -	*Degree and State of Evolution.*
System Life Cycle -	*Life Cycle Stage.*



	Rel	Quality	Delivery	Delivery	Design	Volume	Price/Cost	Utility
End	0.35	55	55	60	60	65	55	122.5
Aly	0.1	20	70	20	60	10	55	23.5
Guide	0.25	25	50	75	40	25	75	72.5
Elephant	0.3	65	20	20	35	75	70	85.5
		47	44.75	47.75	47.5	52.5	64.5	

Figure 5.4 Competitive Criteria Table

The product group definition task (Task 1.3) provides a number of simple tools to aid the specification of the product groups or families. First the product families, variants, etc. can be recorded through a tree-based structure. Once these have been established then a quantitative and qualitative analysis can be carried out to assist the selection of major product groups. Typical criteria which could be applied include: volume, variety, costs, profits, markets and customers, resources and processes and materials (Figure 5.4). Simple ABC analysis tools can be used to assist this process.

Next, the product group analysis (Task 1.4) takes each previously defined product group in turn and asks the analyst to enter relevant information with which to compare the product groups to assess their relative importance. Typically these criteria would be:

volume, variety, costs, profits, market share, product life cycle stage, manufacturing capability and the system's strengths weaknesses, opportunities and threats with respect to the individual product groups. Each criteria should be assigned a relative ranking based on the company's assessment of its importance (Figure 5.5).

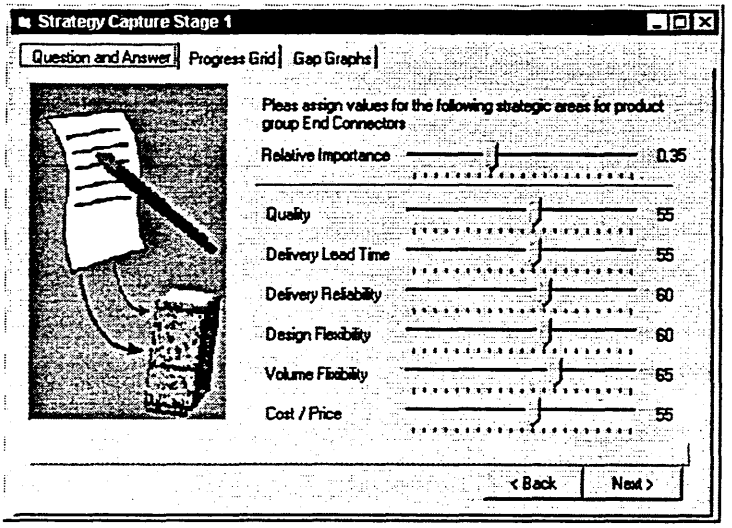


Figure 5.5 Product Group Competitive Criteria Data Capture

MSAMSA Stage 2 - Competitive Criteria Profiles

The general aim of stage 2 is to answer the question, "In order to be competitive, where do we need to be?" It is designed to capture the marketing requirements and manufacturing performance of each of the previously identified product groups. This information, when collected together, will enable a competitive requirement profile to be developed for each of the product groups, indicating the areas of the enterprise on which to focus in order to achieve a superior position in relation to competitors. This allows a greater insight into decisions concerning allocation of resources, prioritisation of activities and initiatives and prevents wasting time and money on non-essential business and manufacturing aspects. Hence, not only are the key success factors defined for the markets in which the enterprise is competing, but also the key success factors are defined through which the manufacturing function will need to contribute towards the enterprise performance and the attainment of a competitive business position. There are essentially three tasks in this stage:

2.1 Product and system requirement profiling

2.2 Product and system performance profiling

2.3 Establishment of the basis for competitive advantage

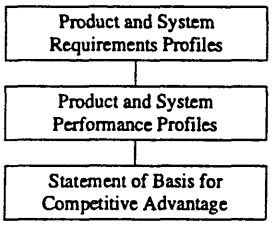


Figure 5.6 Stage 2 - Basis for Competitive Advantage

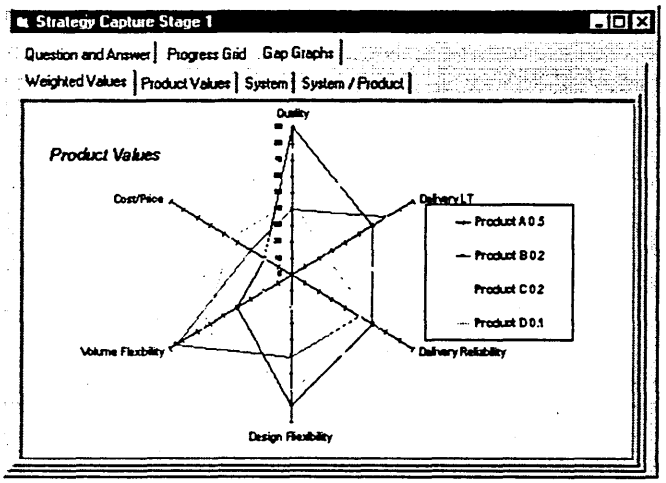


Figure 5.7 Product Profiles Capture

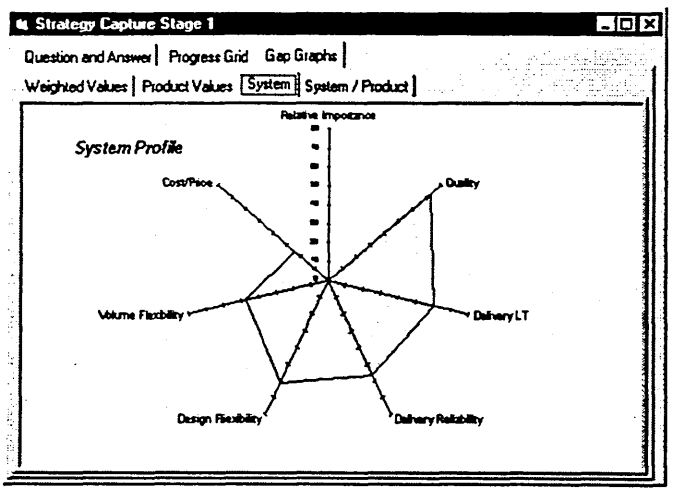


Figure 5.8 Manufacturing System Profile

The approach to be adopted for the profiles of product/system requirement and performance has already been discussed in detail in Chapter 4. Through Stage 2 these

profiles will be presented as the kind of web diagrams as specified in section 4.2 (Figure 5.7 and 5.8), together with their relevant values and profile vectors and matrices. The final section of this stage requires a textural entry of the statement of the basis for the manufacturing function's competitive advantage. This should be based on the information that has previously been entered.

MSAMSA Stage 3 - Key Issues

Generally speaking, the aim of this stage is to identify the problem to be solved. Attention here should be first focused on, in relation to the requirements and performance of each of the product groups, the structure of the existing manufacturing system including its elements, relationships, boundaries, environment, functions and as well as its strengths and weaknesses. The successful completion of this should provide the correct answer to the key question: "Where are we now ?" The combination of Stages 1 and 2 can be referred to as "problem formulation" because, by establishing "where we are now" and "where we should be", these two stages together will indicate the gap between the present system state and what its environment demands from the system - or a "problem" which prompts the search for an appropriate solution so that the gap may be closed.

Therefore, stage 3 of the methodology starts with a gap analysis. This is followed by an analysis of the *Strengths, Weaknesses, Opportunities* and *Threats* (SWOT) of each of the product groups. The results are then used to define the key issues and initial strategic objectives. The complete stage consists of five tasks (Figure 5.9):

3.1 Product group gap analysis

3.2.a 'Quick Hit' table analysis

3.2.b Questionnaires - key issues and manufacturing strategy

3.3 Current manufacturing policy analysis

3.4 Statement of key issues

Again the basis for the product group gap analysis (Task 3.1) has been outlined in the last chapter. It provides a qualitative and quantitative indication of the differences between what the customers wants with respect to the products/company and the actual

performance of the company's manufacturing system, as outlined in Chapter 4 (Figure 5.10).

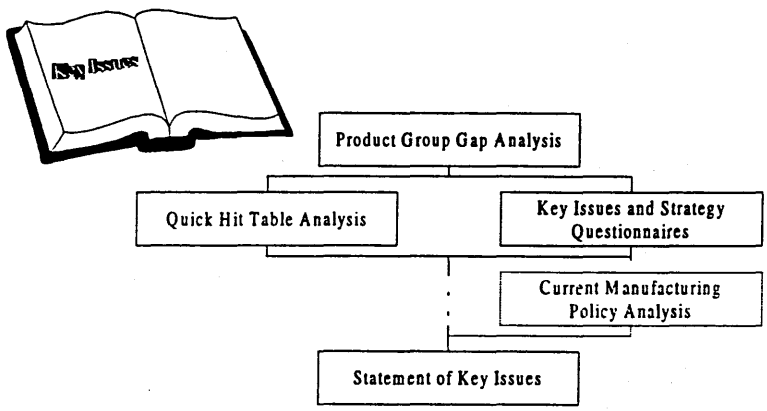


Figure 5.9 Stage 3 - Key Issues

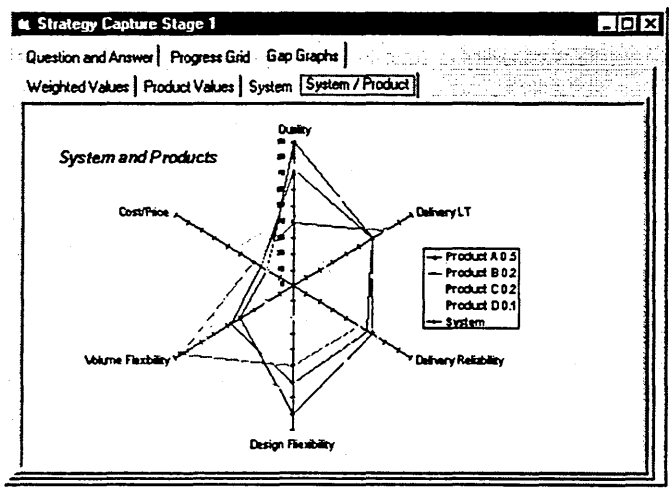


Figure 5.10 Gap Analysis

Following the above the user then has two options: to continue with the strategy capture/development approach and complete a series of questionnaires regarding the key issues (Task 3.2a); and/or to adopt a problem solving approach and examine a 'quick hit' strategy problem chart (Task 3.2b) (CAMSD Report: Nov96-No.1, 1996, Cranfield, UK). The chart itself can be used in conjunction with the key issues questionnaire in order to identify key areas for improvement. Further help and guidelines are also available in the form of strategy tables which provide an in-depth outline of the content of the manufacturing policy areas with respect to the decisions, sub-decisions, options, parameters and influences. The problems highlighted in the quick hit table are then

associated to relevant decisions and sub-decisions to assist the designers in their choice of actions. However, since the quick-hit analysis is optional at this stage of MSAMSA's development, details are not included in its prototype document in Appendix I.

Task 3.3, current manufacturing policy analysis, is again optional and dependent upon the emphasis which the user places on the strategy capture/development process and its influence on MSD. The policy analysis involves the specification of the current manufacturing strategy and the analysis of key aspects within each policy area with respect to the competitive manufacturing criteria.

	Advantage	Disadvantage
Saudization	Decrease the rate of unemployed Support the national economy to keep the cash in the country. More stabilisation of the national economic To increase quality of life of people in future	Government enforcement in each year 5% of the total employee should Saudis nationality. One company two salary systems. Increase the labour cost.
Government Support	Free lands Tax Free Long term loan without interest Industrial cities National products preventive policy	Possible WTO intervention
Exporting (new markets)	Low price in petrochemical industries. Throw international loan or support to meet mutual interest (monetary) Well establish infrastructure Government politic support to open new market Consumerability	Production cost are higher than other country in middle east in general.
Research & Development	Specialise in petrochemical industry Well educated workforce Utilise the university resource to support the industry. Utilise King Abdulaziz technical city to support the industry.	High cost technical transfer
Environmental Issue	Government support International recognition	Increase the overall cost

Table 5.4 Influences of the Current Government Policies on Manufacturing Development

In addition, it is at this stage that a more structured way of linking higher level policies to the process of manufacturing strategy formulation can be provided. Based on the environmental influences (e.g., national policy of a specific government on the long-term development of its industry, available funding schemes and regulations), specific issues regarding a manufacturing industry's strength/weakness and threats/opportunities, could be identified and taken into consideration by providing overall guidelines at the SWOT analysis stage. In the case of MSAMSA, the information presented and summarised in Chapter 3 and 4 are utilised to develop tables such as the one given in

Table 5.4. When incorporated in the overall framework in such a manner, such information can provide an effective mechanism to link, for example, the government's long-term, national industrial policy to the medium-term strategic direction of the individual manufacturing companies. In addition, other useful information are also provided to help the companies in this regard (Figures 5.11 and 5.12).

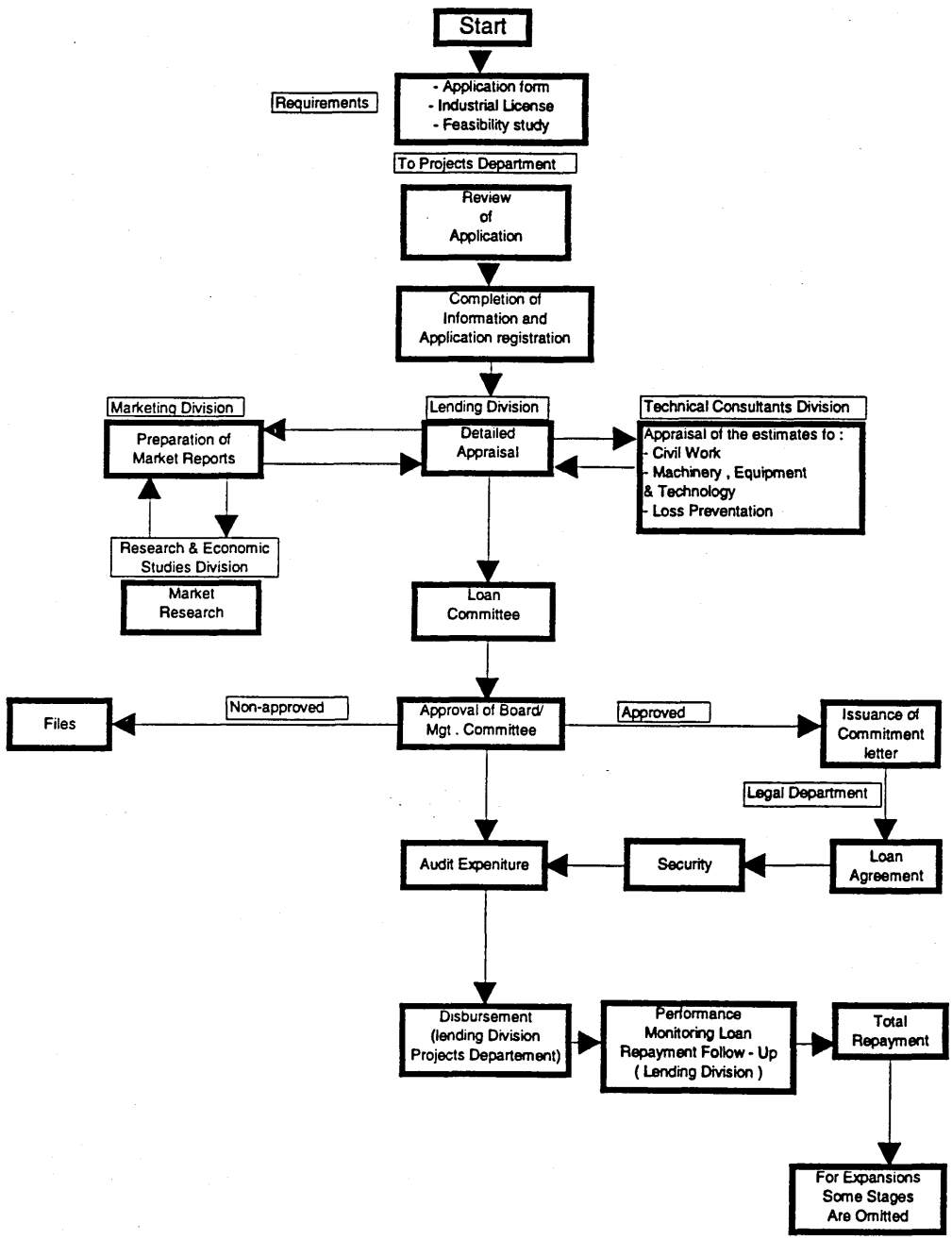


Figure 5.11 Application Procedures for Financial Support Through SIDF

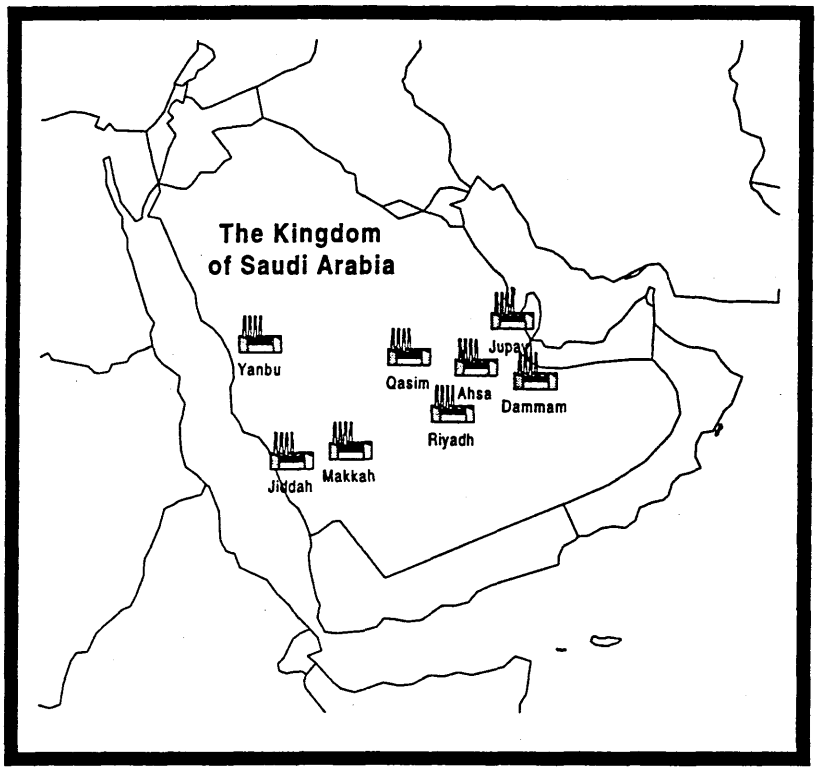


Figure 5.12 Location of Government Supported Industrial Cities

Finally, the last step of this stage, Task 3.4, requires a textural entry of the statement of the key issues for the manufacturing function. This should be based on the information that has previously been entered and be consistent with the previous stages.

MSAMSA Stage 4 - Strategic Aims

Stage 4 represents the fourth element of the manufacturing strategy document and an intermediary stage within a strategy or manufacturing system audit approach. The strategic aims stage captures or develops the details of the manufacturing strategy, based on the previous analytical stages. If a current strategy exists then it is captured through a series of questions and its policies are assessed with respect to the competitive criteria. The future policy can then be captured or produced based on the previous strategy, the analysis results and the strategic aims derived from the key issues. These aims should be a direct response to the key issues. The flow chart of the UK DTI (Department of Trade and Industry) approach provides a good basis for this stage (Platts and Gregory, 1988).

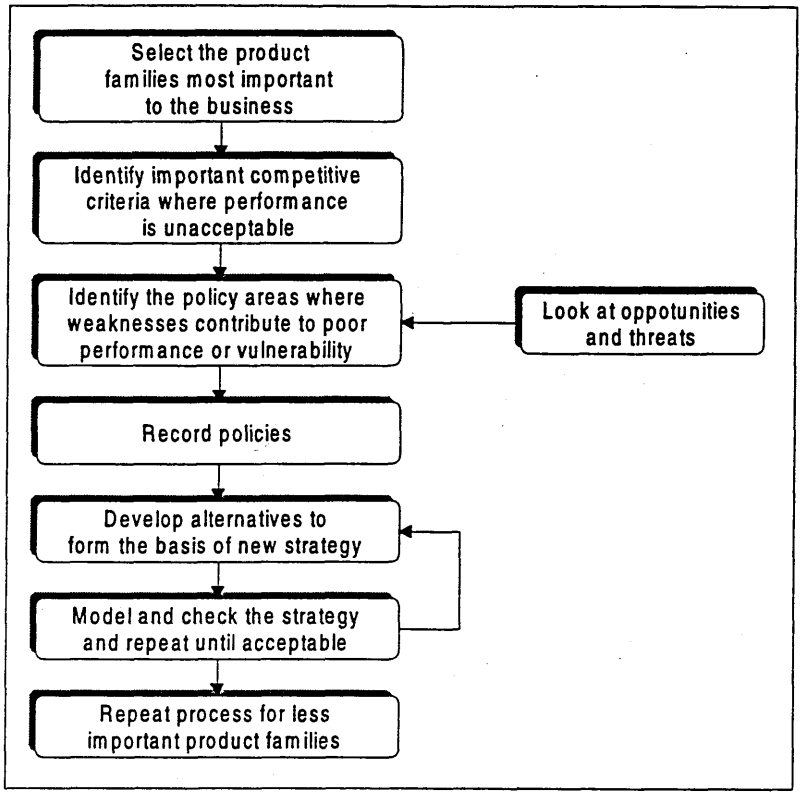


Figure 13 Flowchart of the DTI Approach

To assist in the process of deriving strategic aims and the future manufacturing strategy, generic manufacturing strategy profiles are provided, which provide the basis for an external and qualitative evaluation as described in Chapter 4. A similar means of capturing and analysing the future policies are adopted. There are up to five sections to this stage:

4.1 Manufacturing strategy questionnaires

4.2 Current manufacturing policy analysis

4.3 Future manufacturing policy analysis

4.4 Manufacturing policy gap analysis

4.5 Statement of strategic aims

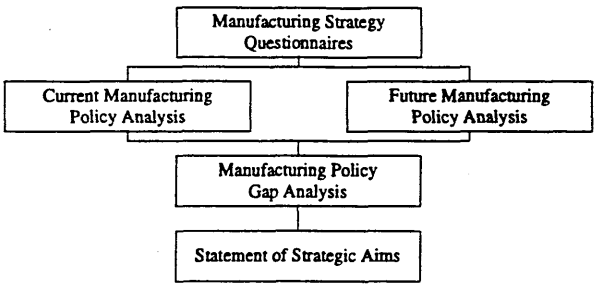


Figure 5.14 Stage 4 - Strategy Aims Definition

The manufacturing strategy questionnaires aim to capture the detailed contents of the current and future manufacturing strategies. A complete set of questions designed to gather the necessary information is provided. This list of questions is not exhaustive, but extensive. It may be supplemented and enhanced by additional user specific decisions and configurations. Through these, the key aspects of each of the policy areas should be identified and assessed with respect to their effect on the competitive manufacturing criteria. Ideally, this assessment can be carried out individually for each product group and then if deemed appropriate an aggregated assessment can be produced for the manufacturing system as a whole.

The next section represents a gap analysis of the current and future manufacturing strategies in a qualitative and quantitative sense. The provision of a set of generic manufacturing strategy priority profiles provide a qualitative measure to carry out external evaluation. The relevant information gathered through Stage 1 will help to identify the type of company under study and hence to choose the right profile to use. Differences in the contents can be readily compared and the differences in the policy easily identified.

Finally, the statement of strategic aims requires a textural input of the direction for the manufacturing function. In particular this should be as a response to the previously identified key issues.

MSAMSA Stage 5 - Strategic Initiatives

Stage 5 represents the final element of the manufacturing strategy document. This stage defines how the strategic aims and manufacturing policies developed in the previous stage are to be achieved. If both a current and future manufacturing strategy exist, then a gap analysis can be carried out to identify changes in approach, emphasis, major

changes in policy and their possible effects on the manufacturing function. The key element of this stage is the development of action plans with which to implement the strategies and policies. Generic action plans are customised and prioritised to produce a preliminary list of action plans and secondary strategic objectives.

This stage contains a single element:

5.1 Statement of strategic initiatives

The aim of this section is to clearly identify the range of MSD projects required, based on the manufacturing strategy and to clearly specify and explain each initiative. It is therefore a purely textural input.

CHAPTER 6 CASE STUDIES

6.1 Introduction

To evaluate the structure and procedures of MSAMSA, a number of case studies were carried out. This involved ten Saudi manufacturing companies, as shown in Table 6.1. The case companies covered a wide range of businesses, and were chosen due to a number of factors such as the type of products involved, the nature of the manufacturing systems and the size of their operations. The format for testing the model was based on the facilitator approach as recommended by Platts & Gregory (1992). The companies requested to follow the overall MSAMSA approach. Although interviews, visits and meetings were frequently arranged, taking on a facilitator role allowed the researcher a certain degree of distance from the strategy formulation actors in order to observe the process and comment on the effectiveness of the model.

The following example provides an overview on how MSAMSA's key features were applied in the case of company No. 1. The results from the rest of the companies are summarised in the subsequent sections.

6.2 Example Case Study - Company No. 1

Manufacturing Background

The following provides the background information regarding the company's manufacturing operations.

CO #	Products	No of employee	Turnover (Million SR/Year)	Location	Year Established
1	Vertical pumps 2400 unit /year Pumps spare parts 3000 unit /year Steel pipe 40,000 ton / year	132	60	Riyadh Saudi Arabia	1981
2	Tissue paper (Rolls) to supply it to the converter manufacture 40,000 ton per year	152	120	Dammam Saudi Arabia	1990
3	Axial Irrigation System 1200 per year Polyethylene Coated pipes 2,400,000 Lm	44	30	Riyadh Saudi Arabia	1985
4	Foundry : Grey and ductile iron casting 1000 ton per year	120	11.8	Dammam Saudi Arabia	1994
5	Design, manufacturing and supply 132,000 ton per year of : • Pre-engineering steel building • Structural steel and plate products. • Lattice towers.		480	Dammam Saudi Arabia	1976
6	3,000,000 ton / year of the following : • Portland cement • Type V cement • Clinker	1204		Riyadh Saudi Arabia	1961
7	Room Air condition 250,000 unit / year Split unit 30,000 unit / year Central A.C 25,000 unit /year	1786	355	Dammam Saudi Arabia	1976
8	Military and non military electronic equipment. 1500 unit per year	450	401	Riyadh Saudi Arabia	1988
9	132,000 ton / year of the following plastics parts : • Injection • Blow moulding • Thermoforming	375	187	Dammam Saudi Arabia	1976
10	Carbonlis paper 10,000 ton /year Coated paper 4,400 ton /year Offset paper 9700 ton / year Other paper 900 ton / year	75	56	Riyadh Saudi Arabia	1995

Table 6.1 Summary of Case Companies

Company Name	: Al-Khoraef Westrn Layne (AWL) ltd	
Authorized Capital	: SR 108,000,000	
Turnover	: SR 60,000,000	
Approximate Profit	: 10,000,000	
Installed Capacity	: Vertical Pump	2400 Unit
	Pump spare parts	3000 Unit
	Steel pipe	42000 Ton
Location	: Riyadh Saudi Arabia	
Year Established	: 1981	

The company produces vertical turbine pumps, gear–drives and steel pipes for agriculture and industrial applications. It also provides machining and sheet metal rolls slitting services on a subcontract basis, see Figure 6.1. The products can be sold separately or as one complete unit.

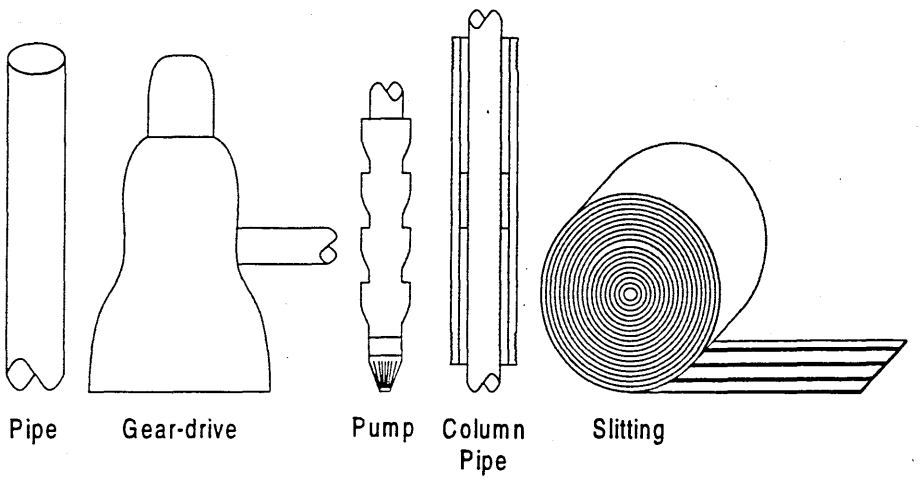


Figure 6.1 Example Company Product Groups

The principle customer is Commercial Company (ACC) which is a sister company, but organisationally and financially separate (with different cost centres). Commercial Company (ACC) specialises in the agriculture equipment. It accepts 90 % of the output from AWL and undertakes sales, spare parts and servicing in its local branches. It sells the products on to farmers and agriculture companies including NADC, Hail Agriculture, Gassim Agriculture Co., Tabouk Agriculture Co., SAFI and Maraei Agriculture. Although the agriculture application within the country represents the

company's main market, it does export a small quantity of its products to other GCC countries, Egypt and the USA. It also faces competition from the following competitors.

Competitors for the pipe:

- Arabian pipe
- Saudi steel pipe
- Saydan pipe
- AlJazerah pipe
- Yammah steel pipe
- Pipe imported from abroad

Competitor for the pump manufacturing:

- Saudi Mechanical Industry (SMI)
- Audi Pump Factory
- National Foundry
- AlAmaas

Competitor for the gear-drive manufacturing:

- Saudi Mechanical Industry (SMI)

The manufacturing system can be considered to be batch manufacture, with typical output level as shown below:

- Vertical pump 1000+ per year, 5 variants
- Gear-drive 1000+ per year, 4 size with many gear variants
- Pipe 23000 ton year, material variations.

Manufacturing facilities are mainly of lower flexibility and some of higher flexibility, with CNC facilities widely employed. The process is based on traditional machine and assembly shops, operating cellular manufacture based on components and not products families. The system is 'make-to-order' from raw material stock and from suppliers, with elements of assemble to order. The company is primarily a "care-taker" organisation.

Product Group Definition

The product group analysis (Table 6.2) gave the following indications of the relative importance of each product group to the business: Steel Pipe 23 %; Gear Drive 23 %; Pumps 23 %; Column Pipe - 23 %; Slitting 5 %; and Engineering 3 %.

Products	Steel Pipe	Gear-drive	Pump	Column Pipe	Slitting	Engin'g
Variants	7 (diameter) 5 (thickness)	15	5	5	3 mm to 25 mm	Customer driven
Volume	23,000 ton per year	1000 per year	1000 per year	30,000 units per year	30,000 ton	?
Sales	$13.5 M	$4 M	$3.73 M	$5.58 M	$180,000	$260,000
% Sales	50.1%	14.5%	13.5%	20.3%	0.7%	0.9%
% Contribution	21.1%	12.3%	28.8%	34.4%	1.1%	2%
Market share	12%	305	35%	35%	2%	2%
Growth opportunities	Very Good	Very Good	Very Good	Good	Good	Excellent
Degree of innovation (out of 10)	Low (2)	Low (3)	Medium (6)	Low (3)	Low (2)	Medium (5)
Life cycle stage	Mature	Mature	Mature	Mature	Mature	N/A
Principle Processes	Slitting ERW	Machining Assembly	Machining Assembly	Threading & Painting	Shear cutters	Machining
Materials	Steel ASTM	Cast iron, Carbon steel Aluminum	Cast iron, Carbon steel Bronze, Stainless steel	Carbon steel Ductile cast iron, Bronze	Carbon steel ASTM A53 others	
Approx. Profit/cost/sales	5%	10%	25%	20%	15-20%	25%
Typical order size	100 to 2000	No typical size	No typical size	Minimum 50	Use excess capacity	None
Standardisation	According to ASTM	4 standard boxes, low standards of boxes	Bearings Shafts	Threads, Length	None	None
Market	Agriculture & industrial	Agriculture	Agriculture	Agriculture	Industrial	Industrial
Customers	ACC, SMI, Saudi Pump, Abasan, Fedari	ACC	ACC	ACC	Gas Cylinder SAIDA SSP	
Relative Importance	23%	23%	23%	23%	5%	3%

Table 6.2 Results of Product Group Analysis

Market Analysis

The market requirements analysis of the individual product groups produced the results as shown in Table 6.3.

	Steel Pipe	Gear-drive	Pumps	Column Pipe	Slitting	Engin'g
Quality	90	95	75	85	90	90
Conformance to spec	90	95	75	80	90	85
Reliability in use	85	90	70	80	50	85
Customer satisfaction	90	90	80	80	80	85
Delivery Lead-time	70	90	90	90	80	80
Lead-time requirements	2-12 wks	2 wks	2 wks	2 wks	2 wks	3-4 wks
Delivery change notice	2 wks	3 wks	3 wks	3 wks	N/A	N/A
Customer satisfaction	60	60	60	60	80	75
Delivery Reliability	60	90	90	90	70	85
Delivery window	< 2 wks	1 wk	1 wk	1 wk	N/A	4 days
Customer satisfaction	55	50	50	50	80	80
Design Flexibility	60	80	80	80	80	90
Design changes	N/A					
Customized products	20	N/A	5 per year	N/A	Yes	Yes
Customer satisfaction	70	80	80	80	65	80
Cost / Price	90	80	75	75	80	75

Table 6.3 Market Requirements Analysis

	Steel Pipe	Gear-drive	Pumps	Column Pipe	Slitting	Engin'ing
Quality	80	95	95	95	90	95
Actual quality level	85%	90-95%	90-95%	95%	90%	0%
Customer reject rate	0	1%	1%	0%	?	2%
Final failure rate	15%	2%	2%	1%	?	2%
Intermediate scrap rate	5%	2%	2%	4%	?	?
Customer satisfaction	90	90	80	80	80	85
Delivery Lead-time	60	45	55	70	90	85
Actual delivery lead-time	3 mnth	3 mnth	3 mnth	1 mnth	3-4 wks	3-4 wks
Manufacturing lead-time	1 mnth	5 days	4 days	1 wk	3 hrs	2 wks
Schedule change ability	60	55	55	75	60	70
Customer satisfaction	60	60	60	60	80	75
Delivery Reliability	60	50	65	60	95	95
Deliveries within window	60%	50%	65%	60%	?	95%
Complete orders	70%	60%	70%	65%	100%	100%
Customer satisfaction	55	50	50	50	80	80
Design Flexibility	60	90	90	70	90	90
Product range ability	85	95	95	85	85%	95
Product change ability	10	N/A	N/A	N/A	N/A	20
Customer satisfaction	70	80	80	80	65	80
Cost / Price	60	60	85	80	85	85
Customer satisfaction	80	75	70	75	70	70

Table 6.4 Current Manufacturing Performance

Current Performance

The analysis of the current factory performance in relation to product groups produced the results as given in Table 6.4.

Profiling and Gap Analysis

The overall market requirements and the overall current manufacturing performance of AWL are summarised in Table 6.5 and Table 6.6 respectively.

Product Group	Steel pipe	Gear-drive	Pumps	Column pipe	Slitt-ing	Engin-eering	Σ R.I *P.G	Priori-ties (1-5)
Relative Importance	23%	23%	23%	23%	5%	3%		
Quality	90	95	75	85	90	90	86.6	5
Delivery Lead-time	70	90	90	90	80	80	84.6	4
Delivery Reliability	60	90	90	90	70	85	82	3
Design Flexibility	60	80	80	80	80	90	75.7	1
Cost / Price	90	80	75	75	80	75	79.9	2

Table 6.5 Market requirement profile

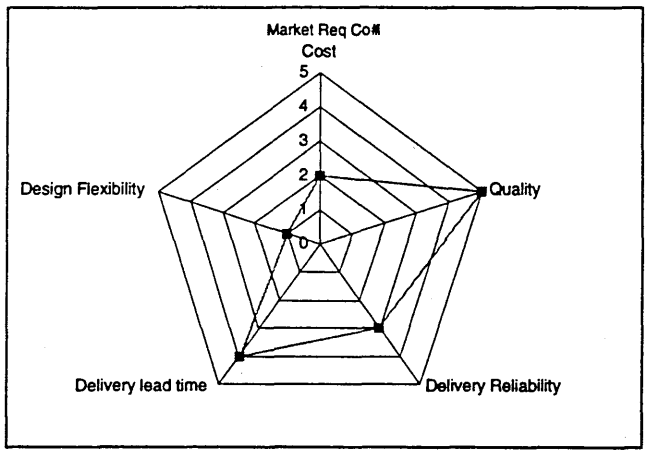


Figure 6.2 Market Requirement Priority Profile

Product Group(P.G)	Steel pipe	Gear-drive	Pumps	Column pipe	Slitting	Engine ering	Σ R.I *P.G	Priorities (1-5)
Relative Importance(R.I)	23%	23%	23%	23%	5%	3%		
Quality	80	95	95	95	90	95	91.3	5
Delivery Lead-time	60	45	55	70	90	85	60	1
Delivery Reliability	60	50	65	60	95	95	61.7	2
Design Flexibility	60	90	90	70	90	90	78.5	4
Cost / Price	60	60	85	80	85	85	72.4	3

Table 6.6 Summary of current system performance

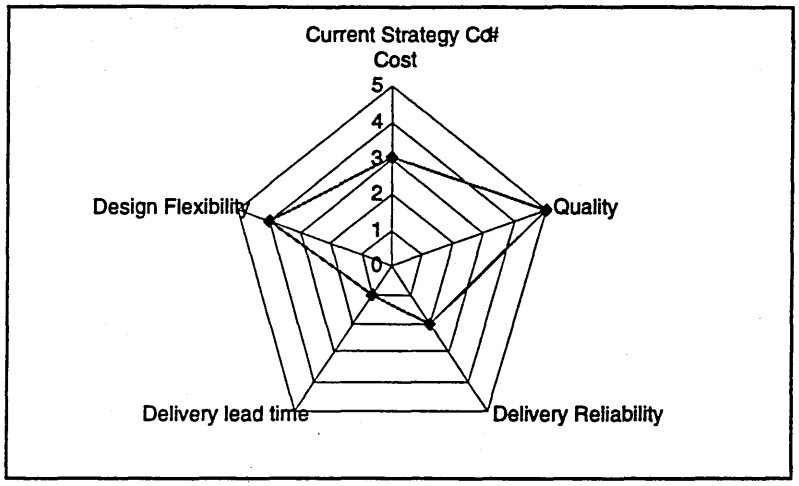


Figure 6.3 Current System Priority Profile

The strategy priority profiles in relation to these two tables are given in Figure 6.2 and 6.3 respectively (for the purpose of demonstration, only five strategic criteria are used in these and the other profile diagrams). Based on the results from the previous analysis, it is now also possible to develop an overall strategy priority profile presenting the market requirement the current system performance, and also how these compare with the relevant generic requirement profile (in this case, that of the Caretaker). The result is shown in Figure 6.4.

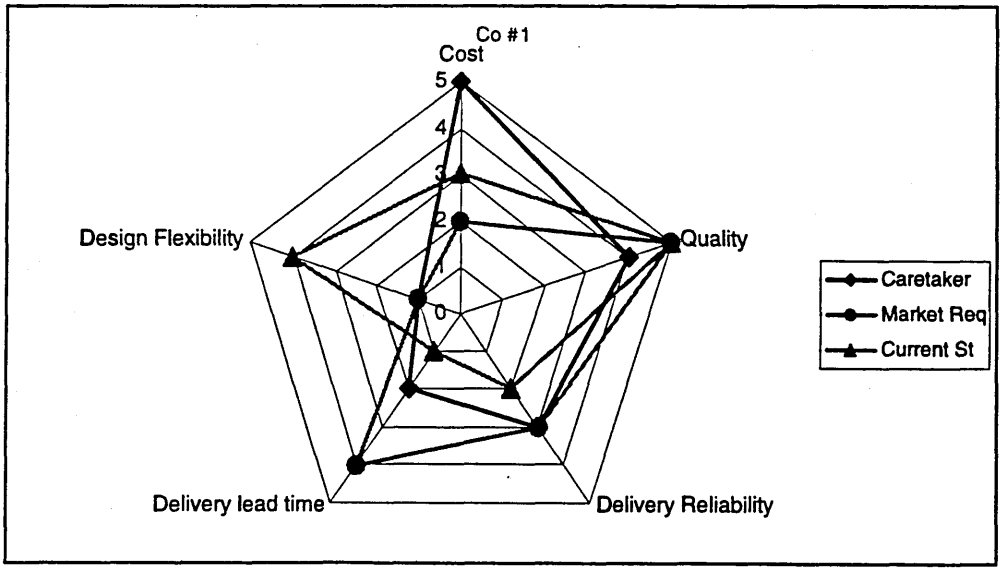


Figure 6.4 Comparison of Priority Profiles

These enable the requirement/performance gap values to be calculated, as shown in Table 6.7 and Table 6.8.

Product Group(P.G)	Steel pipe	Gear-drive	Pumps	Column pipe	Slitting	Engineering
Quality	-10	-	20	10	-	5
Delivery Lead-time	-10	-45	-35	-20	10	5
Delivery Reliability	-	-40	-25	-30	25	10
Design Flexibility	-	10	10	-10	10	-
Cost / Price	-30	-2-	10	5	5	10

Table 6.7 Summary of gap analysis - products groups

Product Group(P.G)	Steel pipe	Gear-drive	Pumps	Column pipe	Slitting	Engineering
Relative Importance(R.I)	23%	23%	23%	23%	5%	3%
Quality	-2.3	-	4.6	2.3	-	.15
Delivery Lead-time	-2.3	-10.35	-8.05	-4.6	.5	.15
Delivery Reliability	-	-10.35	-5.75	-6.9	1.25	.3
Design Flexibility	-	2.3	2.3	-2.3	.5	-
Cost / Price	-6.9	-4.6	2.3	1.15	.25	.3

Table 6.8 Summary of weighted gap analysis

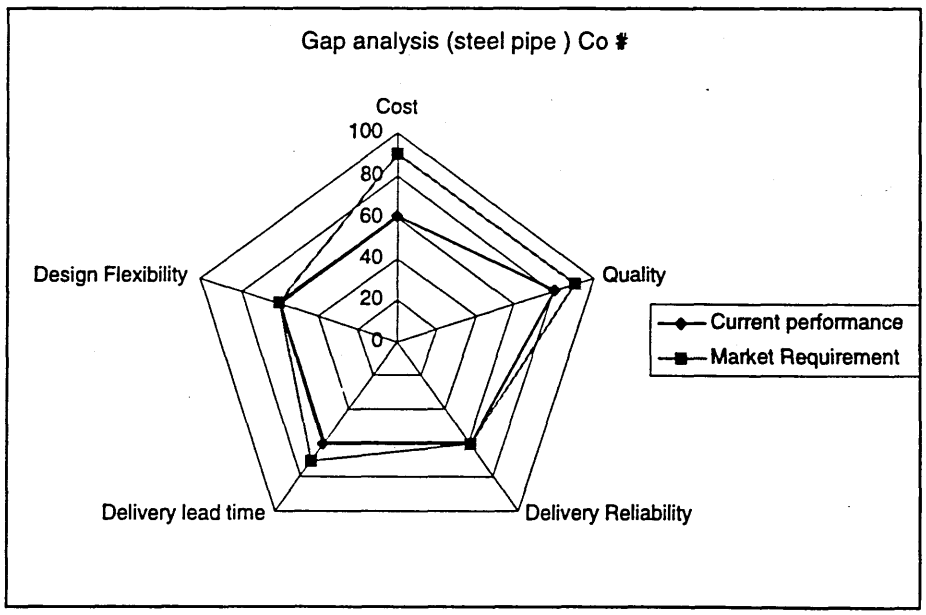


Figure 6.5 Gap Analysis for Product Group 1

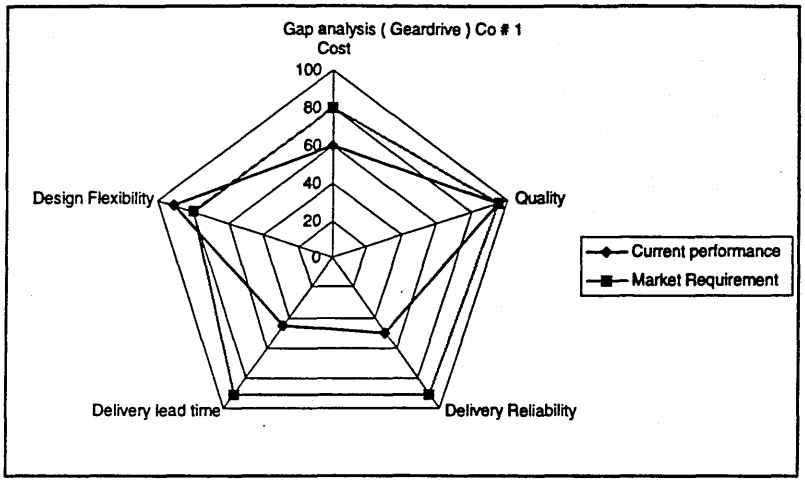


Figure 6.6 Gap Analysis for Product Group 2

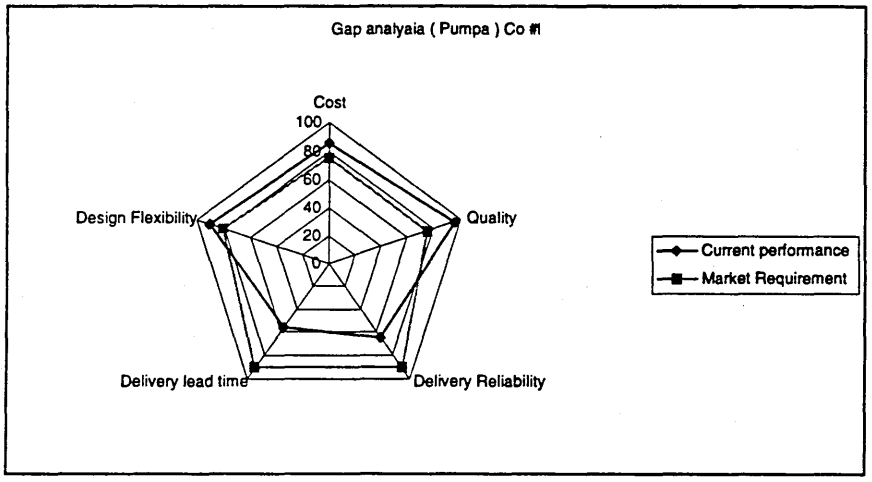


Figure 6.7 Gap Analysis for Product Group 3

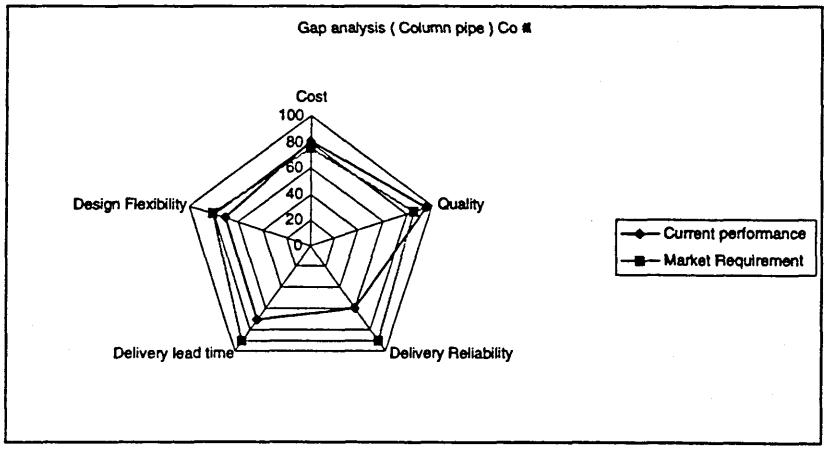


Figure 6.8 Gap Analysis for Product Group 4

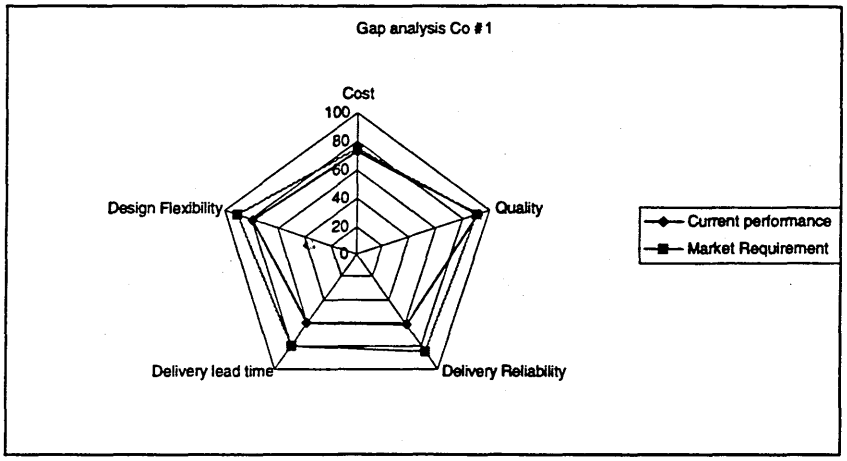


Figure 6.9 Gap Analysis for The Overall System

As explained in Chapter 4 and 5, these profiles provide the basis for an relatively extensive analysis of the situation, through both local and global evaluation:

- ***Local evaluation based on the company market/performance evaluation.*** Both the product group based analysis (Figures 6.5, 6.6, 6.7 and 6.8) and the system-wide analysis (Figure 6.9) revealed that in this case, except for product group 1, the competitive criteria that should initially be targeted are delivery lead-time and delivery reliability. Lead-time and delivery reliability under-performance suggests possible problem areas relating to:

  Under capacity, bottlenecks, lack of flexibility, lack of focus, complexity, lack of co-ordination, supplier unreliability, low skill levels, inappropriate levels of decision making, inappropriate operations quality, ineffective material control, incorrect inventory information, and inappropriate new product introduction process.

  So far as future requirements of the manufacturing system is concerned, the following problems are therefore highlighted:

  capacity shortage, rigid capacity, complex material flow, inaccurate forecasting, incorrect inventory information, long set up times, and subcontractor capabilities mismatched.

- ***General evaluation based on the market/performance priority profile and generic profile.*** When the companies profiles were compared with generic requirement profile (Figure 6.4), two very interesting observations were made:

  1. The different expectations on AWL from its own market (with quality being considered as the first priority), and that generally this company is not competing in the international market (with cost being the most important issue) indicated logically that the current market of AWL was still very much localised, with the majority of its customers being the farmers within the country. Since generous financial supports are provided by the government to this domestic customer base, price had not played an as important role as elsewhere in the international market. Therefore, the strategic directions (as identified through the previous analysis) would meet short/medium term requirements to satisfy the domestic market, for future development and in accordance with the government's policy of long-term development, the company needed to also concentrate on production cost reduction in order to become truly competitive.

  2. Regarding design flexibility, it was observed that although the current market requirement seemed to agree with the general expectation, the company was trying to strengthen its position by attempting to develop a new type of long-life and low corrosion pump groups. This reflects the company's long-term intention to re-allocate its position from that of a care-taker to that of a innovator, see Figure 6.10. This is a strategic direction that is considered to be generally desirable (Sweeney 1993). However, this highlights the needs for strong R&D support, which was still a very much weak area within this company.

The above has clearly demonstrated the logic and value of the proposed framework for extended strategy evaluation. That is, when combining these techniques it will help a company identify manufacturing strategic issues with wider- and longer-term implications that would not be recognised by the traditional technique on its own.

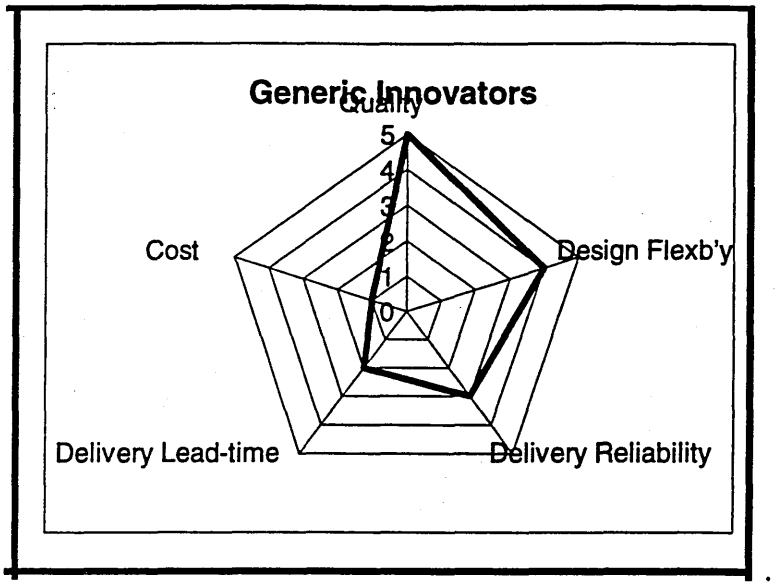


Figure 6.10 The Generic Strategic Profile of a Innovator

SWOT analysis

Table 6.9 provides a summary on the key results from this analysis.

Key Issues and Strategic Initiatives

The results from the previous analysis has clearly identified the main key issues as long lead-time, high production costs and lack of adequate R&D facilities. In order to improve the company's future performance accordingly, the strategic objectives for AWL Ltd are as shown in Table 6.10. This set of recommended manufacturing strategy has to a large extent been implemented in the case company. In particular:

1. The company has established a planning and control department, recruited professional staff, and implemented computerised planning and control system.
2. An international consultant office has been asked to carry out a feasibility study on the new pump range, and assess the possibility of market expansion.
3. A cost analysis section has been set up in the financial department to monitor production cost and introduce cost reduction measures.
4. The management is currently developing and implementing a plan for long-term Saudization.

	Strength/Opportunities	Weakness/Threats
Saudization	• No of Saudi employee : 13 • % of Saudization : 10% • % of Saudis employee in management positions : 1 • % of Saudis employee Labour and operators levels : 12 • Positions held by Saudis employee : • Chairman: Saudi • President: Saudi • On-job training for the technical college students, to help train and select technical operators	• Government enforcement in each year 5% of the total employee should Saudis nationality. The top management is aware of the implications of the policy, but yet no affective plan inside the company for Saudization. • % of Saudis employees in Engineering positions : None • Positions held by Saudis employee: General manger : None Saudi Operation manger : None Saudi Resource manger : None Saudi Finance manger : None Saudi Marketing manger : None Saudi
Governm't Support	• With project funded by SIDF • Expansion programme supported in 1992 • Ministry of Industry and Electricity (MIE) support (electricity supplied to the factory in industrial price) • Located in the 2nd Industrial city in Riyadh area. • Tax free on raw material, machine and spare parts.	
Exporting (new markets)	• Strong local market • Government politic support to open new market • Possibility for new customer in large agriculture countries such as Australia and USA • Few competitors expected for the company's intended new product type	• Too dependent on single major customer • Production cost are higher than other country
Research & Developm,t	• Some R&D facility (R&D responsibility belongs to the production manger) • R&D consultancy available from USA • Good ideas exist within the organisation (such as the possibility for long life pump)	• Lack of organisational support • As a result of above, it takes a long time for any idea to be developed • No official link with the R&D centre in Saudi aerobe • No effective plan for future R&D
Products & Technology	• Development of long life pump with less corrosion	• Limited local resources of iron and steel • Dependent on one major steel supplier
Quality	• Good reputation for quality • ISO 9002 and quality procedures implemented	
Organisatn & Operations	• Better technology than national competitors • Computerised facilities	• Long lead-times, mainly due to raw material supplies • Supplier relations and ordering of raw materials need improvement • Manpower and machine under capacity

Table 6.9 Summary of SWOT Analysis Results

Policy Area	Policies
Capacity	• Increase capacity through new facilities and qualified workforce
Facilities	• Adopt cellular manufacture to cope with key product groups • Rationalise material flow
Supplier Development	• More strategically oriented Make/Buy structure - subcontract volume and easy components, and keep more demanding parts and processes in house • Rationalise the supply chain structure to become less supplier dependant
Human Resources	• Further enhance existing job-training programme • Develop short and long plan for Saudization
Quality Systems	• Maintain the high standard that has so far been achieved
Planning and Control	• Establish effective system and adopt useful techniques to reduce inventory and improve production planning and control
Scope and New Products	• Introduce long-life pump range to satisfy the specific domestic requirement (low level of corrosion), and also explore the possibility of opening new international market
Performance Measures	• Monitor and reduce production cost throughout the organisation
Other	• Develop in-house R&D expertise • Establish formal link with other relevant technological centres

Table 6.10 AWL's Future Strategic Directions

6.3 Case Study Results

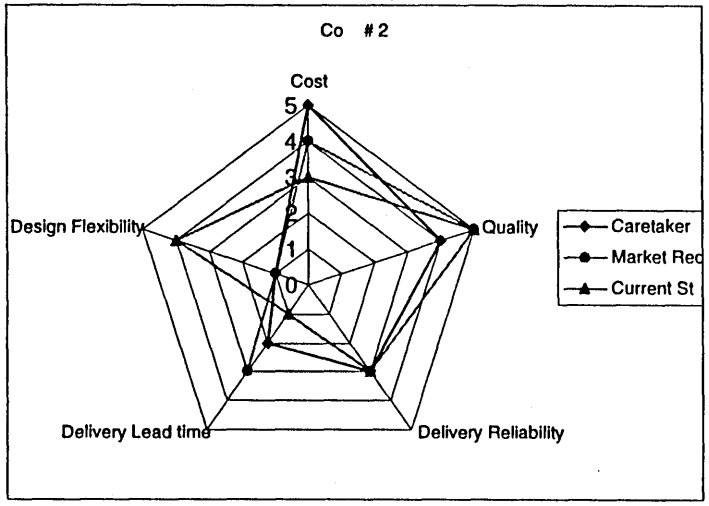
The key results from the other case studies are summarised in Table 6.11 and 6.12, and shown in the figures following Table 6.11. A short discussion on each of these cases is provided in Table 6.12. More detailed results from these case studies can be found in Appendix II.

	Type of operation	(1) Current manufacturing strategy priority	(2) Market need (Short / medium term)	(3) Generic manufacturing system (long-term)	1 & 2	2&3
1	Marketeer	a) Quality b) Delivery lead time c) Delivery Reliability d) Cost e) Design Flexibility	a) Quality b) Delivery lead time c) Delivery Reliability d) Cost e) Design Flexibility	a) Quality b) Cost c) Delivery Reliability d) Delivery lead time e) Design Flexibility	Same	Delivery lead time : (2) > (3) Cost : (3) > (2)
2	Caretaker	a) Quality b) Design Flexibility c) Cost d) Delivery Reliability e) Delivery Lead time.	a) Quality b) Cost c) Delivery Reliability d) Delivery lead time e) Design Flexibility	a) Cost b) Quality c) Delivery Reliability d) Delivery lead time e) Design Flexibility	Cost : (2) > (1) Delivery Reliability : (2) > (1) Delivery lead time : (2) > (1) Design Flexibility : (1) > (2)	Quality : (2) > (3) Cost : (3) > (2)
3	Marketeer	a) Quality b) Cost c) Delivery Reliability d) Delivery lead time e) Design Flexibility	a) Quality b) Cost c) Delivery Reliability d) Delivery lead time e) Design Flexibility	a) Quality b) Cost c) Delivery Reliability d) Delivery lead time e) Design Flexibility	Delivery Reliability : (2) > (1) Delivery Lead Time : (1) >(2)	Cost : (2) > (3) Delivery Reliability : (2) > (3) Delivery Lead time : (3) > (2)
4	Reorganiser	a) Cost b) Quality c) Delivery Reliability d) Design Flexibility e) Delivery lead time	a) Quality b) Cost c) Delivery Reliability d) Delivery lead time e) Design Flexibility	a) Delivery Reliability b) Delivery lead time c) Quality d) Cost e) Design Flexibility	Delivery Reliability : (1) > (2) Delivery Lead time : (2) > (1) Quality : (2) > (1) Cost : (1) > (2) Design Flexibility : (1) > (2)	Delivery Reliability : (3) > (2) Delivery Lead time : (3) > (2) Quality : (2) > (3) Cost : (2) > (3)
5	Reorganiser	a) Delivery lead time b) Quality c) Delivery Reliability d) Cost e) Design Flexibility	a) Delivery lead time. b) Delivery Reliability c) Quality d) Cost e) Design Flexibility	a) Delivery Reliability b) Delivery lead time c) Quality d) Cost e) Design Flexibility	Delivery Reliability : (2) >(1)	Delivery Lead time : (2) > (3)

Table 6.11 Summary of Priority Profiles

	Type of operation	(1) Current manufacturing strategy priority	(2)Market need (Short / medium term)	(3) Generic manufacturing system (long-term)	1 & 2	2&3
6	Reorganiser	a) Delivery Lead time Delivery Reliability b) Quality c) Cost d) Design Flexibility	a) Delivery Reliability b) Delivery lead time c) Quality d) Cost e) Design Flexibility	a) Delivery Reliability b) Delivery lead time c) Quality d) Cost e) Design Flexibility	Delivery Reliability : (2) > (1) Delivery Lead time : (1) > (2)	Delivery Lead time : (2) > (3)
7	Caretaker	a) Cost b) Quality c) Delivery Lead time d) Delivery Reliability e) Design Flexibility	Cost Quality Delivery Lead time Delivery Reliability Design Flexibility	Cost Quality Delivery Reliability Delivery lead time Design Flexibility	Same	Caretaker : Caretaker Delivery Reliability : (3) > (2) Delivery lead time : (2) > (3)
8	Innovators	a) Quality b) Delivery Reliability c) Design Flexibility d) Delivery Lead time e) Cost	a) Quality b) Design Flexibility c) Delivery Reliability d) Delivery Lead time e) Cost	a) Quality b) Design Flexibility c) Delivery Reliability d) Delivery Lead time e) Cost	Design Flexibility : (2) > (1) Delivery Reliability : (1) > (2) Delivery Lead Time : (2) > (1)	Same
9	Caretaker	a) Quality b) Cost c) Design Flexibility d) Delivery Lead Time Delivery Reliability	a) Quality b) Cost c) Design Flexibility d) Delivery Reliability e) Delivery Lead time	a) Cost b) Quality c) Delivery Reliability d) Delivery Lead time e) Design Flexibility	Delivery Reliability : (2) > (1)	Caretaker : Caretaker Cost : (3) > (2) Quality : (2) > (3) Delivery Reliability : (3) > (2) Design Flexibility : (2) > (3)
10	Marketeer	a) Quality b) Cost c) Design Flexibility d) Delivery Reliability e) Delivery Lead time	a) Quality b) Cost c) Delivery Reliability d) Delivery lead time Design Flexibility	a) Quality b) Cost c) Delivery Reliability d) Delivery lead time e) Design Flexibility	Delivery Reliability : (2) > (1) Delivery Lead time : (2) > (1) Design flexibility : (1) > (2)	Same

Table 6.11 continued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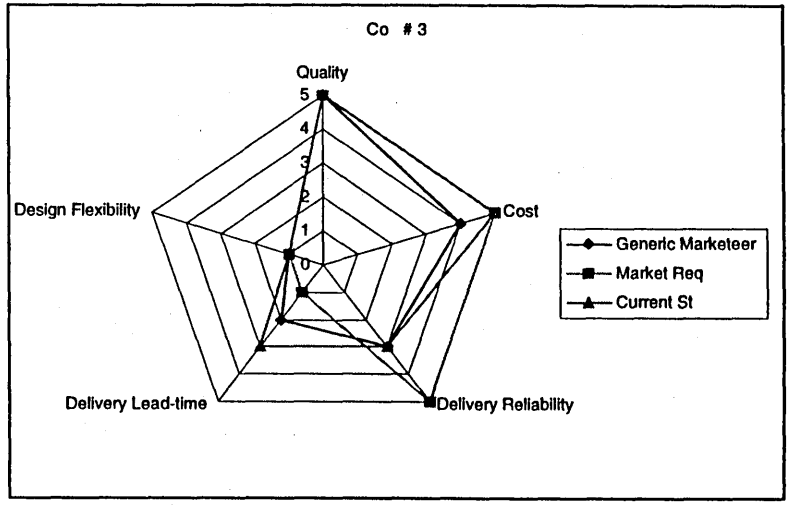
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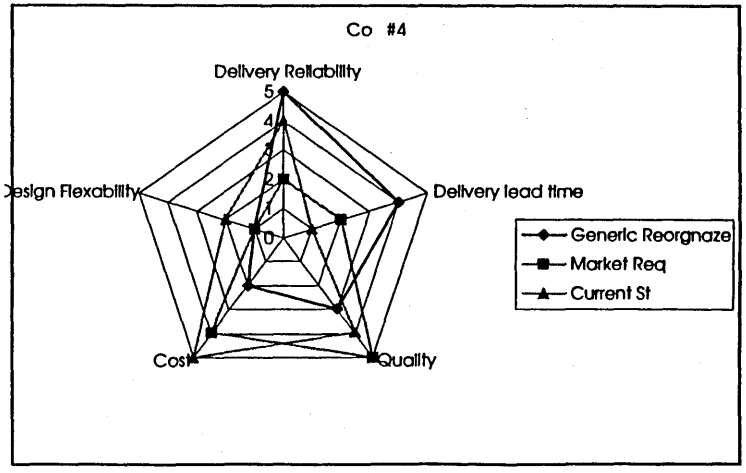
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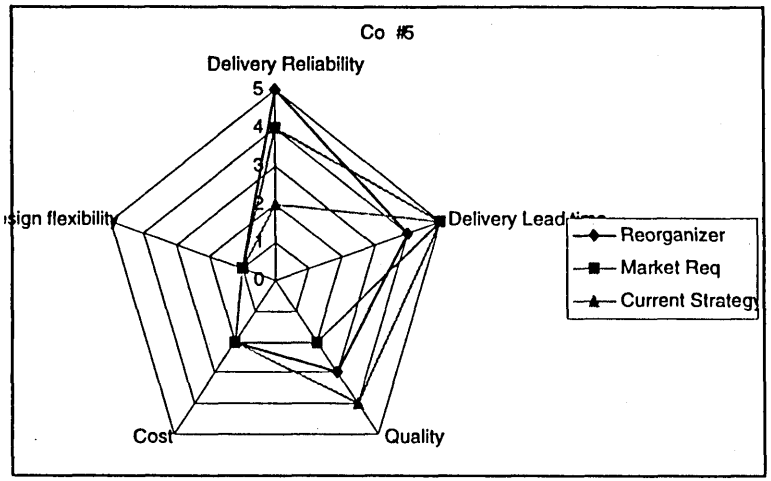
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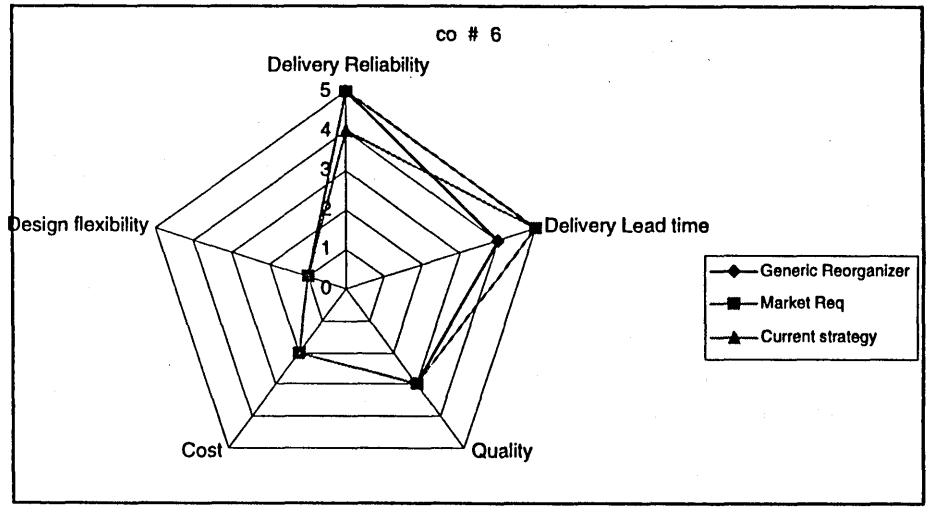
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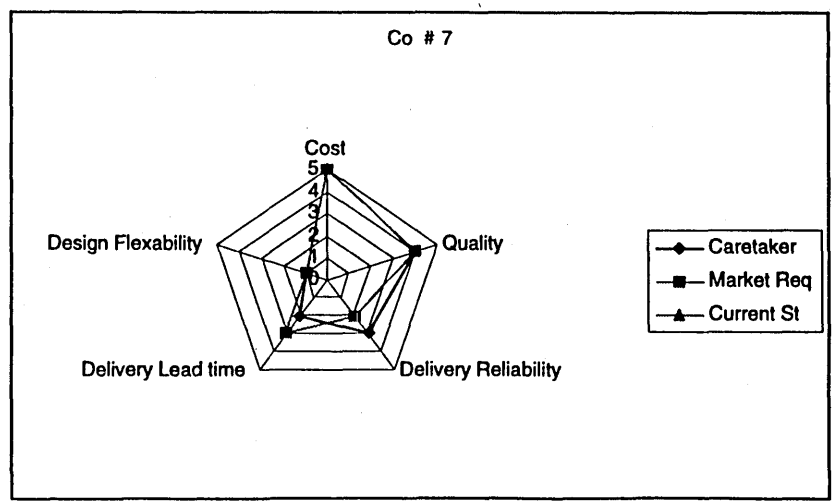
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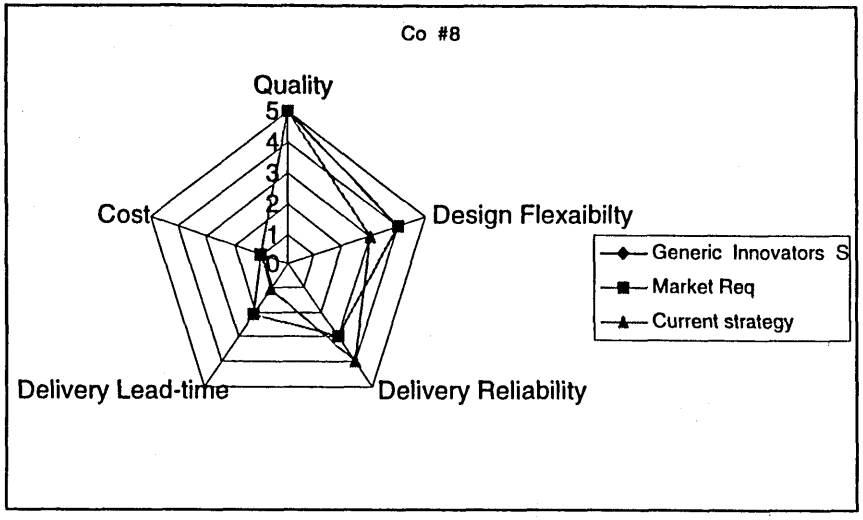
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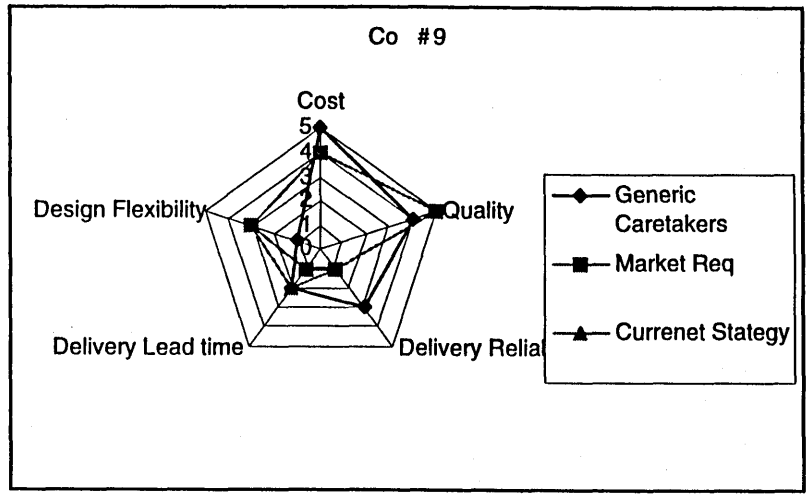
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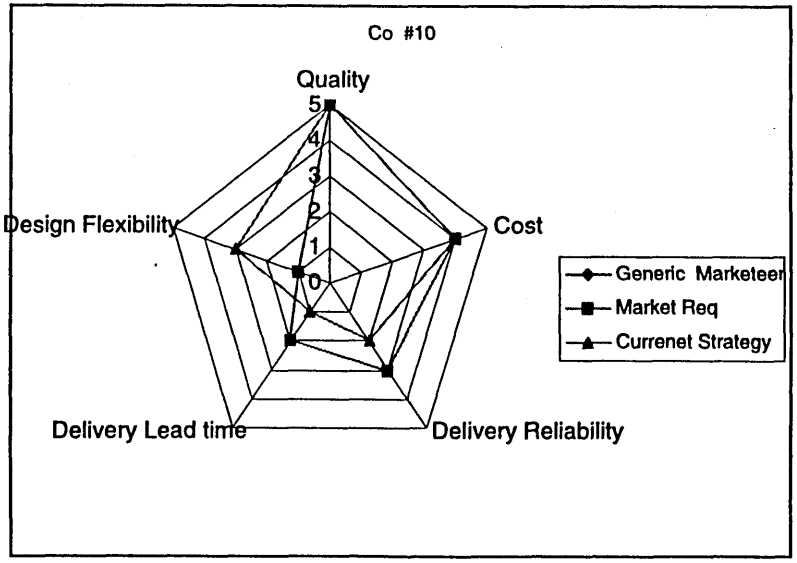
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Table 6.12 Summary of Case Study Results

	Description	Discussion	Key issues and Strategic Direction	Company Actions
1	Products : • Veticl Pumps 2400 unit • Pumps spare parts 3000 unit • Steel pipe Turnover : • SR 60,000,000 No of employee : • 132	Both the product group based analysis and the system-wide analysis revealed that in this case, except for one of the product groups, the competitive criteria that should initially be targeted are delivery lead-time and delivery reliability. Lead-time and delivery reliability under-performance suggests possible problem areas relating to: under capacity, lack of co-ordination and supplier unreliability, and ineffective material control, etc.. Also, different expectations on AWL from its own market and that generally this company is not competing in the international market indicated logically that the current market was still very much localised, and although the strategic directions as identified through the previous analysis would meet short/medium term requirements to satisfy the domestic market, for future development and in accordance with the government's policy of long-term development, the company needed to also concentrate on production cost reduction in order to become truly competitive. In order to support the company's intention to re-allocate its position from that of a care-taker to that of a innovator, needs for strong R&D support was highlighted.	Key Issues • long lead-time • high production costs • lack of adequate R&D facilities Key Strategic Direction • Increase capacity through new facilities and qualified workforce • More strategically oriented Make/Buy structure - subcontract volume and easy components, and keep more demanding parts and processes in house • Rationalise the supply chain structure to become less supplier dependent • Establish effective system and adopt useful techniques to reduce inventory and improve production planning and control • Introduce long-life pump range to satisfy the specific domestic requirement (low level of corrosion), and also explore the possibility of opening new international market	• The company has established a planning and control department, recruited professional staff, and implemented computerised planning and control system • An international consultant office has been asked to carry out a feasibility study on the new pump range, and assess the possibility of market expansion. • A cost analysis section has been set up in the financial department to monitor production cost and introduce cost reduction measures. • The management is currently develop and implementing plan for long-term Saudization.

			• Develop in-house R&D expertise • Establish formal link with other relevant technological centres.	
2	Products: • Tissue papers (Rolls) 40,000 ton Turnover: • SR 120 Million No of employee: • 152	• Possible new market, significant opportunities with less competitors. • Demand is higher than production output, also customer need more variety of the products. • Delivery lead time was not perceived to be very important by the domestic market, and the company's performance seemed to be adequate in this reguard. However, similar to the situation in case study No. 1, it is important for the company to place more emphasis on this issue, in order to become more competitive to meet international requirements. • Production output rate needed significant improvement. • The advantage from SDIF reduced the overall cost which can help provide the company to become more competitive. • Saudization percentage still not meet the government requirement, which requires increasing the number of Saudi employee by 5% in each year. • There were no Saudis professionals working in the technical departments, • This company is located in the industrial city which can reduce its operational cost.	Key Issues • Lead-time reduction • Increase of output rate • Expertise retainment Key Strategic Direction • Explore the opportunities offered by new market. • Focus on products development • Increase production capability and output rate. • Improve production planning and control. • It is very important for the company to recruit some Saudis engineer in the technical department to gain the experience and knowledge, and retain these within the organisation. Otherwise risk of loosing such expertise after a certain number of years exist.	• The company is continuasly looking for new business opportunities, trying to utilise its advantage in product design flexibility. • Stared an expansion project last year, almost doubling the capacity of the production line. • Based on the discussion with the top management, they agree about the importance of the Saudization for the company, and a effective plan will be soon in place.

3	Products : • Axial Irrigation system - 1200 units • Polyethylene coated pipes - 2,400,000 Lm Turnover: • 30,000,000 No of employee : • 44	• The reason of delivery lead time difference between the market requirement and the current system performance could be related to the fact that the company had previously made a wrong forecast to put much effort for the delivery lead time improvement • Delivery Reliability should be improved in the future to meet market needs • The need of design flexibility is relatively low, indicating the function of the current products have meet customer needs • The cost priorities is high, identifying the need to reduce the operational cost in order to become more competitive	• Compared to the other cases, the requirement and performance profiles relatively matched each other in many aspects, indicating the company's current position being comfortable. • However, in the short term reduction of operational cost is important. • Since the products have reached relative maturity, and also agriculture will declare in the country mainly because the limitation of the water resources and hence the market of the company will soon reach its limit, the company should consider the possibility to open new market for long term survival. • Again Saudization is an important issue.	• The company has established an effect plan for exporting and to develop another product to utilise its existing capacity. • The company agree they will face a problem in the Saudization policy, and need an effective and urgent Saudization plan to be adopted.
4	Products : • Grey and ductile iron casting - 1000 ton Turnover : • 11,799,998 No of employee : • 120	• The company was facing tough competition in its market, which is reflected by the demand for both low price and high quality. • Delivery lead time is an important long term issue, in this particular case requiring attention on transportation, intermediate agent services and supply chain management. • At the beginning the company stared with a good Saudization policy, by training and recruit local engineers and technicians. However, most of these early recruits have already left the company.	• The current market needs high quality and diversity products, requiring more effort in technology and production process improvement • Future needs include the improvement on supply chain establishment, and the enhancement on quality and R&D development.	• Based on the realisation that the company can not compete with the traditional foundry on the strategic issues identified, a new and modern continuious production line has been implemented. • The company agreed to invest more on R&D. • After discussion with the general manger and marketing manger the company will develop an

				effective plan for exporting. • New Saudisation plan is now in place.
5	Products: • Pre-engineering steel building • Structural steel and plate products • Lattice towers 132,000 ton of the above products Turnover: • 480,000,000 SR No of employee: • Not known	• Delivery lead time as the first priority sometimes represents a demand that exceeds the supplier's production capability. This is the case in this company. • Many new opportunities and relatively few competitors in this market. • Delivery reliability is a very important aspect in this company's operation - both for the immediate customer satisfaction and long-term development.	• Focus on supply chain establishment to overcome problems experienced on raw material supply • Increase production capacity and enhance production control • Invest on R&D and new product design • Explore new market	• The company has developed and implemented a marketing and exporting plan also. • The company has already started to invest more in its R&D activities.
6	Products : 3,000,000 ton of the following • Portland cement • Type V cement • Clinker No of employee: • 1204	• The delivery lead time was of high priority mainly because of the high demand up to today. • This company and its market were both stable and mature due to sensible development since its establishment in the early 1960's. • Employee training and education for staff well planned and managed. • Saudization percentage in the company met the government requirement, but still need more improvement in the future, which was included in the company plans. • Currently the company used a high-tech filter facility to keep the environment clean from dust because the company suffered from that problem in the past. • Location of the company ideal, conveniently serving the best market areas in the country, with a recent increase in business of 40%.	A well organised and managed company, with its strategic profiles closely matching on another. It only needs to: • Effectively maintain its current strategic direction • Carry out continuous improvement initiatives • Increase production capacity • Explore new market for expansion	The company currently engaged in all of the areas as suggested.

7	Products : • Air condition equipment • Turnover : 355,000,000 • No of employee : 1786	This is another example of a well organised company. • Of particular interests is the fact that its performance profiles not only marched that of the local requirement, but also the generic strategy priority of the caretaker group to which this company belonged. This is due to the fact that the company started to explore the overseas market a long time ago when the local market saturated. This helped the company greatly and it is now a matured player in the international market. • The cause of the small difference in the delivery aspects was mainly attributed to the delay time in raw material supply. • A well qualified group of professional staff manage the company. • Saudization percentage not yet enough for the company and need more improvement. • The product turnover time needed to be improved.	• With a well established base and past experiences, the company had good opportunities for further expansion, particularly in the exporting area. • It needed to move towards a more Innovator oriented operation. • It needed to enhance delivery reliability and delivery lead time. • To improve product turnover time.	• The company has developed a plan to expand its exporting activities. • The company has started to reorganise its department of planning and control in an effort to improve delivery performances. • A good start has been made towards a Saudization policy with the support from its management.
8	Products : • Electronic Equipment - 1500 Units • Turnover : 401,250,000 SR No of employee : • 450	• The company produces electronic equipment for defence purposes. • It was first established and supported by the government, with most of the management team transferred from some of the best companies in the country. • Profiles roughly match, but still indicating certain potential problems marketing which requirement attention in the future. • The company have a very good Saudization policy. • Investment needed for further R&D • Good opportunities to expand products to meet future market needs.	• To invest more capital in R&D. • To expand product groups to meet requirement.	• The company agreed to invest more in the R&D. • To develop more business and also to expand the product group the company established a business development department. • No problem facing this company in Saudization policy. • The fact that the company's current performance priority profile closely follow that of a generic innovator reflects positively the logic of the approach suggested for MSAMSA.

9	Products : 132,000 ton of the following • Plastics injection • Plastics blow • Moulding Thermoforming Turnover : • 187,000,000 No of employee : • 375	This is another example of a company satisfying its local markets in the short- to medium-term, but requiring improvement to enable itself to became an effective international competitor. As a result, issues are very similar to that of Case No. 1.		• The company planned to invest more in R&D • The company planed to install a computer package in the production and planning department linking with all department, to solve the problems in delivery. • There was a big problem in the Saudization policy in the company and it needed an urgent plan for Saudization. The general manager agree on that and they were trying to solve this problem by next year.
10	Products : • Cabonless paper 10,000 ton, oted paper 4,400 ton, Offset paper 9700 ton ,Other paper 900 ton Turnover : 56,000,000 No of employee : • 75	• This case company seemed to be enjoying a market in which its supply could not satisfy customer demand. The local customers were not yet "choosy" due to the fact that the case company has a very good advantage of being the only company in the regain to produce cabonless paper. However, it must maintain and safe garude this advantage by improving its delivery performances. • Also the company seems have developed a good base for market expansion, both internally and internationally.	• Increase capacity through new facilities and qualified workforce • Improve production planning and control	Key issues under management consideration.

CHAPTER 7 FINDINGS AND RECOMMENDATIONS

This chapter discusses the strength and weakness of the proposed methodology, analyses the case study results and recommends further work.

7.1 The Strength of MSAMSA

The case studies presented in the previous chapter have been valuable for proving the logic and potential usefulness of the suggested framework of MSAMSA for the purpose of helping individual Saudi manufacturing companies formulate their future manufacturing strategy, taking both local requirement and global expectation into consideration. In addition, the results have also highlighted issues about the manufacturing industries in the country which should be of value to the authorities' high level decision-making, particularly regarding their future support and development.

Although MSAMSA is still in its early stages of development and the structure and procedures reported in this thesis can only be regarded as a well specified prototype, it has been proven to be conceptually logical, and overall well structured. All of the ten companies have found the exercise useful, providing insight of the company's current strengths, weaknesses and identifying sensible future strategic manufacturing directions. A significant amount of the suggestions to the companies either have been actually implemented or are under serious consideration.

Four needs have been identified for a more extensive and adaptive evaluation scheme, that is:

1. The need for a more structured way to link higher level policies to the process of manufacturing strategy formulation.

2. The need to provide a mechanism for both system-wide and product-group related method for evaluating manufacturing requirements.

3. The need to provide help and guidelines which provide an in-depth outline of the content of the manufacturing policy areas with respect to the decisions, sub-decisions, options, parameters and influences.

4. The need to provide both local-level (internal) and global-level (external) measures, to both qualitatively and quantitatively prioritise and evaluate manufacturing strategic concerns.

MSAMSA has attempted to tackle (1), (2) and partially (4) (global-level, qualitative measures), and illustrated conceptually their feasibility.

Regarding requirement (2), it uses utility functions to integrate different products groups to show the current situation in the company level which provides a comprehensive consideration compared with other methods, many of which have focused on company level strategy or product group oriented consideration alone. As a result gap analysis can be potentially conducted in a flexible way dependent on the specific needs: product-related requirements/system gap analysis, factory-wide requirements/system gap analysis, the maximum-specified-system gap analysis and local and global priority gap analysis.

MSAMSA's approach to tackle requirements (1) and (4) are highly relevant to the Saudi government's current strategy and policy on the country's future industrial development. The key issues reflected by the country's current (The Sixth) five year plan include:

- The need of effective measures for its manufacturing industries in order to study the main factors constraining productive growth, and to increase the overall competitiveness.
- The need to improve production methods and the need for appropriate methods for overcoming marketing obstacles to overcome marketing deficiencies.

- The high priority to the employment and training of Saudi nationals in the manufacturing industry, where they now represent only a small percentage of total employment.

Of particular interest is the incorporation of generic priority files (i.e., that of a Caretaker, Marketer, Re-organiser and Innovator manufacturing organisation), and the macro-level linking table into the analysis process. In many of the case studies, this has been extremely informative, providing the company with an understanding of the its current position within a wider context and providing a new direction of thinking. As illustrated by the case studies, through the various ways to evaluate its situation both locally and internationally, a company will be in a good position to understand its overall competitive requirement. Also, such a company will be able to easily identify means to take full advantage of the government's current policy of supporting industrial development fund and providing incentives to those factories that employ or offer regular training programs to a high percentage of Saudi nationals.

MSAMSA has seen to be both logical and timely. It is a timely development because of the country's strong commitment in the formation of a strong and competitive manufacturing industry. It is logical because its macro-level linking table and cross-checking evaluation help Saudi companies identify key issues and formulation manufacturing strategies which are coherent with the country's long-term, national strategy, and compatible with the current Sixth Development Plan. Since the national level industrial policies cannot succeed without the full participation and support of the individual companies, it is participated that its further enhancement and adaptation within the country will be of national importance.

The basic concepts of the extended framework of evaluation have been shown to be both feasible and effective when applied within the particular macro-environment of Saudi Arabia. However, due to its generic nature, there seems to be no logical reason why the same framework can not be applied to another society or manufacturing sectors to solve their manufacturing strategy problems. What is needed would be the information needed to develop higher level links/guidelines and, preferably, a willingness from the appropriate authorities to help.

7.2 Issues Regarding Future Industrial Development Within The Country

The case study results have also highlighted some issues regarding the needs to support the future development of the manufacturing industries within the country. In particular, the following should be of value to the authorities' high level decision-making:

1. Many of the case studies indicated that production costs were a major factor constraining productive growth and the overall competitiveness. Effective policies and techniques must be sought to help the companies improve their performance in this aspect if they are to become competitive in the international market.

2. The delay in raw material supply was also a major cause in making manufacturing companies less effective because of their effects on delivery performance. Help should again be provided in a similar way.

3. R&D is another key issue in many of the companies studies. Effort should be made to help these companies through, for example, the establishment of R&D centres, technical service providers, official agents to link manufacturing companies and research institutes, and various government schemes to encourage joint R&D projects between companies and universities.

4. There is an urgent need to set up a system to help technology transfer, through again the establishment of official agents to coordinate the overall efforts.

5. The establishment of a information centre at the national level should be considered (e.g., information gathering, technical translation, etc.).

6. The current Saudization policy needs further enhancement - it is a weak point in many of the companies visited.

7. The capacities of the current industrial cities are almost fully filled. Feasibility studies should be initiated for additional sites to be constructed.

8. Government initiatives to support the industry, such as SIDF, have been extremely effective to help the development of the industrial sector in the country. This should be further enhanced.

9. However, the availability of support to the industry through commercial organisations are currently very low. The establishment of industrial banks and the involvement of private investment should be very much encouraged, e.g., through the issue of shares and government/private joint ventures.

10. Infrastructures, both financial and physical, should be invested to facilitate exporting activities (special banks, overseas links, government supported business fairs and exhibitions, etc.).

11. Industrial laws should be enhanced to provide an effective and fair environment within which companies are encouraged to compete and succeed.

7.3 Weakness and Limitations of The Prototype Methodology

It should also be made clear that, at its present form, there are weaknesses and limitations related to both the contents and the evaluation of the prototype methodology. These include the following.

Omission of A Product Dimension

The current prototype does not explicitly include product considerations in its framework, particularly those related to product life cycle and product development. As a result it may be open to criticism that the approach is: (a) only capable of producing manufacturing strategies that merely help the companies manufacture old products more efficiently, and (b) too market/customer driven, hence restricting innovative product research and development.

It may be argued that, strictly speaking, policies and decisions related to product development should have a place of their own within the hierarchy of business strategies (see Figure 2.3), and hence are not within the scope of manufacturing strategy analysis. Indeed, a few of the existing approaches including some of those reviewed in Chapter 2, seem to have followed this argument. They do not include product related issues in the process, and hence assume that product related decisions should be made elsewhere within the organisation. However, they should be treated as an input or constrain to the process of manufacturing strategy formulation.

Also this appears to be a sound argument, and the approaches such formed could work well, provided the companies are aware of the implications and the right way to approach the problem, in practice it will be much more logical and effective if product related issues are directly taken into consideration. This point has been clearly illustrated by the case studies carried out by this research, where R&D issues frequently were highlighted.

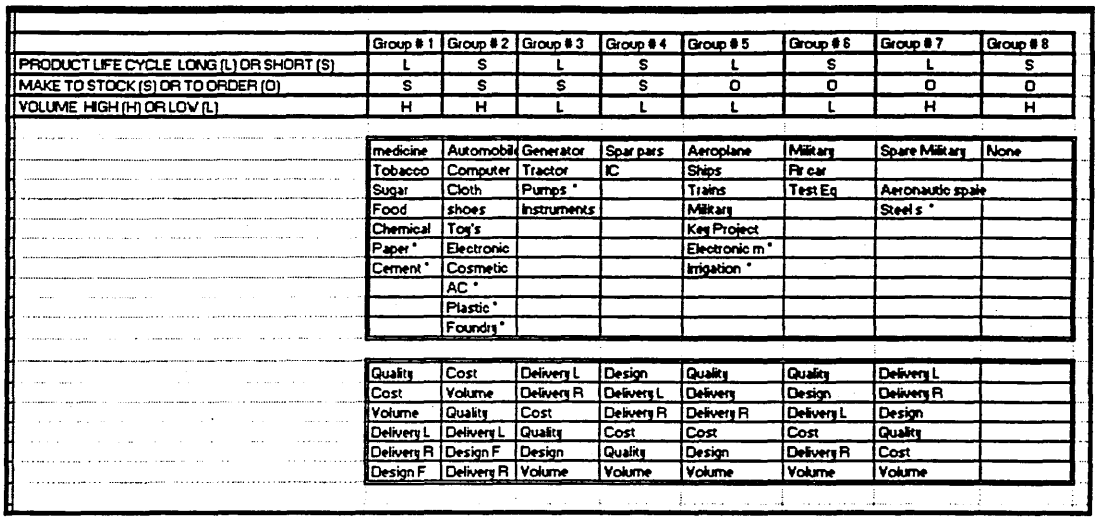
Simplification of Generic Types of Manufacturing Organisation

The classification of manufacturing organisations into four basic generic types is an over simplified approach. Although this structure has been satisfactory for the purpose of testing the concepts, in practice a refined classification method and better guidelines must be provided. This is in fact a quite crucial factor affecting the methodology's successful application: a wrongly classified company type will result in a wrong generic profile being used, which in turn will lead to the wrong conclusions.

In fact, as an attempt to improve the situation an extended structure was initially proposed during the early stages of development. This attempted to classify a manufacturing organisation according to the following scheme:

Dimension	Level	
Product-Life-Cycle	Short	Long
Production Volume	Low	High
Production Organisation	Make-To-Order	Make-To-Stock

thus involving product-life-cycle as an additional dimension, and resulting in a group of eight generic types of manufacturing organisation (Figure 7.1) instead of the four reported in this thesis.



	Group # 1	Group # 2	Group # 3	Group # 4	Group # 5	Group # 6	Group # 7	Group # 8
PRODUCT LIFE CYCLE LONG (L) OR SHORT (S)	L	S	L	S	L	S	L	S
MAKE TO STOCK (S) OR TO ORDER (O)	S	S	S	S	O	O	O	O
VOLUME HIGH (H) OR LOW (L)	H	H	L	L	L	L	H	H

medicine	Automobile	Generator	Spar pars	Aeroplane	Military	Spare Military	None
Tobacco	Computer	Tractor	IC	Ships	Rr car		
Sugar	Cloth	Pumps *		Trains	Test Eq	Aeronautic spare	
Food	shoes	Instruments		Military		Steel s *	
Chemical	Toy's			Key Project			
Paper *	Electronic			Electronic m *			
Cement *	Cosmetic			Irrigation *			
	AC *						
	Plastic *						
	Foundry *						

Quality	Cost	Delivery L	Design	Quality	Quality	Delivery L	
Cost	Volume	Delivery R	Delivery L	Delivery	Design	Delivery R	
Volume	Quality	Cost	Delivery R	Delivery R	Delivery L	Design	
Delivery L	Delivery L	Quality	Cost	Cost	Cost	Quality	
Delivery R	Design F	Design	Quality	Design	Delivery R	Cost	
Design F	Delivery R	Volume	Volume	Volume	Volume	Volume	

Figure 7.1 A Possible Classification Structure of Manufacturing Organisations

However, its further development and verification proved to be beyond the scope and limitation of the current research.

Limitations Related to Case Studies

Due to the limitations such as time and companies available, only a certain number of case studies could be carried out within the scope of this project. Consequently one cannot claim that the proposed methodology and its new techniques have been completely proven. The positive results thus obtained have only demonstrated their usefulness in a practical sense.

In addition, due to the nature of multiple case studies and the fact that companies differed from case to case, certain aspects of the results were difficult to interpret in a general sense. Only a few features of the new approach could be validated with relative confidence (e.g., the practical value of the overall procedure, and in particular the usefulness of the generic strategy profiles).

7.4 Recommendations

National level industrial policies cannot succeed without the full participation and support of the individual companies. In this aspect, MSAMSA's logical, coherent approach and its compatibility with the current national policies on the country's industrial development make it a timely development. Therefore, it is anticipated that its further enhancement and adaptation within the nation will be of national importance.

Therefore, it is recommended that, subject to further development and enhancement, the suggested approach of MSAMSA should be put to the proper authorities to be considered as an official approach to help Saudi manufacturing companies analyse and develop future manufacturing strategies. An government office, with effective links to the proper institutes, should take on the responsibility of the further develop, updating and adaptation of MSAMSA within the country.

Technically, the following are required:

- The structure and documentation of MSAMSA as presented here is only a prototype, specifying the concepts, logical structure and overall procedures. Further enhancement and refinements are needed:

  ⇒ The product life cycle and production development aspects should be taken into consideration;

  ⇒ In relation to a more detailed classification of manufacturing types (probably following the format of Figure 7.1), a set of better specified generic strategy profiles should be developed;

  ⇒ More tests should be carried out to validate the detailed procedures involved.

- The workbook should be made more technically complete, more self-contained and self-explanatory, so that it can be easily understood and effectively applied by the manufacturing managers and engineers.

- Computer-aided tools should be developed to help MSAMSA's actual application in practice.

- Further development of MSAMSA should take the logistic-distribution issue into consideration. Figure 7.1 shows that, from the customer's point of view, there are three main functions contributing to a company's delivery performance. However, current techniques of manufacturing strategy formulation, including MSAMSA, seem to concentrate mainly on the issues related to manufacturing activities alone, without much consideration being directed to their subsequent operations. From the case materials gathered through Cranfield CAMSD research team's previous work, it is evident that many companies have found this restricting, and begun to ask for ways

to take these relevant activities into consideration, and treat them as an integral part of the complete cycle. Due to their geographical locations, this is an important issue for Saudi manufacturing companies who intend to expand into the international market.

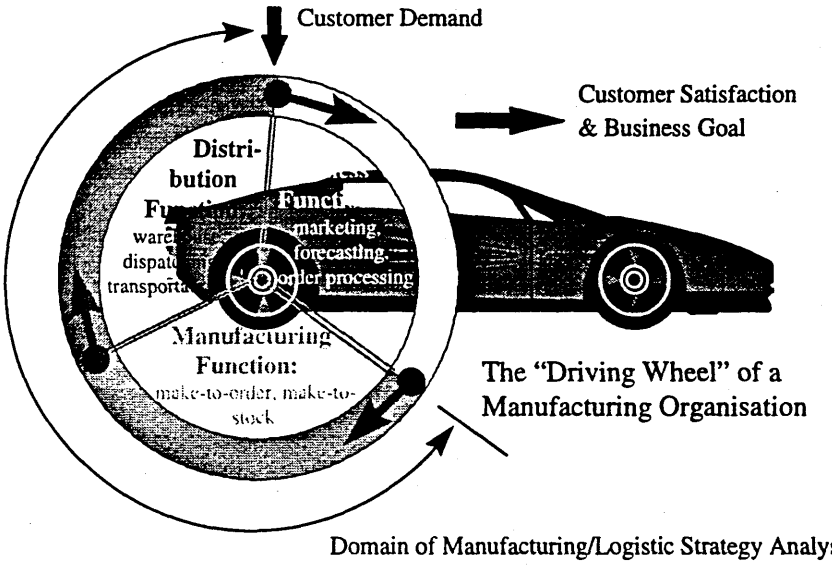


Figure 7.1 The Complete Cycle of Manufacturing Activities

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APPENDIX I MANUFACTURING STRATEGY ANALYSIS FOR THE MANUFACTURING COMPANIES IN SAUDI ARABIA - A WORKBOOK

Manufacturing Strategy Analysis For The Manufacturing Companies In Saudi Arabia (MSAMSA) - A Workbook

Contents

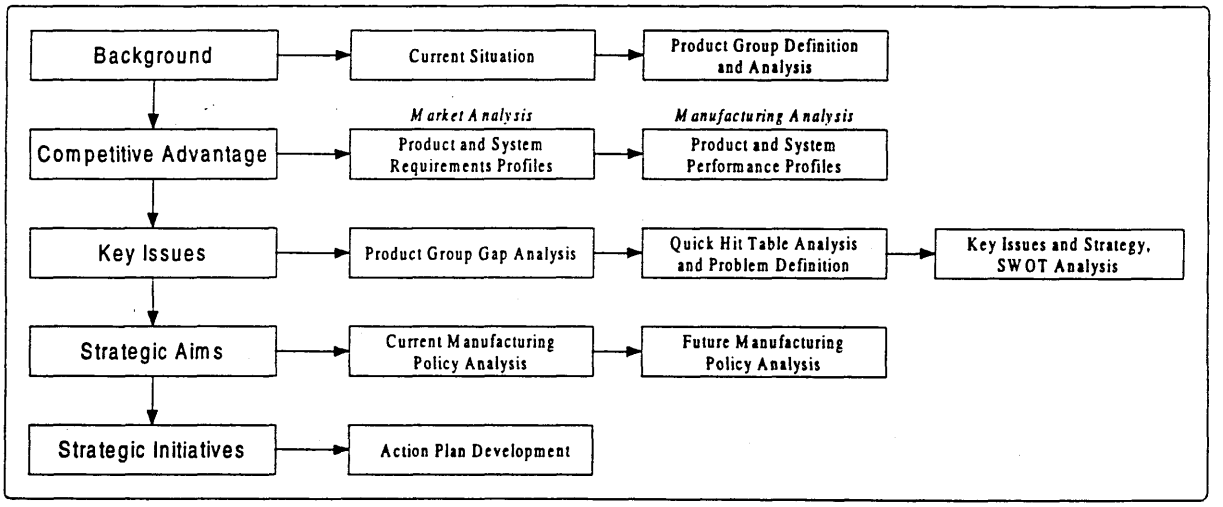
Introduction

The basic structure of MSAMSA is based on a prototype manufacturing strategy formulation and capture process developed previously by the CAMSD (computer-aided manufacturing systems design) research team at Cranfield University, UK. However, the structure and procedures have been further developed to reflect the specific requirement for Saudi manufacturing industries. A number of Saudi specific issues regarding its manufacturing industry, have been identified, taken into consideration and incorporated into the framework. This will provide Saudi companies with an effective approach to help develop manufacturing strategies particularly suitable within the Saudi industrial environment. In particular MSAMSA attempts to satisfy:

- The need for a more structured way to link higher level policies to the process of manufacturing strategy formulation within the Kingdom alongside the logical path of its progression, an extension has been built into the approach, in the form of a "road map" outlining the network of agencies and information sources available. These are set up mainly by the Saudi government to encourage and help local manufacturing industries. The inclusion of this map will provide the user with an useful guide to identify and take advantage of the available support, and hence develop the most suitable strategies in an effective way;

- The need to provide a mechanism for both system-wide and product-group related methods for evaluating manufacturing requirement. An unified algorithm for system strength/weakness analysis is followed to facilitate these processes;

- The need to provide both local-level (internal) and global-level (external) measures, to both qualitatively and quantitatively prioritise and evaluate manufacturing strategic concerns. A set of generic priority profiles are incorporated to provide guidance to help cross-check local requirement profiles against general, global expectation.



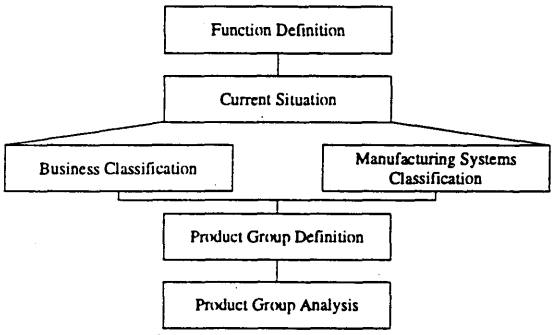
Strategy Formulation Process Overview

The manufacturing strategy formulation process consists of five sections: 1 *Manufacturing Background, 2 Competitive criteria, 3 Key Issues, 4 Strategic Aims* and *5 Strategic Initiatives.* Each section comprises a series of questions and data collection methods in order to develop and assist the capture of the individual manufacturing policy decisions. A number of analytical tools are also provided to assist the decision making process, as shown in the figure.

MSAMSA Stage 1 - Manufacturing Background

Stage 1 produces the first element of the manufacturing strategy document, and is responsible for the initiation or preparation for a strategy or manufacturing system audit. It is designed to gather the relevant background and environmental information at the beginning of journey planning, by classifying the current state of development of the manufacturing system and the role of the manufacturing function within the organisation. In addition, it also attempts to identify the requirements of the manufacturing system, with respect to the products to be manufactured, and assists the analyst later to define appropriate product groups. One of the outcome of this stage is the identification of the type of manufacturing operation involved, according to a generic classification theme. This will provide a basis to facilitate the external assessment process for strategic evaluation purpose. The stage comprises a series of questions relating to the organisation and the manufacturing system, and consists of the following four tasks:

1.1 Manufacturing function definition
1.2 Current situation specification
1.3 Classification of product groups
1.4 Establishment of product group importance



Stage1 - Manufacturing Background

Task 1.1 (*Manufacturing function definition*) attempts to establish whether a statement of the role of manufacturing in the organisation actually exists. If one does not exist then such a definition should be first be formulated before the subsequent analysis. The approach then helps to request a textural input of the manufacturing function definition statement for future reference.

The current situation definition (Task 1.2) is composed of three sections: a statement of the current situation, a classification of the business and a classification of the manufacturing system. The statement of the current situation is similar in format to the definition of the manufacturing function, requesting a textural input. The next two sections are based on a questionnaire approach. The business is to be classified according to its structure, culture and organisational behaviour:

Business Structure - Structural Configuration, Co-ordinating Mechanism, Key Organisational Section, Decentralisation Type.
Business Culture - Culture, Orientation, Organisational Activities.
Organisational Behaviour - Growth, Market, Product Development, New Products and Services, Production, Investment, Concentration, Co-operation, Behaviour to Competitors.

Similarly, the manufacturing system is classified with respect to its structure, relationships, state and life cycle:

System Structure - Product Process Matrix (Volume, Variety, System Type, Degree of Technology Integration, Degree of Technology Automation, Scale of Capacity Increment), Stock and Order Operating system Structure.
System Relationships - Nature of Business, Customer Influence, Organisational Structure.
System State - Degree and State of Evolution.
System Life Cycle - Life Cycle Stage.

The product group definition task (Task 1.3) provides a number of simple tools to aid the specification of the product groups or families. First the product families, variants, etc. can be recorded through a

tree-based structure. Once these have been established then a quantitative and qualitative analysis can be carried out to assist the selection of major product groups. Typical criteria which could be applied include: volume, variety, costs, profits, markets and customers, resources and processes and materials. Simple ABC analysis tools can be used to assist this process.

Next, the product group analysis (Task 1.4) takes each previously defined product group in turn and asks the analyst to enter relevant information with which to compare the product groups to assess their relative importance. Typically these criteria would be: volume, variety, costs, profits, market share, product life cycle stage, manufacturing capability and the system's strengths weaknesses, opportunities and threats with respect to the individual product groups. Each criteria should be assigned a relative ranking based on the company's assessment of its importance.

MSAMSA 1.1 - Current situation

The questions contained in the current situation step, though essentially being used as a research tool, provide the members of the strategy formulation group with the opportunity to assess the business, its organisation and its manufacturing system. The information should assist them to come to a common understanding of the business from a corporate as well as a functional perspective and help them to define the role of manufacturing within the enterprise. Examples of forms to be used here are shown below.

Business / organisation classification

Business Definition

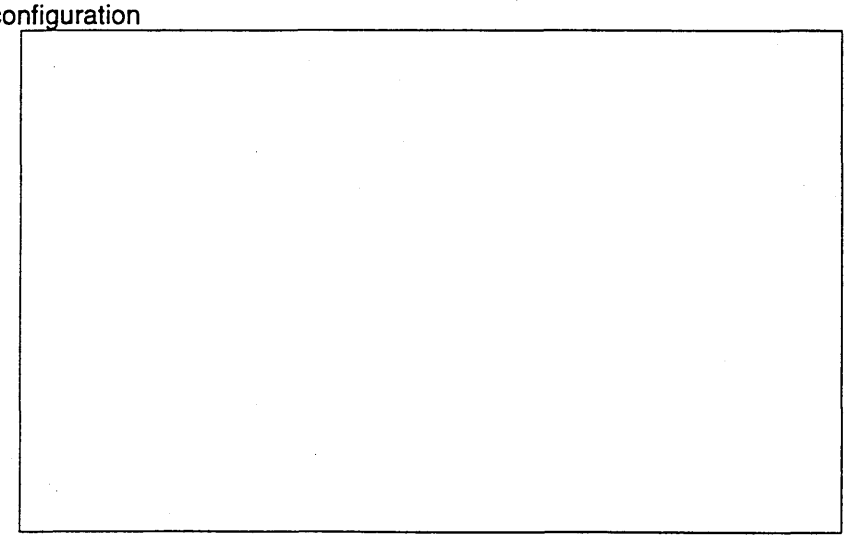
What is the Business ?

Who are the Customers ?

Who are the Competitors ?

Business structure

Structural configuration



Configuration *Simple - Machine bureaucracy - Professional bureaucracy - Divisionalised - Adhocracy - Other*

Co-ordinating mechanism *Direct - Standard Work - Standard Skills - Standard Outputs - Adjustment - Other*

Key part of organisation *Strategic Apex - Technostructure - Operating Core - Middle Line - Support Staff - Other*

Type of decentralisation *Centralised - Limit Horiz Dec - Decentralised - Limit Vert Dec - Selective Dec - Other*

Size of company

Business culture

Ownership

Dominant culture *Power - Role - Task - Person - Other*

Control and power within organisation

Organisational behaviour

Organisational orientation *Entrepreneurial - Bureaucracy - Job / Project Oriented - Person Oriented - Other*

Strategic behaviour -

growth - market - prod develop - new prods - production - invest - concentrate - co-operate - compete

Operating Environment

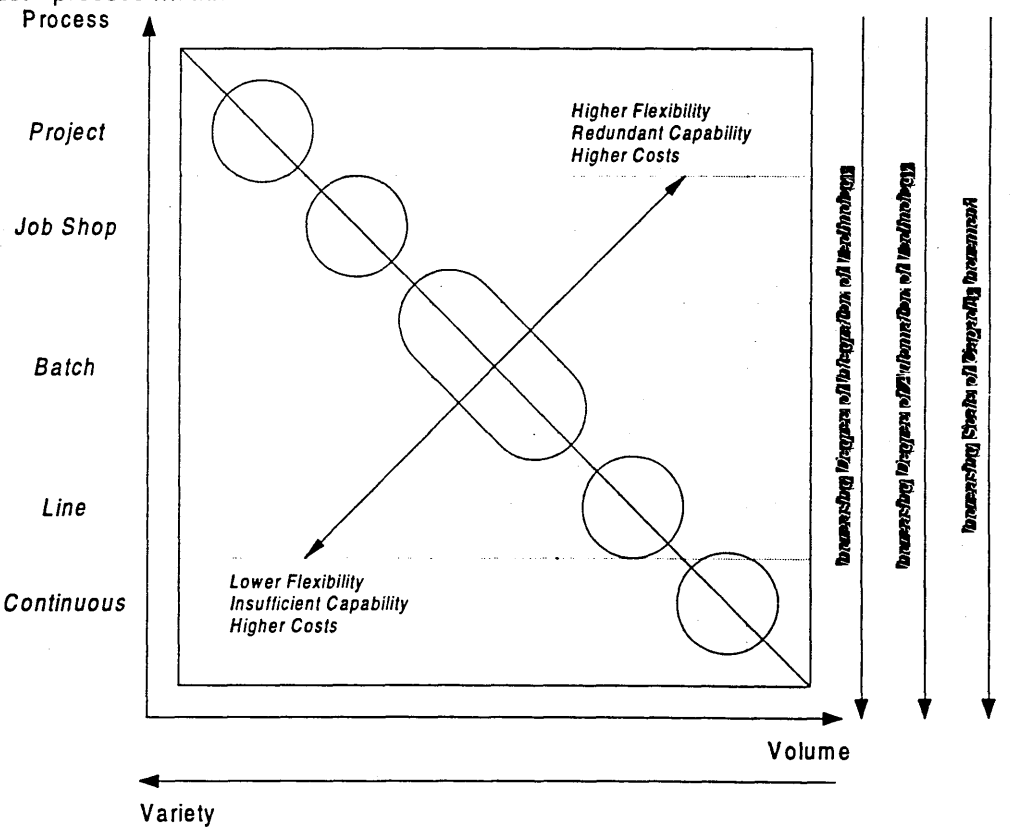
Business purpose

Prevalent technology

Manufacturing system classification

System structure

Product - process matrix



Process type

Operating system structure

Make to stock from stock	
Make to stock directly from supplier	
Make to order from stock	
Make to order directly from supplier	

make to stock - assemble to order - make to order - engineer to order

System relationships

Customer influence on manufacturing

Organisational structure

Organisation *Hierarchy - Functional - Matrix - Product focus - Temporary - Other*

System state

Evolution *complex - simple - integrated - automated - computerised*

System life cycle *Greenfield - Growth - Maturity - Improvements - Brownfield - Maturity - Improvements - Decline*

MSAMSA 1.2 - Role of manufacturing function

In addition to the definition of the manufacturing function's role within the overall organisation, it is also necessary to identify the manufacturing operations concerned according to their strategic characteristics (ie, 'caretaker', 'marketeer', 'innovator' or 're-organiser', as shown in the figure below.

Role of the manufacturing function

	Make for stock	Make for order
Low Volume	**Marketeer** 1.Quality 2.Cost 3.Delivery Reliability 4.Delivery Lead time 5.Design Flexability	**Innovator** 1.Quality 2.Design Flexaibility 3.Delivery Reliability 4.Delivery Lead time 5.Cost
High Volume	**Caretaker** 1.Cost 2.Quality 3.Delivery Reliability 4.Delivery Lead time 5.Design Flexability	**Reorganizers** 1.Delivery Reliability 2.Delivery Lead time 3.Quality 4.Cost 5.Design Flexability

Classification of manufacturing type and their generic strategic priority

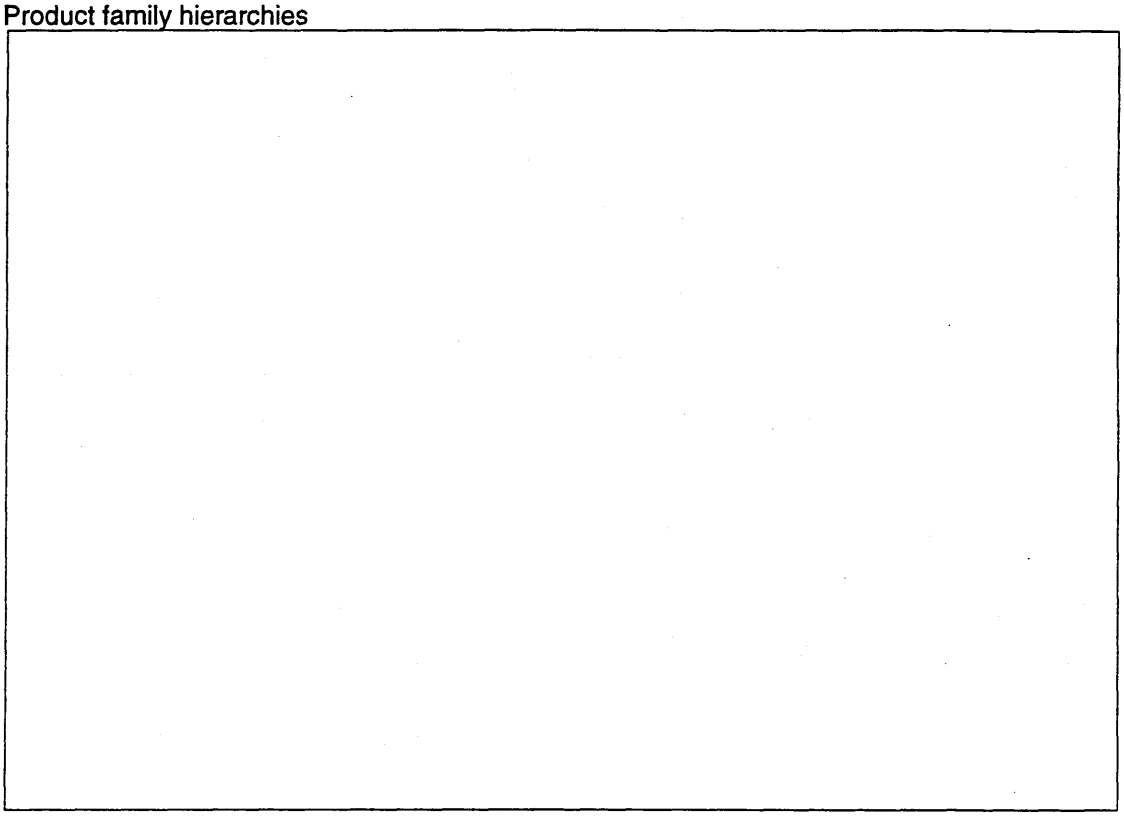
Type of manufacturing operation

MSAMSA 1.3 - Product group definition

During this step and the subsequent analysis step, it is useful to have available copies of the product and marketing strategies, if they exist.

The definition of product groups depends very much upon the company, and its business and markets. Obviously the product range, the number of products and their associated variants within each product line are influencing factors. The first task is therefore to quickly define each of the product ranges, diagrammatically, and to indicate the number of variants available for each of the products within each product line.

Product family hierarchies



The following table provides a number of variables to investigate when defining product groups. However, it is probably easiest to consider a product family as **a grouping of products which compete in the market in identical ways**. Where market segments are being applied, it should be noted that products in the same segment may win orders in different ways to each other. Other useful indicators include the **product life cycle concept** and the manufacturing operations and production processes that are required for the constituent parts.

Products															
Variants															
Volume															
Life cycle stage															
Principle Processes															
.....															
.....															
Materials															
Approx. profit/cost/sales															
Typical order size															
Standardisation															
Product Intro. rate															
Market															
Competing criteria															
Customers															
Other															
.....															
Product Group															

MSAMSA 1.4 - Product group analysis - relative importance

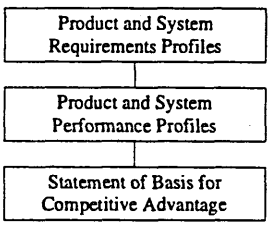
The aim of the next table is to provide an in-depth analysis of each of the product groups previously defined. Much of the information relates to that previously captured and so may simply involve an aggregation of the data. The assignment of the relative importance of each product group is a subjective assessment, based on the information contained in the table.

Product Group							
Sales							
% Sales							
% Contribution							
Volume							
Market share							
Customers							
Competitors							
Product life cycle stage							
Product Intro. rate							
Growth opportunities							
Vulnerabilities							
Breadth of Group							
Standardisation							
Degree of innovation							
Other							
.....							
Relative Importance							

MSAMSA Stage 2 - Competitive Advantage

In order to achieve an understanding of the competitive advantage which manufacturing contributes, or should contribute, towards the fulfilment of the corporate objectives and the support of market requirements, two sets of analysis are required. The first stage simply aims to identify which of the principle competitive criteria are responsible for winning orders in the market and which criteria are required in order to qualify as a potential vendor in the market. The second stage then goes into further detail in order to ascertain the relative importance of each of these criteria for each of the product groups and how well the current manufacturing function is achieving these needs. A detailed review of the market in which the business operates is essential in order to obtain an understanding of the market and how manufacturing contributes. Wherever possible, opinions should be replaced by 'hard' facts derived from data which has been collected, analysed and verified. Three main outcomes should be produced:

2.1 Product and system requirement profiling
2.2 Product and system performance profiling
2.3 Establishment of the basis for competitive advantage



Stage 2 - Basis for Competitive Advantage

The following are required to achieve these.

Market Analyses
This aims to achieve:

- Determination of current and future volumes
- Definition of end-user characteristics
- Assessment of patterns of buying behaviour
- Examination of industrial practices and trends
- Identification of key competitors
- Identification of target markets

When the principle competitive criteria are examined the analysis should attempt to ascertain the requirements of the market place and the specific customers and the performance of competitors with respect to the following criteria.

- *Quality* - Identification of which dimension of quality is predominant for the market in which each of the products/product groups compete.

- *Delivery Lead-time* - Typical market requirements should be identified. Lead-time becomes an order winning criteria for manufacturing if there is a considerable backlog of orders such that process lead-time extends beyond the customer's delivery requirements, or when the process lead-time is considerably greater than the customer's delivery requirements.

- *Delivery Reliability* - On time delivery expectations of customers need to be identified, which customers, what lead-times, delivery windows. Attention should also be paid between the negotiated contractual requirements and what the customers actually require.

- *Design Flexibility* - This relates to the expectations of customers with respect to design changes and the desire for customised products.

- *Volume Flexibility* - Typical market requirements should be identified. Aspects to consider include seasonality of demand and the expectation of 'one-off' demands. It relates to the predictability of demand.

- *Cost / Price* - Where margins are high, price is not an order winner, but should be kept within the bounds of the market. Where price is an order winner there are likely to be low margins and a need to maintain and reduce manufacturing costs.

The following illustrate the form to be used during the analysis process.

Product / Product Group:

Customers						
Quality Conformance to spec Reliability in use Customer satisfaction						
Delivery Lead-time Lead-time requirements Delivery change notice Customer satisfaction						
Delivery Reliability Delivery window Contractual delivery L-time Req'd delivery lead-time Customer satisfaction						
Design Flexibility Design changes Customised products Customer satisfaction						
Volume Flexibility Minimum order size Maximum order size Average order size Seasonally demands One-off demands Predictability Order change notice Customer satisfaction						
Cost / Price Price sensitivity Margins Customer satisfaction						
Product Features Unique features Superior performance Customer satisfaction						
Other criteria e.g Tidy factory for visits						

For each overall heading (e.g. delivery reliability) please indicate the importance or degree to which it is required in order to compete.

Manufacturing Analyses

In order to obtain the information required to assess manufacturing and understand the competitive advantage required, a series of analyses need to be executed. The aim is to review the market from a manufacturing perspective taking into account the reality of the orders received and the demands such orders make on the organisation. Samples of the orders received and forecasted, which have been agreed as being representative of the business, should be analysed. The results can then be related to individual products or aggregated within their respective product groups.

- *Quality* - Rather than providing figures relating to an average conformance level, the analysis should attempt to indicate the actual quality level provided to the customers.

- *Delivery Lead-time* - This should be assessed with respect to the actual lead-time of a product against what the individual customers perceive as their order lead-time.

- *Delivery Reliability* - This should also be assessed with respect to the individual customers rather than as an aggregate figure. All features relating to a reliable delivery should also be recorded, from being delivered within the customer's specified time period, having a complete order and being error free.

- *Design Flexibility* - This should be assessed with respect to manufacturing's ability to cope with product range differences, such as reduced set-up times.

- *Volume Flexibility* - Ability to respond to increases in demand. Other factors which effect this competitive competence include the shelf life of products and the frequency of product modifications in line with market requirements.

- *Cost / Price* - an effort should be made to discover the actual costs incurred in completing the sample orders and, if time and data availability permits, to extend this to provide a comparison with orders outside the sample. The relative value of different orders and customers can be explored with the use of accurate costing information, and so the cost data itself should be investigated in detail. Typically these include the actual contributions of manufacturing to the cost of the product and how this is divided. Total product and manufacturing costs should be investigated, including overheads and materials.

The following illustrate the kind of forms to be used during the analysis process.

Product / Product Group :

Customers					
Quality Actual quality level Customer reject rate Final failure rate Intermediate scrap rate Cost of scrap Warranty costs Customer satisfaction					
Delivery Lead-time Actual delivery lead-time Manufacturing lead-time Non-manufacturing lead-time Schedule change ability Inventory investment Operation hours / Total time in factory Customer satisfaction					
Delivery Reliability Deliveries within window Complete orders Error-free orders Customer satisfaction					
Design Flexibility Ability to cope with product range Ability to cope with product change Design changes per year Ability to cope with design change Proportion customised Customisation ability % increase in lead-time over std product Customer satisfaction					
Volume Flexibility Ability to respond to demand increase Product shelf life Minimum order size Maximum order size Set-up times Seasonal demand variation Random demand variation Frequency of schedule changes Size of schedule changes Effect on delivery lead-time Customer satisfaction					
Cost / Price Actual cost incurred Manufacturing contributions % sales per machine hour per man hour Overheads Materials Direct labour costs Non-manufacturing contributions Capital costs Customer satisfaction					
Other criteria					

For each overall heading please indicate how well manufacturing is performing (scale 0 to 100)

Competitive criteria

A clear indication of how orders are won is essential. In the following tables Order Winning (W), Order Losing (L), Order Qualifying (Q) and Potentially Order Winning (P) Criteria should be identified and differentiated. An understanding of the difference between order winning and qualifying is essential. This can be seen in the market analyses. In the case of order qualifiers, it is likely that the customers will simply check that the product conforms and is within the range deemed acceptable in the market. In the case of order winners, it is likely that customers will be looking for a performance which is better than the competition. To obtain as complete a picture of the market as possible, an informed indication of the approach adopted by the main competitors should also be constructed. Since strategy is both market and time specific, a judgement on the potential situation after a certain time period should also be carried out. The actual time periods depend upon the industry but for guidance, periods of three and seven years are suggested.

Current Period

Product
Quality
Delivery Lead-time
Delivery Reliability
Design Flexibility
Volume Flexibility
Cost / Price
Other
.....
.....

Competitors Approach

Product
Quality
Delivery Lead-time
Delivery Reliability
Design Flexibility
Volume Flexibility
Cost / Price
Other
.....
.....

Own criteria expected after three years

Product
Quality
Delivery Lead-time
Delivery Reliability
Design Flexibility
Volume Flexibility
Cost / Price
Other
.....
.....

Reasons for any anticipated changes

Expected after seven years

Product
Quality
Delivery Lead-time
Delivery Reliability
Design Flexibility
Volume Flexibility
Cost / Price
Other
.....
.....

Reasons for any anticipated changes

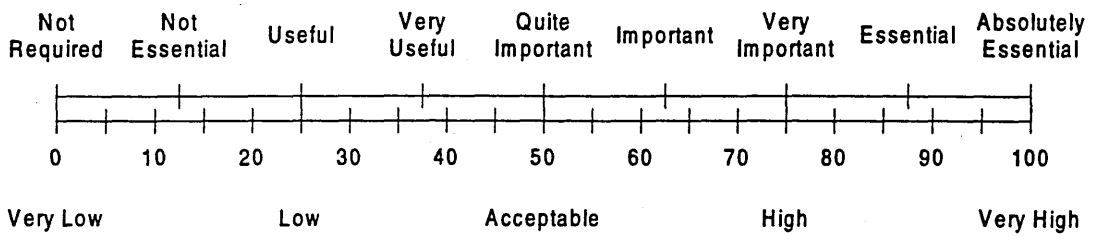
Having gained an understanding of the order winning and order qualifying criteria for the individual product groups or products, the next stage is to consolidate this information with respect to the six key competitive criteria which manufacturing provides: Quality, Delivery Lead-time, Delivery Reliability, Volume Flexibility, Design Flexibility and Cost.

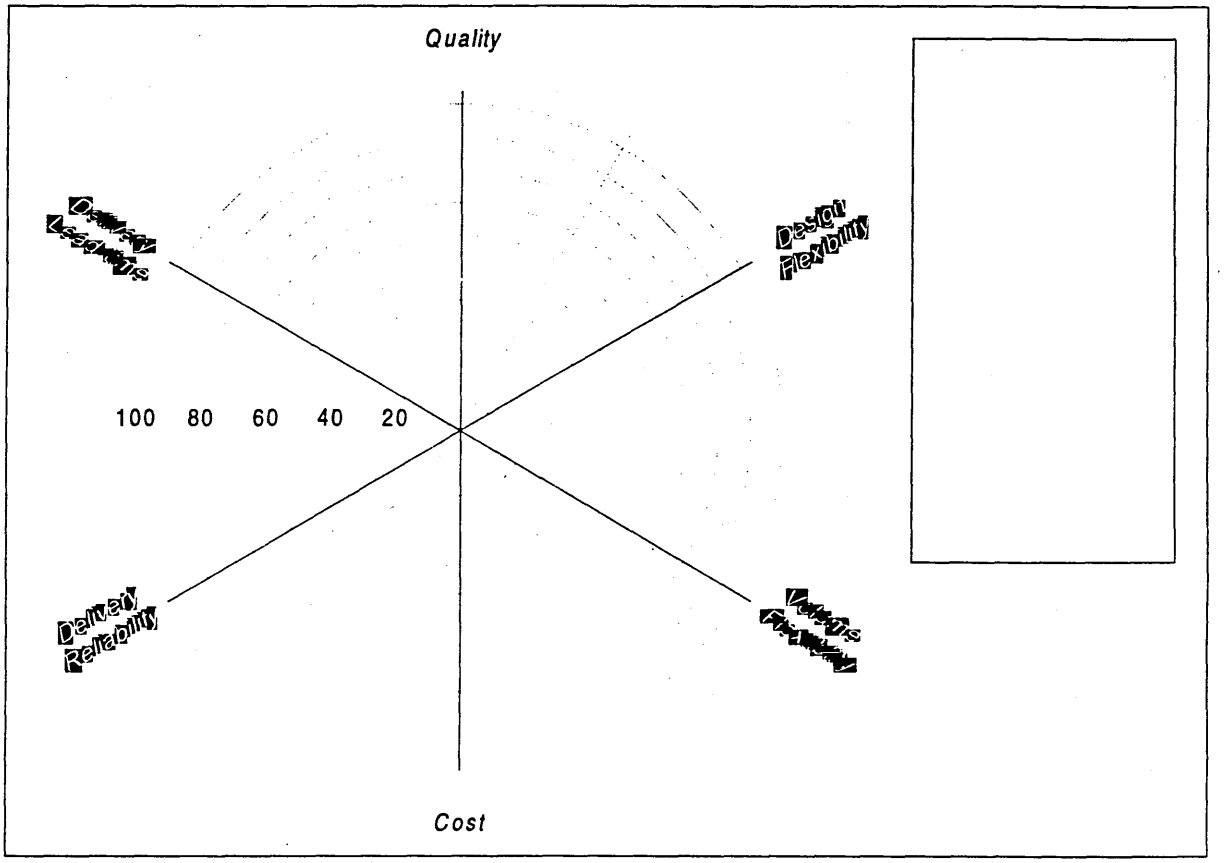
Profiling

As outlined previously, it is stressed that specific objective data should be used in the assessment of such criteria in order that an accurate representation and understanding of the market and its demand on the manufacturing organisation is achieved. A subjective assessment, whether undertaken by marketing, manufacturing or some other functional responsibility will not provide the complete picture and will be influenced and affected by functional policies, culture and internal perspective. The information should be obtained from several sources including the end customer, the actual orders received and benchmarking techniques, and where possible a full debate of the issues should be carried out. The result of such a multi-functional assessment and debate is that a more detailed awareness and understanding is created both of the market demands and their influences on the different sections of the enterprise.

In order to assist this process a simple scale can be used for each competitive criteria being addressed for each product group. A visual representation can then be plotted on the 'radar' diagrams. Once sufficient values have been obtained for each of the product groups, a series of aggregated values can be produced, if deemed applicable, in order to provide a representation of the demand or performance of the entire system. However, care should be taken when drawing conclusions from such aggregated assessments.

MSAMSA 2.1 - Product and Systems Requirements Profiles

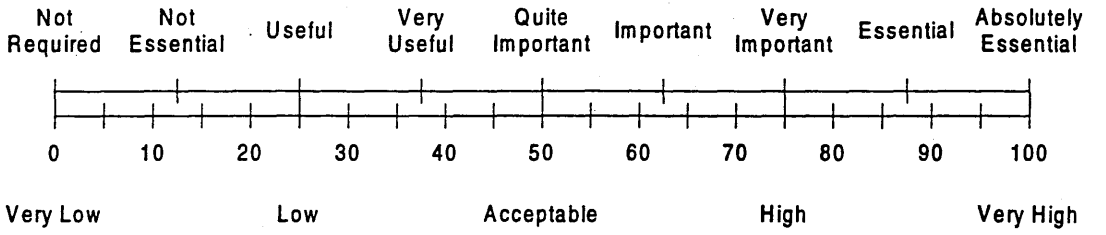


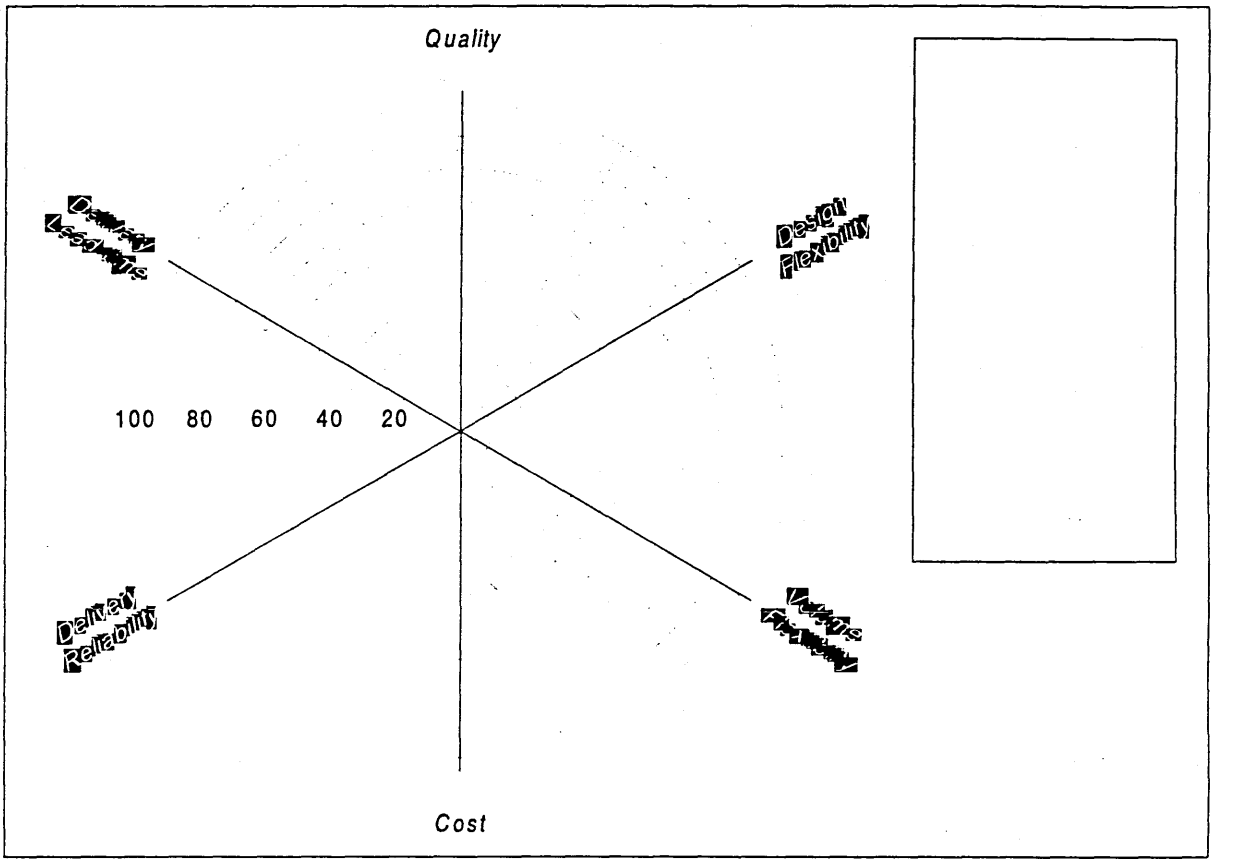


Product Group							
Relative Importance							
Quality							
Delivery Lead-time							
Delivery Reliability							
Design Flexibility							
Volume Flexibility							
Cost / Price							
.....							

Strategic Requirements Analysis

MSAMSA 2.2 - Product and Systems Performance Profiles



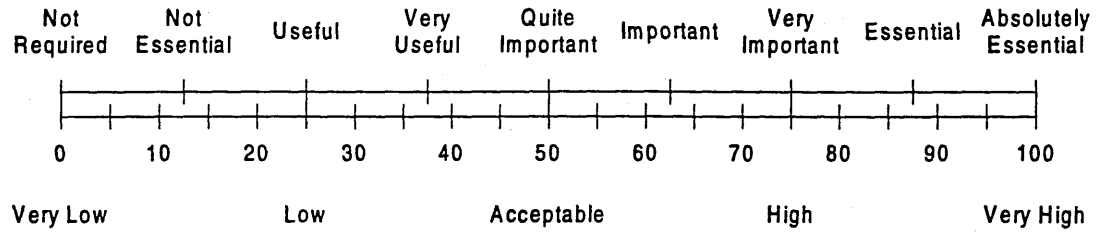


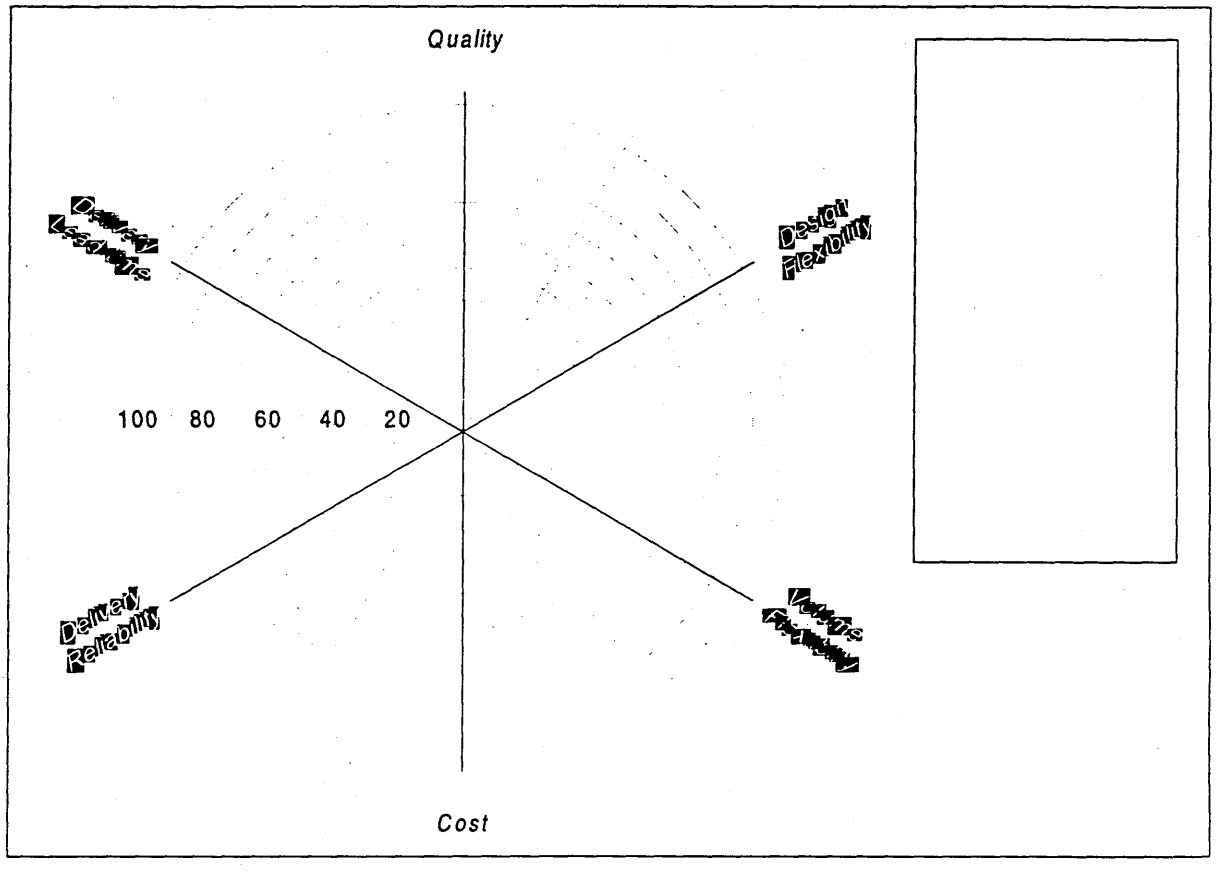
Product Group							
Relative Importance							
Quality							
Delivery Lead-time							
Delivery Reliability							
Design Flexibility							
Volume Flexibility							
Cost / Price							
.....							

Statement of competitive advantage with respect to market requirements

Competitors Product and Systems Performance Profiles

Where possible, an assessment of the performance of the key competitors in each of the product groups would provide a useful comparison. Whilst accurate figures for competitors performance are likely to be relatively scarce, a subjective or intuitive assessment would still provide an indication of how the company is competing in the market. It may also have the side-effect of stimulating the initiation of a benchmarking project.





Product Group							
Relative Importance							
Quality							
Delivery Lead-time							
Delivery Reliability							
Design Flexibility							
Volume Flexibility							
Cost / Price							
.....							

MSAMSA 2.3 Establishment of the basis for competitive advantage

Statement of competitive advantage with respect to competitors

Statement of overall competitive advantage

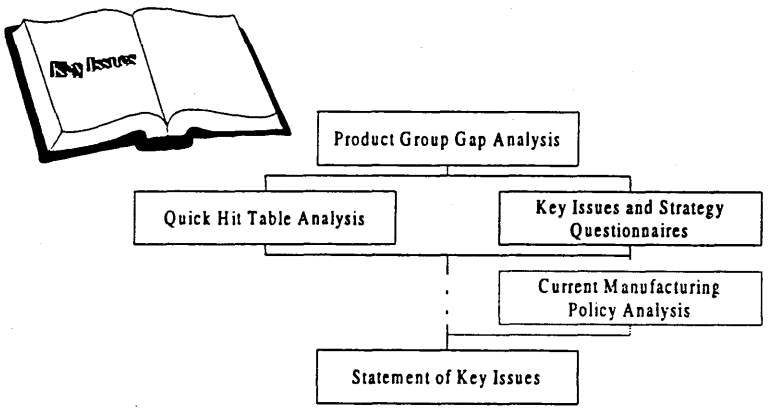
MSAMSA Stage 3 - Key Issues

Generally speaking, the aim of this stage is to identify the problem to be solved. Attention here should be first focused on, in relation to the requirements and performance of each of the product groups, the structure of the existing manufacturing system including its elements, relationships, boundaries, environment, functions and as well as its strengths and weaknesses. The successful completion of this should provide the correct answer to the key question: "Where are we now ?" The combination of Stages 1 and 2 can be referred to as "problem formulation" because, by establishing "where we are" and "where we should be", these two stages together will indicate the gap between the present system state and what its environment demands from the system - or a "problem" which prompts the search for an appropriate solution so that the gap may be closed.

Having identified the basis for competitive advantage, the criteria which the market demands and those which the organisation and the manufacturing function currently provide, the next stage is to identify the key issues which need to be addressed. The principle means of determining these key issues is to carry out a gap analysis on the market requirements and manufacturing system performance. This provides a quantitative and qualitative indication of where improvements may be required.

Where particular weaknesses are perceived a 'quick hit' problem table can be provided which outlines possible problems relating to aspects of the manufacturing function and their likely effect on the competitiveness of the company with respect to the criteria. A further important aspect to determine key issues relates to an examination of events, trends, facts or realities which may have an impact on the organisation and the manufacturing function. Such an assessment can be carried out initially through a SWOT analysis and the more salient points entered into in greater depth. Typically such issues may include the influences arising from tightening environmental and social legislation, and the current government policies on industrial development, etc. Therefore, stage 3 of the methodology starts with a gap analysis. This is followed by an analysis of the *Strengths, Weaknesses, Opportunities* and *Threats* (SWOT) of each of the product groups. The results are then used to define the key issues and initial strategic objectives. The complete stage consists of five tasks:

3.1 Product group gap analysis
3.2.a 'Quick Hit' table analysis
3.2.b Questionnaires - key issues and manufacturing strategy
3.3 Current manufacturing policy analysis
3.4 Statement of key issues



Stage 3 - Key Issues

MSAMSA 3.1 - Product group gap analysis

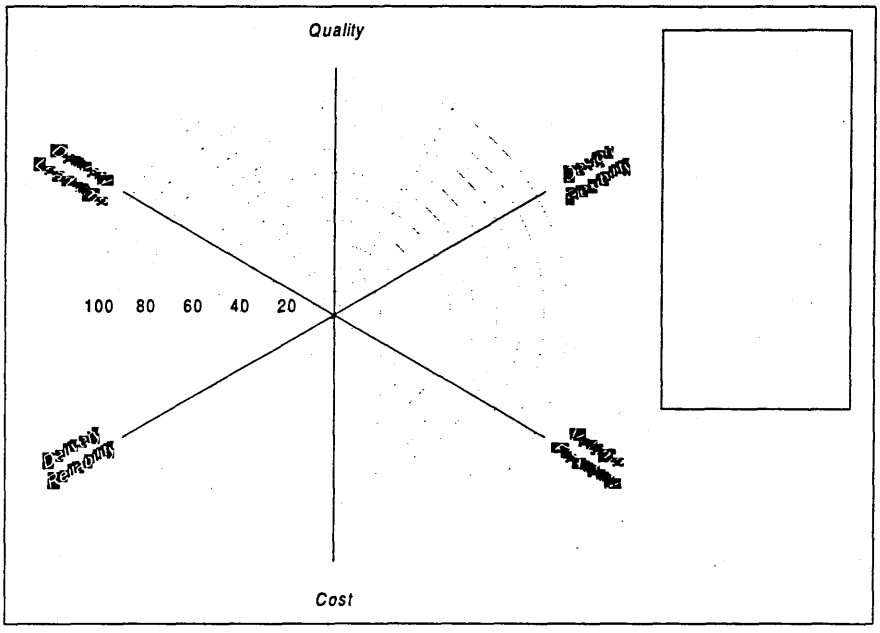
When drawing conclusions from the product gap analysis, care should be taken that any emphasis or relative importance placed on a particular competitive criteria or product group reflects the validity, accuracy and objectiveness/subjectiveness of the information and data used.

A variety of means can be applied to indicate the performance-requirement gaps with tabular and graphical representations. Where applicable a more detailed indication of the gaps can be attained

through simple numerical analysis. Such analysis takes into account the relative importance of each of the product groups.

Once the performance gaps have been identified, possible causes and reasons for the gaps should be investigated and their relevance to the organisation discussed.

Gap Analysis
Product / Product Group :
Product Group Importance :



	Gap	Importance	Reasons
Quality			
Delivery Lead-time			
Delivery Reliability			
Design Flexibility			
Volume Flexibility			
Cost			

MSAMSA 3.2.a & 3.2.b - Quick Hit and Problem definition
The 'quick hit' table provides a simple means of identifying possible problems within the manufacturing system or the current manufacturing strategy policies. It aims to suggest the manufacturing policies which may have contributed towards an increase or decrease in competitive performance for each of the six principle competitive criteria. The problems highlighted can be quickly associated to relevant strategy decisions. However, the table is only provided as a guideline and the intuition and experience of members of the strategy development team are equally valid. The quick-hit analysis is optional at this stage of MSAMSA's development. Details are not included in this prototype document.

MSAMSA 3.3 Current manufacturing policy/SWOT Analysis

The following are general factors that should be taken into consideration. The table below provides specific items that reflect the current government policy on industrial development. In addition, the figure below provides an overview of the procedures that a Saudi manufacturing company needs to follow in applying for financial support from the government, through schemes such as the SIDF.

Opportunities and Threats

Economic Factors		
Interest rates	Exchange rates	SIDF support
Level of employment		
Social and Political factors		
Government legislation	Saudisation	International legislation
Trade barriers	Union issues	Consumer groups
Special interest groups	Environmental and green issues	
Demographic Factors		
Demographics	Income levels	Age composition
Market and Competition Factors		
Customer plans	Competitors plans	Supplier plans
Customer dependence	New competitors(entrants)	Supplier dependence
Level of exportation		
Products and Technology		
New products	New markets	New technology
Substitute products	Automation	
Other Factors		
Availability of natural resources		New site possibility
Expansion possibility	Climate condition	

Strengths and Weaknesses

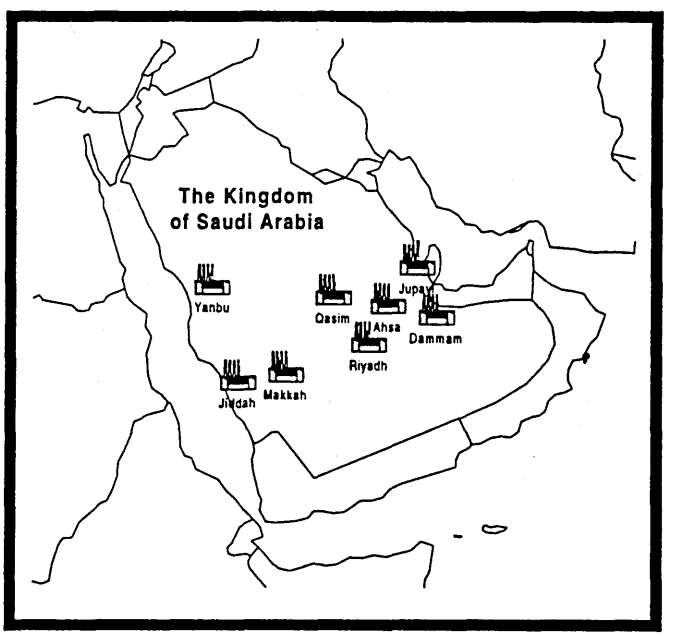
Management and Organisation Factors		
Management systems	Industrial relations	Personnel policies
Morale	Skills	Employee age
Operations		
Quality	Lead-times	Performance
Capacity	Flexibility	Dependability
Location	Material availability	Service availability
Utilities availability	Technology	
Equipment age	Implementing change	
Finance Factors		
Capital structure	Profitability	Financial planning
Accounting system	Cost structure	
Other Factors		
Patents	Image of firm	

The results should be recorded in the form provided below.

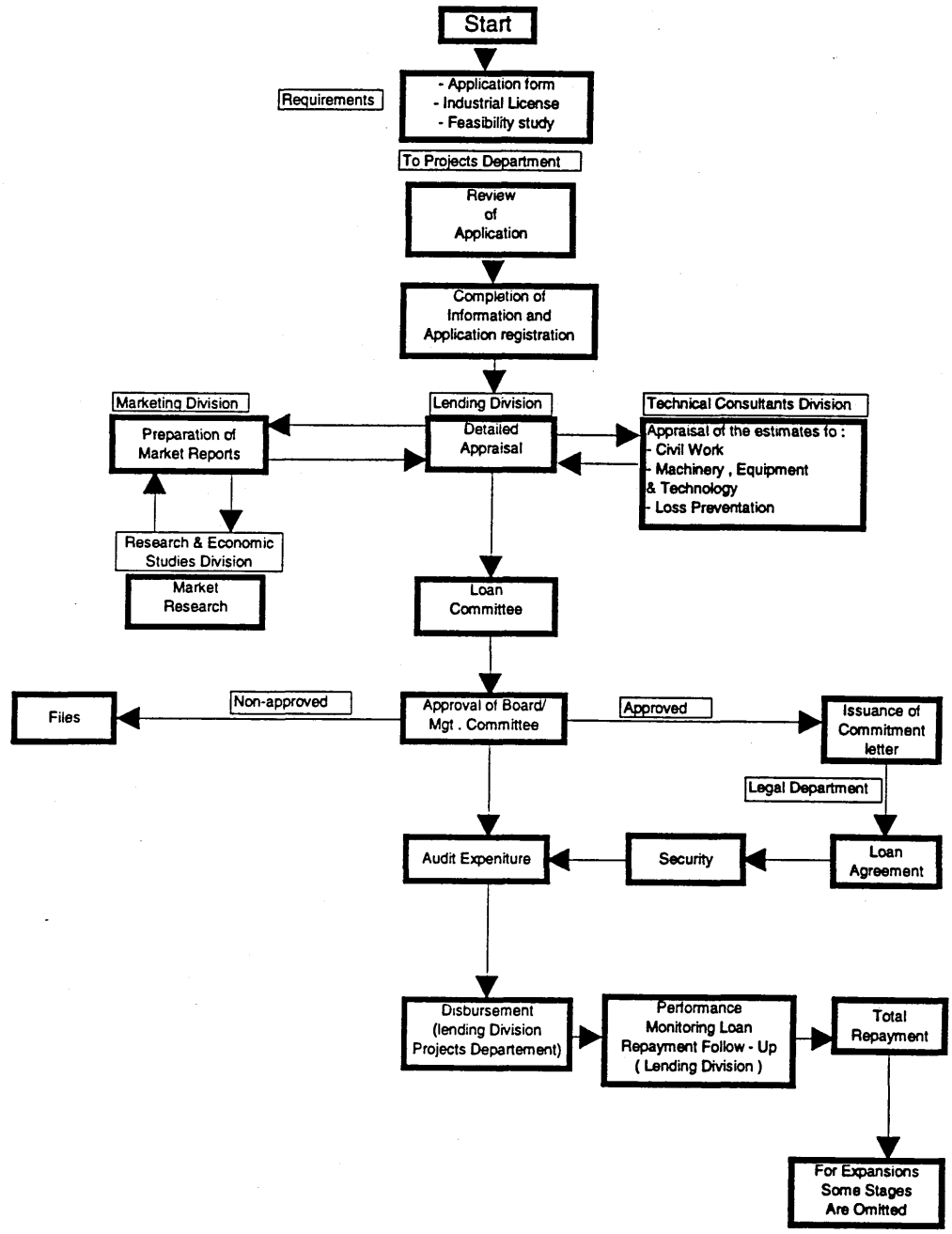
STRENGTHS	WEAKNESSES
OPPORTUNATIES	**THREATS**

	Advantage	Disadvantage
Saudization	Decrease the rate of unemployed Support the national economy to keep the cash in the country . More stabilization of the national economic To increase quality of life of people in future	Government enforcement in each year 5% of the total employee should Saudis nationality. One company two salary systems. Increase the labor cost.
Government Support	Free lands Tax Free Long term loan without interest Industrial cities National products preventive policy	Possible WTO intervention
Exporting (new markets)	Low price in petrochemical industries . Throw international loan or support to meet mutual interest (monetary) Well establish infrastructure Government politic support to open new market Consumerability	Production cost are higher than other country in middle east in general .
Research & Development	Specialize in petrochemical industry Well educated workforce Utilize the university resource to support the industry . Utilize king Abdulaziz technical city to support the industry .	High cost technical transfer
Environmental Issue	Geveroment support International regconition	Increase the overall cost

Influences of the current government policies on manufacturing development



Location of government supported industrial cities



Application procedures for financial support through SIDF

MSAMSA 3.4 - Statement of key issues

Key issues arising from analysis :

Key issues arising from External SWOT analysis

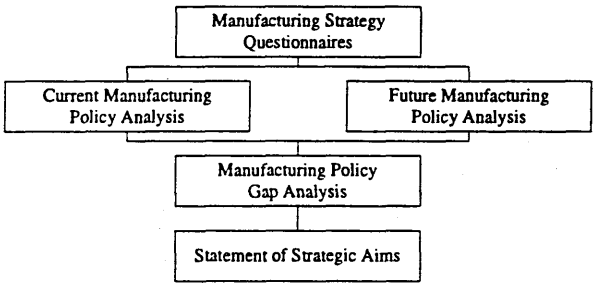
Key issues arising from Internal SWOT analysis

Implications for Manufacturing

MSAMSA Stage 4 - Strategic Aims

The strategic aims stage captures or develops the details of the manufacturing strategy, based on the previous analytical stages. If a current strategy exists then it is captured through a series of questions and its principle policies are assessed with respect to the competitive criteria. The future policy can then be captured or produced based on the previous strategy, the analysis results and the strategic aims derived from the key issues. These aims should be a direct response to the key issues. To assist in the process of deriving strategic aims and the future manufacturing strategy, generic manufacturing strategy profiles are provided, which provide the basis for an external and qualitative evaluation. A similar means of capturing and analysing the future policies are adopted. There are up to five sections to this stage:

- *4.1 Manufacturing strategy questionnaires*
- *4.2 Current manufacturing policy analysis*
- *4.3 Future manufacturing policy analysis*
- *4.4 Manufacturing policy gap analysis*
- *4.5 Statement of strategic aims*



Stage 4 - Strategy Aims Definition

MSAMSA 4.1 - Manufacturing strategy questionnaires

A complete set of questions designed to gather the necessary information is presented below. This list of questions is extensive, but not exhaustive. It may be supplemented and enhanced by additional user specific decisions and configurations for the individual policy areas. In addition, all these questions should be repeated for the future strategy.

CAPACITY

Demand Pitch

How has the total manufacturing capacity been pitched relative to demand ?
How have the individual manufacturing capacities been pitched relative to demand ?
How has the total capacity been specified with respect to floor space ?
How has the total capacity been specified with respect to plant ?
How has the total capacity been specified with respect to equipment ?
How has the total capacity been specified with respect to labour ?

Variation Satisfaction

How have cyclical demand variations been managed ?
How have long term demand variations been managed ?
How have demand highs been satisfied ?
How have demand lows been satisfied ?
What was the degree of flexibility in capacity envisaged for manufacturing ?

Expansion Methods

What methods have been used for expanding capacity ?
What has been the size of expansion increments ?
What has been the trigger for the decision to expand capacity ?

Contraction Methods

What methods have been used for contracting capacity ?

What has been the size of contraction decrements ?
What has been the trigger for the decision to contract capacity ?

Timing
How has the timing of capacity changes been determined with respect to demand ?

Bottlenecks
Are there any significant bottlenecks which have been identified ?

Demand Forecasting
How has demand been monitored ?
How has demand been forecasted ?
What have been the capacity change signals ?

Implications
What have been the implications of capacity for manufacturing ?

FACILITIES

Specification
How many facilities have there been ?
How has the size of each facility been determined ?
What has been the capability of each facility ?

Location
What has primarily determined the location of the factory ?
What has primarily determined the location of the individual production facilities ?
What type of plant layout has been adopted ?

Focus
What has been the degree of specialisation of the facilities ?
What has determined the type of focus or specialisation of the facilities ?
What has been the degree of flexibility of the facilities ?

Function Integration
What has been the degree of functional integration within the enterprise ?
What has been the degree of functional integration within the manufacturing function ?
What has been the degree of functional integration with the supporting services ?

Flow
What degree of emphasis has been placed on the flow of materials within each facility ?
What degree of emphasis has been placed on the flow of information within each facility ?

Implications
What has been the implications of facilities for manufacturing ?

PROCESSES AND TECHNOLOGY

Type of Equipment
What has been the degree of flexibility of the production equipment ?
What has been the degree of capital intensity of the production equipment ?
What has been the degree of capability of the production equipment ?
What has been the degree of mechanisation of the production equipment ?
What has been the degree of automation of the production equipment ?
What has been the degree of integration of the production equipment ?
What has been the policy with respect to key technologies ?
What degree of technological risk has been adopted ?
What has been the degree of process innovation adopted ?
How have set-ups and changeovers been satisfied ?

What has been the degree of labour intensiveness of the production equipment ?
What has been the degree of maintenance required for the production equipment ?
What has been the degree of supervision required for the production equipment ?
How have capacities been balanced internally ?

Competitive Application
What has been the degree of competitive application of tooling within manufacturing ?
What has been the degree of competitive application of equipment within manufacturing ?
What has been the degree of competitive application of manufacturing engineering ?
What has been the degree of competitive application of industrial engineering ?

Material Handling
What has been the degree of automation of materials handling equipment ?
What has been the degree of integration of materials handling equipment ?

Process Organisation
What has been the type of manufacturing process choice adopted ?

Focus
What has been the degree of specificity adopted ?

Man-machine Interface
What has been the extent of job content between machines and manpower ?
What has been the extent of skills required by the workforce ?

Implications
What have been the implications of processes and technologies for manufacturing ?

VERTICAL INTEGRATION

Supply Chain Ownership
What has been the degree of ownership of the supplier network ?
What has been the degree of ownership of the customer network ?
What has been the type of ownership of the supply chain ?
What has been the degree of management of the supply chain ?
What has been the degree of co-ordination of the supply chain ?
What transaction mechanisms have been adopted for the supply chain ?

Expansion and Contraction
What has been the primary means of expanding the supply chain ?
What has been the primary means of contracting the supply chain ?

Position in Chain
What has been the degree of focus with respect to the position in the supply chain ?
How have vertical integration decisions affected supplier relations ?
How have vertical integration decisions affected distributor relations ?
How have vertical integration decisions affected customer relations ?

Implications
What have been the implications for make versus buy decisions ?
What have been the implications of vertical integration for the manufacturing function ?

SUPPLIER RELATIONS

Competitive Type
What type of relationship has the manufacturing function had with its suppliers ?

Time Span

What has been the time span of supplier relationships ?

Sourcing

What have been the sourcing policies adopted ?

Supplier Qualification

What means of supplier qualification have been adopted ?
How has the performance of suppliers been measured ?
How have suppliers been controlled ?
What selection criteria have been used for suppliers ?

Partnerships

What types of supplier partnerships have been adopted ?
What degree of assistance has been given to suppliers ?
What degree of technological co-operation has been given to suppliers ?
What degree of integration has there been with the suppliers ?
What type of integration has there been with the suppliers ?
What type of communications has there been with suppliers

Make versus Buy

What components have been bought ?
What services have been bought ?

Implications

What are the implications of supplier relations for the manufacturing function ?

HUMAN RESOURCES

Cultural Properties

What type of human behaviour has been encouraged within the manufacturing function ?
What degree of supervision has been suitable ?
What type of interdependence has been suitable ?
What degree of risk taking attitudes have been encouraged ?
What has been the degree of ownership of the processes ?
What has been the degree of ownership of the products ?
What degree of responsibility has been encouraged ?
What has been the degree of comfort within the organisation ?
What type of teams have been formulated ?
What has been the extent of communication within the organisation ?

Production Related

What has been the degree of concern for quality ?
What have been the means of controlling quality ?
What has been the degree of concern over the processes ?
What has been the degree of concern for productivity ?
What has been the degree of flexibility and change of the workforce ?
What has been the degree of job content ?
What has been the extent of the cycle times ?
What have been the means of pacing the work ?
What has been the level of skills required ?
What have been the methods of training adopted ?
How have employees been motivated ?

General

What has been the degree of employment security ?
What has been the policy with respect to overtime ?
What has been the policy with respect to employee selection ?
What has been the policy with respect to employee recruitment ?
How many shifts have been maintained ?
What has been the policy with respect to safety issues ?

What has been the policy with respect to health issues ?

Remuneration
What payment systems have been adopted ?
What payment structures have been adopted ?
What has been the range of payments available ?
What incentives and rewards schemes have been adopted ?

Implications
What have been the implications of human resource policies for the manufacturing function ?

QUALITY SYSTEMS

Implementation
What has been the extent of quality systems implementation ?

Design Quality
What aspects of product design quality have been emphasised ?
What quality systems have been adopted for the design process ?

Process Quality
What has been the degree of capability versus inspection ?
What means have been adopted to implement capability and / or inspection ?
What have been the locations of inspection processes within manufacturing ?
What have been the functions of inspection processes ?
What has been the frequency of inspection ?
What quality training has been provided ?
How has quality been monitored ?

Total Quality
What total quality initiatives have been adopted ?
What level of documentation has been adopted ?
What aspects of total quality training have been adopted ?
Where has the responsibility for total quality been within the organisation ?
Where has the responsibility for total quality been within the manufacturing function ?

Quality Levels
How have quality levels been selected ?
What have the quality levels been ?

Implications
What have been the implications of quality policies for the manufacturing function ?

PRODUCTION PLANNING AND CONTROL

Supplier Relations
What has been the inventory policy with respect to the suppliers ?

Inventory
What has been the degree of inventory holdings ?
What has been the degree of spread of inventory ?
What has been the degree of balance of inventory ?
Where has inventory been located within the manufacturing function /
What has been the function of inventory ?

Manufacturing Priorities
What methods have been adopted to determine manufacturing priorities ?
What level within the organisation have manufacturing priorities been determined ?

What has been the degree decentralisation with respect to manufacturing priorities ?
What has been the degree co-ordination with respect to manufacturing priorities ?
What has been the degree autonomy of with respect to manufacturing priorities ?
What has been the degree of response with respect to manufacturing priorities ?

Management
What methods and philosophies have been adopted for materials management ?
What has been the attitude with respect to customer promises ?
What has been the attitude with respect to customer order changes ?

Forecasting
What systems have been adopted for forecasting of demand ?
What has been the level of investment in forecasting demand ?

Planning
What has been the time horizon adopted for production planning ?
What has been the degree of formality of productions planning ?

Scheduling
What has been the time horizon adopted for production scheduling ?
What has been the policies for resource allocation ?
What formal scheduling paradigms have been adopted ?
What informal methods of scheduling have been permitted ?
What has been the degree of centralisation with respect to scheduling ?
What has been the degree of monitoring of production ?
What has been the scheduling time frame updating period ?

Control
What control policies have been adopted ?
What policies have been adopted for the release of orders ?
What policies have been adopted for expediting ?
What policies have been adopted for batch sizes ?

Implications
What has been the approach adopted for production with respect to system structure ?
What have been the implications of production planning and control for manufacturing ?

PRODUCT SCOPE AND NEW PRODUCT INTRODUCTION

Product Details
What has been the degree of scope of products manufactured ?
What has been the degree of focus of products manufactured ?
What has been the range of products manufactured ?
What has been the volume of products manufactured ?

Introduction
What has been the rate of new product introductions ?
What philosophies have been adopted for the introduction of products ?
What have been the typical life cycle duration of products ?
What computer aids have been adopted to assist product introduction ?
What has been the extent of computer assistance ?
What degree of innovation has been adopted within the organisation ?

Lead-times
What has been the extent of product design lead-times ?
What has been the extent of manufacturing lead-times for new products ?

Implications
What have been the implications of product scope and new products for manufacturing ?

PERFORMANCE MEASUREMENT

General

What selection criteria have been adopted for performance measurement ?
What has been the degree of focus on competitive variables ?
What has been the degree of focus on business management integration ?
What has been the attitude towards benchmarking ?
What has been the extent to which performance measures drive strategy ?
How explicit have been the manufacturing performance measures ?
How formal have been the manufacturing process measures ?
How formal have been the manufacturing output measures ?
What has been the extent of feedback of performance measures to manufacturing management ?
What has been the extent of feedback of performance measures to manufacturing operators ?
To what extent have performance measures been aimed at the development of capabilities ?
What has been the balance between financial and non-financial performance measures ?

What has been the reliance on internal measures of performance ?
What has been the reliance on external measures of performance ?
What type of data has been recorded ?
What has been measured ?
How has it been measured ?
Where has the data been measured within the organisation ?
Where has the data been measured within the manufacturing function ?

Implications

What has been the implication of performance measurement with respect to manufacturing ?

ORGANISATION

Structure

What has been the overall structure of the organisation ?
What has been the degree of flatness adopted within the organisation of manufacturing ?
What has been the degree of formality adopted within the organisation of manufacturing ?
What has been the degree of centralisation adopted within the organisation of manufacturing ?
What has been the degree of control adopted within the organisation of manufacturing ?

State

What has been the state of the organisation adopted for manufacturing ?

Management

What has been the degree of openness of management ?
What has been the degree of product understanding of management ?
What has been the degree of manufacturing understanding of management ?
What has been the degree of systems perspective adopted by management ?
What has been the culture adopted by management ?

Functions

Where has the functional emphasis lay within the manufacturing organisation ?
What has been the degree of management supervision adopted ?

Co-ordination

What has been the degree of co-ordination with marketing ?
What has been the degree of co-ordination with engineering ?
What has been the degree of co-ordination with the customers ?

Implications

What have been the implications of organisation with respect to the manufacturing function ?

MSAMSA 4.2 Current manufacturing strategy policy analysis

For each of the eleven manufacturing policy areas, the key strategic decisions are captured. These are then assessed against the competitive criteria. It may be most appropriate to carry out this analysis for each of the product groups previously defined so that the effect of the individual strategic decisions on the competitive criteria for each of the product groups can be determined. This provides a greater degree of continuity with the previous stages and takes into account any differences in strategic policy amongst the product groups. Where applicable a SWOT analysis of each of the decisions can be carried out to aid the assessment of the policy areas

MSAMSA 4.3 Future manufacturing strategy policy analysis

In a similar manner a new strategy is developed. Each of the policy areas for each of the product groups are examined in turn. A list of decisions and options is provided to assist this process. In addition a table outlining some of the principle relationships between decision areas is also provided in order to assist the development team in considering the manufacturing system as a whole. However, despite the provision of such tables, the development of a new strategy is still considered to be a creative process, best resolved in a multi-disciplinary team situation involving detailed discussion, criticism and development of ideas.

The forms and questions needed for this purpose are listed below.

Strategy Analysis

Policy Area	Importance
Capacity	
Facilities	
Processes and Technology	
Vertical Integration	
Supplier Relations	
Quality Systems	
Human Resources	
Production Planning and Control	
New Product Introduction and Scope	
Performance Measurement	
Organisation	

Manufacturing Strategy Policy Analysis

Decision Area	Quality		Delivery Lead-time		Delivery Reliability		Design Flexibility		Volume Flexibility		Cost	
CAPACITY												
Demand Pitch												
Variation Satisfaction												
Expansion Methods												
Contraction Methods												
Timing												
Bottlenecks												
Demand Forecasting												
Implications												
FACILITIES												
Specifcation												
Location												
Focus												
Function Integration												
Flow												
Implications												
PROCESS												
Type of Equipment												
Competitive Application												
Material Handling												
Process Organistion												
Focus												
Man - M/c Interface												
Implications												
VERT. INT.												
Supply Chain Ownership												
Expansion / Contraction												
Position in Chain												
Implications												

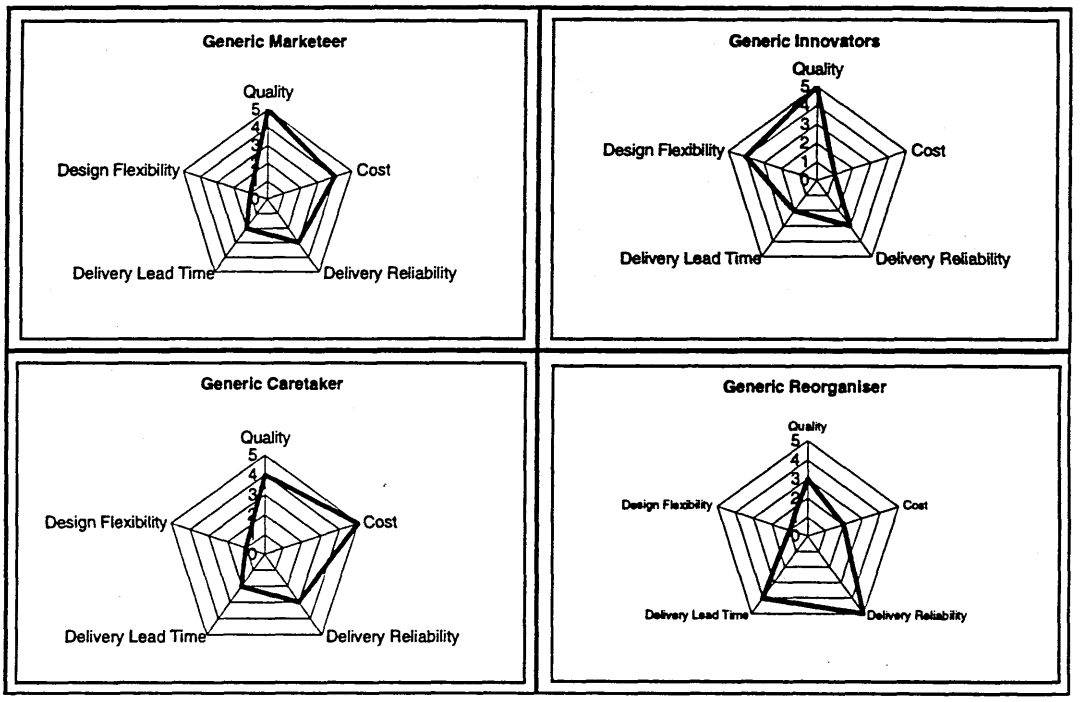
Decision Area	Quality		Delivery Lead-time		Delivery Reliability		Design Flexibility		Volume Flexibility		Cost	
SUPPLIER												
Competitive Type												
Time Span												
Sourcing												
Supplier Qualification												
Partnership												
Make versus Buy												
Implications												
HUMAN R												
Cultural Properties												
Production Related												
General												
Renumertn												
Implications												
QUALITY												
Implementtn												
Design Quality												
Process Quality												
Total Quality												
Quality Levels												
Implications												
PLANNING												
Supplier & Inventory												
Mfg Priority Managemen t												
Forecasting												
Planning												
Scheduling												
Control												
Implications												

Decision Area	Quality		Delivery Lead-time		Delivery Reliability		Design Flexibility		Volume Flexibility		Cost	
PRODUCT												
Product Details												
Introduction												
Lead-times												
Implications												
PERF MES												
General												
Implications												
ORGNSTN												
Structure												
State												
Managemen t												
Functions												
Co-ordination												
Implications												

OTHER												

MSAMSA 4.4 Manufacturing strategy policy gap analysis

This section has three aims. Firstly to provide an indication of the differences between the current and future policies, secondly to provide an indication of the appropriateness of the new strategies with respect to the market demands, and finally to evaluate these manufacturing strategic concerns against a set of generic priority profiles, as shown below, to cross-check local requirement profiles against general, global expectation.



Generic strategic priority profiles

MSAMSA 4.5 Statement of strategic aims

In order to arrive at a statement of the strategic aims of the manufacturing function the preceding stages, the future manufacturing policy and the manufacturing strategy gap analysis should be examined in conjunction with a series of generic strategies. The generic strategies provide a rough guideline and should be modified and customised in order to arrive at a sensible collection of strategic aims. Each of the aims should be associated towards satisfying customers and elements of the market and in maintaining and developing competencies.

The following three tables provide some of the typical generic strategies which can be applied in modified forms to suit the specific needs of the company. It has to be stressed that the manufacturing strategy as outlined in the future manufacturing policy areas and decisions and as developed in this stage should by their very nature be specific to the company.

Hayes and Clark (1986)	Schroeder and Pesch (1987)	Skinner (1983)	Walters (1989)
Invest capital	Manage operations from a strategic viewpoint	Focus on productivity	Participation of manufacturing in developing business strategies
Reduce waste	Take advantage of new product and process technologies	Develop and use manufacturing strategies	Extension of awareness of corporate goals and individuals contribution to the factory floor level
Remove WIP	Plan and schedule output	Return to quality	significant cultural change contribution by manufacturing managers
Focus on learning	Keep things simple and action-oriented	Manage new technology and innovation	Optimisation of results of enterprise rather than departments
Focus on improving profitability	Create an environment in which people can excel	Improve ways to effectively use personnel	Partnerships among functional managers
	Emphasise quality assurance	Use operations technology as a strategic weapon	Systems emphasis for standardisation, timeliness, cost control and accuracy
	Be innovative in operations (continual improvement)	Develop and promote the new breed of manufacturing managers	Flexible manufacturing for adjustment of volume and product mix, yet minimising performance losses

Generic Strategies for Manufacturing Improvements (Source: Samson, 1991, p 225)

Simplify product line Upgrade existing facilities Improve equipment and process technology Increase mechanisation	Redesign jobs Improve departmental performance Change organisational design/focus Improve integration among departments/functions
Increase capacity Optimise make versus buy mix Improve vendors quality Improve distribution Improve energy/utilities efficiency	Improve union-mgt relations and labour-related productivity Reduce time-to-market for new products Reduce order-to-delivery time for existing products Reduce provisioning time Productivity bargaining
Reduce materials losses Improve work methods and procedures Improve equipment utilisation Increase operations standardisation Improve information handling	Establish total quality control programme Encourage employee involvement Institute employee involvement with productivity gains-sharing
Improve product design Improve MIS, financial and operating systems, controls and reports Apply rewards and penalties Improve communications Develop a workforce with multiple, flexible skills Improve manager/supervisor/employee selection, training and development Reduce lost work time	

Generic Operating Plan Strategy Options (Source: Judson, 1996)

MSD Criteria	Behaviour - Approach				
Growth	Expand - grow - suppress - take over - buy in	Hold - keep market share - keep turnover - keep customer	Consolidate - surrender market segment - surrender product range - move	Contract - limit - shrink - surrender	
Market	Open up new markets - geographic - economy - application	Develop - expand / stretch - new marketing routes - new customer segments	Penetrate - Intensification - reduce price - make services attractive	Hold - keep status quo - replace own products with trade goods	Shrink - regarding market share - give up market segment - give up marketing routes
Product Development	Universalise - general application - new markets - expanded product range	Specialisation - on application - on customer segment - on marketing segment	Material - new materials - new components - quality	Technology - functional principles - tolerance class - life time	Production technology - one off production - standardisation - batch manuf. - mass manuf.
New Products or Services	Basic innovation - fundamentally new - radical innovation - principally new	Improvement innovation - new functions - new materials - new applications	Dummy innovation - new presentation - plagiarism - modification	Buy in - trading goods - import goods - buy in products	Diversification - horizontal - vertical - lateral
Production	Modernisation -mechanisation - automation - new technology	Rationalisation - cost reduction - increase productivity - reduce waste - efficient organisation	Expansion - output quantity - new production processes - make, buy in parts	Re-dimensioning - capacity - product range - processes	
Investment and Cost	Invest - increase capacity - rationalisation - modernisation	Segment - partial investments - small improvements - increase productivity	To Milk - no improvements - overload - breakdown maintenance - wreck	De-invest - sell - no replacements - rent out	
Concentration	Decentralisation - establish subsidiary - subsidiaries abroad - joint ventures	Keep - relocate - keep status quo - regroup - build profit centre	Centralisation - one location - integration of sites - integration of departments		
Co-operation	Acquisition - know how - market shares	Partnership - manufacturing - joint venture - franchising	Partial co-operation - development - sales - exchange products	Participation share - majority - minority - patents , licences	Fusion - with independence - integration - equal rights
Behaviour toward Competitors	Aggressive - under cut - suppress - overtake	Active - to develop partial segments with development	Neutral - keep main segments through concentration	Passive Keep only core segments or shares	Defensive - Defence measures

Strategic Behaviour and Approaches (source Aggteleky, 1987)

MSA Stage 5 - Strategic Initiatives

Statement of strategic initiatives

The strategic initiatives is the final stage in the strategy formulation process. Each initiative is essentially a statement about how the strategic aims are to be achieved. There should be sufficient description of each initiative so that they can be easily understood and put into perspective with respect to the competitive criteria, the strategic aims and the current and future operations of the manufacturing function. Relationships with the business strategy and other functional strategies should also be clearly outlined. Each initiative should be able to form the basis for a number of manufacturing systems objectives and action plan activities across a number of departments. Sample procedures to be followed are as shown below.

	Priorities				
Action Plans	i	ii	iii	iv	v

Action Plans	Priority
Strategy	
Link to business strategy	
Define manufacturing strategy	
Activity based costing	
Capacity and Facilities	
Increase capacity	
Lead-time reduction	
Reduce set-up times	
Focus factories	
Manufacturing re-organisation	
Group Technology	
Improve existing systems	
Recondition existing plants	
Relocate plant	
Close plant	
Processes and Technology	
New process, old product	
New process, new product	
Improve equipment and process technology	
Improve energy/utilities efficiency	
Reduce materials losses	
Improve equipment utilisation	
Increase operations standardisation	
Manufacturing mechanisation	
Introduce FMS	
Introduce robots	
Introduce material handling	
Introduce CAM	
Introduce CAD	
Increase technical autonomy	
Automate jobs	
Product Scope and New Products	
Narrow product lines / standardisation	
Reduce number of variants	
Redesign of products	
Value analysis / product design	
Design for manufacture	
Develop product workshops	
Product introduction ability improvement	
Information Systems	
Manufacturing information systems	
Integrated manufacturing information systems	
Interfunctional information systems	
Integrated interfunctional information systems	
Office automation	
Decentralise decision making authority	
Improve information handling	
Improve communications	
Building	
Work environment improvement	
External environment improvement	

Action Plans	Priority
Planning and Control	
Production-inventory control systems	
Production and inventory control systems training	
Just in time manufacture	
Supplier lead-time reduction	
Reduce provisioning time	
Quality Systems	
Establish total quality control programme	
Zero defects	
Statistical process control	
Quality function deployment	
Statistical quality control	
Quality circles	
Improve suppliers quality	
Preventative maintenance	
Improved maintenance	
Vertical Integration	
Optimise make versus buy mix	
Improve distribution	
Human Resources	
Direct personnel training	
Supervisory training	
Manufacturing management education	
Reduce lost work time	
New wage system	
Direct labour motivation	
Apply rewards and penalties	
Productivity bargaining	
Employee involvement with productivity gains-sharing	
Redesign jobs	
Specialise jobs	
Broad scope of work	
Involve workers in planning	
Broad planning responsibility	
Ergonomics	
Worker safety	
Reduce number of employees	
New skills hiring	
Develop a workforce with multiple, flexible skills	
Improve work methods and procedures	
Implement group work	
Interfunctional work teams	
Organisation	
Change labour/management relations	
Encourage employee involvement	
Improve departmental performance	
Change organisational design/focus	
Improve integration among departments/functions	

APPENDIX II SUMMARY DATA OF CASE STUDIES

Company # 1

Company Name	: Al-Khoraef Westrn Layne ltd	
Authorised Capital	: SR 108,000,000 (£18,000,000)	
Turnover	: SR 60,000,000 (£10,000,000)	
Approximate Profit	: 20%	
Installed Capacity	: Vertical Pump	2400 Unit
	Pump spare parts	3000 Unit
	Steel pipe	42000 Ton
Location	: Riyadh Saudi Arabia	
Year Established	: 1981	

The Business

To provide vertical turbine pumps, gear – drives and steel pipes for agriculture and industrial applications. Also to provide machining and sheet metal rolls slitting services on a subcontract basis.

The primary business is to service the agricultural market. The products can be sold separately or as one complete unit.

Government Support :

Saudi Industrial Development Fund (SIDF)

- The project funded by SIDF, and also the expansion in 1992.

Ministry of Industry and Electricity (MIE) Support

- Location
  2nd Industrial city in Riyadh area.
- Tax Free
  Raw material, Machine &, Spare parts.
- Electricity
  Supply to the factory in Industrial price

Market Analysis

Customers

The principle customer is Commercial Company (ACC), which is a sister company, but organisationally and financially separate (different cost centre). Commercial Company (ACC) specialises in the Agriculture equipment's. ACC also accepts 90 % of the output of AWL and undertakes sales, spare parts and servicing in its local branches. It sells the products on to farmers and agriculture companies including (NADC, Hail Agriculture, Gassim Agriculture Co., Tabouk Agriculture Co., SAFI and Maraei Agriculture).

Market area in Saudi Arabia

- All of the Saudi Arabia especially agriculture area.

International

- Export small quantity to GCC country, Egypt, USA

Competitors

The competitors for the pipe :

- Arabian pipe.
- Saudi steel pipe.

- Saydan pipe.
- AlJazerah pipe.
- Yammah steel pipe.
- Pipe imported from abroad.

The competitor for the pump manufacturing :

- Saudi mechanical Industry (SMI).
- Audi Pump Factory.
- National Foundry.
- AlAmaas.

The Competitor for the gear-drive manufacturing :

- Saudi mechanical industry (SMI).

Saudization Policy

- No of the employee :132
- No of Saudi employee : 13
- % of Saudization : 10%
- % of Saudis employee in management positions : 1
- % of Saudis employees in Engineering positions : None
- % of Saudis employee Labor and operators levels : 12
- **Positions held by Saudis employee :**

  Chairman :Saudi
  President :Saudi
  General manager : None Saudi
  Operation manager : None Saudi
  Human resource manager : None
  Finance manager : None Saudi
  Marketing manager : None Saudi
- **Training plan for Saudis**
- **Achievement**

  On job training for the Technical college student, to select some technical operators
- **Future Plan for training.**

  To continue the on job training for the Technical college student to select some of them.
- **Plan for Saudization.**

  The top management think about saudization, put still no effective plan inside the company for saudization.

Research and Development (R &D)

- Some R&D facilities and the responsibility of the R&D belonging to the production manager,
- Also R&D consultants in USA.
- There are good ideas in the factory (e.g., long life pump), but because there is no R&D department these ideas take a very long time to implemented.
- No contact with the R&D center in Saudi Arabia.
- No effective future plans for R&D.

Environmental Issue.

There are no significant negative effects the environment.

Technology and Operations

EDW for pipe manufacture and CNC technology for machining.
Vertical pump 1000+ per year, 5 variants
Gear-drive 1000+ per year, 4 size with many gear variants
Pipe 23000 ton year, material variations.
Make to order from raw material stoke and from supplier.
Assemble to order.
The company is basically a Caretaker.

Product Group Definition

Products Variants	Steel Pipe 7 (diameter) 5 (thickness)	Gear-drive 15	Pump 5	Column Pipe 5	Slitting 3 mm to 25 mm	Engineering Customer driven
Volume	23,000 ton per year	1000 per year	1000 per year	30,000 units per year	30,000 ton	?
Sales	$13.5 M	$4 M	$3.73 M	$5.58 M	$180,000	$260,000
% Sales	50.1%	14.5%	13.5%	20.3%	0.7%	0.9%
% Contribution	21.1%	12.3%	28.8%	34.4%	1.1%	2%
Market share	12%	305	35%	35%	2%	2%
Growth opportunities	Very Good	Very Good	Very Good	Good	Good	Excellent
Degree of innovation (out of 10)	Low (2)	Low (3)	Medium (6)	Low (3)	Low (2)	Medium (5)
Life cycle stage	Mature	Mature	Mature	Mature	Mature	N/A
Principle Processes	Slitting ERW	Machining Assembly	Machining Assembly	Threading & Painting	Shear cutters	Machining
Materials	Steel ASTM	Cast iron, Carbon steel Aluminum	Cast iron, Carbon steel Bronze, Stainless steel	Carbon steel Ductile cast iron, Bronze	Carbon steel ASTM A53 others	
Approx. Profit/cost/sales	5%	10%	25%	20%	15-20%	25%
Typical order size	100 to 2000	No typical size	No typical size	Minimum 50	Use excess capacity	None
Standardization	According to ASTM	4 standard boxes, low standards of boxes	Bearings Shafts	Threads, Length	None	None
Market	Agriculture & industrial	Agriculture	Agriculture	Agriculture	Industrial	Industrial
Customers	ACC, SMI, Saudi Pump, Abasan, Fedari	ACC	ACC	ACC	Gas Cylinder SAIDA SSP	
Relative Importance	23%	23%	23%	23%	5%	3%

Product Group: Market Analysis

	Steel Pipe	Gear-drive	Pumps	Column Pipe	Slitting	Engineering
Quality	**90**	**95**	**75**	**85**	**90**	**90**
Conformance to spec	90	95	75	80	90	85
Reliability in use	85	90	70	80	50	85
Customer satisfaction	90	90	80	80	80	85
Delivery Lead-time	**70**	**90**	**90**	**90**	**80**	**80**
Lead-time requirements	2-12 wks	2 wks	2 wks	2 wks	2 wks	3-4 wks
Delivery change notice	2 wks	3 wks	3 wks	3 wks	N/A	N/A
Customer satisfaction	60	60	60	60	80	75
Delivery Reliability	**60**	**90**	**90**	**90**	**70**	**85**
Delivery window	< 2 wks	1 wk	1 wk	1 wk	N/A	4 days
Customer satisfaction	55	50	50	50	80	80
Design Flexibility	**60**	**80**	**80**	**80**	**80**	**90**
Design changes	N/A					
Customised products	20	N/A	5 per year	N/A	Yes	Yes
Customer satisfaction	70	80	80	80	65	80
Cost / Price	**90**	**80**	**75**	**75**	**80**	**75**

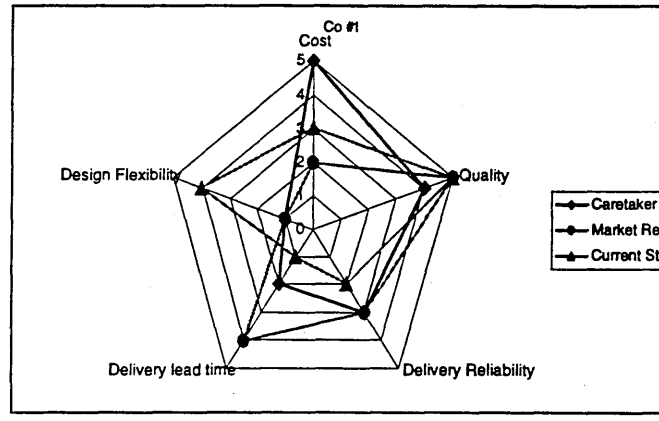
Product Group	Steel pipe	Gear-drive	Pumps	Column pipe	Slitting	Engineering	(R.I *P.G
Relative Importance	23%	23%	23%	23%	5%	3%	
Quality	90	95	75	85	90	90	86.6
Delivery Lead-time	70	90	90	90	80	80	84.6
Delivery Reliability	60	90	90	90	70	85	82
Design Flexibility	60	80	80	80	80	90	75.7
Cost / Price	90	80	75	75	80	75	79.9

Current System Performance

	Steel Pipe	Gear-drive	Pumps	Column Pipe	Slitting	Engineering
Quality	**80**	**95**	**95**	**95**	**90**	**95**
Actual quality level	85%	90-95%	90-95%	95%	90%	0%
Customer reject rate	0	1%	1%	0%	?	2%
Final failure rate	15%	2%	2%	1%	?	2%
Intermediate scrap rate	5%	2%	2%	4%	?	?
Customer satisfaction	90	90	80	80	80	85
Delivery Lead-time	**60**	**45**	**55**	**70**	**90**	**85**
Actual delivery lead-time	3 mnth	3 mnth	3 mnth	1 mnth	3-4 wks	3-4 wks
Manufacturing lead-time	1 mnth	5 days	4 days	1 wk	3 hrs	2 wks
Schedule change ability	60	55	55	75	60	70
Customer satisfaction	60	60	60	60	80	75
Delivery Reliability	**60**	**50**	**65**	**60**	**95**	**95**
Deliveries within window	60%	50%	65%	60%	?	95%
Complete orders	70%	60%	70%	65%	100%	100%
Customer satisfaction	55	50	50	50	80	80
Design Flexibility	**60**	**90**	**90**	**70**	**90**	**90**
Product range ability	85	95	95	85	85%	95
Product change ability	10	N/A	N/A	N/A	N/A	20
Customer satisfaction	70	80	80	80	65	80
Cost / Price	**60**	**60**	**85**	**80**	**85**	**85**
Customer satisfaction	80	75	70	75	70	70

Product Group(P.G)	Steel pipe	Gear-drive	Pumps	Column pipe	Slitting	Engineering	(R.I *P.G	Priorities (1-5)
Relative Importance(R.I)	23%	23%	23%	23%	5%	3%		
Quality	80	95	95	95	90	95	91.3	5
Delivery Lead-time	60	45	55	70	90	85	60	1
Delivery Reliability	60	50	65	60	95	95	61.7	2
Design Flexibility	60	90	90	70	90	90	78.5	4
Cost / Price	60	60	85	80	85	85	72.4	3

Generic Caretaker, market requirement and current performance strategy priority profiles as shown below:



Company # 2

Company Name	**: Saudi Paper Manufacturing Co.**
Authorised Capital	: SR 55,000,000(£9,166,666)
Turnover	: SR 60,000,000 (£23,333,333)
Approximate Profit	: 25%
Installed Capacity	: 40,000 tissue paper
Location	: Dammam Saudi Arabia
Year Established	: 1990

The Business

Manufacturer of roll tissue paper, and primarily a Caretaker.

Government support

Saudi Industrial Development Fund (SIDF)

- Project funded by SIDF, also expansion in 1996.

Ministry of Industry and Electricity (MIE) Support

- Location
  2nd Industrial city in Dammam area.
- Tax Free
  Raw material, Machine & Spare parts.
- Electricity
  Supply to the factory at Industrial price

Market Analysis

Customers

- Napco paper co.
- Ba Ghanem
- Ba wazer
- Al- Hammad paper co
- Olyan paper co
- Shamsan
- Fine paper co.
- Sanabel
- Other paper tissue converters

Market area in Saudi Arabia

- All of Saudi Arabia.

International

- GCC, UK, Spain, Syria, Lebanon and SW Asia

Competitors

- Emirates Paper Mill – UAE.
- Gulf Paper Mill – Kuwait

Saudization Policy

- No of the employee : 152
- No of Saudi employee : 13

- % of Saudization : 8%
- % of Saudis employee in management positions : 3
- % of Saudis employees in Engineering positions : None
- % of Saudis employee Labor and operators levels : 10
- **Positions held by Saudis employee** :

Chairman & President :Saudi
General manager : Saudi
Operation manager : None Saudi
Human resource manager : None
Finance manager : None Saudi
Marketing manager : None Saudi

Product Group Definition

Products	Facial tissue	Toilet tissue	Kitchen tissue	C- Fold tissue	Napkin tissue
Variants	3	3	3	3	3
Volume	24,000 ton	3,000 ton	6,000 ton	3,000 ton	4,000 ton
Sales	$ 24 M	$3 M	$6 M	$3 M	$4 M
% Sales	60%	7.5 %	15%	7.53%	10%
% Contribution	60%	7.5 %	15%	7.53%	10%
Market share	50%	50%	50%	50%	50%
Growth opportunities	Good	Good	Very Good	Very Good	Very Good
Degree of innovation (out of 10)	Low (2)	Low (3)	Low (2)	Low (3)	Low (2)
Life cycle stage	Mature	Mature	Mature	Mature	Mature
Principle Processes	Pulping	Pulping	Pulping	Pulping	Pulping
Materials	Pulp & waste paper	Pulp & waste paper	Pulp & waste paper	Pulp & waste paper	Pulp & waste paper
Approx. Profit/cost/sales	10%	10%	10%	10%	10%
Typical order size	50 –1000 ton	50 –1000 ton	50 –1000 ton	50 –1000 ton	50 –1000 ton
Standardization	Saudi stander	Saudi stander	Saudi stander	Saudi stander	Saudi stander
Market	Paper Converter Co	Paper Converter Co	Paper Converter Co	Paper Converter Co	Paper Converter Co
Customers	Paper Converter Co	Paper Converter Co	Paper Converter Co	Paper Converter Co	Paper Converter Co
Relative Importance	40%	15%	15%	15%	15%

Product Group: Market Analysis

	Facial tissue	Toilet tissue	Kitchen tissue	C- Fold tissue	Napkin tissue
Quality	**95**	**95**	**95**	**95**	**95**
Conformance to spec	90	95	95	90	90
Reliability in use	95	90	90	95	95
Customer satisfaction	90	90	90	90	90
Delivery Lead-time	**90**	**90**	**90**	**90**	**90**
Lead-time requirements	2-12 wks	2 wks	2 wks	2 wks	2 wks
Delivery change notice	2 wks	3 wks	3 wks	3 wks	N/A
Customer satisfaction	90	85	85	85	90
Delivery Reliability	**90**	**90**	**90**	**90**	**90**
Delivery window	< 2 wks	1 wk	1 wk	1 wk	N/A
Customer satisfaction	85	85	85	80	80
Design Flexibility	**70**	**70**	**70**	**70**	**70**
Design changes	N/A				
Customised products	N/A	N/A		N/A	N/A
Customer satisfaction	70	70	70	70	70
Cost / Price	**95**	**90**	**95**	**95**	**90**

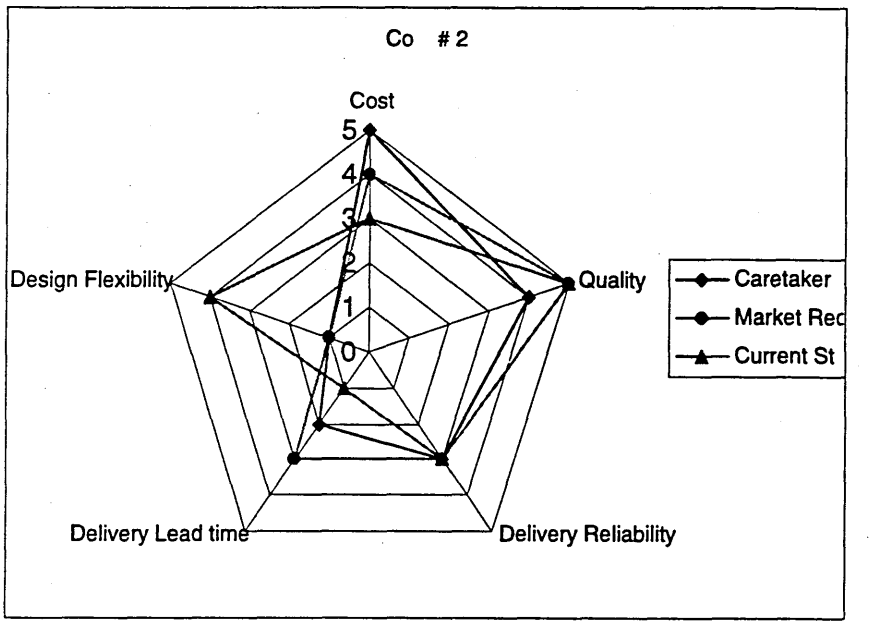
Product Group	Facial tissue	Toilet tissue	Kitchen tissue	C- Fold tissue	Napkin tissue	(R.I *P.G	Priorities (1-5)
Relative Importance	40%	15%	15%	15%	15%		
Quality	95	95	95	95	95	95	5
Delivery Lead-time	90	90	90	90	90	90	3
Delivery Reliability	90	90	90	90	90	90	3
Design Flexibility	70	70	70	70	70	70	1
Cost / Price	95	90	95	95	90	93.5	4

Current Performance

	Facial tissue	Toilet tissue	Kitchen tissue	C- Fold tissue	Napkin tissue
Quality	**90**	**90**	**90**	**90**	**90**
Actual quality level	90%	90-95%	90-95%	90-95%	90-95%
Customer reject rate	0	2%	2%	2%	2%
Final failure rate	10%	4%	4%	4%	4%
Intermediate scrap rate	5%	3%	3%	3%	3%
Customer satisfaction	90	90	90	90	90
Delivery Lead-time	**70**	**70**	**70**	**70**	**70**
Actual delivery lead-time	1 mnth	1 mnth	1 mnth	1 mnth	1 mnth
Manufacturing lead-time	1 mnth	1 mnth	1 mnth	1 mnth	1 mnth
Schedule change ability	70	70	70	70	70
Customer satisfaction	70	70	70	70	70
Delivery Reliability	**80**	**80**	**80**	**80**	**80**
Deliveries within window	70%	70%	70%	70%	70%
Complete orders	75%	75%	75%	75%	75%
Customer satisfaction	80	80	80	80	80
Design Flexibility	**90**	**90**	**85**	**85**	**85**
Product range ability	85	95	80	80	95
Product change ability	5%	N/A	N/A	N/A	N/A
Customer satisfaction	85	80	80	80	80
Cost / Price	**80**	**80**	**80**	**80**	**80**
Customer satisfaction	80	75	70	75	70

Product Group(P.G)	Facial tissue	Toilet tissue	Kitchen tissue	C- Fold tissue	Napkin tissue	(R.I *P.G	Priorities (1-5)
Relative Importance(R.I)	40%	15%	15%	15%	15%		
Quality	90	90	90	90	90	90	5
Delivery Lead-time	70	70	70	70	79	71.35	1
Delivery Reliability	80	80	80	80	80	80	3
Design Flexibility	90	90	85	85	85	87.75	4
Cost / Price	80	80	80	80	80	80	3

The priority profiles are as shown:



Company # 3

Company Name	: Irrigation Company	
Authorised Capital	: SR 27,000,000(£4,500,000)	
Turnover	: SR 30,000,000 (£5,000,000)	
Approximate Profit	: 15%	
Installed Capacity	: Axial Irrigation System	1200 Unit
	Polyethylene Coated pipes	2,400,000 Lm
Location	: Riyadh Saudi Arabia	
Year Established	: 1985	

The Business

Produce pivot irrigation system, and plastic lined pipe for irrigation and industrial use, and primarily a Marketeer.

Government support

Saudi Industrial Development Fund (SIDF)

- The project funded by SIDF, and also the expansion in 1994.

Ministry of Industry and Electricity (MIE) Support

- Location
  2nd Industrial city in Riyadh area.
- Tax Free
  Raw material, Machine & Spare parts.
- electricity
  Supply to the factory at Industrial price

Market Analysis

Customers

Like case company number 1, the principle customer is Commercial Company (ACC), which is a sister company, but organisationally and financially separate. Hence similar customers.

Market area in Saudi Arabia

- All of Saudi Arabia especially agriculture area.

International

- Export small Quantity to GCC country, Egypt, USA

Competitors

- Saydan.
- Imported irrigation system from (lynze) USA.

Saudization Policy

- No of the employee : 44
- No of Saudi employee : 5
- % of Saudization : 11%
- % of Saudis employee in management positions : 1
- % of Saudis employees in Engineering positions : None
- % of Saudis employee Labour and operators levels : 4
- Positions held by Saudis employee :

President :Saudi
General manager : None Saudi
Operation manager : None Saudi
Human resource manager : None
Finance manager : None Saudi
Marketing manager : None Saudi

Prevalent technology

Welding & Cutting for irrigation
Rolling for plastic lining.

Product Group Definition

Products	Irrigation	Plastic lining	Fabrication
Variants	2	3" – 8"	N/A
Volume	300 U	2,400,000	1000 Ton
Sales	7,680,000 $	400,000 $	250,000
% Sales	92%	5%	3%
% Contribution	90%	6%	4%
Market share	40%	95%	2%
Growth opportunities	Good	Very Good	Very Good
Degree of innovation (out of 10)	Low	Medium	Medium
Life cycle stage	Mature	Mature	Mature
Principle Processes	Welding	Rolling & Forming	Shearing & welding
Materials	Steel	Polyethylene	Steel
Approx. Profit/cost/sales	30%	40%	40%
Typical order size	1to 20	1000 m	
Standardization	Pipe as per ASTM	Pipe as per ASTM	
Market	Agriculture.	Agriculture & industrial	
Customers	ACC	ACC & Industrial, Oil Co	General, Oil Co
Relative Importance	70%	20%	10%

Product Group: Market Analysis

	Irrigation	Plastic lining	Fabrication
Quality	**95**	**90**	**90**
Conformance to spec	90	95	90
Reliability in use	85	90	90
Customer satisfaction	90	90	90
Delivery Lead-time	**90**	**80**	**90**
Lead-time requirements	2-12 wks	2 wks	2 wks
Delivery change notice	2 wks	3 wks	3 wks
Customer satisfaction	80	80	80
Delivery Reliability	**95**	**90**	**90**
Delivery window	< 2 wks	1 wk	1 wk
Customer satisfaction	90	80	85
Design Flexibility	**90**	**80**	**80**
Design changes	1 per year	1 per year	
Customised products	20		
Customer satisfaction	5	80	80
Cost / Price	**95**	**90**	**90**

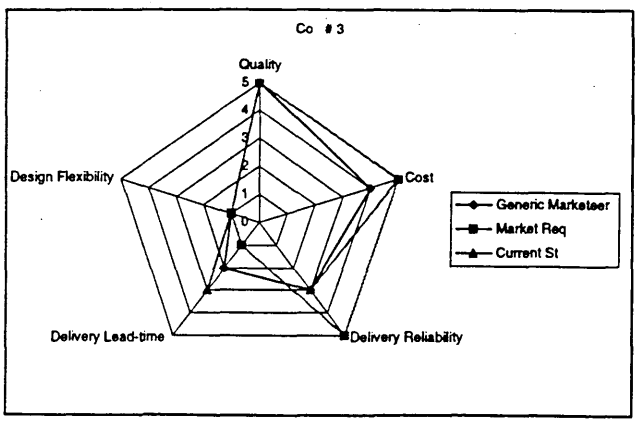
Product Group	Irrigation	Plastic lining	Fabrication	(R.I *P.G	Priorities(1-5)
Relative Importance	70%	20%	10%		
Quality	95	90	90	93.5	5
Delivery Lead-time	90	80	90	88	1
Delivery Reliability	95	90	90	93.5	5
Design Flexibility	90	80	80	88	1
Cost / Price	95	90	90	93.5	5

Current Performance

	Irrigation	Plastic lining	Fabrication
Quality	**90**	**95**	**90**
Actual quality level	90%	90-95%	90-95%
Customer reject rate	0	1%	1%
Final failure rate	5%	2%	2%
Intermediate scrap rate	5%	2%	2%
Customer satisfaction	90	90	80
Delivery Lead-time	**70**	**60**	**60**
Actual delivery lead-time	3 mnth	3 mnth	3 mnth
Manufacturing lead-time	1 mnth	5 days	4 days
Schedule change ability	60	55	55
Customer satisfaction	60	60	60
Delivery Reliability	**70**	**60**	**60**
Deliveries within window	60%	50%	65%
Complete orders	70%	60%	70%
Customer satisfaction	55	50	50
Design Flexibility	**60**	**70**	**60**
Product range ability	70	60	55
Product change ability	10	N/A	N/A
Customer satisfaction	70	60	69
Cost / Price	**90**	**95**	**90**
Customer satisfaction	90	95	90

Product Group(P.G)	Irrigation	Plastic lining	Fabrication	(R.I *P.G	Priorities
Relative Importance(R.I)	70%	20%	10%		
Quality	90	95	90	83.2	5
Delivery Lead-time	70	60	60	62.2	3
Delivery Reliability	70	60	60	62.2	3
Design Flexibility	70	60	60	57.2	1
Cost / Price	90	95	90	83.2	5

Manufacturing Strategy Priority Profiles



Company # 4

Company Name	: National Foundries Co. (Masabik)
Authorised Capital	: SR 55,000,000 (£ 9,166,666)
Turnover	: SR 12,000,000 (£2,000,000)
Approximate Profit	: loss
Installed Capacity	: 1000 Ton
Location	: Dammam Saudi Arabia
Year Established	: 1994

The Business

Casting of ductile iron, fundamentally a Reorganiser,

Government support :

Saudi Industrial Development Fund (SIDF)

- The project funded by SIDF.

Ministry of Industry and Electricity (MIE) Support

- Location
  2nd Industrial city in Dammam area.
- Tax Free
  for raw material, Machine, Spare parts.
- Electricity
  Supply to the factory at Industrial price

Market Analysis

Customers

- Saudi mechanical
- Saudi pump
- Western layne pump
- Valve manufacturer
- Axle manufacturer
- General factories.

Market area in Saudi Arabia

- All of Saudi Arabia.

International

- Export small Quantity to GCC country, Europe.

Competitors

- Foundries in Saudi Arabia.
- Saudi cast.
- National foundry.

Saudization Policy

- No of the employee : 120
- No of Saudi employee : 24
- % of Saudization : 20%
- No of Saudis employee in management positions : 3

- No of Saudis employees in Engineering positions : 1
- No of Saudis employee Labor and operators levels : 16
- **Positions held by Saudis employee :**

Chairman :Saudi
President :Saudi
General manager : Saudi
Operation manager : None Saudi
Human resource manager : None
Finance manager : None Saudi
Marketing manager : None Saudi

Research and Development (R &D)

- Small R&D facility, most of technical issue reporting to Gemco Engineers of the Netherlands.

Prevalent technology

Casting.

Operation

Make to order from stock and from supplier

Product Group Definition

Products Variants	Auto parts 1	Pump parts 15	Valve parts 3	Pipe fitting 15
Volume	2000 ton	2000 ton	3000 ton	3000 ton
Sales	25%	20%	20%	30%
% Sales	25%	20%	20%	30%
% Contribution	15%	20%	20%	30%
Market share	80%	60%	70%	40%
Growth opportunities	Very Good	Good	Very Good	Good
Degree of innovation (out of 10)	Low (2)	Low (3)	Medium (6)	Low (3)
Life cycle stage	Mature	Mature	Mature	Mature
Principle Processes	Casting.	Casting	Casting	Casting
Materials	Grey & Ductile	Grey & Ductile	Grey & Ductile	Grey & Ductile
Approx. Profit/cost/sales	10%	10%	15%	20%
Typical order size	100 ton	20 ton	100 ton	10 ton
Standardization	International	Local	Local	International
Market	Local / Export	Local	Local /Export	Local
Customers	Local / Export	Local	Local /Export	Local
Relative Importance	30%	20%	20%	30%

Product Group: Market Analysis

	Auto parts	Pump parts	Valve parts	Pipe fitting
Quality	**90**	**80**	**80**	**90**
Conformance to spec	90	90	75	90
Reliability in use	85	80	80	90
Customer satisfaction	90	80	80	95
Delivery Lead-time	**80**	**80**	**70**	**80**
Lead-time requirements	2-12 wks	2 wks	2 wks	2 wks
Delivery change notice	2 wks	3 wks	3 wks	3 wks
Customer satisfaction	70	80	70	80
Delivery Reliability	**80**	**80**	**70**	**80**
Delivery window	< 2 wks	1 wk	1 wk	1 wk
Customer satisfaction	80	80	70	80
Design Flexibility	**80**	**80**	**80**	**60**
Design changes	N/A			
Customised products	3	N/A	5	N/A
Customer satisfaction	70	80	80	60
Cost / Price	**80**	**80**	**80**	**80**

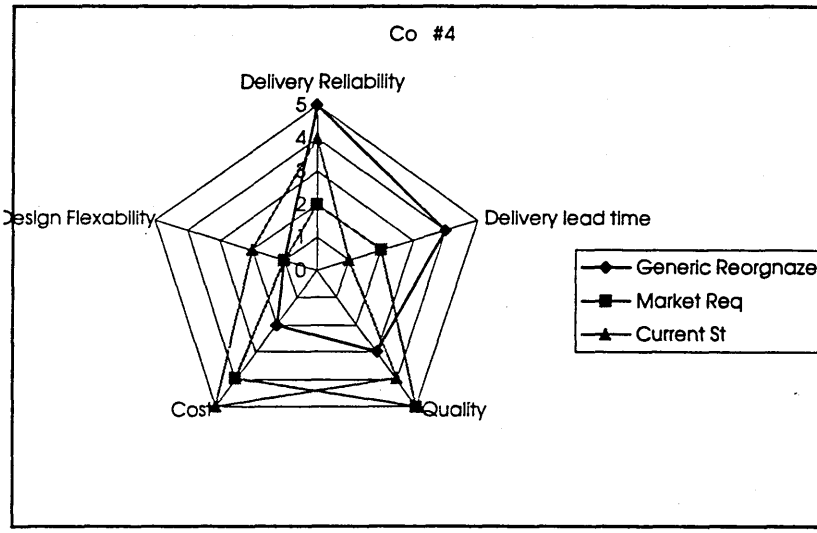
Product Group	Auto parts	Pump parts	Valve parts	Pipe fitting	(R.I *P.G	Priorities (1-5)
Relative Importance	30%	20%	20%	30%		
Quality	90	80	80	90	86	5
Delivery Lead-time	80	80	70	80	78	3
Delivery Reliability	80	80	70	80	78	3
Design Flexibility	80	80	80	60	74	1
Cost / Price	80	80	80	80	80	4

Current Performance

	Auto parts	Pump parts	Valve parts	Pipe fitting
Quality	**70**	**80**	**80**	**90**
Actual quality level	80%	80%	80%	90%
Customer reject rate	0	1%	1%	0%
Final failure rate	10%	2%	2%	1%
Intermediate scrap rate	5%	2%	2%	2%
Customer satisfaction	70	90	80	90
Delivery Lead-time	**60**	**60**	**60**	**70**
Actual delivery lead-time	3 mnth	3 mnth	3 mnth	1 mnth
Manufacturing lead-time	1 mnth	5 days	4 days	1 wk
Schedule change ability	75	70	70	75
Customer satisfaction	60	60	60	70
Delivery Reliability	**70**	**80**	**80**	**90**
Deliveries within window	80%	85%	75%	80%
Complete orders	90%	80%	70%	80%
Customer satisfaction	70	80	80	90
Design Flexibility	**80**	**70**	**70**	**70**
Product range ability	85	95	95	65
Product change ability	10	N/A	N/A	N/A
Customer satisfaction	80	70	70	70
Cost / Price	**90**	**90**	**80**	**80**
Customer satisfaction	90	90	80	80

Product Group(P.G)	Auto parts	Pump parts	Valve parts	Pipe fitting	(R.I *P.G	Priorities (1-5)
Relative Importance(R.I)	30%	20%	20%	30%		
Quality	70	80	80	90	80	4
Delivery Lead-time	60	60	60	70	63	1
Delivery Reliability	70	80	80	90	80	4
Design Flexibility	80	70	70	70	73	2
Cost / Price	90	90	80	80	85	5

Priority Profiles



Company # 5

Company Name	**:** Zamil Steel Building Co. LTD
Authorised Capital	: SR15,000,000 (£2,500,000)
Turnover	: SR480,000,000 (£80,000,000)
Approximate Profit	: 15 – 20 %
Installed Capacity	: 132,000 Ton.
Location	: Dammam Saudi Arabia
Year Established	: 1976

The Business

Design, manufacturing and supply of :

- Pre – engineering steel building.
- Structural steel and plate products.
- lattice towers.

Primarily a Reorganiser.

Government support :

Saudi Industrial Development Fund (SIDF)

- The project funded by SIDF, and also the expansion in 1992.

Ministry of Industry and Electricity (MIE) Support

- Location
  1st Industrial city in Dammam area.
- Tax Free
  Raw material, Machine & Spare parts.
- Electricity
  Supply to the factory at Industrial price

Market Analysis

Customers

- Government organisation (Public firms).
- Global manufacturing companies.
- Contractor engineering.

Market area in Saudi Arabia

- All of Saudi Arabia especially.

International

- Export small Quantity to GCC country, Middle east, Far east, Africa.

Competitors

- Kirby – Kuwait.
- Butler – Jeddah
- IBSF – Riyadh

Saudization Policy

- No of Saudi employee : 9
- % of Saudization : 10%
- % of Saudis employee in management positions : 1
- % of Saudis employees in Engineering positions : None

- % of Saudis employee Labour and operators levels : 8
- **Positions held by Saudis employee :**

Chairman :Saudi
President :Saudi
General manager : None Saudi
Operation manager : None Saudi
Human resource manager : None
Finance manager : None Saudi
Marketing manager : None Saudi

Research and Development (R &D)

- A good R&D facility, run by qualified engineers, using the latest techniques.
- Also R&D consltance in USA.
- A long term R&D plan

Prevalent technology

Shearing, cutting, forming, welding and painting.

Product Group Definition

Products Variants	Simple building	Medium Complex	Complex
Volume	50,000 ton	15000 ton	24000 ton
% Sales	56%	17%	27%
Market share	30%	30%	35%
Growth opportunities	Very Good	Very Good	Very Good
Degree of innovation (out of 10)	Low	Medium	Medium
Life cycle stage	Mature	Mature	Mature
Principle Processes	Cutting, Shearing, forming & painting	Cutting, Shearing, forming & painting	Cutting, Shearing, forming & painting
Materials	Steel	Steel	Steel
Approx. Profit/cost/sales	5%	10%	25%
Typical order size	100	200	1200
Standardization	According to ASTM	4 standard boxes, low standards of boxes	Bearings Shafts
Market	All steel building	All steel building	All steel building
Customers	As before	As before	As before
Relative Importance	40%	30%	30%

Product Group: Market Analysis

	Simple building	Medium Complex	Complex
Quality	**90**	**90**	**85**
Conformance to spec	90	95	75
Reliability in use	85	90	70
Customer satisfaction	90	90	85
Delivery Lead-time	**95**	**90**	**90**
Lead-time requirements	2-3 wks	2 wks	2 wks
Delivery change notice	1w ks	3 wks	3 wks
Customer satisfaction	95	90	90
Delivery Reliability	**90**	**90**	**90**
Delivery window	< 2 wks	1 wk	1 wk
Customer satisfaction	90	90	90
Design Flexibility	**75**	**80**	**80**
Design changes	N/A		
Customised products	20	N/A	5 per year
Customer satisfaction	70	80	80
Cost / Price	**90**	**90**	**85**

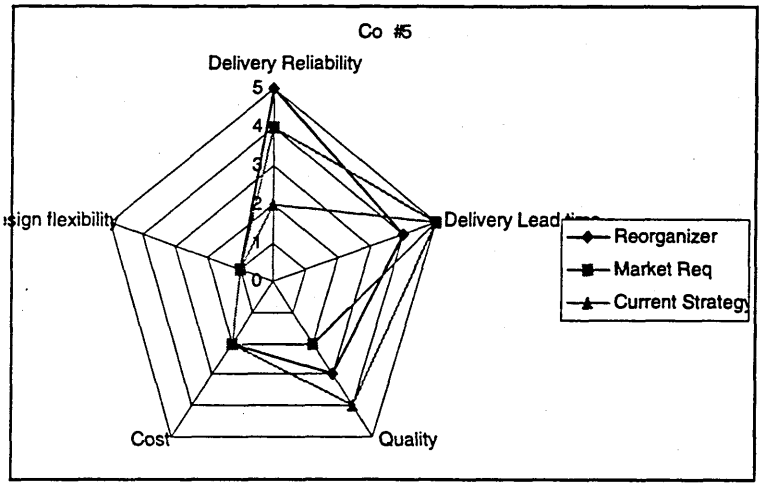
Product Group	Simple building	Medium Complex	Complex	(R.I *P.G
Relative Importance	40%	30%	30%	
Quality	90	90	85	
Delivery Lead-time	95	90	90	
Delivery Reliability	90	90	90	
Design Flexibility	75	80	80	
Cost / Price	90	90	85	

Current Performance

	Simple building	Medium Complex	Complex
Quality	**80**	**80**	**80**
Actual quality level	85%	90-95%	90-95%
Customer reject rate	0	1%	1%
Final failure rate	15%	2%	2%
Intermediate scrap rate	5%	2%	2%
Customer satisfaction	80	80	80
Delivery Lead-time	**80**	**90**	**80**
Actual delivery lead-time	3 mnth	3 mnth	3 mnth
Manufacturing lead-time	1 mnth	5 days	4 days
Schedule change ability	60	80	80
Customer satisfaction	80	90	80
Delivery Reliability	**70**	**70**	**80**
Deliveries within window	60%	50%	65%
Complete orders	70%	60%	70%
Customer satisfaction	70	70	80
Design Flexibility	**60**	**70**	**70**
Product range ability	85	65	75
Product change ability	10	N/A	N/A
Customer satisfaction	70	80	80
Cost / Price	**70**	**70**	**80**
Customer satisfaction	70	70	80

Product Group(P.G)	Simple building	Medium Complex	Complex	(R.I *P.G	Priorities(1-5)
Relative Importance(R.I)	40%	30%	30%		
Quality	80	80	80		
Delivery Lead-time	80	90	80		
Delivery Reliability	70	70	80		
Design Flexibility	60	70	70		
Cost / Price	70	70	80		

Priority Profiles



Company # 6

Company Name	: Yamamah cement company
Authorised Capital	: SR 900,000,000 (£150,000,000)
Turnover	: SR 1,532,000,000 (£255,333,333)
Approximate Profit	: 15%
Installed Capacity	: 3,000,000 Ton.
Location	: Riyadh, Saudi Arabia
Year Established	: 1961

The Business

Produce Portland cement, type v cement and clinker. A Reorganiser

Government support

Saudi Industrial Development Fund (SIDF)

- The project funded by SIDF.

Ministry of Industry and Electricity (MIE) Support

- Location
  1st Industrial city in Dammam area.
- Tax Free
  Raw material, Machine & Spare parts.
- Electricity
  Supply to the factory at Industrial price

Market Analysis

Customers

- All Cement dealer in Riyadh area.

Market area in Saudi Arabia

- Mainly Riyadh area.

International

- Export small Quantity to GCC country.

Competitors

- Saudi cement
- Eastern cement co
- Gassem cement co
- South cement co

Saudization Policy

- Total employee : 1204
- No of Saudi employee : 302
- % of Saudization : 25 %
- % of Saudis employee in management positions : 5
- % of Saudis employees in Engineering positions : 3
- % of Saudis employee Labor and operators levels : Other
- **Positions held by Saudis employee :**
  Chairman :Saudi

President :Saudi
General manager : Saudi
Operation manager : None Saudi
Human resource manager : Saudi
Finance manager : None Saudi
Marketing manager : None Saudi

Environmental Issue.

Produce dust which can be a big problem, but high-tech filters are used.

Prevalent technology

Cement mill

Product Group Definition

Products	Portland	Type V	Clinker
Variants	2	-	-
Volume	1,710,000 ton	1,200,000	90,000
% Sales	56%	17%	27%
Market share	60%	30%	10%
Growth opportunities	Very Good	Very Good	Good
Degree of innovation	Low	Low	Low
Life cycle stage	Mature	Mature	Mature
Principle Processes	Cement mill	Cement mill	Cement mill
Materials	Lime stone	Lime stone	Lime stone
Approx. Profit/cost/sales	20%	20%	20%
Typical order size	20	20	1000
Standardisation	International	International	International
Market	Riyadh area	Riyadh area	Riyadh area
Customers	As before	As before	As before
Relative Importance	60%	30%	10%

Product Group: Market Analysis

	Portland	Type V	Clinker
Quality	**90**	**90**	**90**
Conformance to spec	90	95	90
Reliability in use	90	90	85
Customer satisfaction	90	90	90
Delivery Lead-time	**95**	**95**	**90**
Lead-time requirements	2-3 wks	2 wks	2 wks
Delivery change notice	1w ks	3 wks	3 wks
Customer satisfaction	95	95	90
Delivery Reliability	**95**	**95**	**90**
Delivery window	< 2 wks	1 wk	1 wk
Customer satisfaction	95	95	90
Design Flexibility	**60**	**60**	**60**
Design changes	N/A		
Customised products		N/A	
Customer satisfaction	60	60	60
Cost / Price	**90**	**85**	**80**

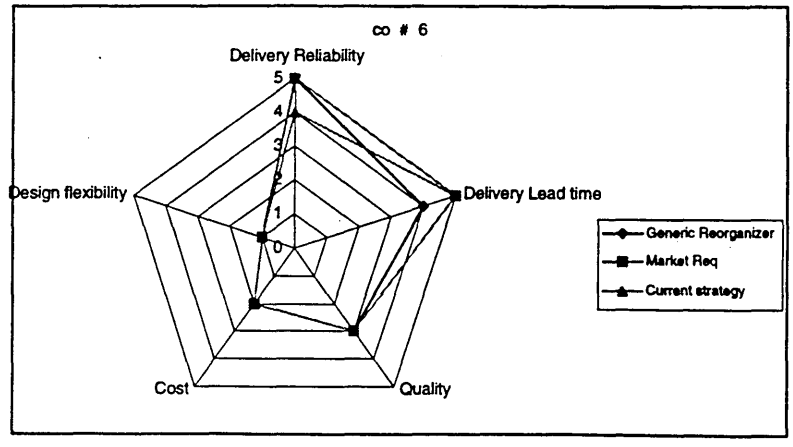
Product Group	Portland	Type V	Clinker	(R.I *P.G	Priorities(1-5)
Relative Importance	60%	30%	10%		
Quality	90	90	90	90	3
Delivery Lead-time	95	95	90	94.5	5
Delivery Reliability	95	95	90	94.5	5
Design Flexibility	60	60	60	60	1
Cost / Price	90	85	80	87.5	2

Current Performance

	Portland	Type V	Clinker
Quality	**90**	**90**	**90**
Actual quality level	85%	90-95%	90-95%
Customer reject rate	0	1%	1%
Final failure rate	15%	2%	2%
Intermediate scrap rate	5%	2%	2%
Customer satisfaction	90	90	90
Delivery Lead-time	**95**	**95**	**90**
Actual delivery lead-time	3 mnth	3 mnth	3 mnth
Manufacturing lead-time	1 mnth	5 days	4 days
Schedule change ability	60	80	80
Customer satisfaction	95	95	95
Delivery Reliability	**95**	**95**	**95**
Deliveries within window	60%	50%	65%
Complete orders	70%	60%	70%
Customer satisfaction	70	70	80
Design Flexibility	**70**	**70**	**70**
Product range ability	85	65	75
Product change ability	10	N/A	N/A
Customer satisfaction	70	80	80
Cost / Price	**90**	**90**	**80**
Customer satisfaction	70	70	80

Product Group (P.G)	Portland	Type V	Clinker	(R.I *P.G	Priorities(1-5)
Relative Importance(R.I)	60%	30%	10%		
Quality	90	90	90	90	3
Delivery Lead-time	95	95	90	94.5	4
Delivery Reliability	95	95	95	95	5
Design Flexibility	70	70	70	70	1
Cost / Price	90	90	80	89	2

Priority Profiles



Company # 7

Company Name	: Zamil Air Conditioners
Authorised Capital	: SR26,250,000 (£4,375,000)
Turnover	: SR360,000,000 (£60,000,000)
Approximate Profit	: 15 – 20 %
Installed Capacity	: 132,000 Ton.
Location	: Dammam Saudi Arabia
Year Established	: 1976

The Business

To design, manufacture, market, distribute and service a wide range of air conditioning equipment. A Caretaker organisation.

Government support

Saudi Industrial Development Fund (SIDF)

- The project funded by SIDF, and also the expansion in 1992.

Ministry of Industry and Electricity (MIE) Support

- Location
  1st Industrial city in Dammam area.
- Tax Free
  Raw material, Machine & Spare parts.
- Electricity
  Supply to the factory at Industrial price

Market Analysis

Customers

- Government organisation (Public firms).
- Consumers
- Contractor

Market area in Saudi Arabia

- All of Saudi Arabia markets

International

- Export GCC country, Middle east, Far east, Africa, Europe and south America.

Competitors

- Carire.
- Trane
- York

Saudization Policy

- Total manpower : 1768
- No of Saudi employee : 317
- % of Saudization : 22%
- % of Saudis employee in management positions : 5
- % of Saudis employees in Engineering positions : 4

- % of Saudis employee Labor and operators levels :other
- **Positions held by Saudis employee :**

Chairman :Saudi
President :Saudi
General manager : Saudi
Operation manager : None Saudi
Human resource manager : Saudi
Finance manager : Saudi
Marketomg manager : Saudi

Product Group Definition

Products Variants	Room A.C 8	Split U 4	Central A.C 4
Volume	250,000 unit	30,000 unit	25,000 unit
% Sales	60%	20%	10%
Market share	45%	30%	35%
Growth opportunities	Very Good	Very Good	Very Good
Degree of innovation	Medium	Medium	Medium
Life cycle stage	Mature	Mature	Mature
Principle Processes	Cutting, Shearing, forming, painting & assembly	Cutting, Shearing, forming, painting & assembly	Cutting, Shearing, forming, painting & assembly
Approx. Profit/cost/sales	15%	20%	20%
Typical order size	100	5	1-10
Standardization	International	International	International
Relative Importance	60%	20%	10%

Product Group: Market Analysis

	Room A.C	Split U	Central A.C
Quality	**95**	**95**	**90**
Conformance to spec	90	95	90
Reliability in use	90	90	85
Customer satisfaction	95	95	90
Delivery Lead-time	**90**	**90**	**90**
Lead-time requirements	2-3 wks	2 wks	2 wks
Delivery change notice	1w ks	3 wks	3 wks
Customer satisfaction	95	90	90
Delivery Reliability	**95**	**90**	**90**
Delivery window	< 2 wks	1 wk	1 wk
Customer satisfaction	90	90	90
Design Flexibility	**60**	**70**	**80**
Design changes	N/A		
Customised products			Yes
Customer satisfaction	70	80	80
Cost / Price	**95**	**95**	**95**

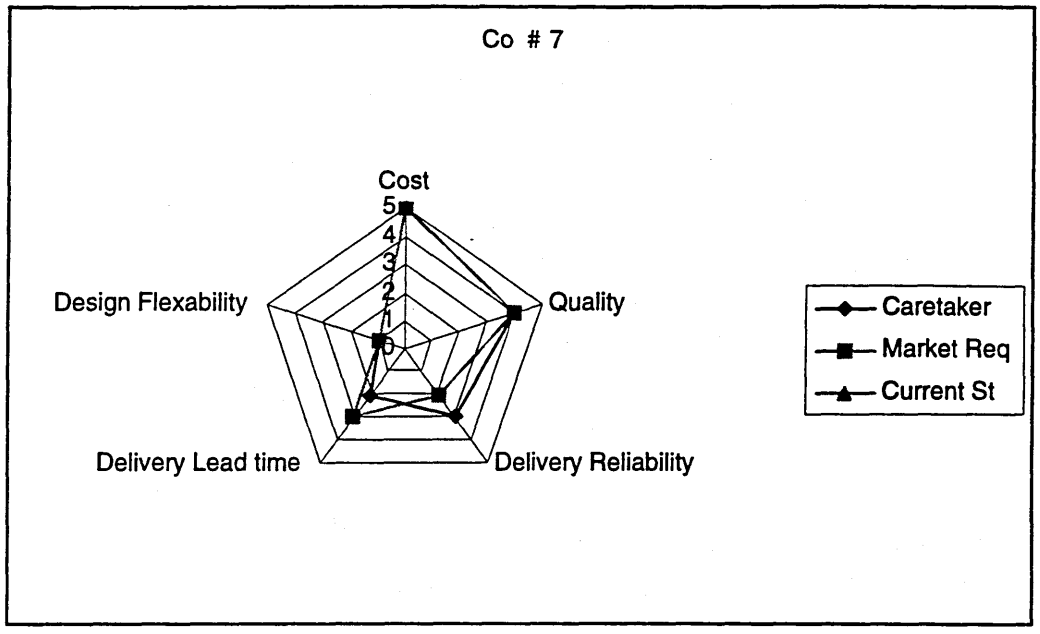
Product Group	Room A.C	Split U	Central A.C	(R.I *P.G	Priorities(1-5)
Relative Importance	60%	20%	10%		
Quality	95	95	90	85	4
Delivery Lead-time	90	90	90	81	2
Delivery Reliability	95	90	90	84	3
Design Flexibility	60	70	80	58	1
Cost / Price	95	95	95	85.5	5

Current Performance

	Room A.C	Split U	Central A.C
Quality	**90**	**90**	**90**
Actual quality level	85%	90-95%	90-95%
Customer reject rate	0	1%	1%
Final failure rate	15%	2%	2%
Intermediate scrap rate	5%	2%	2%
Customer satisfaction	80	80	80
Delivery Lead-time	**80**	**90**	**80**
Actual delivery lead-time	3 mnth	3 mnth	3 mnth
Manufacturing lead-time	1 mnth	5 days	4 days
Schedule change ability	60	80	80
Customer satisfaction	80	90	80
Delivery Reliability	**90**	**90**	**80**
Deliveries within window	90%	90%	75%
Complete orders	90%	90%	70%
Customer satisfaction	90	90	80
Design Flexibility	**60**	**70**	**70**
Product range ability	85	65	75
Product change ability	10	N/A	N/A
Customer satisfaction	70	80	80
Cost / Price	**95**	**95**	**90**
Customer satisfaction	95	95	90

Product Group(P.G)	Room A.C	Split U	Central A.C	(R.I *P.G	Priorities(1-5)
Relative Importance(R.I)	60%	20%	10%		
Quality	90	90	90	81	4
Delivery Lead-time	80	90	80	74	2
Delivery Reliability	90	90	80	80	3
Design Flexibility	60	70	70	57	1
Cost / Price	95	95	90	85	5

Priority Profiles



Company # 8

Company Name	: Advanced Electronic Company Ltd.
Authorised Capital	: SR112,500,000 (£ 18,750,000)
Turnover	: SR 401,250,000 (£ 66,875,000)
Approximate Profit	: 15 – 20 %
Installed Capacity	: Electronic equipment 1500 U
Location	: Riyadh Saudi Arabia
Year Established	: 1988

The Business

Design, development, manufacture, repair, modification and upgrades of electronic products and systems for military, civil and industrial customers. To a large extent an Innovator.

Government support :

The company established under the Kingdom of Saudi Arabia economic offset program.

Saudi Industrial Development Fund (SIDF)

- The project funded by SIDF.

Ministry of Industry and Electricity (MIE) Support

- Location :
  Industrial city in Riyadh area.
- Tax Free
  Raw material, Machine, Spare parts.
- Electricity
  Supply to the factory at Industrial price

Market Analysis

Customers

- Royal Saudi armed force.
- Saudi presidency of civil aviation.
- Ministry of Interior.
- Ministry of Post, Telegraph and Telephone.
- MOWAG
- United Defence.
- Boeing Middle East ltd.
- General Dynamics Land Systems.
- Smith Industries.
- McDonnell Douglas.
- Texas Instruments
- Us Army CECOM
- Lockheed Martin
- Raytheon

Market area in Saudi Arabia

- Air force, Army, PTT & Ministry of interior.

International :

- Export GCC country, USA.

Competitors

- Electronic – Dammam
- All of the electronic manufacture from outside of the Kingdom.

Saudization Policy

- Total manpower : 450
- No of Saudi employee : 283
- % of Saudization : 63%
- % of Saudis employee in management positions : 20
- % of Saudis employees in Engineering positions : 62
- % of Saudis employee Labor and operators levels :121
- **Positions held by Saudis employee :**

  Chairman :Saudi
  President :Saudi
  General manager : Saudi
  Operation manager : Saudi
  Human resource manager : Saudi
  Finance manager : Non Saudi
  Marketing manager : Saudi
- **Training plan for Saudis**
- **Achievement**

  Very good training program and courses for the Saudi employee outside the kingdom in some of the best industrial companies like (Hughes, McDouglas etc).
  Also on job training
  English language courses for Saudis

Research and Development (R &D)

- A very good R&D facility, run by qualified engineers, using the latest techniques
- Also they have R&D consltance in USA.
- A very good relation with the R&D center and universities.
- Plan to design special communication system, also another new electronic system.

Prevalent technology

Printed circuit bored (Throw-hole, surface mount)
Test (Incircut test, Functional test)

Product Group Definition

Products	M1A2	F-15S	Tactical Radio	TEP-6
Variants	25	10	3	6
Volume	19 PCB type, total over 21,000 and 4 LRU. spare :1200 PCB	2328 PCB 767 LRUs 2166 RF cable	1200 radio	160,000 PCB 2700 cabins
% Sales	10%	10%	50%	30%
Market share	45%	30%	35%	30%
Growth opportunitie	Very Good	Very Good	Very Good	Very Good
Degree of innovation (out of 10)	High	High	High	High
Life cycle stage	Mature	Mature	Mature	Mature
Principle Processes	PCB (Throe- hole, SMT) Electronic test	PCB (Throe- hole, SMT) Electronic test	PCB (Throe-hole, SMT) Electronic test	PCB (Throe-hole, SMT) Electronic test
Approx. Profit/cost/sales	25%	20%	20%	20%
Standardization	MIL - 45208	MIL - 45208	ISO – 9002	ISO – 9002
Relative Importance	15%	15%	40%	30%

Product Group: Market Analysis

	M1A2	F-15S	Tactical Radio	TEP-6
Quality	**95**	**95**	**95**	**95**
Conformance to spec	90	95	95	95
Reliability in use	90	90	95	90
Customer satisfaction	95	95	95	95
Delivery Lead-time	**85**	**85**	**85**	**85**
Lead-time requirements				
Delivery change notice				
Customer satisfaction	85	85	85	85
Delivery Reliability	**85**	**90**	**90**	**90**
Delivery window	< 2 wks	1 wk	1 wk	2 wk
Customer satisfaction	90	90	90	90
Design Flexibility	**90**	**90**	**95**	**95**
Design changes				
Customised products				
Customer satisfaction	90	90	95	90
Cost / Price	**80**	**80**	**80**	**80**

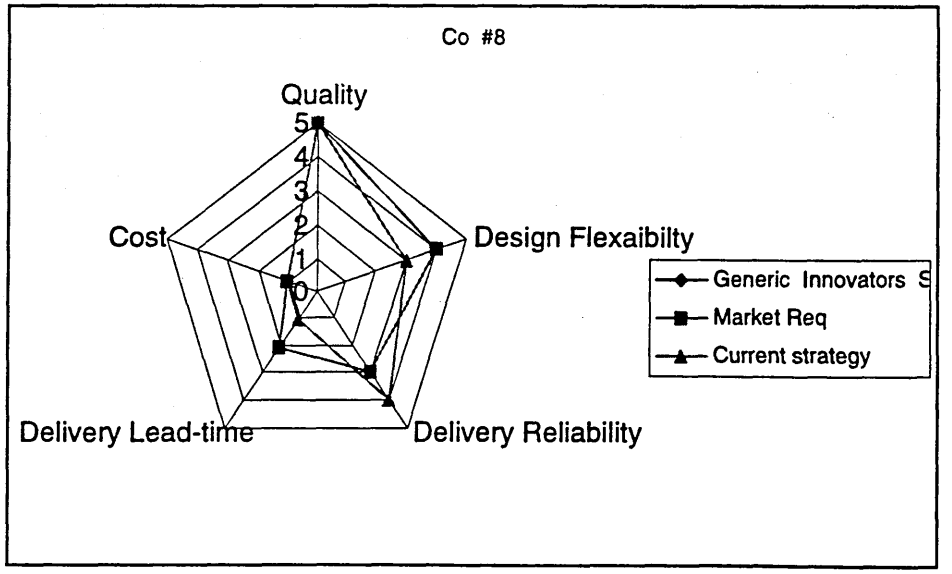
Product Group	M1A2	F-15S	Tactical Radio	TEP-6	(R.I *P.G	Priorities(1-5)
Relative Importance	15%	15%	40%	30%		
Quality	95	95	95	95		
Delivery Lead-time	85	85	85	85		
Delivery Reliability	85	90	90	90		
Design Flexibility	90	90	95	95		
Cost / Price	80	80	80	80		

Current Performance

	M1A2	F-15S	Tactical Radio	TEP-6
Quality	**90**	**90**	**95**	**95**
Actual quality level	85%	90-95%	90-95%	90-95%
Customer reject rate	0	1%	1%	1%
Final failure rate				
Intermediate scrap rate				
Customer satisfaction	90	90	90	90
Delivery Lead-time	**80**	**80**	**80**	**80**
Actual delivery lead-time				
Manufacturing lead-time				
Schedule change ability	60	60	80	80
Customer satisfaction	80	80	80	80
Delivery Reliability	**90**	**90**	**90**	**80**
Deliveries within window				
Complete orders				
Customer satisfaction	90	90	90	80
Design Flexibility	**85**	**85**	**85**	**85**
Product range ability	85	85	65	75
Product change ability	10	10	N/A	N/A
Customer satisfaction	70	70	80	80
Cost / Price	**80**	**80**	**80**	**80**
Customer satisfaction	80	80	80	80

Product Group(P.G)	M1A2	F-15S	Tactical Radio	TEP-6	(R.I *P.G	Priorities (1-5)
Relative Importance(R.I)	15%	15%	40%	30%		
Quality	90	90	95	95		
Delivery Lead-time	80	80	80	80		
Delivery Reliability	90	90	90	80		
Design Flexibility	85	85	85	85		
Cost / Price	80	80	80	80		

Priority Profiles



Company # 9

Company Name	: Plastic Factory.
Authorised Capital	: SR 56,250,000 (£4,375,000)
Turnover	: SR187,500,000 (£31,250,000)
Approximate Profit	: 15 – 20 %
Installed Capacity	: 132,000 Ton.
Location	: Dammam Saudi Arabia
Year Established	: 1976

The Business

Plastic moulding processing. Primarily a Caretaker.

Government support :

Saudi Industrial Development Fund (SIDF)

- The project funded by SIDF.

Ministry of Industry and Electricity (MIE) Support

- Location :
  1st Industrial city in Dammam area.
- Tax Free
  Raw material, Machine & Spare parts.
- Electricity
  Supply to the factory at Industrial price

Market Analysis

Customers

- Air condition manufacturer.
- Chemical factories
- Food factories
- Detergent industries
- Dairy (milk)factories.
- Paint factories

Market area in Saudi Arabia

- All of Saudi Arabia..

International

- Export small Quantity to GCC country, Middle east, Far east, Africa.

Competitors

- Alsharq plastic factory
- Watanyah plastic factory
- Gulf plastic factiry.
- Precision plastic factory.
- Savola plastic.factory
- Saudi plastic factory
- Alarbi plastic factory

Saudization Policy

- Total manpower : 375

- No of Saudi employee : 25
- % of Saudization : 7%
- % of Saudis employee in management positions : 2
- % of Saudis employees in Engineering positions : None
- % of Saudis employee Labor and operators levels :other
- **Positions held by Saudis employee :**

Chairman :Saudi
President :Saudi
General manager : Saudi
Operation manager : None Saudi
Human resource manager : None
Finance manager : None Saudi
Marketing manager : None Saudi

Product Group Definition

Products Variants	Injection 7	Blow molding 6	Thermoforming 5
Volume			
% Sales	20%	45%	35%
Market share	30%	30%	35%
Growth opportunities	Very Good	Very Good	Very Good
Degree of innovation (out of 10)	Medium	Medium	Medium
Life cycle stage	Mature	Mature	Mature
Principle Processes	Plastic Injection	Blow molding	Thermoforming
Materials	Polyethylene	Polyethylene	Polyethylene
Approx. Profit/cost/sale	20%	20%	20%
Market	Air condition manufacturer. Chemical factories Food factories Detergent industries Dairy (milk)factories. Paint factories	Aircondition manufacturer. Chemical factories Food factories Detergent industries Dairy (milk)factories. Paint factories	Air condition manufacturer. Chemical factories Food factories Detergent industries Dairy (milk)factories. Paint factories
Customers	As before	As before	As before
Relative Importance	20%	45%	35%

Product Group: Market Analysis

	Injection	Blow molding	Thermoforming
Quality	**95**	**90**	**90**
Conformance to spec	90	95	75
Reliability in use	85	90	70
Customer satisfaction	95	90	90
Delivery Lead-time	**80**	**80**	**80**
Lead-time requirements	2-3 wks	2 wks	2 wks
Delivery change notice	1w ks	3 wks	3 wks
Customer satisfaction	80	80	80
Delivery Reliability	**80**	**80**	**80**
Delivery window	< 2 wks	1 wk	1 wk
Customer satisfaction	80	80	80
Design Flexibility	**90**	**80**	**80**
Design changes	N/A		
Customised products	20	N/A	
Customer satisfaction	90	80	80
Cost / Price	**90**	**90**	**90**

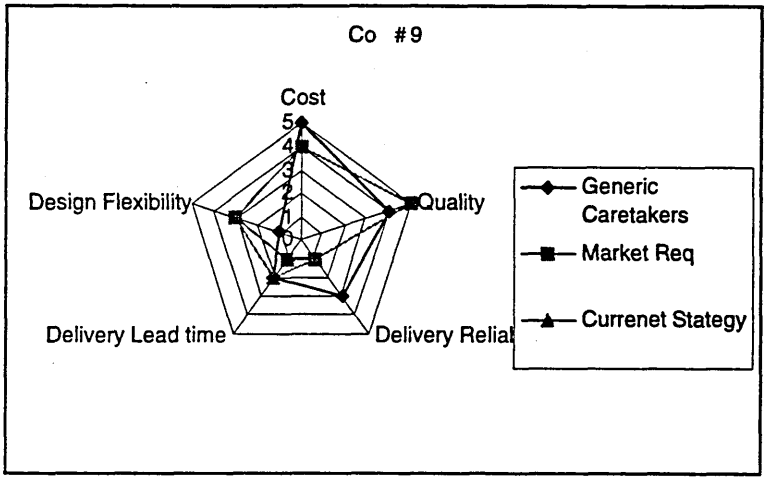
Product Group	Injection	Blow molding	Thermoforming	(R.I *P.G	Priorities (1-5)
Relative Importance	20%	45%	35%		
Quality	95	90	90	91	5
Delivery Lead-time	80	80	80	80	1
Delivery Reliability	80	80	80	80	1
Design Flexibility	90	80	80	82	3
Cost / Price	90	90	90	90	4

Current Performance

	Injection	Blow molding	Thermoforming
Quality	**90**	**90**	**90**
Actual quality level	85%	90-95%	90-95%
Customer reject rate	0	1%	1%
Final failure rate	15%	2%	2%
Intermediate scrap rate	5%	2%	2%
Customer satisfaction	90	90	90
Delivery Lead-time	**80**	**80**	**75**
Actual delivery lead-time	3 mnth	3 mnth	3 mnth
Manufacturing lead-time	1 mnth	5 days	4 days
Schedule change ability	80	80	75
Customer satisfaction	80	80	75
Delivery Reliability	**80**	**80**	**80**
Deliveries within window	80%	80%	80%
Complete orders	80%	80%	80%
Customer satisfaction	80	80	80
Design Flexibility	**85**	**80**	**80**
Product range ability	85	80	80
Product change ability	10	N/A	N/A
Customer satisfaction	70	80	80
Cost / Price	**90**	**90**	**85**
Customer satisfaction	90	90	85

Product Group(P.G)	Injection	Blow molding	Thermo-forming	(R.I *P.G	Priorities (1-5)
Relative Importance(R.I)	20%	45%	35%		
Quality	90	90	90	90	5
Delivery Lead-time	80	80	75	78.25	1
Delivery Reliability	80	80	80	80	2
Design Flexibility	85	80	80	81	3
Cost / Price	90	90	85	88.25	4

Priority Profiles



Company # 10

Company Name	: Al- Nakhil Paper Industries
Authorised Capital	: SR37,500,000 (£6,250,000)
Turnover	: SR 56,250,000 (£9,375,000)
Approximate Profit	: 15-20 %
Installed Capacity	: 10,000 ton Carbonlees paper 4,400 ton Coated paper 9700 ton Offset paper 900 ton Other paper
Location	: Riyadh, Saudi Arabia
Year Established	: 1995

The Business

Produce carbonless paper and other types of paper, and mainly a Marketeer.

Government support :

Saudi Industrial Development Fund (SIDF)

- The project funded by SIDF.

Ministry of Industry and Electricity (MIE) Support

- Location
  3rd Industrial city in Riyadh area.
- Tax Free
  Raw material, Machine & Spare parts.
- Electricity
  Supply to the factory at Industrial price.

Market Analysis

Customers

- Al-Obekan Industies
- Al-khaled printer
- Safer factory
- Asfhany Printer
- All other Printers

Market area in Saudi Arabia

- All of Saudi Arabia area.

International

- GCC, Mildest country.

Competitors

- Simplex
- Al-Jerasy
- Al-Hoshan

Saudization Policy

- Total employee : 75
- No of Saudi employee : 5

- % of Saudization : 25 %
- % of Saudis employee in management positions : 1
- % of Saudis employees in Engineering positions : None
- % of Saudis employee Labor and operators levels : 4
- **Positions held by Saudis employee :**

Chairman :Saudi
President :Saudi
General manager : None
Operation manager : None Saudi
Human resource manager : Saudi
Finance manager : None Saudi
Marketing manager : Saudi

Prevalent technology

- Micro capsule production
- Coating process.
- Converting
- Ribbing Package

Product Group Definition

Products	Carbonlis	Other paper
Variants	3	4
Volume	10,000 ton	15,000
% Sales	45%	55%
Market share	60%	30%
Growth opportunities	Very Good	Very Good
Degree of innovation (out of 10)	Medium	Low
Life cycle stage	Mature	Mature
	Coating	Converting & Cutting
Materials	Paper & Chemical	Paper
Approx. Profit/cost/sales	20%	20%
Typical order size	5	5
Standardization	International	International
Market	Saudi Arabia, Gcc, Middle east	Saudi Arabia, Gcc, Middle east
Customers	As before	As before
Relative Importance	50%	50%

Product Group: Market Analysis

	Carbonlis	Other paper
Quality	**95**	**95**
Conformance to spec	90	95
Reliability in use	95	95
Customer satisfaction	95	95
Delivery Lead-time	**85**	**85**
Lead-time requirements	2-3 wks	2 wks
Delivery change notice	1w ks	3 wks
Customer satisfaction	85	85
Delivery Reliability	**90**	**90**
Delivery window	< 2 wks	1 wk
Customer satisfaction	95	95
Design Flexibility	**85**	**80**
Design changes	N/A	
Customised products		N/A
Customer satisfaction	85	80
Cost / Price	**90**	**95**

Product Group	Portland	Type V	(R.I *P.G	Priorities(1-5)
Relative Importance	50%	50%		
Quality	95	95	95	5
Delivery Lead-time	85	85	85	2
Delivery Reliability	90	90	90	3
Design Flexibility	85	80	82.5	1
Cost / Price	90	95	92.5	4

Current Performance

	Carbonlis	Other paper
Quality	**90**	**90**
Actual quality level	90%	90-95%
Customer reject rate	0	1%
Final failure rate	4%	2%
Intermediate scrap rate	3%	2%
Customer satisfaction	90	90
Delivery Lead-time	**80**	**75**
Actual delivery lead-time		
Manufacturing lead-time		
Schedule change ability		
Customer satisfaction	80	75
Delivery Reliability	**80**	**80**
Deliveries within window	755	80%
Complete orders	70%	80%
Customer satisfaction	70	70
Design Flexibility	**85**	**80**
Product range ability	85	65
Product change ability	10	N/A
Customer satisfaction	70	80
Cost / Price	**90**	**80**
Customer satisfaction	90	80

Product Group(P.G)	Carbonlis	Other paper	(R.I *P.G	Priorities(1-5)
Relative Importance(R.I)	50%	50%		
Quality	90	90	90	5
Delivery Lead-time	80	75	77.5	1
Delivery Reliability	80	80	80	2
Design Flexibility	85	80	82.5	3
Cost / Price	90	80	85	4

Priority Profiles