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Integrated Manufacturing System Design For food production facilities in Palestine

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This thesis was defended successfully on 25/1/2011 and approved by:

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Abdallah Dweekat

الإقرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

Integrated Manufacturing System Design

For food production facilities in Palestine

اقر بأن ما اشتملت عليه هذه الرسالة إنما نتاج جهدي الخاص, باستثناء ما تمت الإشارة إليه حيثما ورد, و أن هذه الرسالة ككل, أو أي جزء منها لم يقدم من قبل لنيل أية درجة علمية أو بحث علمي أو بحثي لدى أية مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student Name : Abdallah Jamal Abdallah Dweekat

Signature :

Date : 3/2/2011

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Abbreviations

IMSD	Integrated Manufacturing System Design
OEE	Overall Equipment Effectiveness
GT	Group Technology
FMS	Flexible Manufacturing System
EOQ	Economic Order Quantity
ERP	Enterprise Resource Planning
MRP	Material Requirements Planning
SPC	Statistical Process Control
PALTRADE	Palestine trade center
VMI	Vender Managed Inventory
JIT	Just In Time
LRIP	Low Rate Initial Production
WIP	Work In Process
QFD	Quality Function Deployment
3P	Production Preparation Process
PCBS	Palestinian Central Bureau of Statistic

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Abstract

The purpose of this study was to develop a framework for designing an Integrated Manufacturing System which can live and interact through research environment special conditions. A successful manufacturing system designs must be capable of satisfying the strategic objectives of a company. The current manufacturing systems especially those systems used in foodstuff enterprises within this research environment, Palestine, suffer from many problems and difficulties.

Both qualitative and quantitative research methodology was utilized in this study. The qualitative research data consisted of three in-depth interviews with research sample companies' managers. The quantitative research data was gathered with the aid of a online survey. Fifty two surveys were sent to foodstuff enterprises in Palestine and thirty six responses were received. The response rate was sixty nine percent.

The results of the interviews and survey revealed a high level of weaknesses in planning process prior to the establishment of Palestine foodstuff production enterprises. There is also a mismatching between markets need, production capacity, and process technology in the current enterprises. Sixty two of the responses said that they do not have any strategic objectives. More than forty per cent of the responses utilized less than fifty per cent of their production lines.

In order to treat these weaknesses the researcher introduces a framework for designing an Integrated Manufacturing System (IMS) for foodstuff enterprises in Palestine. The framework develops a tool to help manufacturing system designers (1) clearly understand the different components and levels of the manufacturing system design, (2) link low-level activities and decisions to high-level goals and requirements, (3) understand the interrelationships and the integration among the different elements of a system design. Such manufacturing system enables a firm to simultaneously achieve cost, quality, flexibility, and delivery responsiveness to the customer objectives. The application section illustrates how the Integrated Manufacturing System Design (IMSD) can be applied through concurrent activities between its different functions and levels.

Chapter 1

1. Introduction

1.1 Overview

Palestinian industrial environment like any other environment in developing countries suffers many difficulties and constrains, which increases working risks, and resulting in uncertain business circumstance. Furthermore Israel occupation adds more constrains in front of any business investment. These conditions lead the researcher to put his efforts to develop a framework for designing manufacturing systems in order to help investors within research environment to plan and design their businesses in a proper ways, to decrease risks, accommodate uncertain conditions, and increase success opportunities.

Designing an Integrated Manufacturing System to achieve a set of strategic objectives involves making a series of complex decisions over time. Making these decisions in a way that supports a firm's high-level objectives requires an understanding of how detailed design issues affect the interactions among various components of a manufacturing system; those components may vary from industrial environment to another. This thesis presents an Integrated Manufacturing System Design framework consists of two main levels, infrastructure design and structure design. The two levels have been connected by a functional strategies level which aims to achieve the integration between all of the system components. Each level in the framework contains a general set of functional requirements and design parameters. This framework can be used as an approach to aid engineers and managers in the design, implementation, and operation of manufacturing systems.

In practice, designing the details of manufacturing systems (equipment design and specification, layout, manual and automatic work content, material and information flow, etc.) in a way that is supportive of a firm's business strategy has proven to be a difficult challenge. Because manufacturing systems are complex entities involving many interacting elements, it can be difficult to understand the impact of detailed, low-level deficiencies and change the performance of a manufacturing system as a whole.

Shingo (1998) discusses the problem of optimizing individual operations as opposed to the overall process. Hopp and Spearman (1996) describe the same problem, calling it a reductionist approach where the focus is on breaking a complex system into its more simple components and then analyzing each component separately. They go on to point out that "too much emphasis on individual components can lead to a loss of perspective for the overall system," and that a more holistic approach can lead to better overall system performance.

The framework presented in this thesis develops a tool to help manufacturing system designers (1) clearly understand the different components and levels of the manufacturing system design, (2) link low-level activities and decisions to high-level goals and requirements, (3) understand the interrelationships and the integration among the different elements of a system design.

The framework for manufacturing system design integrates several disciplines such as corporate level and business unites strategies, functional strategies, and plant layout design and operation, human work organization, equipment design, material supply, use of information technology, and performance measurement. The target industries of the framework are above small size foodstuff manufacturing companies in Palestine industry environment.

1.2 Research questions

The research questions have been designed based on the observed gap between the situation of research environment manufacturing systems and current global manufacturing systems illustrated in literature review chapter.

Based on that the research questions were formulated as follows:

1. What are the gaps between Palestine enterprises' manufacturing systems and the modern manufacturing systems used in successful world enterprises?
2. What is the suitable manufacturing system design framework that can be used in the research environment – Palestine- with regarding to its special conditions?

1.3 Research Objectives

For a manufacturing system to satisfy the strategic objectives of a company it should be designed with clear understanding of its components, and the main levels of such systems.

Clear understanding of the manufacturing system components and its designing levels allows designers relate system designing details to the manufacturing system objectives. For example when designers start by identify stakeholders needs and corporate goals (infrastructure design), and by understanding the importance of integration between all of the functions within the corporate (functional strategies), then they can easily design all of the physical aspects (structure design) that leads to achieve corporate goals and fulfill stakeholders needs.

Based on the above conceptual thinking about manufacturing systems, this research aims:

1. To clarify the current situation of research environment enterprise's manufacturing systems

2. To propose a framework for an Integrated Manufacturing System Design, this framework designed specially to be used in foodstuff enterprises in research environment. It can be used also in the other industrial sectors without any restrictions.

3. To introduce a process design view for the developed framework concepts after clarifying the current situation of research environment enterprise's manufacturing systems.

Furthermore, the research aims to add a contribution to foodstuff manufacturing systems design within research environment, and also it aims to explore some main fields within same topic which needs further researches and studies.

1.4 Research design and methodology

The significance of this research is that it highlights the weaknesses that exist in the research environment foodstuff manufacturing systems, and that it proposes a solution which is helpful for such enterprises by introducing a framework for designing best practice manufacturing systems which can treat these weaknesses and change it to strengths points.

The methodology preferred for this research was a conceptual model, quantitative and inductive methodological approach. The collected data shall be validated through using different data sources. Research hypotheses have been approved using quantitative statistical tools.

However, given the parameters of the research's scope, associated with time and resource constraints, it was decided that the defined Framework for Integrated Manufacturing System Design would best satisfy the articulated objectives and respond to the research questions. The next chapter reviews the results of the survey, which lead to the framework formulation.

1.5 Related work

Other frameworks and approaches have been developed that guide people in making decisions about manufacturing system design by relating design decisions to important system characteristics such as operational costs. Hayes and Wheelwright developed the well-known product-process matrix relating the structure of a manufacturing system to the volume and variety of the products it is to produce (Hayes & Wheelwright, 1979).

Miltenburg (1995) expanded upon this approach by comparing how layout, material flow, product volume and variety affected cost, quality, and flexibility in different high-level system designs (job shop, equipment-paced line, etc.).

Approaches such as these can increase understanding of high-level system design choices at a conceptual level. However, these approaches fail to communicate how lower-level design decisions (such as equipment design, operator work content, etc.) will affect system performance. These approaches treat manufacturing system design as a problem of selecting an appropriate off-the-shelf design from a given set of choices and criteria. Designers are not given the freedom to create a unique manufacturing system to satisfy a broad set of requirements in a particular environment.

Lean Aerospace Initiative (LAI) has developed a framework based upon the experiences, knowledge and observations of their team members. It was an attempt to describe the manufacturing system design process in a holistic manner. It was a meta-framework, meaning that the framework itself contains other tools, methods and frameworks within it. It was divided the designing activities into two levels, infrastructure design and structure design, connected by anew concept called product design. The framework developed according to the aerospace industry requirements in order to satisfying their industrial sector needs.

In our research we have tried to customize a framework which fits research environment considerations and constrains, some of the ideas in our framework have been taken from the above mentioned frameworks and from other related researches.

1.6 Thesis Outline

The thesis will be comprised of five chapters as shown in Table 1.1. Following the introductory chapter, which outlines the nature of the study, Chapter 2 will present reviews on related literature on manufacturing systems components and related topics. Chapter 3 will present and defend the dissertation's selected methodology. Chapters 4 will discuss data gathering and analysis issues. Chapter 5 will present the framework and its implementation process. Finally, Chapter 6 will conclude the study through an articulation of the research findings, and conclusions.

Table 1.1: Outline of the thesis

Chapter 1	Introduction	Overview	Research objectives	Related works
		Research question	Research design and methodology	Thesis outline
Chapter 2	Literature review	Introduction	summery	
		Manufacturing system design		
Chapter 3	Methodology	Introduction	Research design and methodology	Research methodology description
		Research background	Research approach	Summery
Chapter 4	Data gathering and analysis	Introduction	Data analysis	Conclusions
		Discussion of results	Findings	
Chapter 5	Framework	MSD framework general principles	MSD Framework	
		Palestine business environment constrains	MSD Process	
Chapter 6	Conclusion and recommendations	Thesis conclusion summery	Recommendations	
		Contribution to knowledge	Future work	

Chapter 2

2 .Literature review

2.1 Introduction

In the context of this thesis, enterprise can be defined as a profitable entity whatever it is public or privet, the primary purpose for any enterprise is to create profits and values, for its stakeholders; Any enterprise consists of both tangible components; such as information system, machines, equipments, and intangible ones; i.e., intellectual capabilities/property, etc . Those components are exploited and interact to perform tasks, activities, and functions through business processes which designed to provide products and /or services for the customers, ensure cost effectiveness and efficiency of operations. (Mykityshyn & Rouse, 2007).

Those institutions need a system to control its activities on both strategic and operational levels; system has been defined as "a collection of mutually dependent entities whose initiatives, activities, and actions form a dynamic process toward the accomplishment of some purpose". Therefore, the enterprise is a comprehensive system which organizes and controls its activities, processes, and resources in order to achieve its strategic and operational goals (Rouse W. , 2005). In this literature the researcher will explain what the manufacturing system, the components of such systems, detailed description of its components, and finally researcher opinions and conclusion.

2.2 Manufacturing System design

In ancient times manufacturing system design was simply encompasses the problems of factory layout, material handling, inventory and other functions necessary for the production of products or provision of services. (Kwok, 1992-1993). Nowadays; this concept expands to include many other important attributes such as choosing the appropriate manufacturing system to be employed, business strategy, functional strategies , and other issues which have to be integrated in order to minimizing risks and maximizing success opportunities for the enterprise.

As shown in Figure 2.1 any manufacturing system design consists of two main levels. The infrastructure design and structure design. (Vaughn, et al., 2002). Each level contains different aspects, managing Overlaps and interactions between both levels components leads to an integrated manufacturing system design which aims to achieve the targeted efficacy and effectiveness for the enterprise.

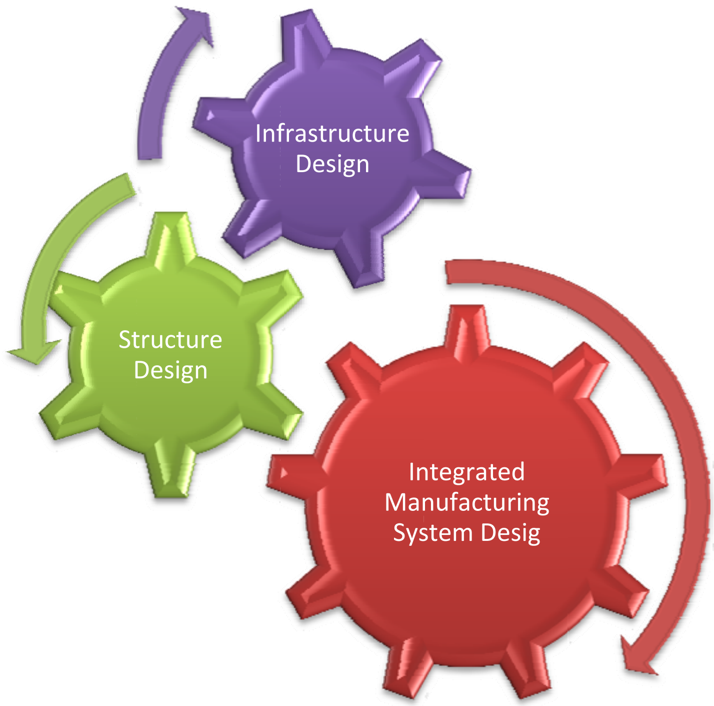

Figure 2.1: Manufacturing system design levels

2.2.1 Infrastructure Design

In an environment characterized by globalization and based on definitely accessible knowledge the enterprises are subjected to increase the pressure with respect to competitiveness, innovations, flexibility, quality, and information processing capability (Croteau, et al., 2009). These pressures lead to consider three types of strategies: corporate strategy, business strategy and functional strategy. Corporate strategy describes a company overall direction and answers the question "In what industry or industries will we compete?" Business strategy occurs at the business level and answers the question “How will we compete in each of our chosen businesses?” And functional strategy is concerned with developing a distinctive competence to provide accompany or business unit with a competitive advantage and figuring out “How will each of the organization’s functional areas support our business and corporate level strategies?” These three strategies are not mutually exclusive and will link in the implementation of a particular strategy (Sun & Hong, 2002; Ketchen & David, 2003).

These three levels of strategy form the infrastructure design of any manufacturing system which contains all the activities associated with the overall operating environment of the system, the operating policy, organizational structure, choice of location, etc.

Stakeholders whatever they are internal such as investors, management, and employee, or external e.g. customers, suppliers, and society or environment have to be involved in the infrastructure design stage because each group of them have their own needs and requirements, that could produce some conflicts between one group and another, the corporation strategy have to balance these conflicts through establishing business unit strategies in order to fulfill all of the stakeholders needs. (Vaughn, et al., 2002).

The board of directors also should be actively engaged in the process of strategy creation and they should insure that management demonstrates commitment to the strategy, allocate adequate resources to its fulfillment, has a provisional and financial stake in the execution, and adequately reports on its progress. The board should also monitor execution of the strategy against milestones. On continuous bases, the board must be willing and able to recognize whether or not the enterprise has winning strategy and if it does not, must be ready to urge corrective actions. The board should ensure that management makes modification to the strategy as necessary (Directorship, 2009).

2.2.1.1 Corporate Strategy

Corporate level strategy fundamentally is concerned with the selection of businesses in which the company should compete and with the development and coordination of that portfolio of businesses. It concern with defining the issues that are corporate responsibilities; these might include identification the overall goals of the corporate, the types of businesses in which the corporate should be involved, and the way in which businesses will be integrated and managed.

The corporate strategy defines where in the corporation competition is to be localized. It seeks to develop synergies by sharing and coordinating staff and other resources across business units, investing financial resources across business units, and using business units to complement other corporate business activities. It also decides how business units are to be governed: through direct corporate intervention (centralization) or through more or less autonomous government (decentralization) that relies on persuasion and rewards.

Corporation is responsible for creating value through its business units. It does so by managing its portfolio of businesses, ensuring that the businesses are successful over the long term, developing business units, and sometimes ensuring that each business is compatible with others in the portfolio.

National Association of Corporate Director (NACD) defined corporate strategy as “an ongoing process that requires oversight. Management brings vision, while boards bring perspective.” So the management chooses the direction where its goals and objectives can be achieved, while the board, based on members’ divers view points, asks: why? How? What if? To support appropriate direction, developments, execution, and modification of the enterprise strategy. (Directorship, 2009).

Kim and Mauborgne (2009) identified three strategy propositions: the first one is a value proposition that attracts customers and shapes enterprise competitive advantages and the business unit strategy will treat it. The second proposition is a profit proposition that enable the company to make money out of the value proposition and these two propositions set out the content of the strategy. And the last one is a people proposition that motivates those working for or with the company (stakeholders) to execute the strategy. Based on these facts we can define strategy as the development and alignment of the three propositions to either exploit or reconstruct the industrial and economic environment in which an organization operates.

Corporate Strategy approaches

There are two strategic approaches: structuralist approach that assumes that the operating environment is given, and deconstructionist approach that seeks to shape the environment. In choosing which of the two approaches is most appropriate for the corporation we need to consider the environmental attractiveness, the recourse and capabilities availability, and the strategic mind set. Whatever strategy approach is chosen the success will depend on creating an alignment set of the three strategy propositions of deferent set of stakeholders: buyers, stockholders and the people working for or with the organization.

Under structuralist approach an organization's entire system of activities, and its strategy propositions, need to be aligned with the distinctive choice of pursuing either differentiation or low cost, each being an alternative strategic position in an industry. A strategy is unlikely to be successful if the value and profit propositions are aligned around differentiation but people proposition is targeted at low cost, so it is a good fit when the structural condition are attractive and the organization has the recourses and capabilities to build a distinctive position or when the structural condition is less attractive but the organization has the resources and capabilities to outperform competitors.

While under the deconstructionist approach, high performance is achieved when all three strategy propositions pursue both differentiations and low cost, this alignment in support of differentiation and low cost enable a company to open new market space by breaking the existing value cost trade-off, it allow strategy to shape structure, it is also alignment that leads to more sustainable strategy, so it is a good fit when structural conditions are attractive but players are well entrenched and the organization lacks the resources or capabilities to outperform them or when the structural conditions are unattractive and the work against an organization irrespective of its resources and capabilities. But when the structural condition and resources and capabilities are not distinctively indicate one approach or the other , the right choice will turn on the organization's strategic mind set, that mean choosing structuralist approach when the organization has a bias toward defending current strategic positions and a reluctance to venture into unfamiliar territory and choosing deconstructionist approach when the organization has an orientation toward innovation and willingness to pursue a new opportunities (Kim & Mauborgne, 2009).

Corporate vision

Corporate vision is a short, and inspiring statement of what the organization intends to become and to achieve at some point in the future, often stated in competitive terms. Vision refers to the category of intentions that are broad, all-inclusive and forward-thinking. It is the image that a business must have of its goals before it sets out to reach them. It describes aspirations for the future, without specifying the means that will be used to achieve those desired ends, so the vision statement should answer the question “What does the enterprise want to become?” (David, 2005).

Warren Bennis (1986) a noted writer on leadership, says: "To choose a direction, an executive must have developed a mental image of the possible and desirable future state of the organization. This image, which we call a vision, may be as vague as a dream or as precise as a goal or a mission statement."

Corporate mission

A mission statement is an organization's vision translated into written form. It makes concrete the leader's view of the direction and purpose of the organization. For many corporate leaders it is a vital element in any attempt to motivate employees and to give them a sense of priorities.

Current thought on mission statements is based largely on guidelines set forth in the mid-1970s by Drucker, who is often called "the father of modern management" for his pioneering studies at General Motors Corporation and for his hundreds of articles. Drucker says that asking the question "What is our business?" is synonymous with asking the question "What is our mission?" An enduring statement of purpose that distinguishes one organization from other similar enterprises, the mission statement is a declaration of an organization's "reason for being." A clear mission statement is essential for effectively establishing objectives and formulating strategies (David, 2005).

A mission statement should be a short and concise statement of goals and priorities. In turn, goals are specific objectives that relate to specific time periods and are stated in terms of facts. The primary goal of any business is to increase stakeholder value. The most important stakeholders are shareholders who own the business, employees who work for the business and clients or customers who purchase products and/or services from the business.

Mission statements can and do vary in length, content, format, and specificity. Most practitioners and academicians of strategic management feel that an effective statement exhibits nine characteristics or components. Because a mission statement is often the most visible and public part of the strategic-management process, it is important that it includes all of these essential components, see Table 2.1. (David, 2005):

Table 2.1: Mission statement components

#	Components	Related Question
1	Customers	Who are the firm's customers?
2	Products or services	What are the firm's major products or services?
3	Markets	Geographically, where does the firm compete?
4	Technology	Is the firm technologically current?
5	Concern for survival, growth, and profitability	Is the firm committed to growth and financial soundness?
6	Philosophy	What are the basic beliefs, values, aspirations, and ethical priorities of the firm?
7	Self- Concept	What is the firm's distinctive competence or major competitive advantage?
8	Concern for public image	Is the firm responsive to social, community, and environmental concerns?
9	Concern for employees	Are employees a valuable asset of the firm?

Long –Term objectives

The major outcome of strategic road-mapping and strategic planning, after gathering all necessary information, is the setting of goals for the organization based on its vision and mission statement.

Long-term objectives represent the results expected from pursuing certain strategies. *Strategies* represent the actions to be taken to accomplish long-term objectives. The time frame for objectives and strategies should be consistent (2-5 years). Objectives should be quantitative, measurable, realistic, understandable, challenging, hierarchical, obtainable, and congruent among organizational units. Each objective should also be associated with a time line. Objectives are commonly stated in terms such as growth in assets, growth in sales, profitability, market share, degree and nature of diversification, degree & nature of vertical integration, earnings per share, and social responsibility.

Long-term objectives are needed at the corporate, divisional, and functional levels of an organization. They are an important measure of managerial performance. They provide direction, allow synergy, aid in evaluation, establish priorities, reduce uncertainty, minimize conflicts, stimulate exertion, and aid in both the allocation of resources and the design of jobs.

Without long-term objectives, an organization would go aimlessly toward an unknown end. It is hard to imagine an organization or individual being successful without clear objectives. Success only rarely occurs by accident; rather, it is the result of hard work to achieve objectives.

Two types of objectives are especially common in organizations—financial and strategic. Financial objectives include those associated with growth in revenues, growth in earnings, higher dividends, larger profit margins, greater return on investment, higher earnings per share, a rising stock price, improved cash flow, etc.

Strategic objectives include things such as a larger market share, quicker on-time delivery than rivals, shorter design-to-market times than rivals, lower costs than rivals, higher product quality than rivals, wider geographic coverage than rivals, achieving ISO 14001 certification, etc. Often there is a trade-off between financial and strategic objectives to make crucial decisions. For example, there are things a firm can do to maximize short-term financial objectives which would harm long-term strategic objectives (such as to improve financial position in the short run through higher prices may, for example, jeopardize long-term market share). Other trade-offs between financial and strategic objectives are related to riskiness of actions, concern for business ethics need to preserve the natural environment, and social responsibility (David, 2005).

2.2.1.2 Business unit strategy

A strategic business unit may be a division, product line, or other profit center that can be planned independently from other business units of the enterprise. The strategic issues in this level are less about the coordination of operating units and more about developing and sustaining a competitive advantage for the goods and services that produced.

At this level the formulation phase deal with positioning the business against rivals, anticipating changes in demand and technologies and adjusting the strategy to accommodate them, and influencing the nature of competition through strategic action such as vertical integration and through political actions such as lobbying. Each business unit has to study tow pairs of forces that affecting its position in the market, external (environmental) forces, and internal forces, to decide which strategy can be used in order to achieve the corporate objectives and completely integration with the corporate strategy.

The External Assessment

It is also called environmental or industrial factors, which classified into two categories, opportunities that could benefit the business unit, and threats that should be avoided. Fred R. David in his book “strategic management: concepts and cases” divide the external forces into five main categories, (1) economic forces; (2) social, cultural, demographic, and environmental forces; (3) political, governmental, and legal forces; (4) technological forces; and (5) competitive forces.

The Internal Assessment

The internal strengths and weaknesses of the enterprise have to be studied also in order to choose the strategy to compete with, these forces can be a functional areas such as marketing, finance, accounting, management, information system, production/operation and others, or it can be sub-areas such as customer service, advertizing, packaging and pricing under marketing.

Strategy/s Selection

Business strategy identified also as a tactics that will enable enterprise to reach its objectives by allocating its resources and capabilities. Those tactics can be an offensive or defensive actions used to counter competitive forces and thus provide the firm with an increased return on investment.

Over time various classification approaches for business level strategies have been developed including narrative, typological, and comparative approaches. Miles and snow typology is the most popular and widespread classification scheme for the last 25 years (Croteau, et al., 2009).

Assuming the relationships and interdependence among an organization's strategy, structure, and processes, Miles and Snow further developed the "adaptive cycle" concept as a foundation for their strategic typology, thus explaining how organizations respond to their environment.

The above discussion emphasize that organizations are constituted and evolve through the resolution of three managerial problems: the entrepreneurial problem, the engineering problem, and the administrative problem. The entrepreneurial problem refers to the positioning of the organization within its market and the exploitation of new opportunities. This necessitates making choices with regard to the products or services offered and the markets or market segments entered. The engineering problem refers to the effective production and distribution of goods and services. One solution to this problem consists in adopting and assimilating scalable technologies that will render the production apparatus more flexible and allow for improvements in quality. Finally, the administrative problem mainly refers to the control and effectiveness of the organization. A potential solution to this last problem is double: redesign and integration of business processes to reduce uncertainty on one hand, development of managerial processes that support organizational learning and adaptation on the other hand.

The adaptive cycle demonstrates how the choice of a given strategy (the entrepreneurial problem) demands a particular portfolio of technologies and capabilities (the engineering problem), and how these choices affect the design of organizational structures and processes (the administrative problem). Finally, the choice of structure and process will influence and constrain future strategic decisions (Zahar & Pearce, 1990).

Miles and Snow typology classified the firms with regard to the business strategy that it uses into four main categories, prospector, analyzer, defender, and reactor.

Prospector organizations face the entrepreneurial problem of locating and exploiting new product and market opportunities. These organizations thrive in changing business environments that have an element of unpredictability, and succeed by constantly examining the market in a quest for new opportunities. Moreover, prospector organizations have broad product or service lines and often promote creativity over efficiency. Prospector organizations face the operational problem of not being dependent on any one technology. Consequently, prospector companies prioritize new product and service development and innovation to meet new and changing customer needs and demands and to create new demands. The administrative problem of these companies is how to coordinate diverse business activities and promote innovation. Prospector organizations solve this problem by being decentralized, employing generalists (not specialists), having few levels of management, and encouraging collaboration among different departments and units.

Defender organizations face the entrepreneurial problem of how to maintain a stable share of the market, and hence they function best in stable environments. A common solution to this problem is cost leadership, and so these organizations achieve success by specializing in particular areas and using established and standardized technical processes to maintain low costs. In addition, defender organizations tend to be vertically integrated in order to achieve cost efficiency. Defender organizations face the administrative problem of having to ensure efficiency, and thus they require centralization, formal procedures, and discrete functions. Because their environments change slowly, defender organizations can rely on long-term planning.

Analyzer organizations share characteristics with prospector and defender organizations; thus, they face the entrepreneurial problem of how to maintain their shares in existing markets and how to find and exploit new markets and product opportunities. These organizations have the operational problem of maintaining the efficiency of established products or services, while remaining flexible enough to pursue new business activities. Consequently, they seek technical efficiency to maintain low costs, but they also emphasize new product and service development to remain competitive when the market changes. The administrative problem is how to manage both of these aspects. Like prospector organizations, analyzer organizations cultivate collaboration among different departments and units. Analyzers organizations are characterized by balance—a balance between defender and prospector organizations.

Reactor organizations, as the name suggests, do not have a systematic strategy, design, or structure. They are not prepared for changes they face in their business environments. If a reactor organization has a defined strategy and structure, it is no longer appropriate for the organization's environment. Their new product or service development fluctuates in response to the way their managers perceive their environment. Reactor organizations do not make long-term plans, because they see the environment as changing too quickly for them to be of any use, and they possess unclear chains of command.

Miles and Snow argued that companies develop their adaptive strategies based on their perception of their environments. Hence, as seen above, the different organization types view their environments in different ways, causing them to adopt different strategies. These adaptive strategies allow some organizations to be more adaptive or more sensitive to their environments than others, and the different organization types represent a range of adaptive companies. Because of their adaptive strategies, prospector organizations are the most adaptive type of company. In contrast, reactor organizations are the least adaptive type. The other two types fall in between these extremes: analyzers are the second most adaptive organizations, followed by defenders.

Since business environments vary from organization to organization, having a less adaptive strategy may be beneficial in some environments, such as highly regulated industries. For example, a study of the airline industry in the 1960s and 1970s indicated that the defender airlines were more successful than the prospector airlines in that the business environment changed slowly during this period because of the heavy regulation. Hence, the emphasis on efficiency by the defender airlines worked to their advantage.

On the other hand, prospector organizations clearly have an advantage over the other types of organizations in business environments with a fair amount of flux. Companies operating in mature markets in particular benefit from introducing new products or services and innovations to continue expanding. As Miles and Snow note, no single strategic orientation is the best. Each one—with the exception of the reactor organization—can position a company so that it can respond and adapt to its environment. What Miles and Snow argue determines the success of a company ultimately is not a particular strategic orientation, but simply establishing and maintaining a systematic strategy that takes into account a company's environment, technology, and structure.

2.2.1.3 Functional Level Strategy

The functional level of any organization is the level of the operating divisions and departments. The strategic issues at the functional level are related to functional business processes and value chain. Functional level strategies in R&D, operations, manufacturing, marketing, finance, and human resources involve the development and coordination of resources through which business unit level strategies can be executed effectively and efficiently.

Functional units of the organization are involved in higher level strategies by providing input into the business unit level and corporate level strategy, such as providing information on customer feedback or on resources and capabilities on which the higher level strategies can be based. Once the higher level strategy or strategic intent is developed, the functional units translate them into discrete action plans that each department or division must accomplish for the strategy to succeed.

In this literature we will discuss the two main functional strategies that directly affecting any manufacturing system infrastructure formulation, which are marketing strategies and manufacturing strategies.

Marketing Strategy

Marketing strategy is essentially a pattern or plan that integrates corporate major goals, policies, and action sequences in a cohesive whole to achieve customer success. Marketing strategies are generally concerned with four P's (Marketing Mix): product strategies, pricing strategies, promotional strategies, and placement strategies.

Product strategy

Product strategy concerns with developing a new products, repositioning existing ones and scrapping old ones, adding new features and benefits, balancing product portfolios, and changing the design or packaging. This part of the marketing strategy focuses on the uniqueness of the product or service, and how the customer will benefit from using the products or services you're offering. Product strategies describe the physical attributes of the product or service, and any other relevant features, such as what it does, or how your product or service differs from competitive products or services.

It also explains how will the product or service benefit the customer? Those benefits can be intangible as well as tangible; for instance, if you're selling a cleaning product, your customers will benefit by having a cleaner house, but they may also benefit by enjoying better health.

Pricing strategy

Pricing strategy concerns with setting price to skim or penetrate, Pricing for different market segments, and deciding how to meet competitive pricing. The pricing strategy portion of the marketing strategy involves determining how the product or service will be priced; the price has to be competitive but still allow make a reasonable profit. The keyword here is "reasonable"; we can charge any price we want to, but for every product or service there's a limit to how much the consumer is willing to pay. The pricing strategy needs to take this consumer threshold into account.

The most common question small business people have about the pricing strategy section of the marketing strategy is, "How to know what price to charge?" Basically pricing sited through a process of calculating the costs, estimating the benefits to consumers, and comparing products, services, and prices to others that are similar. Set a pricing by examining how much it cost to produce the product or service and adding a fair price for the benefits that the customer will enjoy. Examining what others are charging for similar products or services will guide the pricing process when figuring out what a "fair" price for such benefits would be.

Placement (distribution) strategies

Place (or placement) decisions are those associated with channels of distribution that serve as the means for getting the product to the target customers. The distribution system performs transactional, logistical, and facilitating functions. Distribution decisions include market coverage, channel member selection, logistics, and levels of service.

Promotional strategies

Promotional strategies, Specifying the advertising platform and media, deciding the public relations brief and organizing the sales force to cover new products and services or markets. Promotion decisions are those related to communicating and selling to potential consumers. Since these costs can be large in proportion to the product price, a break-even analysis should be performed when making promotion decisions. It is useful to know the value of a customer in order to determine whether additional customers are worth the cost of acquiring them. Promotion decisions involve advertising, public relations, media types, etc.

Manufacturing strategy

Manufacturing strategy is “a collective pattern of decisions that acts upon the formulation and deployment of manufacturing resources”. To be most effective, the manufacturing strategy should act in support of the overall strategic direction of the business and provide for competitive advantages (Cox III & Blackstone, 2001).

Manufacturing strategy can be defined also as a set of co-ordinate objectives and action programs applied to a firm's manufacturing function and aimed at securing medium and long term objectives, sustainable advantage over that firm's competitors. The manufacturing function requires a strategy to ensure a match, or congruence, between the corporate strategy and the existing and future abilities of the production system. Manufacturing strategy generally addresses issues including: manufacturing capacity, production facilities, use of technology, vertical integration, quality, and production planning/materials control, Table 2.2 contains Manufacturing Strategy’s main decision areas.

Table 2.2: Manufacturing Strategy's main decision areas

Structural decision area	
Capacity	Capacity flexibility, Shift patterns, temporary subcontracting policies
Facilities	The size, Location and focus on manufacturing resources
Manufacturing process technology	Degree of automation, technology choices, configuration of equipment into lines, cells, etc., maintenance polices and potential for developing new process in house
Vertical integration	Strategic make-versus-buy decision, supplier polices, extent of dependence of suppliers
Infrastructural decision area	
Organization	Structure, accountabilities and responsibilities
Quality policy	Quality resource and quality control policies and practices
Production control	Production and material control systems
Human resource	Recruitment, training and development, culture and management style
New product introduction	Design of manufacturing guidelines, introduction strategy, organizational aspects
performance measurement and reward	Financial and non financial performance management and linkages to recognition and reward systems

Source: (adapted from HAYES and WHEELWRIGHT, 1984 and MILLS et al., 1996)

There are three aspects that have to be taken into account in developing the manufacturing strategy. The first one is to make balancing between manufacturing capabilities and the competitive priorities such as manufacturing cost, product quality, customer service, and flexibility of the productive apparatus, given market need. Second, strategic choices must be made with regard to manufacturing structure and infrastructure, in maters of plant and equipment, of production planning and control, of human resource development, and of product, organization, and management development, while ensuring internal and external coherence. Third, the way of implementation through using best practices which include the advance manufacturing systems such as Just In Time JIT, Total Quality Management TQM, and concurrent engineering (Croteau, et al., 2009).

Manufacturing strategy can be assumed as the mediating force between the organization and its environment through choosing a compatible organizational technology in order to create a significant competitive advantage.

Many researches have been done to study the performance effects of the alignment between business strategies and manufacturing strategies, the performance indicator usually identified by productivity or profitability because it is directly related to the objectives the firm's manufacturing strategy. Miles and Snow assumes many aspects of their typology are related to the manufacturing strategy, including the prospectors' need for innovation in term of product development, the analyzers' need for flexibility to conciliate efficiency, quality, and innovation, and the defenders' emphasis on operational efficiency in terms of manufacturing costs and efficient planning (Croteau, et al., 2009).

Kotha and Swamidass (2000) categorize the manufacturing strategies into three main groups, based on their functions and information processing capabilities, (1) technologies for the design of new or improved products, such as CAD , meant to enable organizational innovation, (2) technologies linked to the manufacturing process such as Flexible Manufacturing System (FMS), meant to provide manufacturing flexibility, and (3) application related to logistics and planning such as Enterprise resource Planning (ERP) , meant to increase business and system integration, fourth category have been included by Kotha and Swamidass which is information exchange technologies such as electronic data interchange (EDI) and Internet-based networks (extranet) with customers and suppliers, meant to increase inter organizational or external integration (Swamidass & kotha, 2000).

Based on the above categorization of the manufacturing strategies (MS), the alignment researches with business strategies (Williams, 1995; Croteau, et al., 2009) concluded that there are three groups of MS aligned with Miles and Snow's three business strategies. Table 2.3 contains ideal manufacturing strategy profile of defenders, analyzers, an prospectors.

MS for innovation is associated with the prospector enterprises that make greater use of product design technologies when developing innovative products. MS for flexibility is reflected in greater use of process technologies by analyzer enterprises that often need technologies that offer multiple automated ways of producing goods. Finally, MS for integration associated with the defender enterprises that are more likely to use logistics and planning applications such as CIM applications that provide appropriate information, communication, and control mechanisms.

Table 2.3: Ideal manufacturing strategy profile of defenders, analyzers, and prospectors

Manufacturing strategy (assimilating of advance manufacturing systems)	Type of business strategy		
	Prospector (AMS for innovation)	Analyzer (AMS for flexibility)	Defender (AMS for integration)
Product Design Technology (PDT)[1]	High	medium	low
Process Technology (PT)[2]	medium	High	low
Logistic/Planning application (LPA)[3]	Low	medium	high

[1]Product Design Technology (PDT): computer aided drawing, CAD, CAM, CAD/CAM.

[2]Process Technology (PT): computer numerical control (CNC), Programmable logic controls (PLC), robotized operations, FMS, automated handling.

[3]Logistic/Planning application (LPA): production scheduling, bar coding, EDI, Material requirement planning (MRP), MRP-II, ERP.

Source: (Raymond, Louis & Croteau, A.M, May2009)

2.2.2 Structure design

After developing and identifying all of the three levels of enterprises strategies, management have to start preparing for the structural issues in order to achieve the overall corpora strategic goals and objectives. Structure design is the physical manifestation of the manufacturing system design consisting of the factory layout, machines, methods and processes.

Manufacturing system structure design is strongly related with operation management science which identified as “the activity of managing the resources which are devoted to the production and delivery of products and services". The operations function is the part of the organization that is responsible for this activity. Every organization has an operations function because every organization produces some type of products and/or services. However, not all types of organization will necessarily call the operations function by this name (Slack, et al., 2007).

We must distinguish between two meanings of 'operations': operations as a function, meaning the part of the organization which produces the products and services for the organization's external customers; and operations as an activity, meaning the management of the processes within any of the organization's functions

The operations function is central to the organization because it produces the goods and services which are its reason for existing, but it is neither the only nor necessarily the most important function. It is, however, one of the three core functions of any organization:

- Marketing (including sales) function – which is responsible for communicating the organization's products and services to its markets in order to generate customer requests for service.

- Product/Service development function – which is responsible for creating new and modified products and services in order to generate future customer requests for service.

- Operations function – which is responsible for fulfilling customer requests for service throughout the production and delivery of products and services.

In addition, there are the support functions which enable the core functions to operate effectively. These include, for example:

- Accounting and finance function – which provides the information to help economic decision making and manages the financial resources of the organization.

- Human resources function – which recruits and develops the organization's staff as well as looking after their welfare.

- Technical function- which identify the process technology needs and the available technology options to choose the best one for the enterprise.

- Information System function- which is responsible about the communicating system needs and also the systems for design, planning and control, and improvements.

Remember that different organizations will call their various functions by different names and will have a different set of support functions. Almost all organizations, however, will have the three core functions because all organizations have a fundamental need to sell their services, satisfy their customers and create the means to satisfy customers in the future. Organization's functions consist of three main components, inputs, transformation process, and outputs as shown in Figure 2.2.

The Inputs to the process classified into two sets: transformed resources which are the resources that are treated transformed or converted in the process. They are usually a mixture of materials, information, and customers. The other set of inputs to any operations process are transforming resources. These are the resources which act upon the transformed resources. There are two types which form the 'building blocks' of all operations, facilities (the buildings, equipment, plant and process technology of the operation), and stuff (the people who operate, maintain, plan and manage the operation) (Slack, et al., 2007).

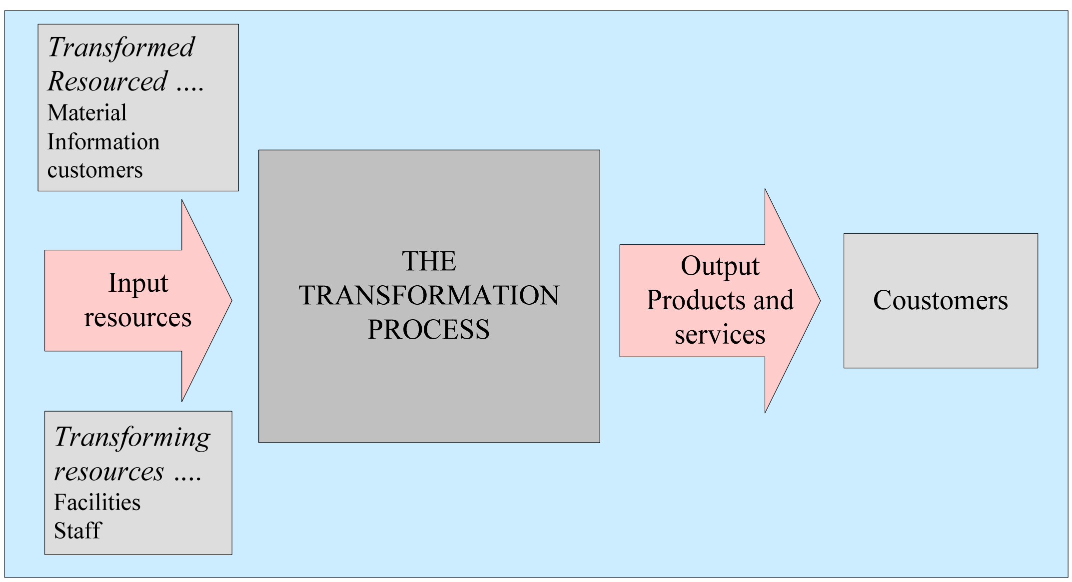

Figure 2.2: Organization function components

SOURCE: (NIGEL SLACK, 2007)

Operation strategies (functional level strategies); can be considered as the linking point between the infrastructure design and the structure design in any manufacturing system, Nigel Slack, Stuart Chambers and Robert Johnston in their book “Operations Management” classified MS structure design into three main activities, Design, planning and control, and improvements activities .

2.2.2.1 Design

Design activities contains process design, product or services design, supply network design, layout and flow design, process technology choosing, and job design and work organization, each activity related to other activities on away on another way to make that integration which increase the value added and give he best design for the targeted manufacturing system (Slack, et al., 2007).

Process design

Before constructing the processes in all functions within any MS, we have to design that processes in order to achieve its objectives, in the same time we can’t separate the process design and the product or services design; because each one design activity clearly affecting the design of the other, so the process design can be defined as the activity that shapes the physical form and purpose of both product or services design and processes that produce them (Roemer & Ahmadi, 2010).

The overall purpose of the process design is to meet the needs of the customers through achieving appropriate levels of quality, speed, dependability, flexibility and cost. The design activity must also take account of environmental issues. These include examination of the source and suitability of materials, the sources and quantities of energy consumed the amount and type of waste material, the life of the product itself and the end-of-life state of the product (Evans, 2007).

The process design strongly influenced by the volume and variety of what it has to process, so process types term summarizes how volume and variety affect overall process design, In manufacturing, these process types are (in order of increasing volume and decreasing variety) project (producing a customized products for one time and within a time scale), jobbing (same as project but the products is smaller), batch (each time batch processes produce a product they produce more than one), mass (producing goods in high volume and relatively narrow variety), and continuous processes (producing the products in a continuous lines) . In service operation although there is less consensus on the terminology, the terms often used (again in order of increasing volume and decreasing variety) are professional services, service shops and mass services (Slack, et al., 2007; Evans, 2007).

Product or services design

Products and services are the first things that the customers see of a company, and it is the things that those customers willing to pay his money in order to get it, because of that a good product or services design makes good business sense because it translates customer needs into the shape and form of the product or service and so enhances profitability (Agouridas, 2007).

Three aspects have to be considered in product or services design, the concept which is the understanding of the nature use and value of the service or product, the package of 'component' products and services that provide those benefits defined in the concept, and finally the process, which defines the way in which the component products and services will be created and delivered (Slack, et al., 2007; Roemer & Ahmadi, 2010).

Products and services design goes through five stages:

1. Concept generation transforms an idea for a product or service into a concept which captures the nature of the product or service and provides an overall specification for its design.

2. Screening the concept involves examining its feasibility, acceptability and vulnerability in broad terms to ensure that it is a sensible addition to the company's product or service portfolio.

3. Preliminary design involves the identification of all the component parts of the product or service and the way they fit together. Typical tools used during this phase include component structures and flow charts.

4. Design evaluation and improvement involve re-examining the design to see whether it can be done in a better way, more cheaply or more easily. Typical techniques used here include quality function deployment, value engineering and Taguchi methods.

Supply network design

All operations within any enterprise have its own supply network which involved in bringing the inputs, processing it, and delivering the outputs to other operations or to the customers. In another words a supply network perspective means setting an operation in the context of all the other operations with which it interacts, some of which are its suppliers and its customers. Materials, parts, other information, ideas and sometimes people all flow through the network of customer–supplier relationships formed by all these operations (Sarode, et al., 2010).

Three core benefits gained by designing supply network; first one is the competitiveness understanding which comes by understanding the closed suppliers and customers who have a direct contact with the operation or enterprise and also going beyond them to understand why customers and suppliers chain act as they do.

The second benefit is that the supply network design helps identify the significant links in the network, the network design start by identifying and analyzing the downstream parts downward to the final customers who specifying the values and which satisfying his needs and requirements, after this the upstream part will be designed to fulfill that values achievement, in this stage the significant parts of the network clearly appears and gives more interest in order to increase supply network efficiency. Finally the third benefits of the supply network design are that it helps focus on long term issues and increase competition resistance in the future (Evans, 2007; Slack, et al., 2007).

Supply network deign pass through three main decisions, configuring the supply network, the location of the business capacity, and the long term capacity size. Supply network configuring decision is determining the shape of the network, if it is going down completely to the final customer or it is stopping in semi stage before them, and how it is relation with suppliers, and how much of the network should the operation own?, outsourcing, do or buy decisions.

The location of the capacity decision determines where should each part of the network owned by the company be located? If the company builds a new factory, should it be close to its suppliers or close to its customers, or somewhere in between? These decisions are called operations location decisions. The stimuli which act on an organization during the location decision can be divided into supply-side and demand-side influences. Supply-side influences are the factors such as labor, land and utility costs which change as location changes. Demand-side influences include such things as the image of the location, its convenience for customers and the suitability of the site itself (Slack, et al., 2007; Sarode, et al., 2010).

What physical capacity should each part of the network owned by the company have at any point in time? How large should the factory be? If it expands, should it do so in large capacity steps or small ones? Should it make sure that it always has more capacity than anticipated demand or less? These decisions are called long-term capacity management decisions. The amount of capacity an organization will have depends on its view of current and future demand. It is when its view of future demand is different from current demand that this issue becomes important. When an organization has to cope with changing demand, a number of capacity decisions need to be taken. These include choosing the optimum capacity for each site, balancing the various capacity levels of the operation in the network and timing the changes in the capacity of each part of the network. Important influences on these decisions include the concepts of economy and diseconomy of scale, supply flexibility if demand is different from that forecast, and the profitability and cash flow implications of capacity timing changes (Tompkins, 2010).

Layout and flow design

The layout design is concerned with the physical location of its transforming resources. This means deciding where to put all the facilities, machines, equipment and staff in the operation. And how it's positioned relative to each other and how its various tasks are allocated to these transforming resources. It also determines the way in which transformed resources – the materials, information and customers – flow through the operation (Tompkins, 2010; Stevensom, 2005).

Layout design influenced by process design because it is the physical manifestation of a process type, most practical layouts are derived from only four basic layout types. These are:

- Fixed-position layout
- Functional layout
- Cell layout
- Product layout

The relation between process types ad these four layout types is shown in Figure 2.3, a process type does not necessarily imply only one particular basic layout (Tompkins, 2010; Slack, et al., 2007).

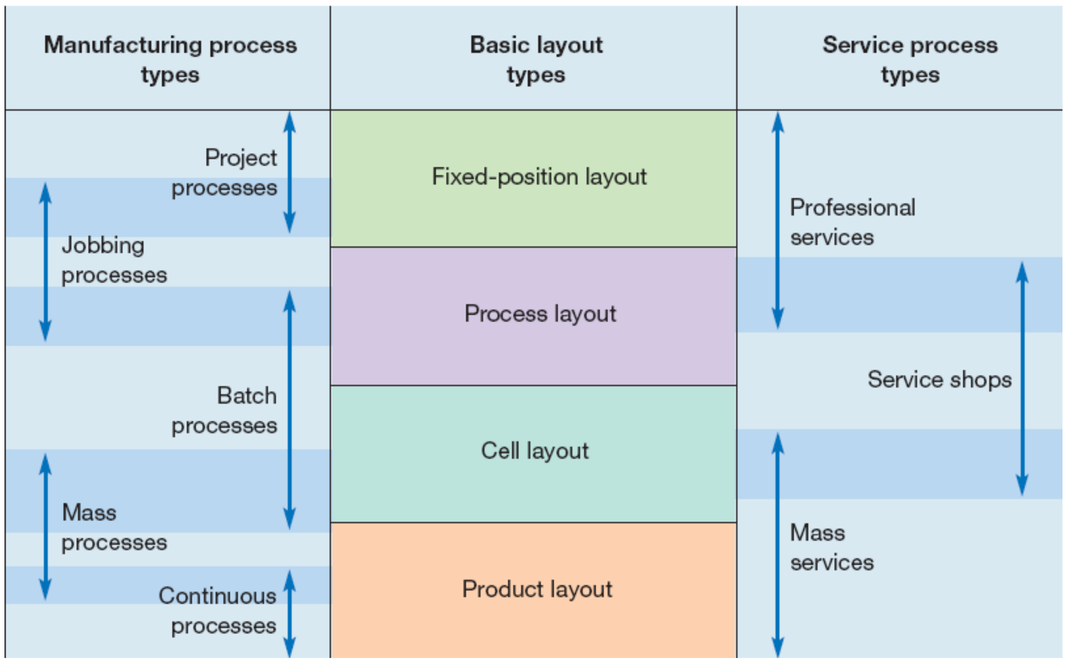

Figure 2.3: The relationship between process types and basic layout types

SOURCE: (NIGEL SLACK, 2007)

In fixed position layout, the main product being produced is fixed at a particular location. Resources, such as equipment, labor and material are brought to that fixed location. This type of layout is useful when the product being processed is very big, heavy or difficult to move. Some examples of fixed position layout are shipbuilding, aircraft assembly, farming, road building and home building, etc (Stevensom, 2005; Slack, et al., 2007).

Functional layout is also called as process layout. Similar machines or similar operations are located at one place as per the functions. For example, all milling operations are carried out at one place while all lathes are kept at a separate location. Grinding or finishing operation is kept at a separate location. This functional grouping of facilities is useful for job production and non-repetitive manufacturing environment. in this type of layout Different products or customers will have different needs and therefore take different routes. Usually this makes the flow pattern in the operation very complex. (Stevensom, 2005; Tompkins, 2010).

Cellular manufacturing is a type of layout where machines are grouped according to the process requirements for a set of similar items (part families) that require similar processing. These groups are called cells. Therefore, a cellular layout is an equipment layout configured to support cellular manufacturing. Processes are grouped into cells using a technique known as group technology (GT). Group technology involves identifying parts with similar design characteristics (size, shape, and function) and similar process characteristics (type of processing required, available machinery that performs this type of process, and processing sequence (Stevensom, 2005; Nazariana, et al., 2010).

Workers in cellular layouts are cross-trained so that they can operate all the equipment within the cell and take responsibility for its output. Sometimes the cells feed into an assembly line that produces the final product. In some cases a cell is formed by dedicating certain equipment to the production of a family of parts without actually moving the equipment into a physical cell (these are called virtual or nominal cells). In this way, the firm avoids the burden of rearranging its current layout. However, physical cells are more common (Tompkins, 2010).

An automated version of cellular manufacturing is the flexible manufacturing system (FMS). With an FMS, a computer controls the transfer of parts to the various processes, enabling manufacturers to achieve some of the benefits of product layouts while maintaining the flexibility of small batch production (Stevensom, 2005).

Product layouts are found in flow shops (repetitive assembly and process or continuous flow industries). Flow shops produce high-volume, highly standardized products that require highly standardized, repetitive processes. In a product layout, resources are arranged sequentially, based on the routing of the products. In theory, this sequential layout allows the entire process to be laid out in a straight line, which at times may be totally dedicated to the production of only one product or product version. The flow of the line can then be subdivided so that labor and equipment are utilized smoothly throughout the operation (Tompkins, 2010).

Two types of lines are used in product layouts: paced and unpaced. Paced lines can use some sort of conveyor that moves output along at a continuous rate so that workers can perform operations on the product as it goes by. For longer operating times, the worker may have to walk alongside the work as it moves until he or she is finished and can walk back to the workstation to begin working on another part (this essentially is how automobile manufacturing works).

On an un-paced line, workers build up queues between workstations to allow a variable work pace. However, this type of line does not work well with large, bulky products because too much storage space may be required. Also, it is difficult to balance an extreme variety of output rates without significant idle time. A technique known as assembly-line balancing can be used to group the individual tasks performed into workstations so that there will be a reasonable balance of work among the workstations (Slack, et al., 2007).

Product layout efficiency is often enhanced through the use of line balancing. Line balancing is the assignment of tasks to workstations in such a way that workstations have approximately equal time requirements. This minimizes the amount of time that some workstations are idle, due to waiting on parts from an upstream process or to avoid building up an inventory queue in front of a downstream process (Tompkins, 2010).

Many situations call for a mixture of more than one layout type. These mixtures are commonly called combination or hybrid layouts. For example, one firm may utilize a process layout for the majority of its process along with an assembly in one area. Alternatively, a firm may utilize a fixed-position layout for the assembly of its final product, but use assembly lines to produce the components and subassemblies that make up the final product (e.g., aircraft) (Stevensom, 2005).

In addition to the abovementioned layouts, there are others that are more appropriate for use in service organizations. These include warehouse/storage layouts, retail layouts, and office layouts.

With warehouse/storage layouts, order frequency is a key factor. Items that are ordered frequently should be placed close together near the entrance of the facility, while those ordered less frequently remain in the rear of the facility. Pareto analysis is an excellent method for determining which items to place near the entrance. Since 20 percent of the items typically represent 80 percent of the items ordered, it is not difficult to determine which 20 percent to place in the most convenient location. In this way, order picking is made more efficient (Evans, 2007).

While layout design is much simpler for small retail establishments (shoe repair, dry cleaner, etc.), retail stores, unlike manufacturers, must take into consideration the presence of customers and the accompanying opportunities to influence sales and customer attitudes. For example, supermarkets place dairy products near the rear of the store so that customers who run into the store for a quick gallon of milk must travel through other sections of the store. This increases the chance of the customer seeing an item of interest and making an impulse buy. Additionally, expensive items such as meat are often placed so that the customer will see them frequently (e.g., pass them at the end of each aisle). Retail chains are able to take advantage of standardized layouts, which give the customer more familiarity with the store when shopping in a new location (Slack, et al., 2007; Tompkins, 2010).

Office layouts must be configured so that the physical transfer of information (paperwork) is optimized. Communication also can be enhanced through the use of low-rise partitions and glass walls.

The volume–variety characteristics of the outputs will, to a large extent, narrow down the choice to one or two layout options. The decision as to which layout type to adopt will be influenced by an understanding of their relative advantages and disadvantages. Table 2.4 shows some of the more significant advantages and disadvantages associated with each layout type (Slack, et al., 2007).

Table 2.4: The advantages and disadvantages of the basic layout types

	Advantages	Disadvantages
Fixed-position	Very high mix and product flexibility	Very high unit costs
	Product or customer not moved or disturbed	Scheduling of space and activities can be difficult
	High variety of tasks for staff	Can mean much movement of plant and staff
Process	High mix and product flexibility	Low facilities utilization
	Relatively robust in the case of disruptions	Can have very high work-in-progress or customer queuing
	Relatively easy supervision of equipment or plant	Complex flow can be difficult to control
Cell	Can give a good compromise between cost and flexibility for relatively high-variety operations Fast throughput	Can be costly to rearrange existing layout
	Group work can result in good motivation	Can need more plant and equipment
		Can give lower plant utilization
Product	Low unit costs for high volume	Can have low mix flexibility
	Gives opportunities for specialization of equipment	Not very robust if there is disruption
	Materials or customer movement	Work can be very repetitive

SOURCE : (Nigel Slack, 2007)

Process technology selection

Process technology is the machines, equipment or devices that help operations to create or deliver products and services. Indirect process technology helps to facilitate the direct creation of products and services. There are three types of process technologies, material processing technologies, information processing technologies, and customer processing technologies. Tables 2.5, below illustrate an example of subcategory of the three types of process technologies (Slack, et al., 2007). Technology should reflect the volume and variety requirements of the work, high verity low volume processes required process technology that is general purpose which can perform wide range of processing activities that high verity demands, but high volume low variety processes need a dedicated process technology to its narrower range to is processing requirements.

All technologies can be conceptualized on three dimensions: the degree of automation of the technology, the scale or scalability of the technology and the degree of coupling or connectivity of the technology. The ratio of technological to human effort it employs is sometimes called the capital intensity of the process technology. Generally processes that have high variety and low volume will employ process technology with lower degrees of automation than those with higher volume and lower variety, moving towards more automated technology is often justified on the labor costs saved, but that does not always mean that the net effect is an overall cost saving (Slack, et al., 2007).

Table 2.5: Examples of subcategory of the three types of process technologies

Materials-processing technologies CNC machine tools	
What does it do?	Performs the same types of metal-cutting and forming operations which have always been done, but with control provided by a computer
How does it do it?	Preprogrammed instructions are read from a disk, tape or paper tape by a computer which activates the physical controls in the machine tool
What advantages does it give?	Precision, accuracy, optimum use of cutting tools which maximizes their life and higher labor productivity
What constraints does it impose?	Higher capital cost than manual technology. Needs skilled staff to preprogram
Information-processing technologies Local area network (LANs) and wireless LAN	
What does it do?	Allows decentralized information processors such as personal computers to communicate with each other and with shared devices over a limited distance
How does it do it?	Through a hard-wired, or wireless, network and shared communication protocols
What advantages does it give?	Flexibility, easy access to other users, shared databases and applications software
What constraints does it impose?	The cost of installing the network can be high initially
Customer processing technologies Bar-code scanner	
What does it do?	Tracks items, for example usage, costs, movement
How does it do it?	Links individual items to central information processing
What advantages does it give?	Fast and easy detailed information about items
What constraints does it impose?	Requires wide-scale usage and acceptance of bar-coding and common conventions

SOURCE : (Nigel Slack, 2007)

Scalability means the ability to shift to a different level of useful capacity quickly and cost effectively, the advantage of large-scale technologies is that they can usually process items cheaper than small-scale technologies, but usually need high volume and can cope only with low variety. By contrast, the virtues of smaller-scale technology are often the nimbleness and flexibility that are suited to high-variety, lower-volume processing (Slack, et al., 2007).

Coupling or connectivity means the linking together of separate activities within a single piece of process technology to form an interconnected processing system. Tight coupling usually gives fast process throughput, Tight coupling also means that flow is simple and predictable, making it easier to keep track of parts when they pass through fewer stages or information when it is automatically distributed to all parts of an information network, closely coupled technology can be both expensive (each connection may require capital costs) and vulnerable (a failure in one part of an interconnected system can affect the whole system) (Slack, et al., 2007).

Like many 'design' decisions, technology choice is a relatively long-term issue. It can have a significant effect on the operation's strategic capability. Because of that in order to make technology choices, it is useful to return to the two perspectives market requirements perspective, which emphasizes the importance of satisfying customer needs, and the operations resource perspective, which emphasizes the importance of building the intrinsic capabilities of operations resources. Both these perspectives provide useful views of technology choice. In addition, the more conventional financial perspective is clearly important. Together, these three perspectives provide useful questions which can form the basis for technology evaluation and chosen.

Market requirements perspective can be translate into operation objectives by using five performance objectives, **the quality** which means choosing that process technology which gives the customers the quality he won't, **the Speed** which mean the pace of introducing customer requirements, **the dependability** which means how reliable the system is? **The flexibility** which means how flexible the system is? And finally **the cost** of process technology and its maintenance which directly affecting the cost of the outputs (Slack, et al., 2007; Evans, 2007).

Any process technology resource can be evaluated operationally by looking to the two factors, **intrinsic constrains** which means the things it will find difficult to do because of the acquisition of the technology, and **capabilities** which means the things which the operation can now do because of the technology (Slack, et al., 2007).

Financial evaluation involves the use of some of the more common evaluation approaches, such as net present value which give some future values which can be gained by owning this process technology (Slack, et al., 2007).

Job design and work organization

Job design is about how we structure individuals' jobs and the workplace or environment in which they work and their interface with the technology they use. Work organization, although used sometimes interchangeably with job design, is a broader term that considers the organization of the whole operation, material, technology and people, to achieve the operations objectives. In essence job design and work organization defines the way in which people go about their working lives. It positions their expectations of what is required of them and it influences their perceptions of how they contribute to the organization. It defines their activities in relation to their work colleagues and it channels the flow of communication between different parts of the operation. But most importantly it helps to develop the culture of the organization – its shared values, beliefs and assumptions (Slack, et al., 2007; Nazariana, et al., 2010).

Job design consists of six main elements each one defined by answering its question which illustrated below:

What are the environmental conditions of the workplace?

The conditions under which jobs are performed will have a significant impact on people's effectiveness, comfort and safety. This is called ergonomic environmental design. It is concerned with issues such as noise, heat and light in the workplace.

What technology is available and how will it be used?

The vast majority of operational tasks require the use of technology, even if the technology is not sophisticated. Not only does the technology need to be appropriate and designed well, so does the interface between the people and the hardware. This is called ergonomic workplace design.

What tasks are to be allocated to each person in the operation?

Producing goods and services involves a whole range of different tasks which need to be divided between the people who staff the operation. Different approaches to the division of labor will lead to different task allocations.

What is the best method of performing each job?

Every job should have an approved method of completion and this should be the 'best' method. Although there are different ideas of what is 'best', it is generally the most efficient method but that fits the task and does not unduly interfere with other tasks. This is usually referred to as work study – one element of scientific management.

How long will it take and how many people will be needed?

The second element of scientific management is work measurement. Work measurement helps us calculate the time required to do a job so that we can then work out how many people we will need.

How do we maintain commitment?

Keeping staff motivated is not easy. There is a danger that in considering the previous questions it may be tempting to see the person as a unit of resource rather than a human being with feeling and emotions. So understanding how we can encourage people and maintain their commitment is the most important of the issues in job design and work organization. This is concerned with the behavioral approaches to job design including empowerment, teamwork and flexible working (Slack, et al., 2007).

2.2.2.2 Planning and control

Planning and control is the reconciliation of the potential of the operation to supply products and services, and the demands of its customers on the operation. It is the set of day-to-day activities that runs the operation on an ongoing basis.

A plan is a formalization of what is intended to happen at some time in the future. Control is the process of coping with changes to the plan and the operation to which it relates. Although planning and control are theoretically separable, they are usually treated together. The balance between planning and control changes over time. Planning dominates in the long term and is usually done on an aggregated basis. At the other extreme, in the short term, control usually operates within the resource constraints of the operation but makes interventions into the operation in order to cope with short-term changes in circumstances (Slack, et al., 2007).

The degree of uncertainty in demand affects the balance between planning and control. The greater the uncertainty, the more difficult it is to plan and greater emphasis must be placed on control. This idea of uncertainty is linked with the concepts of dependent and independent demand. Dependent demand is relatively predictable because it is dependent on some known factor. Independent demand is less predictable because it depends on the chances of the market or customer behavior (Tompkins, 2010).

In planning and controlling the volume and timing of activity in operations, four distinct activities are necessary:

- Loading, this dictates the amount of work that is allocated to each part of the operation.
- Sequencing, this decides the order in which work is tackled within the operation.
- Scheduling, this determines the detailed timetable of activities and when activities are started and finished.
- Monitoring and control, which involve detecting what is happening in the operation, preplanning if necessary and intervening in order to impose new plans. Two important types are ‘pull’ and ‘push’ control. Pull control is a system whereby demand is triggered by requests from a work centre’s (internal) customer. Push control is a centralized system whereby control (and sometimes planning) decisions are issued to work centers which are then required to perform the task and supply the next workstation. In manufacturing, ‘pull’ schedules generally have far lower inventory levels than ‘push’ schedules.

Capacity planning and control

Capacity is the way operations organize the level of value-added activity which they can achieve under normal operating conditions over a period of time. Usual there is distinguishing between long-, medium- and short-term capacity decisions. Medium and short-term capacity management where the capacity level of the organization is adjusted within the fixed physical limits which are set by long-term capacity decisions is sometimes called aggregate planning and control. Almost all operations have some kind of fluctuation in demand (or seasonality) caused by some combination of climatic, festive, behavioral, political, financial or social factors (Slack, et al., 2007; Stevensom, 2005).

Capacity measured either by the availability of its input resources or by the output which is produced. Which of these measures is used partly depends on how stable is the mix of outputs. If it is difficult to aggregate the different types of output from an operation, input measures are usually preferred. The usage of capacity is measured by the factors 'utilization' and 'efficiency'. A more recent measure is that of overall equipment effectiveness (OEE) (Tompkins, 2010; Slack, et al., 2007).

There are deferent strategies used in order to coping with demand fluctuation such as:

- Output can be kept level, in effect ignoring demand fluctuations. This will result in underutilization of capacity where outputs cannot be stored or the build-up of inventories where output can be stored.
- Output can chase demand by fluctuating the output level through some combination of overtime, varying the size of the workforce, using part-time staff and sub-contracting
- Demand can be changed, either by influencing the market through such measures as advertising and promotion or by developing alternative products with a counter-seasonal demand pattern.
- Most operations use a mix of all these three 'pure' strategies.

Capacity level can be control by considering the capacity decision as a dynamic decision which periodically updates the decisions and assumptions upon which decisions are based (Tompkins, 2010).

Inventory planning and control

Inventory, or stock, is the stored accumulation of the transformed resources in an operation. Sometimes the words 'stock' and 'inventory' are also used to describe transforming resources, but the terms stock control and inventory control are nearly always used in connection with transformed resources. Almost all operations keep some kind of inventory, most usually of materials but also of information and customers (customer inventories are normally called queues). Inventory occurs in operations because the timing of supply and the timing of demand do not always match. Inventories are needed, therefore, to smooth the differences between supply and demand (Stevensom, 2005).

There are five main reasons for keeping inventory:

- To cope with random or unexpected interruptions in supply or demand (buffer inventory).
- To cope with an operation's inability to make all products simultaneously (cycle inventory).
- To allow different stages of processing to operate at different speeds and with different schedules (de-coupling inventory).
- To cope with planned fluctuations in supply or demand (anticipation inventory).
- To cope with transportation delays in the supply network (pipeline inventory).

Inventory amount which have to be hold depends on balancing the costs associated with holding stocks against the costs associated with placing an order. The main stock-holding costs are usually related to working capital, whereas the main order costs are usually associated with the transactions necessary to generate the information to place an order (Tompkins, 2010).

The best known approach to determining the amount of inventory to order is the economic order quantity (EOQ) formula. The EOQ formula can be adapted to different types of inventory profile using different stock behavior assumptions. EOQ approach, however, has been subject to a number of criticisms regarding the true cost of holding stock, the real cost of placing an order and the use of EOQ models as prescriptive devices (Slack, et al., 2007).

Inventory replenishment depends on the uncertainty of demand. Orders are usually timed to leave a certain level of average safety stock when the order arrives. The level of safety stock is influenced by the variability of both demand and the lead time of supply. These two variables are usually combined into a lead-time usage distribution. Using re-order level as a trigger for placing replenishment orders necessitates the continual review of inventory levels. This can be time-consuming and expensive. An alternative approach is to make replenishment orders of varying size but at fixed time periods. Inventory is usually managed through sophisticated computer-based information systems which have a number of functions: the updating of stock records, the generation of orders, the generation of inventory status reports and demand forecasts. These systems critically depend on maintaining accurate inventory records (Slack, et al., 2007; Tompkins, 2010).

Supply chain planning and control

Supply chain management is a broad concept which includes the management of the entire supply chain from the supplier of raw material to the end customer; supply chain component activities include purchasing, physical distribution management, logistics, materials management and customer relationship management (CRM) (Tompkins, 2010).

Supply networks are made up of individual pairs of buyer–supplier relationships. The use of internet technology in these relationships has led to a categorization based on a distinction between business and consumer partners. Business to business (B2B) relationships is of the most interest in operations management terms. They can be characterized on two dimensions what is outsourced to a supplier, and the number and closeness of the relationships (Sarode, et al., 2010).

Traditional market supplier relationships are where a purchaser chooses suppliers on an individual periodic basis. No long-term relationship is usually implied by such ‘transactional’ relationships, but it makes it difficult to build internal capabilities. Partnership supplier relationships involve customers forming long-term relationships with suppliers. In return for the stability of demand, suppliers are expected to commit to high levels of service. True partnerships are difficult to sustain and rely heavily on the degree of trust which is allowed to build up between partners (Tompkins, 2010).

Marshall Fisher distinguishes between functional markets and innovative markets. He argues that functional markets, which are relatively predictable, require efficient supply chains, whereas innovative markets, which are less predictable, require ‘responsive’ supply chains (Slack, et al., 2007).

Enterprise resource planning (ERP)

ERP is an enterprise-wide information system that integrates all the information from many functions that is needed for planning and controlling operations activities. This integration around a common database allows for transparency. It often requires very considerable investment in the software itself, as well as its implementation. More significantly, it often requires a company’s processes to be changed to bring them in line with the assumptions built into the ERP software.

ERP can be seen as the latest development from the original planning and control approach known as materials requirements planning (MRP). Increased computer capabilities allowed MRP systems to become more sophisticated and to interface with other information technology systems within the business to form manufacturing resources planning or MRP II.

MRP stands for materials requirements planning which is a dependent demand system that calculates materials requirements and production plans to satisfy known and forecast sales orders. It helps to make volume and timing calculations based on an idea of what will be necessary to supply demand in the future. MRP works from a master production schedule which summarizes the volume and timing of end products or services. Using the logic of the bill of materials (BOM) and inventory records, the production schedule is ‘exploded’ (called the MRP netting process) to determine how many sub-assemblies and parts are required and when they are required. Closed-loop MRP systems contain feedback loops which ensure that checks are made against capacity to see whether plans are feasible (Slack, et al., 2007).

MRP II systems are a development of MRP. They integrate many processes that are related to MRP, but which are located outside the operation's function. A system which performs roughly the same function as MRP II is optimized production technology (OPT). It is based on the theory of constraints, which has been developed to focus attention on capacity bottlenecks in the operation.

Although ERP is becoming increasingly competent at the integration of internal systems and databases, there is the even more significant potential of integration with other organizations' ERP (and equivalent) systems, the use of internet-based communication between customers, suppliers and other partners in the supply chain has opened up the possibility of web-based integration (Slack, et al., 2007).

Quality planning and control

Many deferent definition for quality have been introduce; the manufacturing-based approach which views quality as being 'free of errors; the user-based approach which views quality as fit for purpose; the product based approach which views quality as a measurable set of characteristics; and the value-based approach which views quality as a balance between cost and price (Kim & Gershwin, 2005).

Quality is best modeled as the gap between customer's expectations concerning the product or service and their perceptions concerning the product or service. Modeling quality this way will allow the development of a diagnostic tool which is based around the perception–expectation gap. Such a gap may be explained by four other gaps:

- The gap between a customer's specification and the operation's specification.

- The gap between the product or service concept and the way the organization has specified it.

- The gap between the way quality has been specified and the actual delivered quality.
- The gap between the actual delivered quality and the way the product or service has been described to the customer.

Six steps can lead any operation to conform the specification of any output, define quality characteristics, and decide how to measure each of the quality characteristics, set quality standards for each characteristic, control quality against these standards, find and correct the causes of poor quality, continue to make improvements (Mykityshyn & Rouse, 2007).

Most quality planning and control involves sampling the operation's performance in some way. Sampling can give rise to erroneous judgments which are classed as either type I or type II errors. Type I errors involve making corrections where none is needed. Type II errors involve not making corrections where they are in fact needed.

Statistical process control (SPC) involves using control charts to track the performance of one or more quality characteristics in the operation. The power of control charting lies in its ability to set control limits derived from the statistics of the natural variation of processes. These control limits are often set at ± 3 standard deviations of the natural variation of the process samples (Tompkins, 2010).

Control charts can be used for either attributes or variables. An attribute is a quality characteristic which has two states (for example, right or wrong). A variable is one which can be measured on a continuously variable scale. Process control charts allow operations managers to distinguish between the 'normal' variation inherent in any process and the variations which could be caused by the process going out of control (Evans, 2007).

2.2.2.3 Improvement

Before choosing improvement approach in any enterprise or any operation there is a need to make a performance measurement which is the activity of measuring and assessing the various aspects of a process or whole operation's performance.

Performance measurement is the process of quantifying action, where measurement means the process of quantification and the performance of the operation is assumed to derive from actions taken by its management. Performance here is defined as the degree to which an operation fulfils the five performance objectives at any point in time, in order to satisfy its customers. Some kind of performance measurement is a prerequisite for judging whether an operation is good, bad or indifferent. Without performance measurement, it would be impossible to exert any control over an operation on an on-going basis (Shingo, 1988; Slack, et al., 2007).

The five generic performance objectives – quality, speed, dependability, flexibility and cost – can be broken down into more detailed measures, Table 2.6 , or they can be aggregated into composite measures, such as customer satisfaction, overall service level or operations agility. These composite measures may be further aggregated by using measures such as achieve market objectives, achieve financial objectives, achieve operations objectives even achieve overall strategic objectives. The more aggregated performance measures have greater strategic relevance in so much as they help to draw a picture of the overall performance of the business, although by doing so they necessarily include many influences outside those that operations performance improvement would normally address. The more detailed performance measures are usually monitored more closely and more often, and although they provide a limited view of an operation's performance, they do provide a more descriptive and complete picture of what should be and what is happening within the operation. In practice, most organizations will choose to use performance targets from throughout the range. This idea is illustrated in Figure 2.4 (Slack, et al., 2007; Evans, 2007).

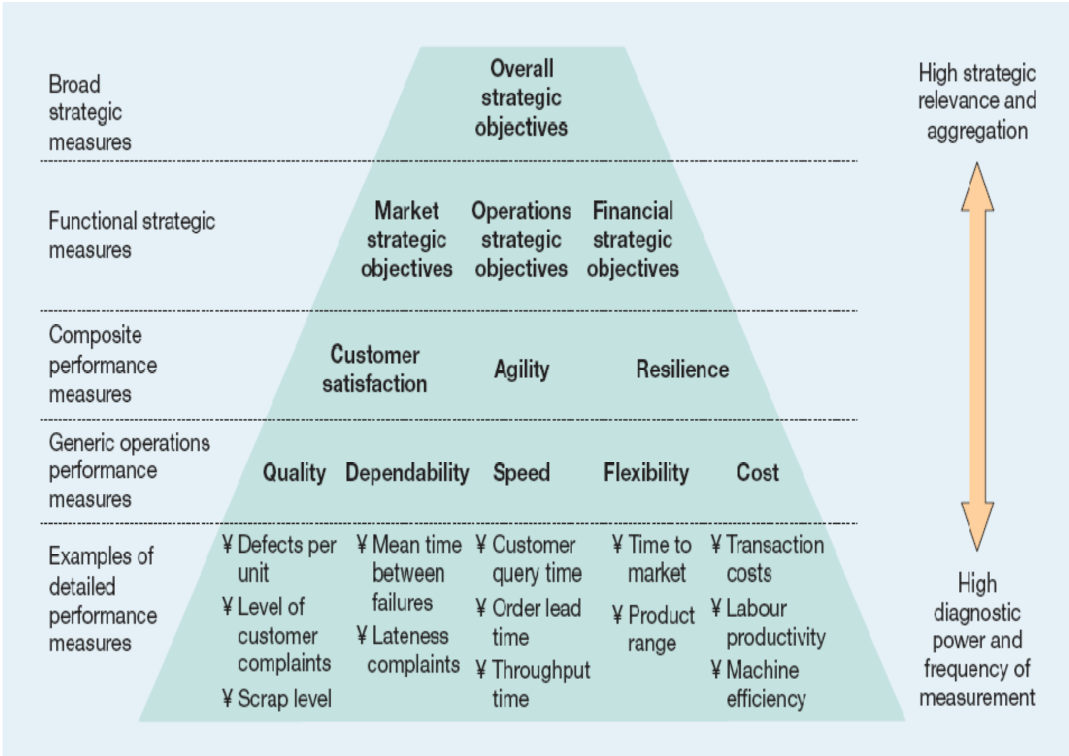

Figure 2.4: Performance measures can involve different levels of aggregation

SOURCE : (Nigel Slack, 2007)

It is unlikely that for any operation a single measure of performance will adequately reflect the whole of a performance objective. Usually operations have to collect a whole bundle of partial measures of performance. Each partial measure then has to be compared against some performance standard. There are four types of performance standard commonly used:

- Historical standards, which compare performance now against performance sometime in the past.
- Target performance standards, which compare current performance against some desired level of performance.
- Competitor performance standards, which compare current performance against competitors' performance.

- Absolute performance standards, which compare current performance against its theoretically perfect state.

Table 2.6: Some typical partial measure of performance

SOURCE : (Nigel Slack, 2007)

Performance objectives	Some typical measures
Quality	Number of defects per units
	Level of customer complaints
	Scrap level
	Warranty claims
	Mean time between failures
	Customer satisfaction score
Speed	Customer query time
	Order lead time
	Frequency of delivery
	Actual versus theoretical throughput time
	Cycle time
Dependability	Percentage of order delivery late
	Average lateness of order
	Proportion of products in stock
	Mean deviation from promised arrival
	Schedule adherence
Flexibility	Time needed to develop new products/services
	Range of products/services
	Average batch size
	Time to increase activity rate
	Average capacity/maximum capacity
	Time to change schedules
Cost	Minimum delivery time/average delivery time
	Variance against budget
	Utilization of resources
	Labor productivity
	Added value
	Efficiency
	Cost per operation hour

Benchmarking

Benchmarking is 'the process of learning from others' and involves comparing one's own performance or methods against other comparable operations. It is a broader issue than setting performance targets and includes investigating other organizations' operations practice in order to derive ideas that could contribute to performance improvement. Its rationale is based on the idea that, problems in managing processes are almost certainly shared by processes elsewhere, and there is probably another operation somewhere that has developed a better way of doing things (Slack, et al., 2007).

There are many different types of benchmarking, some of which are listed below:

- **Internal benchmarking** is a comparison between operations or parts of operations which are within the same total organization. For example, a large motor vehicle manufacturer with several factories might choose to benchmark each factory against the others.
- **External benchmarking** is a comparison between an operation and other operations which are part of a different organization.
- **Non-competitive benchmarking** is benchmarking against external organizations which do not compete directly in the same markets.
- **Competitive benchmarking** is a comparison directly between competitors in the same, or similar, markets.
- **Performance benchmarking** is a comparison between the levels of achieved performance in different operations. For example, an

operation might compare its own performance in terms of some or all of our performance objectives – quality, speed, dependability, flexibility and cost – against other organizations' performance in the same dimensions.

- **Practice benchmarking** is a comparison between an organization's operations practices, or way of doing things, and those adopted by another operation. For example, a large retail store might compare its systems and procedures for controlling stock levels with those used by another department store.

Benchmarking is a continuous process of comparison, it does not provide solutions; rather, it provides ideas and information that can lead to solutions, and it does not involve simply copying or imitating other operations, it is a process of learning and adapting in a pragmatic manner benchmarking cannot be done without some investment, but this does not necessarily mean allocating exclusive responsibility to a set of highly paid managers (Evans, 2007).

Approaches to improvement

An organization's approach to improving its operation can be characterized as lying somewhere between the two extremes of 'pure' breakthrough improvement and 'pure' continuous improvement (Slack, et al., 2007).

Breakthrough improvement, which is sometimes called innovation-based improvement**,** sees improvement as occurring in a few, infrequent but major and dramatic changes. Although such changes can be abrupt and volatile, they often incorporate radical new concepts or technologies which can shift the performance of the operation significantly (Slack, et al., 2007).

Continuous improvement assumes a series of never-ending, but smaller, incremental improvement steps. This type of improvement is sometimes called kaizen improvement. It is gradual and constant, often using collective group-based problem-solving. It does not focus on radical change but rather attempts to develop a built-in momentum of improvement (Slack, et al., 2007).

2.3 Summery

The structural and infrastructural aspects of any enterprise can be strongly integrate, that done by taking into account the relation between strategic planning activities which have to be effectively prepared based on the environment, resources, and capabilities available, and the physical issues which should be use in order to fulfill the goals and objectives for all of the operations and functions within the organization whatever it's a large, medium, or small in its size, simple or complex in its structure, local or international in its market.

Many schools of strategic planning have been founded, each one classified enterprises based on specific rules and principles, those rules identify the directions where the enterprise go after studying its internal and external forces, the closest classification to our research environment (Palestine) was Miles and Snow typology which classified the firms with regard to the business strategy that it uses into four main categories, prospector, analyzer, defender, and reactor, based on this classification the most critical functional strategies which is manufacturing strategy have to be chosen, and the integration features between all of the operations in the organization and between the strategic planning, operation planning, tactical planning, processes and layout design, technology used, HR, and financial issues will be clearly appear and oriented to maximize the work effectiveness and efficiency.

Chapter 3

3 .Methodology

3.1 Introduction

This chapter aims to provide an overview of the methodological approaches and research design selected to design effective manufacturing systems for industrial environment in Palestine, That through study the actual situation of the current manufacturing systems which currently working in research environment, and also through reviewing the global manufacturing systems, includes some latest researches about such topic. The food manufacturing sector was used as a tested sample in order to explore research environment features and characteristics.

The thesis investigates the gap between current used systems and similar success global manufacturing systems, the special condition for the research environment is enrolled in the designing stage of the framework. Furthermore the thesis provides a detailed description of the process of manufacturing system design which should achieve the highest efficiency and productivity by producing the products which meet consumer satisfaction in quality, price and good delivery, taking into account the optimal use of all elements of production. Therefore the success of the manufacturing system is linked to improving the production efficiency. This means an optimal choice of the production process and an optimal use of the three major elements of the manufacturing process (inputs, production process and outputs).

Finally, a proposal for framework implementation process be proposed and the proposal defended through using suitable tools required to identifying deferent designing stages requirements, considerations or constraints.

3.2 Research Background

3.2.1 Research Hypotheses

H1. The production facilities in Palestine suffer from weakness in strategic planning process.

H2. The actual situation of production enterprises in Palestine is not compatible with their pre-investment plans and business plans.

H3. Palestinian production enterprises suffer from some problems in the design and selection of their processes components such as inventories, layout, factory size, tools and equipments, and others.

3.2.2 Research Questions

1. What are the gaps between Palestine enterprises' manufacturing systems and the modern and manufacturing systems used in successful world enterprises?
2. What is the suitable manufacturing system design framework that can be used in the research environment – Palestine- with regarding to its special conditions?

3.2.3 Research Objectives

1. To clarify the current situation of research environment enterprise's manufacturing systems.
2. To improve and customize a framework for manufacturing systems design used in research environment (i.e. Palestine).
3. To introduce a process prescription for the framework implementation steps.
4. To add a contribution to the understanding of the design of integrated manufacturing systems methodologies.

3.3 Research Design and Methodology

A research methodology references the procedural rules for the evaluation of research claims and the validation of the knowledge gathered, while research design functions as the research blueprint (Creswell, 2003). As Sekaran (2003) further clarifies, a research methodology may be defined as academia's established regulatory framework for the collection and evaluation of existent knowledge for the purpose of arriving at, and validating, new knowledge. Cooper and Schindler (1998) said that the determination of the research methodology is one of the more important challenges which confronts the researcher. In essence, the research activity is a resource consumptive one, and must maintain its purposeful or functional activity through the justification of resource expenditure. In other words, given that research is ultimately defined as constructive, the resources that it utilizes must fulfill explicit purposes and withstand critical scrutiny. Research methodology occupies a position of unique importance. A methodology does not simply frame a study but it identifies the research tools and strategies (i.e. resources) that will be employed, and relates their use to specified research aims. As Sekaran (2003) suggests, its importance emanates from the fact that it defines the activity of a specified research, its procedural methods, strategies, for progress measurement and criteria for research success.

Within the context of the research methodology, each research poses a set of unique questions and articulates a specified group of objectives. The research design functions to articulate the strategies and tools by and through which empirical data will be collected and analyzed. It additionally serves to connect the research questions to the data and articulate the means by which the research hypothesis shall be tested and the research objectives satisfied (Punch, 2000). In order to satisfy the stated, the research design has to proceed in response to four interrelated research problems. These are (1) the articulation and selection of the research questions; (2) the identification of the relevant data; (3) determination of data collection focus; and (4) the selection of the method by which the data will be analyzed and verified (Punch, 2000).

Although research methodology and research design are distinct academic constructs, Punch (2000) maintains the former to be more holistic than the latter and, in fact, inclusive of it.

3.3.1 Research Purpose

Research scholars have identified three main purposes to the research activity. These are the exploratory, the descriptive and the explanatory purposes (Saunders, 2000). Patton (1990) identifies a fourth purpose which he defines as the prescriptive objective. Proceeding from Jackson's (1994) contention that the researcher should identify the purpose(s) by correlating the research questions to the research objectives, this is precisely the strategy that the current research shall adopt.

3.3.1.1 Exploratory

Exploratory research unfolds through focus group interviews, structured or semi structured interviews with experts and a search of the relevant literature (Saunders, 2000). Its primary purpose is the exploration of a complex research problem or phenomenon, with the objective being the clarification of the identified complexities and the exposition of the underlying nature of the selected phenomenon. In other words, and as Robson (2002) explains, exploratory research investigates a specified problem/phenomenon for the purpose of shedding new light upon it and, consequently, uncovering new knowledge. The research questions directly tie in with, and compliment one another. They additionally correlate to research objectives and are fundamentally explorative in nature.

3.3.1.2 Descriptive

Punch (2000) explains the purpose of the descriptive research as the collection, organization and summarization of information about the research problem and issues identified therein. Similar to the descriptive research, it renders complicated phenomenon and issues more understandable. Dane's (1990) definition of the descriptive research and its purposes coincides with the stated. Descriptive research entails the thorough examination of the research problem, for the specified purpose of describing the phenomenon, as in defining, measuring and clarifying it (Dane, 1990).

Jackson (1994) contends that all research is partly descriptive in nature. The descriptive aspect of a research is, simply stated, the (1) who, (2) what, (3) when, (4) where, (5) why, and (6) how of the study.

Proceeding from the above and bearing in mind that the first research question is partly descriptive in nature; the research adopts a descriptive purpose in parts. To answer the research question, and test the proposed hypotheses, it is necessary to ask (1) What are the characteristics of the current foodstuff manufacturing systems? (2) Why is there clear gap between research environment manufacturing systems and the global manufacturing systems? (3) How can we reduce such gaps? These questions, immediately correlate to the research objectives, are integral to the testing of the hypotheses and are essential for the answering of the research questions. More importantly, these questions are descriptive in nature, it will be answered through the literature review and as such impose a descriptive purpose upon the research.

3.3.1.3 Explanatory

Miles and Huberman (1994) define the function of explanatory research as the clarification of relationship between variables and the componential elements of the research problem. Explanatory research, in other words, functions to highlight the complex interrelationships existent within, and around, a particular phenomenon and contained within the research problem (Miles & Huberman, 1994). Expounding upon this, Punch (2000) asserts that explanatory, or causal research, elucidates upon the nature of the problem under investigation and explains the basis for the proposed solution. It is an explanation of the complex web of interrelated variables identified and follows directly from a clearly stated central research hypothesis and research question.

While both research questions have an undeniably descriptive component to them, they possess a fundamentally explorative intent. Responding to these questions necessitates the clarification of the variable relating to the manufacturing systems components design. The research questions can only be satisfactorily answered, and the requirements of research objectives 1, 2 and 3 can only be adequately satisfied if the relationships between the three levels of the manufacturing system design are explained. Accordingly, the research shall further adopt an explanatory purpose.

3.3.1.4 Prescriptive

Hair et al. (2003) defines prescriptive research as studies which purport to propose well defined solutions to the investigated research problem. A prescriptive research does not simply prescribe a set of solutions or recommendations but presents a well-defined, comprehensively explained and implementable blueprint for a specified solution. Patton (1990) contends that the prescriptive research purpose builds upon the other purposes but extends beyond them in one key aspect. Whereas the descriptive, exploratory and explanatory purposes focus upon facts on ground, the prescriptive approach focuses on what should be. Research scholars, concurring, have determined that research which embraces the prescriptive purpose tend to be more valuable than those which eschew it, as they add to a field and expand its parameters (Patton, 1990; Jackson, 1994; Punch, 2000; Cooper & Schindler, 2005; Hair, et al., 1992; Ghauri & Gronhaug, 2005)

The second research question and research objective 4 impose a fundamentally prescriptive purpose upon the study. Quite simply, the ultimate objective of the research is the proposal of a manufacturing system design framework which includes a successful implementation to the research environment foodstuff enterprises. Consequently, while the research has undeniably descriptive, exploratory and explanatory purposes, its ultimate purpose is prescriptive in nature.

3.4 Research Approach

The selection of the research approach is, according to a critically important decision. The research approach does not simply inform the research design but it gives the researcher the opportunity to critically consider how each of the various approaches may contribute to, or limit, his study, allow him/her to satisfy the articulated objectives and design an approach which best satisfies the research's requirements (Creswell, 2003).

The research approach embraces the quantitative versus the qualitative and the deductive versus the inductive. Each set of approaches is commonly perceived of as referring to polar opposites (Hair, et al., 1992). Jackson (1994) takes issue with this perception and contends that a researcher should not limit himself to a particular approach but, instead should use a variety of approaches, if and when required by his study.

3.4.1 The Deductive versus the Inductive Approach

Marcoulides (1998) defines the deductive approach as a testing of theories. The researcher proceeds with a set of theories and conceptual precepts in mind and formulates the study's hypotheses on their basis. Following from that, the research proceeds to test the proposed hypotheses. The inductive approach, on the other hand, follows from the collected empirical data and proceeds to formulae concepts and theories in accordance with that data, see Figure 3.1 (Marcoulides, 1998). While not disputing the value of the deductive approach, the research opted for the inductive approach, or the bottom-up as opposed to the top-down method.

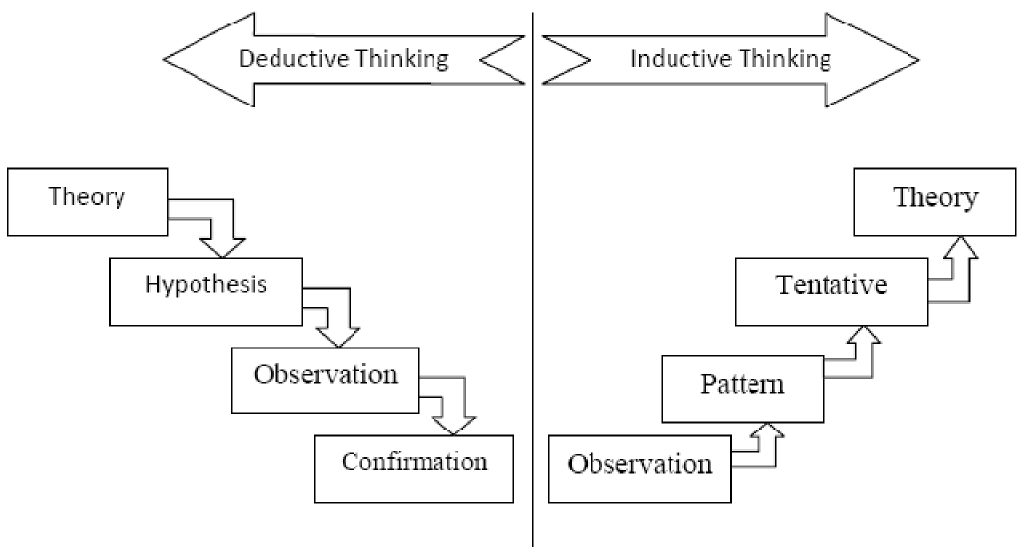

Figure 3.1: Deductive and inductive thinking

Source: adapted from Trochim (2001)

3.4.2 The Qualitative versus the Quantitative Approach

The quantitative tools for data analysis generally borrow from the physical sciences, in that they are structured in such a way so as to guarantee (as far as possible), objectivity, generalizability and reliability (Creswell, 2003). Here the researcher is viewed as external to the research and results are expected to be constant if the study is replicated, regardless of the identity of the researcher.

Accordingly, the matrix of quantitative research techniques is inclusive of random and unbiased selection of respondents. It is primarily used for the production of generalizable data for such purposes as evaluation of outcomes, tending towards the near total decentralization of human behavior. It is such decentralization that raises criticisms amongst those who tend to exhibit preference for qualitative tools, arguing that these offer insight into perceptions and interactions (Creswell, 2003). Accordingly, whereas questionnaires are leading tools for the first, qualitative methods include interviews, observations and focus groups, are designed to explicate the underlying meaning/cause behind selected phenomenon. In other words, while qualitative tools analyze the reasons behind a particular phenomenon, quantitative tools analyze the phenomenon itself, independent of human perceptions of reasons why (Creswell, 2003).

In comparison, quantitative tools are used for the production of statistical data which proceeds from the availability of quantitative data, essentially decontextualizing the human factor. The first of these tools, means, standard deviations and frequency distribution is a cost efficient method of reducing close-ended questionnaire data into straightforward statistics, representing the average and variability of responses, with the frequency distribution functioning as the graphical representation of the number of times particular responses were given. This tool reduces data to comprehensible, manageable and (ideally) objective numerical or graphical representations (Creswell, 2003). The second tool, cross tabulation, scatter diagram, and correlation coefficients, goes a step beyond the first in the sense that it draws conclusions on the relationship between the variables. The last tool, difference tests, measures one sample group against a baseline for purpose of examining the differences between specific variables over a time frame (Creswell, 2003).

From this the researcher can conclude that the conditions necessitating the use of quantitative tools includes presence of quantifiable research data and the goal of reducing that data into straightforward statistical representations of basic facts regarding aspects in the inputs, outputs or design components in any of the organization, group and individual levels.

The differences between the quantitative and qualitative approached are illustrated in Table 3.1:

According to Punch's (2000) advice that a research's value is inevitably maximized should it exploit both approaches, this research shall contain both quantitative and qualitative approach. The questioner or the survey as long as interviews approaches have been adapted in order to collect the data required for this research.

Table 3.1: Distinction between Quantitative and Qualitative Methods

Quantitative research	Qualitative research
Objective is to test hypotheses that the researcher generates.	Objective is to discover and encapsulate meanings once the researcher becomes immersed in the data.
Concepts are in the form of distinct variables	Concepts tend to be in the form of themes, motifs, generalizations, and taxonomies. However, the objective is still to generate concepts.
Measures are systematically created before data collection and are standardized as far as possible; e.g. measures of job satisfaction.	Measures are more specific and may be specific to the individual setting or researcher; e.g. a specific scheme of values.
Data are in the form of numbers from precise measurement.	Data are in the form of words from documents, observations, and transcripts. However, quantification is still used in qualitative research.
Theory is largely causal and is deductive.	Theory can be causal or non-causal and is often inductive.
Procedures are standard and replication is assumed.	Research procedures are particular and replication is difficult.
Analysis proceeds by using statistics, tables, or charts and discussing how they relate to hypotheses.	Analysis proceeds by extracting themes or generalizations from evidence and organizing data to present a coherent, consistent picture. These generalizations can then be used to generate hypotheses.

Source: Creswell (2003)

3.4.3 Research Strategy

Robson (2002) identifies three research strategies, or plans for responding to the research question. These are the experimental, the survey and the case study strategies. A researcher may select one, or even all three of these strategies, depending on the requirements of the research itself and the nature of the study. Naturally, and as Yin (1989) concurs, scientific researches exploit the experimental strategy while the social sciences tend towards the survey and the case study strategies. The current research adopts survey model approach.

The survey approach have been chosen in this research in order to achieve research descriptive and explanatory purposes, the survey examines respondents' current situation through answering what, why, how questions. Then the survey statistical analysis tools have been used in order to measure the relation between survey questions. In addition the exploratory purposes have been achieved by executing some direct interviews, and meetings discussions. Finally, the exploratory, descriptive, and explanatory purposes achievement led to fulfill the main purpose as a prescriptive purpose which is the framework which has been designed.

3.4.3.1 Sampling criteria

When selecting a sample for a qualitative survey, a different set of priorities must be considered. Each qualitative survey that is conducted is almost similar to an individual scientific research. According to Patton (1987), “The sample should be large enough to be credible, given the purpose of evaluation, but small enough to permit adequate depth and detail for each case or unit in the sample”

Non-probability sampling method has been used in this research. A purposive sampling method have been chosen, this sampling criteria has been chosen to overweigh subgroups that are more readily accessible in the population, also in order to collect reliable and accurate data.

Research population was foodstuff enterprises in Palestine which represents 16.6% of manufacturing industries in Palestine and it also employs 18.7% of the industries working force, research population as per Palestinian economic ministry and Palestinian Central Bureau of Statistics (PCBS) documents consist of a large number of enterprises under four main subgroups, micro, small, medium, and large sized enterprises. In order to fulfill research objectives the sample size which has been chosen was above small sized enterprises, the total number of those enterprises was 188 companies, after a full scanning about those enterprises the researcher found that 52 enterprises are still working currently in the research environment, based on that all of those companies have been surveyed.

3.4.3.2 Qualitative Data Collection

Cooper and Schindler (2005) warn the business researcher against approaching the research with a specified data collection method in mind. Instead, the researcher should first identify the type and nature of the required data and then select those collection methods which are best suited to the collection of the identified data types. While Ghauri and Gronhaug (2005) largely agree with this advice, they nevertheless assert that the researcher must limit his selection of data collection methods, not to the type of data required, but to the collection methods available to him. For example, it is simply not feasible for the researcher to undertake the collection of primary data across several countries, for example, even if the nature of the required data has determined this to be the optimal collection method. It is necessary for the researcher to compromise between the available data collection methods and the methods optimally required by the needed type of data (Ghauri & Gronhaug, 2005).

For the purposes of this research three data collection methods have been used. On line survey, personal observations of the researcher through his work, meetings discussion, and interviews based data collection method.

The on line survey have been used in order to reach all of the research sample enterprises specially Gaza strip enterprises which can't be accessed because of the research special conditions (Israelian occupation). Such type of survey may add more seriousness and official to respondent, it is easier to fill, let alone the online surveys facilitate analysis work and it can give direct results

3.4.4 Credibility and Quality of Research Findings

Ultimately, the data collected is used to inform the research findings. If the data is not verifiable, the implication is that the findings are potentially suspected. Accordingly, it is incumbent upon the researcher to validate his/her findings (Sekaran, 2003).

The Research data have been collected using four different ways.

1. On-line survey which was sent to the respondent by mails.
2. Direct interviews.
3. Previous related – local- researches.

4. Observations

The sample size was 52 enterprises. A period of three weeks was taken for the completion of the surveys and their return back to the researcher. At the end of the third week period, 37 surveys were returned; one was rejected and excluded from the study because it was not complete. Therefore, only 36 had been approved. The average time to complete the online survey was 19 minutes; the response rate was 69 per cent.

Pilot test have been conducted and the feedbacks taken into consideration before sending the final survey. Furthermore some external experts have been asked to review the survey and their feedback also considered and accepted.

3.5 Research methodology description

After deciding research objectives, the researcher started by collecting a Manufacturing System Design related topics in a literature review chapter which form the main base for the research. Then the foodstuff enterprises sector have been chosen as a representative research sample in order to investigate the current situation of the manufacturing systems that working in research environment. Then an electronic survey has been developed in order to gather the data, which have been analyzed using some statistical tools and methodologies. According to the results came from analysis stage, and also according to the related researches and observations within research environment, the researcher developed a framework which can be used as a roadmap for designing any manufacturing system in research environment. Figure 3.2 shows the research methodology diagram.

Letreture Review

- Collecting some of related topics based on a comprehensive and focused readings of scientific articles and papers, books, and other resources.

Research Study and Data Gathering

- Identifying research objectives.
- Sample study choosing.
- Developing an electronic survey.
- Conducting a pilot test.
- Conducting the actual surveys.
- Data processing and analysis.
- Results and conclusions formulation

Framework Developing

- Infrastructure design
- Operation stratagy formulatio
- Structure design

Figure 3.2: Research methodology diagram

3.6 Summary

As may have been deduced from the above, this research adopts a quantitative and inductive methodological approach. Exploratory, descriptive, explanatory, and prescriptive research purposes have been formulated; the collected data was validated by using different data sources. Research hypotheses have been approved using quantitative statistical tools such as Chi square, banner tables and others.

However, given the parameters of the research's scope, associated with time and resource constraints, it was decided that the defined Framework for Integrated Manufacturing System Design would best satisfy the articulated objectives and respond to the research questions. The next chapter reviews the results of the survey, which lead to develop the framework formulation chapter.

Chapter 4

4 .Data Gathering and Analysis

4.1 Introduction

The data have been collected using an online survey distributed to the foodstuff processing companies in Palestine. Some of the data came from Palestine trade center (PLTRADE) and also from Palestinian Central Bureau of Statistics (PCBS). In addition to direct interviews which have been conducted with some foodstuff companies' managers within research activities.

Foodstuff industry is considered as one of the oldest industries in the West Bank and Gaza Strip and plays a key role in the Palestinian economy; it represents 16.6% of manufacturing industries in Palestine and it also employs 18.7% of the industries working force (Establishment Census, 2008).

According to the PCBS, food industry sector can be classified based on its workforce size: the micro enterprises which employ fewer than five persons, these constitute around 73 per cent of total establishments in 2007. While the shares of small enterprises (employing 5-19 persons) and medium-sized enterprises (employing 20-50 persons) in total registered establishments were 25.3 per cent and 1.1 per cent respectively as shown in Figure 4.1. The number of enterprises employing 50-99 persons was 10, and those employing more than 100 persons did not exceed six enterprises (Establishment Census, 2008).

Developing an Integrated Manufacturing System Design (IMSD) framework for such an industry depends upon identifying the current situation of the working firms in research environment. In order to do that the researcher conducted an electronic survey; the respondents were asked to answer the survey questions, **see Appendix A**, 36 completed responses constitutes the basis of the results of this chapter.

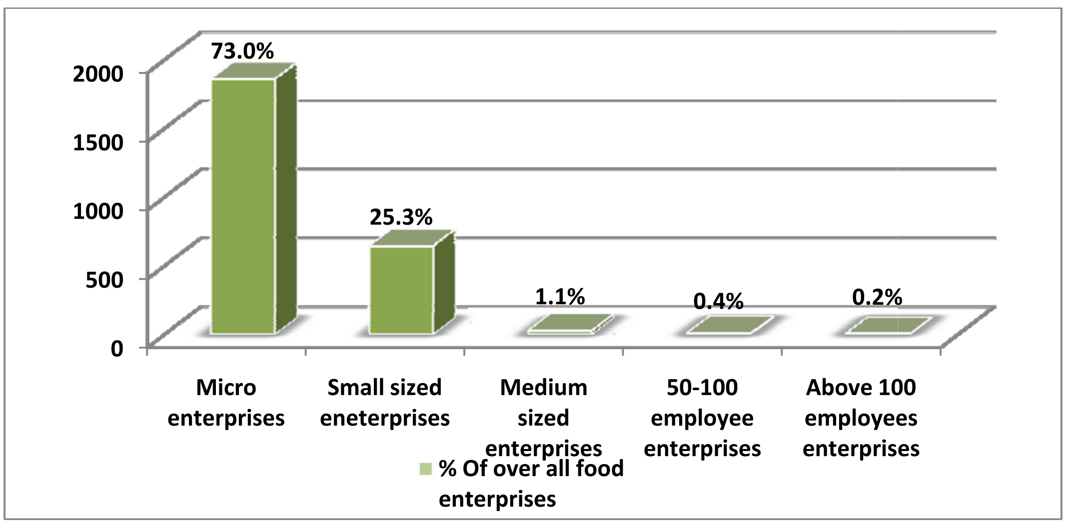

Figure 4.1: Palestine food industries classification according to workforce size

This chapter presents a discussion of the study's results as related to the statement of the problem, purpose of the research, and the research questions, followed by results analysis, findings and conclusions.

4.2 Discussion of results

As noted earlier, the electronic survey was distributed to a number of food manufacturing companies in Palestine which represent the main enterprises whose sizes were above small-Sized and employed above 10 persons.

The researcher chose this sample of population in order to achieve the research objectives which were generally the large companies and could not be clearly noticed in small and micro firms.

The researcher had requested that at least 52 responses to be completed, which had been calculated as an appropriate sample which are currently working and satisfying research requirements. A period of three weeks was taken for the completion of the surveys and their return back to the researcher. At the end of the third week period, 37 surveys were returned; one was rejected and excluded from the study because it was not complete. Therefore, only 36 had been approved. The average time to complete the online survey was 19 minutes; the response rate was 69 per cent.

The surveyed firms were selected following a geographical perspective to cover the different industrial zones within research environment, Palestine, as shown in Figure 4.2.

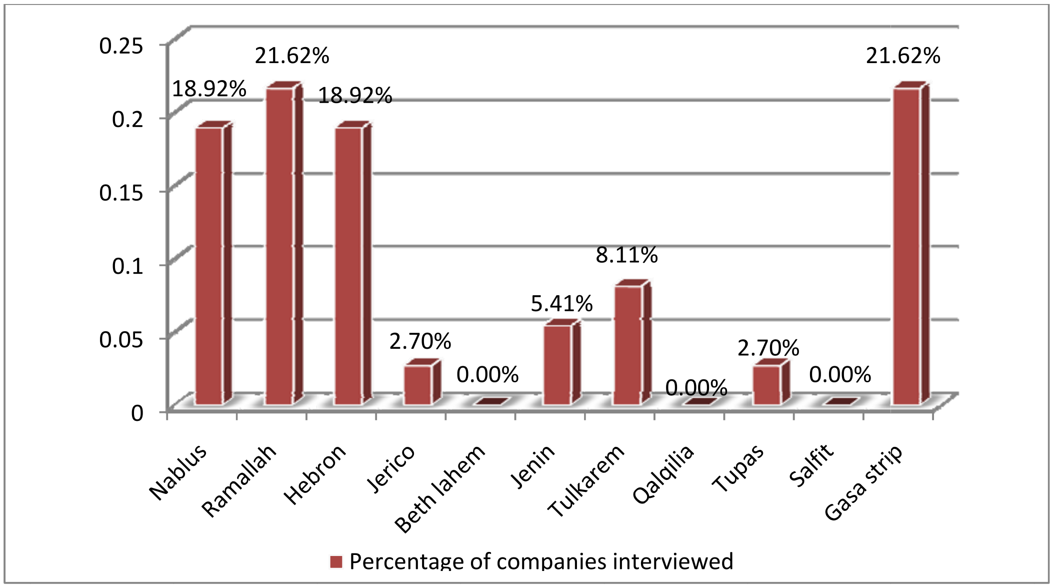

Figure 4.2: Geographical distribution of the surveyed firms

Meanwhile the responses included eight foodstuff industries categories: dairy products firms, soft drinks and juice, agricultural products, confectioneries and sweets, meat processing firms, canned food, oils and ghee firms, and others, Figure 4.3.

The average investment for the sample companies was $4,000,000. The largest investment was $25,000,000 while the smallest one was $200,000. The average number of production lines owned by each firm was 4.3 lines and the average number of products was 22 products. Also the average number of senior employees and the plants' workers was 22 and 47 respectively.

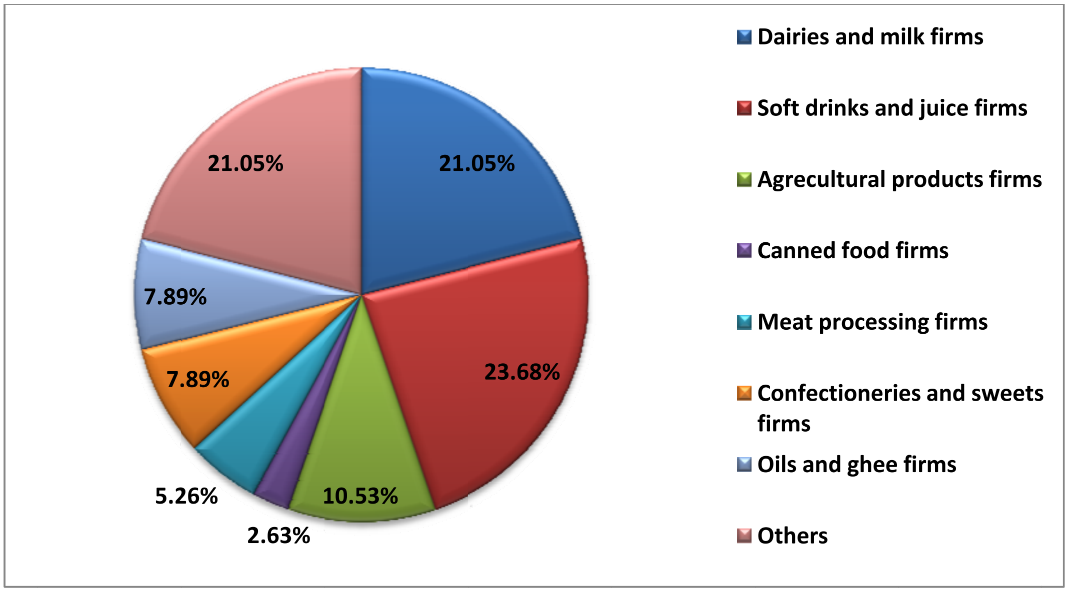

Figure 4.3: Categories of foodstuff firms in Palestine

The study tested the following determinants of manufacturing systems in Palestine foodstuff enterprises, all of which were derived from the literature review during the research process and included in Chapter Two. These determinants included:

1. The compliance degree with the requirements of the Strategic Planning (infrastructure design).
2. The compatibility of pre-investment plans and business plans with the current situation for each surveyed company.
3. The adequacy of physical aspects of enterprises (plant size, layout, inventories, capacity, HR, and others) to its strategic plans (structure design).
4. The compatibility of process technology and production capacity with the market requirements.

4.2.1 Strategic planning (infrastructure) situation

The first objective of the survey was to investigate whether the sample companies had developed their investments according to strategic bases or not; the results obtained were as follows:

The surveyed companies that proved they kept a written mission statement which clearly explains their overall goals were 92%, whereas 8% did not; at the same time 81% of the companies had a clear and written vision; 25% of these visions had not been understood and realized by stakeholders, these results putting some a doubts about their visions and missions effectiveness.

Most of the surveyed companies (91%) had a board of directors, and 92% of them develop their estimated budgets every year, but 26% did not have any organizational structure, which means that the authorities and responsibilities are not clear as it should be, that leads to weakness organizational and managerial activities.

A direct question was asked about the availability of strategic objectives in each surveyed company. The answers are shown in Figure 4.4.

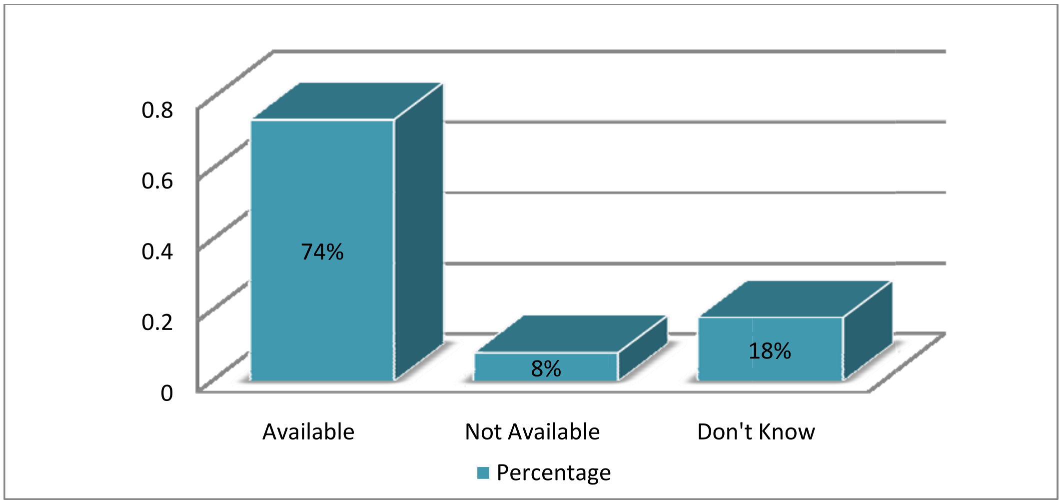

Figure 4.4: Answers for strategic objectives availability question

A dynamic logic was used to proceed answering this question, when the respondent chooses the Yes option; another online window displays and asks him to fill some of the company strategic objectives. 26% showed that there were no clear strategic objectives, and 74% had some objectives which mostly could not be considered Specific, Measurable, Achievable, Realistic and Time horizon (SMART) objectives, some of these objectives are illustrated in Table 4.1.

As a result, the strategic objectives, whatever it is available or not, suffering from some weaknesses which means that some doubts can be added regarding strategic planning availability in the surveyed companies.

Table 4.1: Examples of companies' strategic objectives

Sample #	Strategic Objectives
1	Investing in soft drink processing line
2	Improving the company and increase its capacity
	Introducing a high quality products by Palestinian hands
3	Increasing market share to be the first in the market
	Introducing a best products in order to compete israelian ones
	Increasing the capacity by 50%
	Adding new fields and products
4	Adding new related production lines and products
	changing company geographical place and increasing its size
5	Improving the production lines
6	Adding new products
	Increasing market share
7	Increasing company products to 200 by 2012

The survey also showed that 8% of the companies had not developed any feasibility study to initiate its investment and 22% said that they don't know whether their investment based on a feasibility study or not, these results could mislead strategic planning efforts and demonstrates the lack of strategic planning since the establishment stages.

The research sample distributed on the three competitive strategies is shown in Figure 4.5, and 32% of the sample did not have any short term objectives as shown in Figure 4.6.

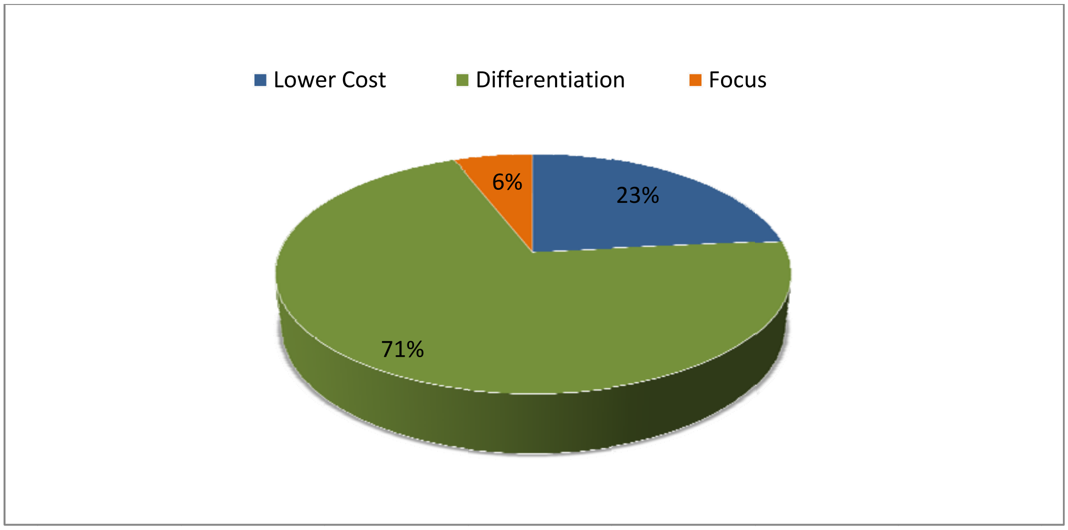

Figure 4.5: Survey sample competitive strategies

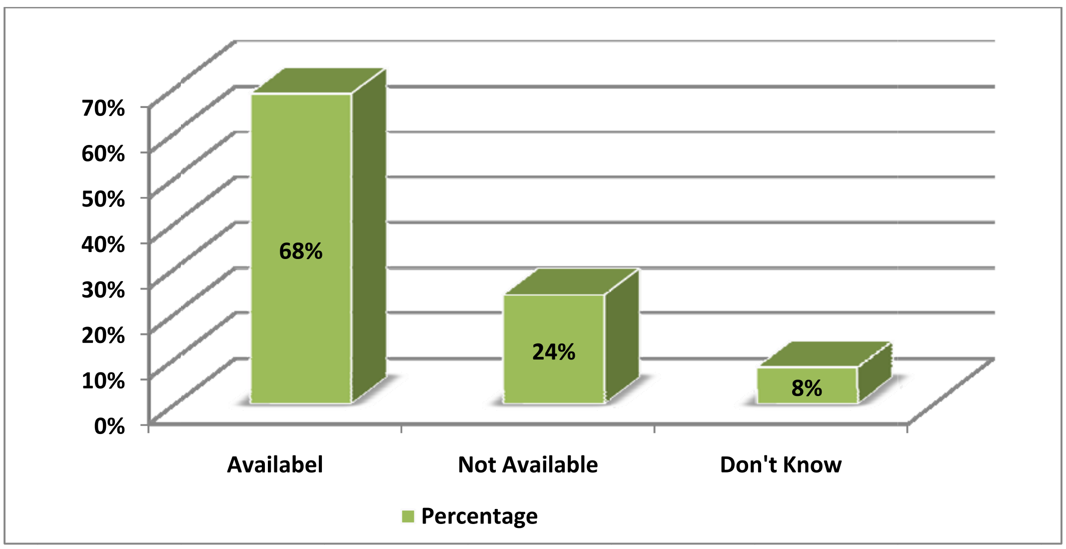

Figure 4.6: Short term objectives availability in the research sample companies

Other indirect questions (Q10, Q12, Q15, Q17, Q31, and Q33), see Appendix A, had been asked to explore strategic planning current situation in food processing sector in Palestine, and the results of these questions were as follows.

- 21% of the surveyed companies were still without expansion its targeted markets.

- 30% of the surveyed companies stayed without increasing its products packages.
- 18% of the surveyed companies did not evaluate their competitors periodically, and 13% did not evaluate the economic, social, and political situation regularly.
- 34% of the surveyed companies did not get any international certificate such as ISO9001, HASAP and others.
- 13% of the surveyed companies did not evaluate their employees till now.
- 24% of the surveyed companies did not design their supply chain to match their strategies.

According to the above results, the compliance degree with the requirements of the Strategic Planning is not strong to prove the availability and effectiveness of the strategic planning process in the surveyed companies. So we can say that the strategic planning process in foodstuff companies in Palestine should be reinforced.

4.2.2 Current businesses situation

The second objective of the survey was to study strategic planning effects on the company's activities, and see the level of work in that companies, results came as below:

As mentioned earlier, 74% of the companies had strategic plans, 32% of them looked to increase their sales by 20 per cent or above this year, while 52% of the companies achieved 50% of the expected sales for the previous year.

Concerning the markets and products, 37% of the companies had 40 per cent or above of the market share for its main products, while 34% of them had 20 to 40 per cent, and 45% of the companies were not much satisfied about its products design and value towards their customers. Also 37% of the responses said: the packaging was highly attractive for their customers, and 61% said: it was attractive but not much as it had to be.

The supply chains had been designed in 75% of the surveyed companies according to the business strategies, and they were classified into two types of supply chains as shown in Figure 4.7.

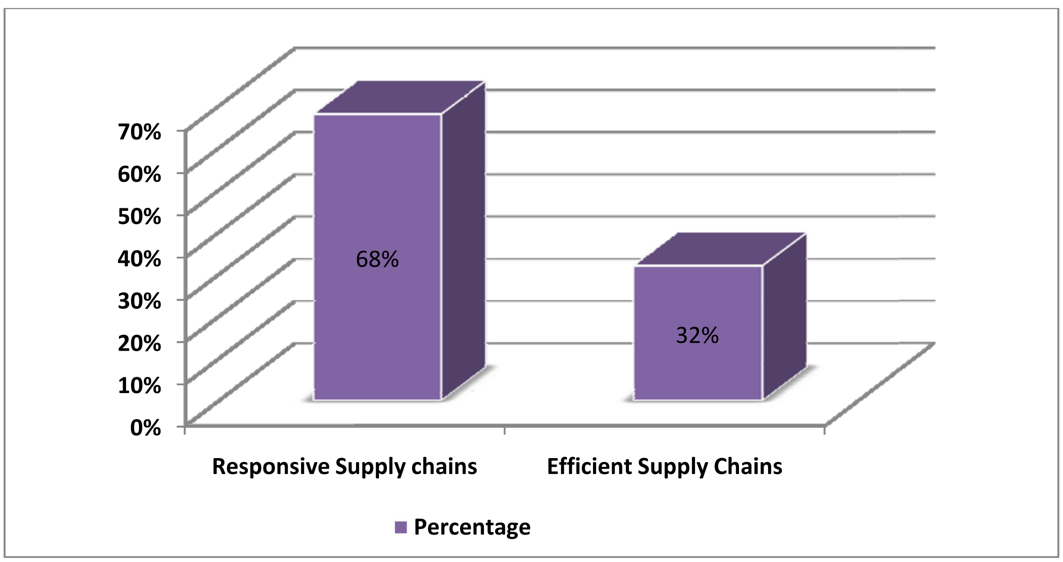

Figure 4.7: Supply Chain types in the research sample companies

The research sample distributed on four types of production systems as shown in Figure 4.8; most of the companies had utilized 50 to 75 per cent of its production capacity, see Figure 4.9. 42% of the companies alleged that their production capacity were not sufficient to meet market needs. Most of the companies (84%) made some improvements on its production lines since its starting up.

Based on the results mentioned above regarding the current situation of the surveyed companies businesses, one can say that there is a mismatching between pre-investment plans and actual situation of the companies especially if you look to the production lines utilization which mostly not exceeds 50%.

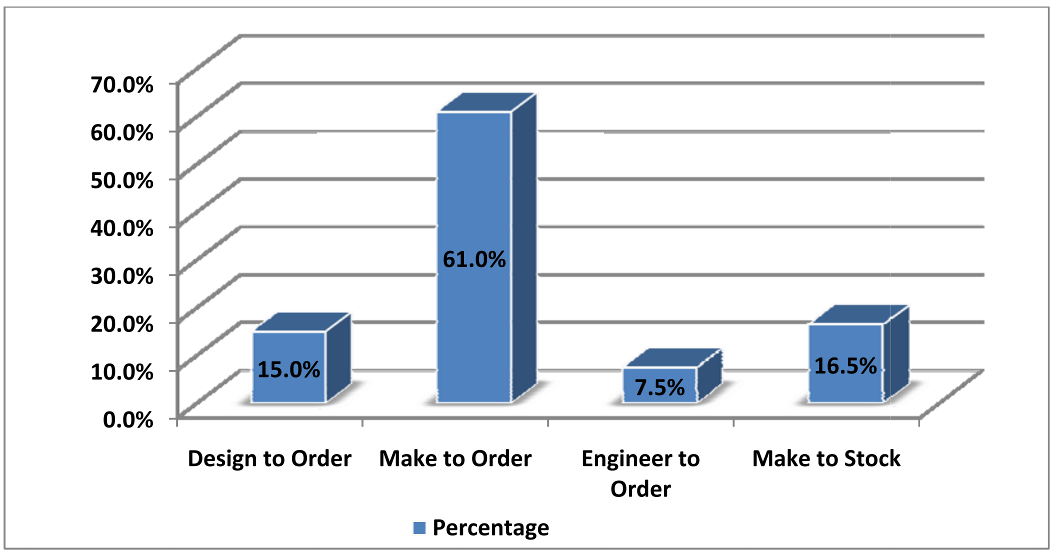

Figure 4.8: Production Systems (PS) types in the research sample companies

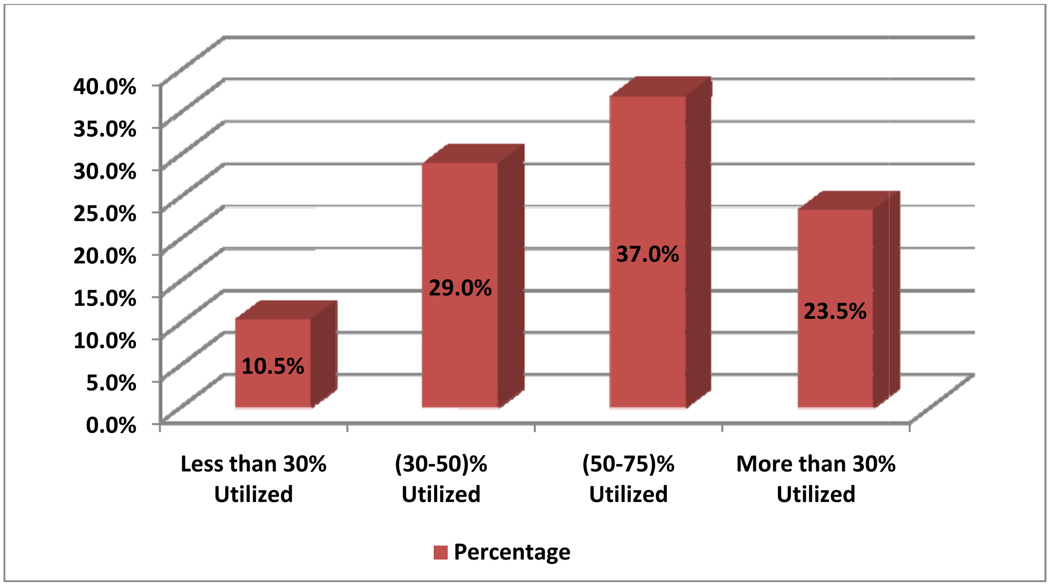

Figure 4.9: Production lines utilization in the research sample companies

4.2.3 Physical aspects (structure) situation

The third objective of the survey was to study the physical components situation of the research sample companies, the results can be summarized as follows.

The companies which had expressed complete satisfaction with its geographical location with regards to its markets were 40%, whereas 60% did not, and 52% of the sample showed that the size and design of the inventory system could not be considered as the most suitable system for its activities. So, the location choosing criteria and factories size estimation were not actually met companies requirements, as estimated in pre-investment plans.

In connection with the human resources the responses showed that 29% of research sample were highly satisfied about the numbers and the capabilities of the current human resources, whereas 71% said that it needed some improvements, so the human resources choosing and developing processes have some weaknesses in the surveyed companies which reflects an imbalance in human resources planning and managing activities.

With regard to production lines and work stations, the survey showed that, 42% of the companies were very satisfied about the design and layout of their production lines and work stations, whereas the rest (58%) said they were not that very suitable as they ought to be, that means the present designs not equivalents companies strategic plans as it should be and there were a chances to choose better designs for the companies layout.

4.2.4 Production capacity and process technology situation

The last goal of the survey was to study the level of production capacity, and process technology used in the surveyed companies. The results obtained are listed below.

The production capacity in the surveyed companies against the market requirements are shown in Figure 4.10.

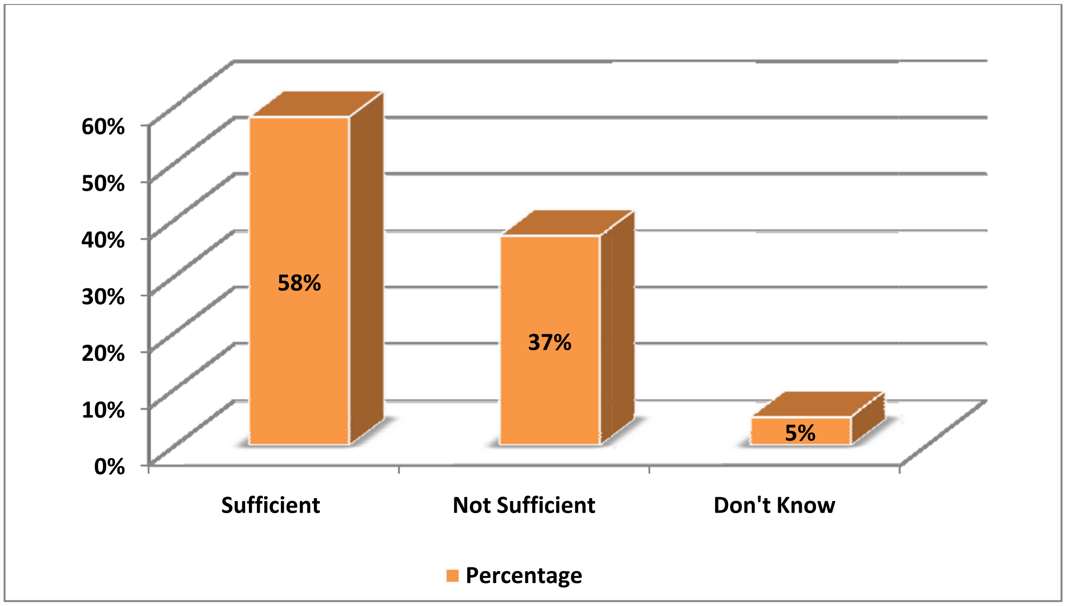

Figure 4.10: Production capacity vs. markets needs in the research sample companies

In terms of the process technology, the survey showed that, 45% of the companies were very satisfied about the technology used in their processes, whereas the rest (55%) said it was not very suitable as it should be. Based on this, 74% of the companies think that there is a superior technology in the market that can do the job better, and capable of reducing costs and improving quality.

Twenty one per cent of the surveyed companies are not active research and developments activities, whereas 79% spent some thousands of dollars, spending amounts shown in Figure 4.11.

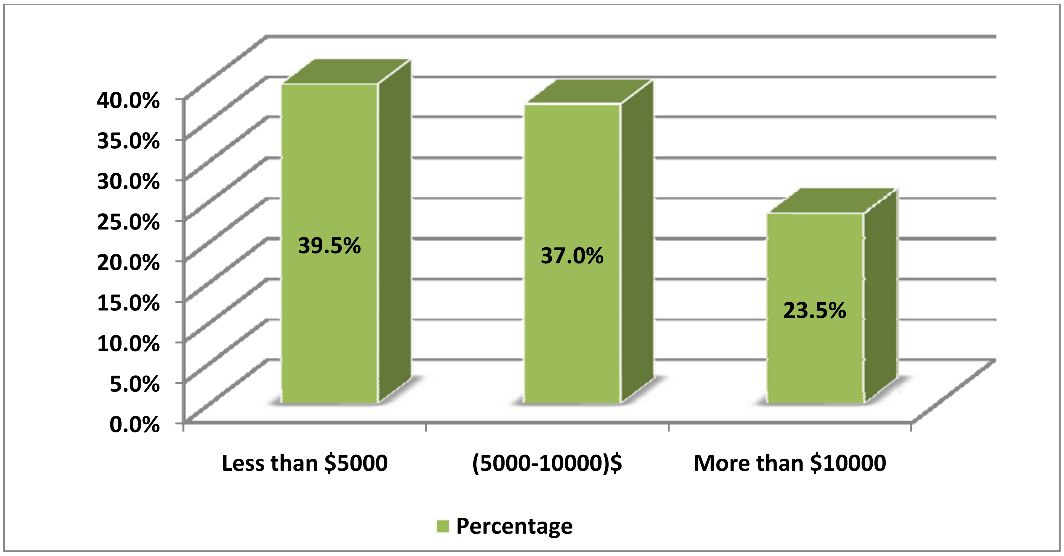

Figure 4.11: Spending on R&D in the research sample companies

Based on these results, one can say that the technology used in the surveyed companies not exactly be chosen to be compatible with factories and markets needs as it should be.

4.3 Data analysis

Data analysis is statistically based on some hypotheses; statistical analysis tools will be use to analyze data and getting the results.

4.3.1 Strategic planning availability and effectiveness

The first tested hypothesis claims that the production facilities in Palestine suffer from weakness in strategic planning process, according to the data mentioned at the beginning of this chapter and also the actual observations of the researcher; manufacturing enterprises in Palestine suffer from lack proper strategic planning, although the survey showed that the theoretical side of strategic planning was actually available.

The researcher used Chi Square analysis tool which is a tool uses to check relations between two different question or factors and see whether it is dependent or independent.

After making a Chi Square test for thirteen related pairs of questions, Table 4.2, 69% of the results showed that their was no relation between that pairs, which mean that the answers cant prove the availability of strategic planning in the research sample. An example of the test illustrated below in Tables 4.3, while the other tests can be seen in the Appendix B.

Table 4.2: Chi Square statistical tool used to see the relation between strategic planning

PEARSON'S CHI-SQUARE TEST	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Group of questions to show Strategic Planning availability and effectiveness
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Criteria	If the pairs of variables are dependent, there is a relation to prove the strategic planning availability, and effectiveness. If the pairs of variables are independent, there is a relation to demonstrate the strategic planning unavailability and its weaknesses

Table 4.3: Chi square test example

Example # 1	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Did the company expand its markets since its foundation?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	4.758
Conclusion	As chi square value(4.758) dose not exceed alpha critical value (9.488), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning was not available or not effective.

Another pair of questions had been tested in order to check the Compatibility of different strategies with each other, and according to the chi square test there were some conflict between the strategies used in the surveyed companies as in Table 4.4.

After taking a look at the strategic objectives illustrated in previous section, the researcher could argue that most of the companies did not have any SMART objectives to make a real indication about strategic planning availability as well as effectiveness, let alone that 26% and 31% of the responses said directly that they do not have any strategic objectives and short term objectives respectively.

Table 4.4: Strategies' compatibility chi square test

Strategies compatibility test	
First Variable	What is the competitive strategy used by the company?
Second Variables	What is the supply chain strategy used by the company?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	0.074
Conclusion	As chi square value (0.074) dose not exceed alpha critical value (5.991), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that the strategies used in the companies, according to their responses, are not compatible and harmonized.

Other indications also could be seen when the results showed that 9.38% of the responses which said that it had a strategic objectives while it did not have any vision or mission statement. Furthermore there were 18.75% of the responses alleged that it had strategic objectives but not any organizational structure and working procedures. In addition to that 15.63% of the responses that claim it had strategic objectives did not expand its markets or release any new products since it was founded. From those who claimed to have strategic plans, 9.38% also did not make any feasibility study in the initiation stage. 12.5% did not do any periodic evaluation to their competitors. This leads to a large doubt regarding strategic planning availability and effectiveness in such companies.

4.3.2 The evaluation of Actual situation

The second tested hypothesis was that the actual situation of production enterprises in Palestine is not compatible with their pre-investment plans and business plans.

The data showed that most of the companies achieved less than 50 per cent of its sales targets, 21% did not expand its markets, 29% did not release any new products, 31% did not have any short term objectives. Moreover 18.5% did not have any incentives and rewards programs for the employees. All of these indicators lead to the conclusion that some weaknesses were available in the planning and executive activities in the surveyed companies.

Also 40.54% of the responses did not utilize their production lines more than 50 per cent. Furthermore the responses showed that, 42.8% of the companies think that its capacity does not satisfy market needs had been utilized (50-70) per cent of their production capacity's, and 28.5% of them had been just utilized (30-50) per cent. Depending on these realities it is possible to say that there were some problems in production management or in marketing management.

4.3.3 Physical components evaluation

The third tested hypothesis was that the Palestinian production enterprises suffer from some problems in the design and selection of their processes components such as inventories, layout, factory size, tools and equipments, and others.

The data showed that, 54% of the companies were not much satisfied with their plants size and layout. Also 59.46 were not completely satisfied with their inventories work stations design.

The responses which said that the human resources needed more improvements were 16%, and 13% did not do any evaluation to their human resources.

All of he above results mean that the actual situation of the physical aspects in the production enterprises in Palestine included some weakness that had to be compensated.

4.3.4 Process technology and production capacity evaluation

The last tested hypothesis in this research was that the technology management, and capacity management in Palestine production factories suffers from misalignment and weaknesses between the business strategy and production strategy.

The results showed that 40.54% of the surveyed companies utilized their capacity by less than 50%, and half of the surveyed companies did not completely satisfy with the technology used in their processes. This means that there is some mismatch in technology and capacity choosing.

4.4 Findings and conclusions

The real question to ask at this point and after the results of the survey have been discussed is what the previous information says about the research questions. In other words, what are the responses to the research question as can be inferred from both the survey and the literature reviewed?

The research questions were: what is the actual situation of the manufacturing systems in Palestine manufacturing enterprises? Is it matching the modern manufacturing systems? How about its efficiency and workability? What is the suitable manufacturing system design framework that can be used in the research environment – Palestine- with regarding to its special conditions?

Both the literature reviewed and the findings of the survey questionnaire provide a very good indication of the answer to this question. According to survey data, the key findings and the gaps in practice were:

- There are weaknesses in the planning process prior to the establishment of Palestine production enterprises.
- The poor integration of the infrastructure design and the structure design in Palestine production enterprises limit the effectiveness and efficiency of their manufacturing systems.

- Several manufacturing enterprises in Palestine have been created without having any investment studies, and the prior plans.
- Low utilization for the production line results from not choosing the production capacity and manufacturing technologies which matching the supplying capability and markets needs.

On the basis of the above findings for the research question, it is clear that the researcher hypotheses is valid, and there is potential need to improve an Integrated Manufacturing System Design to guide the investors and enterprises owners, toward better planning for their investment.

As may be determined from the foregoing, the survey exposed the key determinants of Palestine production enterprises manufacturing systems and its weaknesses. Consequently, there is a need to develop a framework that explain how to design an Integrated Manufacturing System to be fit with the Palestinian special situation, on one hand, and to be effective, on the other hand.

Chapter 5

5 .Framework

5.1 Introduction

Manufacturing is a complex activity derived from many disciplines and technologies, reflecting management attitudes and philosophies, dependent upon organizational structures, influenced by the customers for products and by the suppliers of the many materials, machines, and equipment used to produce those products; Manufacturing systems came to manage and control these activities, and also to make that integration between all of its components.

Many researches and studies have been done in order to make those systems efficient, responsive, and effective. The researcher in this master degree thesis aims to develop a method or a process that would assist manufacturing system designers as they develop (or upgrade) the manufacturing system for their needs.

The current knowledge of manufacturing systems and the lack of a generally accepted scientific basis for relating the multiple variables needed for a successful manufacturing system design in research environment required us to develop a framework to approach the manufacturing system design process rather than a definitive design methodology. The manufacturing system design framework containing other tools, methods and processes applicable to the manufacturing design process. The framework designed to fit with the research business environment which has some special constraints.

After describing Palestinian business environment constrains, the research outline the framework phases which developed based on some ideas came from similar global frameworks and researches such as the International Framework Designed by Manufacturing Systems Team of the Lean Aerospace Initiative LAI, 2002, and the Manufacturing Systems: Foundations of World-Class Practice, 1992. Those frameworks and researches have been developed by experts, who are specialized in different industrials filed, and it was designed to be implemented internationally.

5.2 Manufacturing system Design Framework general principles

According to the Foundations of Manufacturing Committee, 1992, there are a core set of principles “foundations” on which manufacturing systems could be analyzed, designed, and managed. These principles have been designated because of their comprehensive applicability; they are generic, not specific to a particular industry or company; they are operational in that they lead to specific actions and show directions that should be taken; and their application should lead to improved system performance. These operating principles must be recognized, understood, and aggressively adopted by manufacturing organizations that aspire to world-class performance standards (Joseph & Aale, 1992).

Another important note, regarding these principles; that they represent a system of actions that cannot be embraced easily. The foundations must be viewed as a system of action-oriented principles whose collective application can produce important improvements in the manufacturing enterprise.

The principles are illustrated bellow as it comes in Foundations of Manufacturing Committee report.

5.2.1 GOALS AND OBJECTIVES

World-class manufacturers have established as an operating goal that they will be world-class. They assess their performance by benchmarking themselves against their competition and against other world- class operational functions, even in other industries. They use this information to establish organizational goals and objectives, which they communicate to all members of the enterprise, and they continuously measure and assess the performance of the system against these objectives and regularly assess the appropriateness of the objectives to attaining world-class status.

5.2.2 THE COUSTOMERS

World-class manufacturers instill and constantly reinforce within the organization the principle that the system and everyone in it must know their customers and must seek to satisfy the needs and wants of customers and other stakeholders.

5.2.3 THE ORGANIZATION

A world-class manufacturer integrates all elements of the manufacturing system to satisfy the needs and wants of its customers in a timely and effective manner. It eliminates organizational barriers to permit improved communication and to provide high-quality products and services.

5.2.4 THE EMPLOYEE

Employee involvement and empowerment are recognized by world-class manufacturers as critical to achieving continuous improvement in all elements of the manufacturing system. Management's opportunity to ensure the continuity of organizational development and renewal comes primarily through the involvement of the employee.

5.2.5 THE SUPPLYER AND VENDOR

A world-class manufacturer encourages and motivates its suppliers and vendors to become coequals with the other elements of the manufacturing system. This demands a commitment and an expenditure of effort by all elements of the system to ensure their proper integration.

5.2.6 THE MANAGEMENT TASK

Management is responsible for a manufacturing organization's becoming world-class and for creating a corporate culture committed to the customer, to employee involvement and empowerment, and to the objective of achieving continuous improvement. A personal commitment and involvement by management is critical to success.

5.2.7 METRICS

World-class manufacturers recognize the importance of metrics in helping to define the goals and performance expectations for the organization. They adopt or develop appropriate metrics to interpret and describe quantitatively the criteria used to measure the effectiveness of the manufacturing system and its many interrelated components.

5.2.8 DESCRIBING AND UNDERSTANDING

World-class manufacturers seek to describe and understand the interdependency of the many elements of the manufacturing system, to discover new relationships, to explore the consequences of alternative decisions, and to communicate unambiguously within the manufacturing organization and with its customers and suppliers. Models are an important tool to accomplish this goal.

5.2.9 EXPERIMENTATION AND LEARNING

World-class manufacturers recognize that stimulating and accommodating continuous change forces them to experiment and assess outcomes. They translate the knowledge acquired in this way into a framework, such as a model, that leads to improved operational decision making while incorporating the learning process into their fundamental operating philosophy.

5.2.10 TECHNOLOGY

World-class manufacturers view technology as a strategic tool for achieving world-class competitiveness by all elements of the manufacturing organization. High priority is placed on the discovery, development, and timely implementation of the most relevant technology and the identification and support of people who can communicate and implement the results of research.

5.3 Palestine business environment constraints

According to a research reported by United Nations Conference on Trade And Development (UNCTAD) in July 2004 (UNCTAD secretariat, 2004), and according to observations and some formal meeting discussions in PADICO[1], many factors may influencing Palestine enterprises growth, in the same time those factors can be considered as a limitations which

[1] Some of the ideas cam from Palestine Development and Investment Company (PADICO) group Companies senior manager's discussions, "www.padico.com".

affecting that enterprises' work, all of that limitations have to taken into account among manufacturing systems design to be more effective and to achieve the goals behind developing that systems. In this section the researcher will illustrate the major factors as it was introduced by the UNCTAD report.

5.3.1 Location

The political division of the Palestinian territory into Region A, Region B, and Region C, is one of the most important factors that constitute an obstacle when taking decisions to choose the right places for any industrial enterprise that because of special regulations that controls each region, these regulation mostly affecting the availability and accessibility of infrastructure, water and sewage networks, electricity, roads, and advertisements and signs.

In addition to that, proximity to the local markets considered as a major factor that influencing location choosing decision. Also proximity to Israel which is the Palestinian enterprises’ main trading partner and source of supply inputs, and the imposition of prohibitive transaction costs facing Palestinian traders in view of the restrictive Israeli security measures and the cumbersome customs and overland transport procedures at the main borders seems to be one of the important factors that affecting location choosing decision.

5.3.2 Subcontracting arrangements

Subcontracting arrangements, which are often relied upon to facilitate the transfer of technology to enterprises in developing countries, have generally been detrimental to the growth of Palestinian production companies. As shown earlier, the majority of Palestinian production enterprises are engaged in subcontracting arrangements with Israeli enterprises, resulting in the diversion of their backward and forward linkages towards Israel, which are the main source of input supplies, machines and equipment, trade credit and outlets for products.

Furthermore, Israeli firms have been setting the limits for the development of these enterprises' production capacity and experience in industrial management, restricting their production processes to labor-intensive activities. This has contributed to the impoverishment of those industrial bases, especially these enterprises, which are supposed to spur technological progress, are underdeveloped.

This contrasts with the experience of other developing countries, where subcontracting arrangements have played an important role in improving such enterprises performance. In particular, these arrangements have provided enterprises with access to modern production technologies and exposed them to international best practices, in addition to extending their outreach by incorporating them into international networks of producers and traders who form a complete marketing and production cycle for particular products.

5.3.3 Source of finance

Most of Palestine production companies rely on personal savings to cover their start-up and operating costs. Bank loans are the second source of finance and it cant be considered as an important source of finance for Palestine production companies; that due to the uncertain condition which not encourage bank lending.

Moreover, in the absence of formal land registration, most enterprises fail to meet banks' collateral requirements, since these are based on real estate mortgages. The PA is yet to complete the registration of the lands under its jurisdiction, making it difficult for many enterprises to legally prove their ownership. Moreover, enterprises find the application procedures "complex" and the interest rates high. Based on that, Palestine production enterprises may rely on other financing sources, particularly moneylenders, leasing and suppliers' credit loans. Some enterprises also make use of market finance (equity issues and bonds), but this is organized through informal channels, since they are not listed on the Palestinian stock market.

5.3.4 The legal framework

The absence of a comprehensive legal framework regulating economic transactions can be considered as one of the special constrain in Palestine business environment. Despite the considerable progress made in developing it, the Palestinian legal framework remains weak, lacking the key laws for ensuring a conducive business environment. The Palestinian Legislative Council (PLC) is yet to issue such key laws as: Capital Markets

Authority Law, Income Tax Law amendments, Chambers of Commerce Law, Insurance and Securities Law, Competition Law, Foreign Trade Act, Intellectual Property Law, and Customs Law. At present, the legal framework for economic activity consists of a combination of different legal codes, including Israeli military orders, in addition to outdated Ottoman, British, Jordanian and Egyptian laws. Moreover, the PA has yet to institutionalize the separation of executive and judicial powers and develop its court system, which lacks experienced judges.

5.3.5 Natural resources and power resources

The scarcity of natural resources available to the Palestinians under the Oslo agreements stands as a major impediment to industrial development. At present, the PA's jurisdiction is restricted to 80 per cent of the Gaza Strip, the town of Jericho and 3 per cent of the rest of West Bank areas, excluding Jerusalem. These areas are characterized by geographic discontinuity, with the Gaza Strip totally isolated from the West Bank areas by Israeli control of routes.

Water resources available to the Palestinians during the interim period have been limited, notwithstanding a transitional agreement to increase water quotas allocated to Palestinian areas. This is due in particular to the fact that Israel has not fulfilled its commitment to allocate 28.6 million cubic meters of water per year to the Palestinians during the interim period, though the occupied Palestinian territory's water needs are estimated at 70-80 million cubic meters per year. In the Gaza Strip, excessive tapping of the aquifers has led to seawater leakage, rendering the water brackish. Meanwhile, the process of desalination, which stands as the only option for solving water shortages, is prohibitively expensive for most, if not all, enterprises.

Moreover, the occupied Palestinian territory is not endowed with natural gas, despite the recent discovery of commercially viable gas fields in the Gaza Strip, and it has yet to develop an electrical grid of its own. It is therefore heavily dependent on neighboring countries, particularly Israel, to satisfy local demand. This has increased production costs for industries that also lack three-phase electric power, which is important for the use of heavy electrical equipment.

5.3.6 Market limitations

In general, Palestine markets suffer from many weaknesses that have to be taken into account. Such as the local market size is small and limited, there is a barrier between West Bank and Gaza strip markets, exports to neighboring counters and foreign countries have many limitation, and others.

5.4 Manufacturing System Design Framework

5.4.1 Overview

The researcher argues that the Palestine manufacturing organization cannot be competitive if it continues to operate as independent elements without proper integration between its functions and without clear vision toward its overall objectives; because of that this work efforts comes to develop a framework under the title of Integrated Manufacturing System Design for foodstuff industries in Palestine.

This framework can be used by manufacturing executives and practitioners to improve their capability to predict the outcomes of product, process, and operating decisions and to assist them in analyzing, designing, and controlling their systems. For educators and those engaged in research, the framework identifies opportunities for greater exploration and the discovery of additional foundations of manufacturing systems.

The framework consists of three sections, the infrastructure section: which contains the decision making or strategy formulation activities that precede a detailed manufacturing system design, the functional strategies section: which aims to ensure congruence between the corporate level and business strategy including the different functional strategies. Fundamentally, the functional strategies section is an instrument to align manufacturing and other functions with the overall corporate strategy, the structure section: The structure section contains the detailed design, piloting and modification of the manufacturing system, see Figure 5.1.

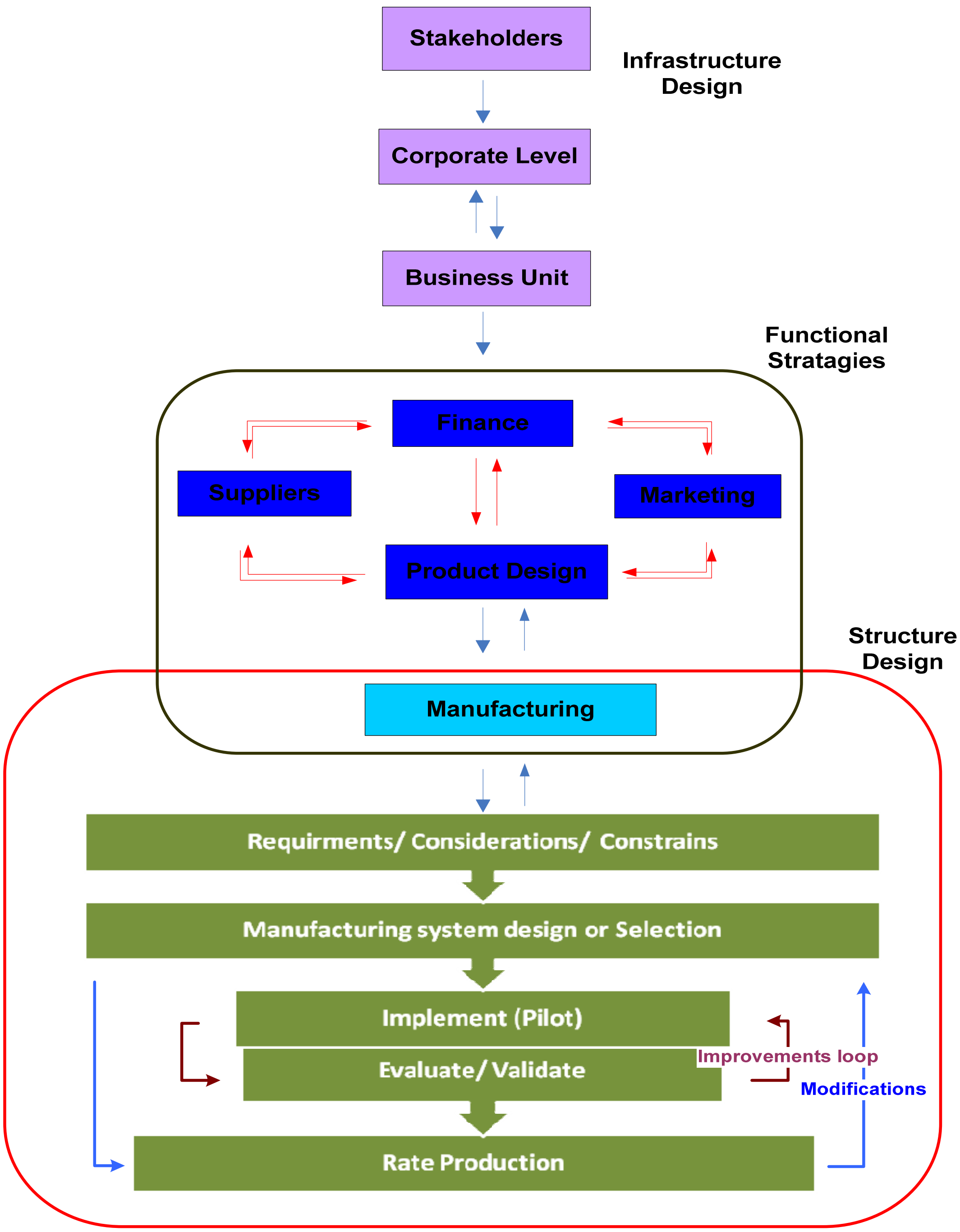

Figure 5.1: Integrated Manufacturing System Design Framework

5.4.2 Infrastructure design

The first section of the framework is the manufacturing system infrastructure design which consists of three levels, stakeholders, corporate level, and business unit level. The stakeholders are those whom the corporate was established in order to satisfying their needs, the stakeholders could be the owners or investors, employees, customers, and society or environment at a large level (see Figure 5.2).

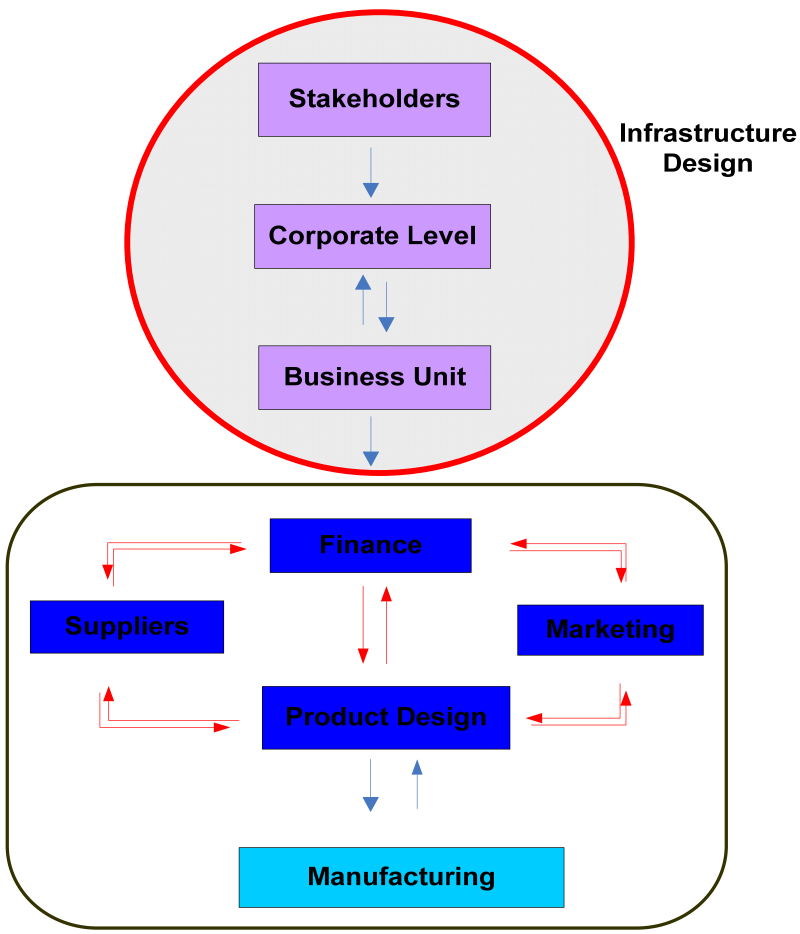

Figure 5.2: Infrastructure Design section

The corporate level strategy formulation body is where the corporate level management responsible about balancing and establishing priorities of the stakeholders conflicting needs. The corporate level strategy is transferred down to each business unite in the enterprise, each business unit will responsible about developing it own strategy business strategy.

If the enterprise contain more than one business unit, then the corporate level strategy links all off the separate business units. Those links is not a one way link. All of the functions within each business unit have to do all efforts in order to fulfill corporate strategy objectives. So the business unit passes up to the corporate level its capabilities, potential future directions and what a reasonable strategy for the business unit may be. The corporate level strategists are responsible for balancing out the input of possibilities from the business units with the needs from the stakeholders to create the overall strategic focus and direction for the corporation.

In research environment case, most of the food stuff enterprises have just one or two business units, and it is mostly located in the same place, so there is no need to complicate the infrastructure design by dividing it into corporate level strategy and business unit strategy, and it can be considered as a one strategy level contains both of the two level strategy components.

After the above introduction of infrastructure design the process of designing this section of any Integrated Manufacturing System Design can be illustrated as bellow:

5.4.3 Functional Strategies

The second section of the framework is the "Functional Strategy" design, which is the most critical stage in the designing process, in this stage the management will develop it is functional strategies specially manufacturing and marketing strategies, these two strategies will identify enterprise competitive characteristics.

Functional strategies concern the pattern of strategic decisions and actions which set the role, objectives and activities of the operation. The strategic decisions which have to be taken in this section are those decisions which are widespread in their effect, define the position of the organization relative to its environment and move the organization closer to its long-term goals.

Referring to the research environment and its special conditions and constraints mentioned in the beginning of this chapter; five main functions should be integrated in this section, manufacturing, marketing, product design, finance and suppliers. As in Figure 5.3, the overlapping between the different functions represents the product strategy design; the formulation of that integration requires collaboration between these functions.

With regarding to research environment a special note can be added here, that the product design function usually not available as a separate or specialized department and it is mostly available as a small part of enterprises manufacturing departments. The reasons behind this fact are: the lack of research and development activities within those enterprises, the poorness of food production specialist, and most of the available products were copied from regional or international markets.

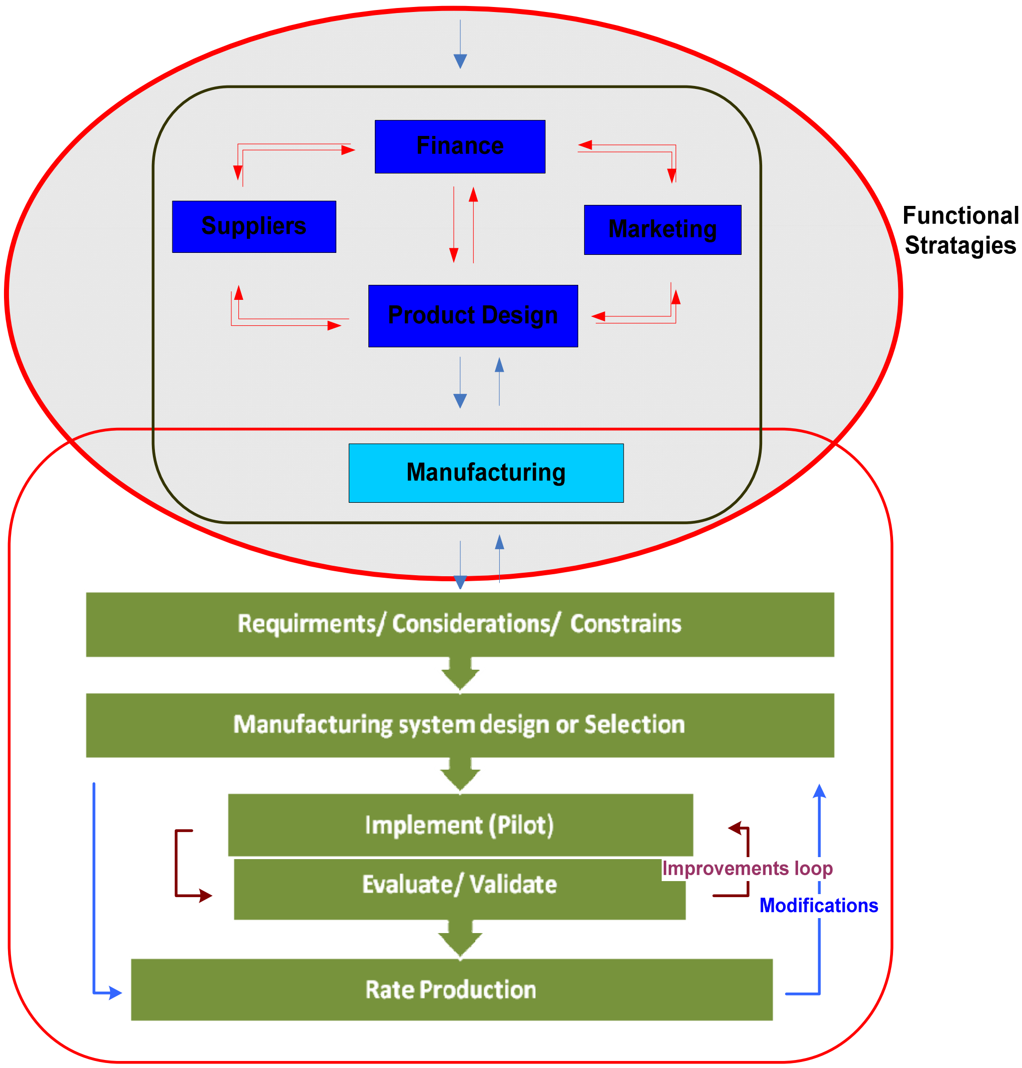

Figure 5.3: Functional Strategies Design

Make or buy decisions and the formation of risk sharing partnerships can be formulated between product design, manufacturing and the suppliers,. The relationship between marketing, manufacturing and product design leads to an understanding of the true customer needs and technical feasibility of those needs. The relationship between product design and manufacturing is what will lead to the design of a manufacturable product which will be more conducive to high performance in the factory. The relation between finance and other functions will decide the cash flow design, capital investment amount, and all of the financing decisions.

In summary, a well-functional strategies design provides alignment of manufacturing strategy and marketing strategy (as well as other functional strategies) with business and corporate strategies and helps ensure that decisions made within the function are based on that strategy and long-term objectives of the corporation or enterprise. The structure of the operation strategy part ensures that manufacturing is an integral part of the corporate structure and allows for clear communication between functions and management levels. The goal of the integration is to ensure consistency between decisions made within each function and overall corporate goals.

The functional strategies provide the link between the manufacturing system infrastructure and structure design, corresponding to the top and bottom sections of the framework. It does this because the manufacturing strategy itself, along with the input from the other functions, generates a set of requirements, considerations and constraints for the manufacturing system design. This leads to the design of the manufacturing structure.

5.4.4 Structure design

The last section of the framework is the structure design (see Figure 5.4); in this section the actual physical manifestation of the manufacturing system design is conceptualized, piloted and refined. Each element is addressed as a separate phase with some specific characteristic events and a set of tools that are applicable in transitioning between phases.

Following the functional strategies formulation, design activities of all the functions would begin and proceed in parallel, the manufacturing system structure is made up of the activities that actually deal with the factory floor such as people, machines and processes, each of the phases within the manufacturing system structure design process will be discussed in turn.

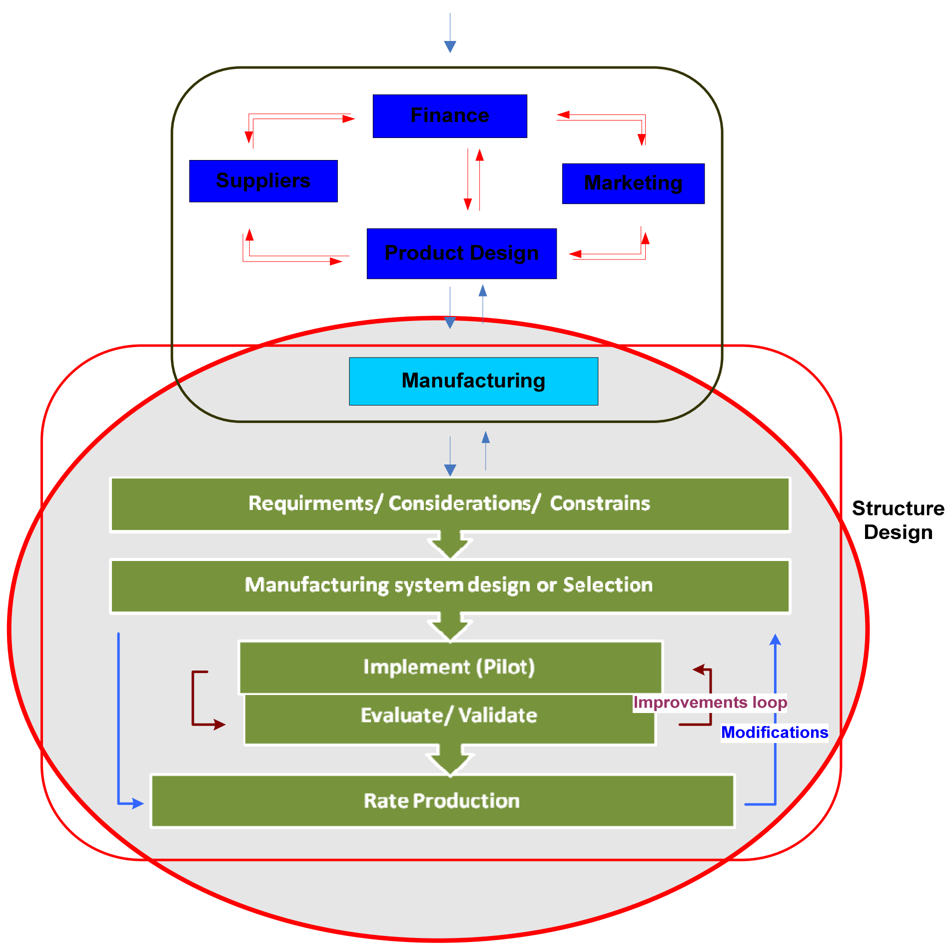

Figure 5.4: Structure Design section

5.4.4.1 Concurrent Product Design, Manufacturing, Supplier, finance and Marketing Activities

The concurrent activities for the different functions in functional strategies section should extend from each function to others and pass through all off structure design phases. This means that the various design activities are all performed concurrently. For example, the product design is progressing at the same time as the manufacturing system design and the suppliers are designing or modifying their own systems or processes to incorporate the new part or components.

All of the functions within the functional strategies section have to decide its requirements, considerations, and constraints concurrently with other functions, that in order to take all of those aspects in the structure design of the manufacturing system.

Based on the functional strategic decisions which already came from the concurrent activities of marketing, supplying, and financing functions, the structure design of the manufacturing system will be started, generally this section consists of four phases which illustrated bellow.

5.4.4.2 Requirements/Considerations/Constraints

The next phase in the framework is the determination and definition of the requirements, considerations or constraints that will guide the detailed design effort. These requirements, considerations or constraints could result from internal or external influences, be mandatory or voluntary, but the effect on the manufacturing system design process is the same. These are the goals that must be met for the system to be a success.

Those requirements, considerations or constraints for all the function within the functional strategies section usually make some conflicts; the designer duty will be treating that conflicts and formulate the final decisions that should be taken before going to the next phase of the structure design.

5.4.4.3 Manufacturing system design or selection

In this phase the actual design of all physical components of the manufacturing system will be started, the designing team has two choices, introducing new designs or selecting ready designs from the market, all of the components should be design or select according to the requirements, considerations or constraints which already came from all the functions in the previous phase.

Six main components of any manufacturing system should be designed or select, processes, products or services, supply network, layout and flow, process technology, and job design and work organization. In addition, five planning and control decisions should be made and taken into accounts among the designing phase. All of these aspects will be briefly discussed below.

Process design

Process design is the activities that shape the physical form and purpose of both product or services design and processes that produce them, so it is difficult to separate process design and product design. Products and services should be designed in such a way that they can be created effectively, whereas processes should be designed so they can create all products and services which is likely to introduce, so it is clearly that the product and service design has an impact on process design and vice versa.

As mentioned by Slack, 2007 in his book “Operation management”, In addition to volume and variety consideration, five basic performance objectives should be taken into account among process design activities, lowest cost, highest quality, greatest dependability and flexibility, and fastest response to customer demands, see Table 5.1.

Deferent standards process types are available, the designer have to chose which one is appropriate based on the requirements, considerations or constraints which came from previous phase, Job shop, Assembly lines, Batch processing lines, or Continuous production lines which was mentioned in literature review chapter.

Performance objectives differ from industry type to another; food industries concentrate its interest on cost and quality more than the others. Construction material producer assume quality, dependability, and flexibility more important than the others. Banking and service industries focus on fast response and dependability more than the others.

Table 5.1: Process performance objectives

Performance Objective	Description
Law cost	Doing things cheaply; that is, produce goods and services at a cost which enables them to be priced appropriately for the market while still allowing for a return to the organization. When the organization is managing to do this, it is giving a cost advantage to its customers.
Highest quality	Doing things right; that is, you would not want to make mistakes and would want to satisfy your customers by providing error-free goods and services which are fit for their purpose'. This is giving a quality advantage to the company's customers.
Greatest dependability	Doing things on time, so as to keep the delivery promises which have made to the customers. If the process can do this, it is giving a dependability advantage to its customers.
Flexibility	The ability to change what you do; that is, being able to vary or adapt the process's activities to cope with unexpected circumstances or to give customers individual treatment. Hence the range of goods and services which you produce has to be wide enough to deal with all customer possibilities. Either way, being able to change far enough and fast enough to meet customer requirements gives a flexibility advantage to your customers.
Fastest response	Doing things fast, minimizing the time between a customer asking for goods or services and the customer receiving them in full, thus increasing the availability of your goods and services and giving your customers a speed advantage.

Product or services design

Three aspects should be considered in product or service design, the first one is concept which is the understanding of the nature, use, and value of the service or product. There are two main types of products or services. Functional products or services; which are that the customers buy in order to use its known function, and creative products or services: which is that attract the customers to by to fulfill new need came with releasing those products or services. Most of food products are considered as a functional product where customers buy in order to use its value.

The second aspect is **package** of 'component' products and services that provide those benefits defined in the concept. The packaging in food industry is one of the major competitive advantages that should attract the customers to buy those products. The third aspect is the **process** which defines the way in which the component products and services will be created and delivered.

In deed, the industry in research environment still going toward functional products because lack of technology, researches, and resources, in addition to the constraints coming from the external environment; so, the companies go toward selecting that products which are similar to existing products in local markets or global markets and adding some modifications that make this product or service belong to that companies.

Supply network design

A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in both service and manufacturing organizations, although the complexity of the chain may vary greatly from industry to industry and firm to firm.

Supply chain network design is the practice of locating and rationalizing the facilities within the supply chain, determining the capacity of these facilities, determining how to source demand through the network and selecting modes of transportation in a manner that provides the required level of customer service at the lowest cost.

Network design problems are concerned with determining logistics infrastructure over a multi-year strategic planning horizon. The strategic decisions may include location and capacity of facilities and warehouses along with the sourcing allocations between them and customers. The objective is to provide the most effective solution so as to minimize total costs while providing customers with the highest possible level of service. Supply chain network design includes deferent aspects such as.

- Best fit Procurement model – Buying decision and processes- Vender managed Inventory VMI, Just In Time JIT, Kanban, procurement cost models etc.
- Production processes – One or more number of plants, plant capacity design, Building to order, build to stock etc, in-house

manufacturing or outsource manufacturing and related decisions including technology for production.

- Manufacturing Facility design – Location, number of factories, size of unit, time frames for the plant setup project etc.
- Finished Goods Supply Chain network – Number of warehouses, location & size of warehouses, inventory flow and volume decisions, transportation.
- Sales and Marketing Decisions – Sales Channel and network strategy, Sales pricing and promotions, order management and fulfillment process, service delivery process definitions.

Designing Supply Chain Network involves determining and defining market structure, demands plotting or estimation, market segment, procurement cost, product /conversion costs, logistics costs including inventory holding costs, over heads, and cost of sales.

There are key factors that affect the supply chain network modeling in research environment such as.

- Government Policies of the Country where plants are to be located.

  Political climate
- Local culture, availability of skilled / unskilled human resources, industrial relations environment, infrastructural support, energy availability etc.

- Taxation policies, Incentives, Subsidies etc across proposed plant location as well as tax structures in different market locations.
- Technology infrastructure status.
- Foreign investment policy, Foreign Exchange and repatriation Policy and regulations.

Layout flow design

The layout and flow design are one of the most important issues within the general area design in operations management. This is because the way facilities, machines, equipment and staff are positioned relative to each other has an important effect on so many aspects of operations such as traveling distance for materials, information, and employees, the quality issues, throughput time, required spaces, and others.

There are four basic layout types **(Fixed-position layout, Functional layout, Cell layout, Product layout)** which was mentioned in literature review chapter, the layout type are chose based on the manufacturing process type, whether it is Job shop, Assembly, Batch, Continuous, or project.

Product layout usually used in food products manufacturing enterprises, where Flow shops produce high-volume, highly standardized products that require highly standardized, repetitive processes. In a product layout, resources are arranged sequentially, based on the routing of the products.

Process technology choosing

Process technology is the machines, equipment or devices that help operations to create or deliver products and services. Indirect process technology helps to facilitate the direct creation of products and services.

Three main categories of process technology should be chosen for any manufacturing system design, **material processing technologies** which is the technologies that have had a particular impact include numerically controlled machine tools, robots, automated guided vehicles, flexible manufacturing systems and computer-integrated manufacturing systems**, information processing technologies** which is Significant technologies include local area networks, wireless local area networks LANs and wide area networks WANs, the internet, and the World Wide Web and extranets. Of particular importance are the latter which include the integration of computing and telecommunications technology. Other developments include management information systems, decision support systems and expert systems**, and customer processing technologies** which are technologies by which the interaction between customers, staff and the technology itself can be managed and controlled, technologies can be categorized into those with direct customer interaction and those which are operated by an intermediary.

Job design and work organization

Job design contains those activities which influence the relationship between people, the technology they use and the work methods employed by the operation. Job design is about how we structure each individual's job, the workplace or environment in which they work and their interface with the technology they use. Work organization, although used sometimes interchangeably with job design, is a broader term that considers the organization of the whole operation, material, technology and people, to achieve the operations objectives. In essence job design and work organization defines the way in which people go about their working lives. It positions their expectations of what is required of them and it influences their perceptions of how they contribute to the organization. It defines their activities in relation to their work colleagues and it channels the flow of communication between different parts of the operation. But most importantly it helps to develop the culture of the organization – its shared values, beliefs and assumptions.

5.4.4.4 Implement (Pilot) ←→ Evaluate/Validate Loop

The implementation and evaluation loop is the smaller loop in the framework which calls for implementing the chosen manufacturing system on a smaller scale, either in terms of rate or capacity, to test the concepts embedded within the manufacturing system design. This allows the system design to be tested, fine tuned and eventually brought to rate or full-scale production.

This can be accomplished using either computer simulations, scale models, full-scale models operating at a low rate, moonshine shops, physical mock-ups or pathfinders. The objective of the piloting activity is the same: to subject the system design to practical tests to pinpoint problems.

The oxford American Dictionary (Ehrlich, et al., 1989) defines simulation a way “to reproduce the conditions of a situation. As by means of a model, for study or testing or training, etc.” the computer model simulation is the most usable simulation systems nowadays and it is consider as a powerful planning and decision making tool. It is flexible to model any system, and it can show behaviors over time. It is less costly, time consuming, and disruptive than experimenting on the actual system. It can provide information on multiple performance measures and it is visually appealing and engages people’s interest, also it can provide results that are easily to understand and communicate, it can also runes in compressed, real, or even delayed time, and it forces attention to detail in a design.

Dr Harrell said: “The power of simulation lies in the fact that it provides a method of analysis that is not only formal of and predictive, but it is capable of accurately predicting the performance of even the most complex system” (Harrell, et al., 2004).

The piloting loop is intended to find and fix problems so the system can function smoothly when it is brought up to rate production levels. The piloting step allows an additional opportunity for creative, new ideas to make their way into the system. Throughout history, the “experimental” plant has played an important role in the development of radically new ideas for production concepts and the piloting activities help instill this creative atmosphere into the manufacturing system design process as well as helping to smooth the transition to rate production when the time comes. In spite of the importance of such loops, it is rarely used in the research environment manufacturing systems. So it should be considered as one of the most important roles in this designing framework.

5.4.4.5 Rate Production

The next phase of the manufacturing system design framework is the rate production phase which represents the finalized product design, and at this stage, the manufacturing system is ready to support the production effort. “Rate” production can be interpreted many different ways and does not necessarily mean “Full-Rate”. In the food industry, low-rate initial production (LRIP) certainly counts as rate production and should take place in a manufacturing system that will be used for full-rate production.

5.4.4.6 Modification Loop

The last phase of the manufacturing system design framework is the modification loop. This is the cycle that represents continuous improvement showing that the manufacturing system design process is never complete. This loop is active as long as the manufacturing system is in operation. The modification loop can be active to fix problems that have emerged since the system entered rate production. This loop accommodates a manufacturing process or design change, or perhaps incorporates new technology into the product or the manufacturing system.

The modification loop captures the essence of the Toyota Production System where the quest for perfection through continuous improvement never stops. As examples from Toyota illustrate, continuous improvement requires the continuous redesign of the manufacturing system. It is a way of life for companies striving to become lean.

The modification loop, like the rest of the framework, also requires the different functions within the organization to be linked. Success in continuous improvement activities requires equal emphasis on product and process design, which must be closely integrated. This also means that improvement activities don't necessarily have to occur on the factory floor. There is a potential of benefiting from improvements and modifications in the other functional areas. Also, the improvement efforts cannot be done in isolation of the system strategy. Rather than improving the system for the sake of improving the system, the goals of the system that were established by the operation strategy need to be revisited. This will help ensure that the improvement activities will support the corporate strategy in the long run.

5.4.5 Framework Summary

This chapter serves as an introduction to the manufacturing system design framework. In summary, the manufacturing system design framework is a visual framework. It aims to guide the manufacturing system design process and does not assume any particular solution. It is comprised of two halves which represent the design of the manufacturing system infrastructure and structure. These two halves are linked by the functional strategies section that is based on collaboration between different functional elements of the company. This idea emphasizes the need to treat manufacturing as a source of competitive advantage for the enterprise. Each phase within the framework represents the necessary decision making activities that should be occurring at that point in the design process.

There are also some key insights to be gained from studying the manufacturing system design framework. The integration of the framework across the different functions and the inclusion of the high-level strategy formulation body, show that manufacturing system design extends beyond the factory floor and includes all functions of the corporation. The presence of the strategy formulation body emphasizes that the key decision-makers are part of this design process and the manufacturing system design process should have a strategy that supports the core competencies of the enterprise. The formulation of this strategy will have an impact on the product characteristics and requirements on the manufacturing system. Also, the modification loop of the waterfall emphasizes the fact that manufacturing system design never ends. There are always improvements to be made. This framework applies the principles of systems engineering in a rigorous manner to a domain where systematic principles have seldom been used.

5.5 Manufacturing System Design Process

Based on the framework, a manufacturing system design process is presented below. The process not only offers a checklist to ensure all pertinent steps have been followed but it also helps in understanding the design activity. The following 14 steps also provide a quick way of understanding the framework itself. Since the purpose of the process is to provide a way to think about each of the steps involved,. The process below is most useful in introducing a new product in the market. However, provided that an appropriate infrastructure exists, the structure design part of the process can be very useful in inserting a new product into an existing facility

5.5.1 Infrastructure design

1. Corporate strategy formulation

- Identifying corporate stakeholders.
- Defining corporate stakeholder's needs.
- Choosing strategic approaches' to chose, Structuralist, or Deconstructionist.
- Developing corporate vision statement.
- Developing corporate mission statement.
- Identifying the corporate goals (long term objectives).

2. Business strategy formulation (for reach business unit).

- Identification of Products, Markets and Competitive Priorities.
- Identifying each business unit internal strengths and weaknesses.
- Identifying each business unit external forces (environmental or industrial factors).
- Identifying the type of business in each business unit whether it is, market-qualifying products[2], and order winning products[3].
- Identifying business units core competencies.
- Defining the future growth areas in the industry.

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[2] Market qualifying: characteristics a product must have to be in the market.

[3] Order winning: characteristics make a product different and cause customers to by.

3. Developing a Marketing strategy

- Defining product and competitive strategy.
- Determining pricing strategy.
- Determining and identifying placement (distributions) strategy.
- Determining and identifying promotion strategy.

4. functional strategies formulation

a. Determining and specifying the current maturity of the industry (industry life cycle), by identifying industry type maturity risk factors can be estimated as mentioned in, see Appendix D.
b. Determining and specifying the current product life cycle stage, wither it is in growing, mature, or declining. Many decisions should be taken based on the product maturity, see Appendix C.
c. Identifying products characteristics and values (customer point view) using QFD, survey, or any other tools. Product characteristics may be such as Commonality, Reliability, Compatibility, Safety, Payload capacity, Weight, Serviceability, Life cycle cost, Performance, etc.
d. Based on the above points, manufacturing system performance objectives or competitive priorities which are the elements, in which operations must excel in order to support corporate strategy and business strategy, should be identified and prioritized. Delivery, Innovativeness, Quality Lead-time, dependability, performance, Flexibility, Cost/price, Volume.

e. Identifying supply chain components and determining its characteristics. Availability, dependability, security, conformity, achievability, etc.
f. Determining whether the supply chain is an efficient or responsive.
g. Based on point f determine the core competences of the suppliers and the type of relation with them, risk sharing partners or build to print contractors.
h. Identifying financial sources, future cash flow, budgeting, financial system, and financial polices.

5. Developing a Manufacturing strategy

- Determining organizational decisions (Structure, accountabilities and responsibilities)?
- Identifying quality resource, quality control policies, certificates, and practices.
- Identifying and choosing production and material control systems.
- Determining required human resources (Recruitment, training and development, culture and management style).
- Identifying performance measurements and reward (Financial and non financial performance management and linkages to recognition and reward systems).

With the formulation of the manufacturing strategy, the infrastructure design is complete. Based on those strategies, a structure design can be attempted.

5.5.2 Structure design

6. **Determine the technical/physical requirements to achieve the strategy needs**
    - A tool like Quality Function Deployment (QFD) might be useful to convert the strategy requirements into manufacturing system design requirements.
    - Manufacturing system design inputs see Appendix E.

7. **Receive requirements from product design. Give feedback to product design**
    - This is not just a one way communication dominated by product design but the collaboration of the two. Depending on the status of the industry, the dominant component of a product strategy should be given more control. If manufacturing has the highest leverage, it should provide guidance to product design regarding existing manufacturing capability such that the product can be designed to use current capabilities
    - Physical product characteristics/requirements
    - Tolerance requirements
    - New manufacturing technology development requirements

8. **Receive requirements from Marketing and Suppliers – Give feedback**
    - Get rough forecasts on volume and mix
    - Determine supplier location, transportation time, supplier quality etc.

9. **Perform a cross check between step 6 strategy requirements and steps 7&8 engineering requirements to verify contradicting elements (this could be the correlation matrix of QFD, roof of the house etc.)**
    - Feedback up the chain to eliminate contradictions
    - A check and balance system to keep strategy as the priority and not the design
    - Establish a final set of technical requirements

10. **Manufacturing system design factors**

    - From the result of step 9, compile a data set for the following 10 factors, Market, Uncertainty, Process Capability, Production Volume, Worker Skill, Production Mix, Type of Organization, Frequency of Changes, Time to first part, Product Complexity, and Investment amount.

11. **Design/select a manufacturing system that meets the above requirements**

    Current capability analysis:

    - Is there an existing manufacturing system (cellular, job shop etc.) that can fulfill the requirements/business needs?
    - Can features of different systems be combined to design a suitable system?
    - Is there a need for an entirely new system?

- Do you have the time, capability and funds needed to develop a new system?
    - I. Check your strategy, reformulate
    - II. Prioritize factors
    - III. Check product design requirements
- What types of systems do other industries and competitors use for this type of product?

12. Once a system is selected, design an appropriate *operating policy* for that system

Operating policy is a set of rules that translate the strategy into operational guidelines for day to day decisions. It is the operations side of the manufacturing strategy. It is an extension of the strategy to keep manufacturing in line with the rest of the company. Manufacturing managers should make their decisions based on this policy, which ensures compliance with the underlying manufacturing, business and corporate strategy.

Operating Policy should determine:

- Factory control mechanism
- □WIP (work In Process)
- □Inventory levels
- Required skill level
- Daily decision guide
- Quality checks/quality levels
- Metrics
    - ♦ Financial metrics

- ♦ Product performance metrics
- ♦ Unit operation metrics
- ♦ System operation metrics
- ♦ Aggregated measures of performance
- Employee freedom for innovation

13.Implementation plan (pilot)

Implementation depends on type of system chosen.

- Use known implementation methods, if possible
- Trial and error
- 3P (Production Preparation Process)
- Consultants
- Analytical tools/computer simulations

14.Test/fine tune

- The prototype system is tested to detect shortcomings, performance levels, and other systemic issues, which cannot be detected during the design stage. There are many tools available for this step.

Tools:

- Macro Value Stream Mapping
- Value Stream Mapping
- Kaizen
- Trial and error
- Computer simulations

15.Full rate production

- The system is ready to full rate production when the minimum design performance levels can be achieved at full rate production. This does not mean that the system is operating at its best.

16.Continuous improvement

- The design task is not yet complete. Once full rate production has been reached, the system is just operating at perceived best levels. There is lot to improve, just as a new product design goes through series of revisions. Use Kaizen continuously to find problems before they surface and take care of them before they affect system performance. After repeated Kaizen activities, the rate of change introduced will typically slow down. The next step should be to introduce drastic changes via Kaikaku techniques. The continuous improvement loop operates throughout the life cycle of the manufacturing system to detect and eliminate waste and inefficiencies. All the tools used in the Test/fine tune stage can be used here. The focus of the continuous improvement should be to build capability for the long term whereas the focus of step 14 was to bring the system up to speed as soon as possible. There should be a plan based on which the improvement activities should be performed.

Chapter 6

6 .Conclusions and recommendations

6.1 Thesis conclusions summary

Integrated manufacturing system design framework for Palestine foodstuff industries was introduced as a result of this thesis research. The researcher starts his thesis by introducing research objectives which can be summarized by studying the current research environment (Palestine) manufacturing systems characteristics, based on that study the researcher aimed to develop his framework and its implementation process view.

Inductive researching approach has been used, and the data was collected using an electronic survey, 52 companies have been surveyed and the response rate was 69 per cent. Another data collection ways have been used also such as interviews, local related researches, and personal observations.

As a result Palestine foodstuff industry suffers from some weaknesses such as: the lack of pre investment planning activities, poor integration between infrastructure and structure design, and miss matching between process technology choosing and production capacity needed. Furthermore Palestine special conditions as an occupied country extremely affecting its business environment by adding more constrains and difficulties which have been taken into account among framework formulation activities.

The resulting framework consisted from two main sections, infrastructure design, and structure design, those two sections were connected by a new concept which is functional strategies.

The Infrastructure design contains the decision making or strategy formulation activities that precede a detailed manufacturing system design; it is consisting of the three levels: stakeholders, corporate level and business unit. Together, these three units make up the strategy formulation body. Structure design section contains the detailed design, piloting and modification of the manufacturing system; it is consisting of the actual physical manifestation of any manufacturing system. The functional strategies level contains all of the functional strategies, specially manufacturing and marketing strategies. It is concerns the pattern of strategic decisions and actions which set the role, objectives and activities of the functions within any manufacturing system.

Based on the framework, a manufacturing system design process has been presented. The process not only offers a checklist to ensure all pertinent steps have been followed but it also helps in understanding the design activity. The process is most useful in introducing a new product in the market. However, provided that an appropriate infrastructure exists, the structure design part of the process can be very useful in inserting a new product into an existing facility.

6.2 Contribution to knowledge and practice

This research makes several contributions to the topic. In summary, the contribution can be summarized as bellow:

1. Clarifying the current situation of research environment enterprise's manufacturing systems
2. Developing a framework for an Integrated Manufacturing System Design which Fits with the privacy of research environment.
3. Introducing a process design view for the developed framework concepts and activities.
4. Contributing in the process of understanding Integrated Manufacturing Systems Designing methodologies. its different levels and components , the interrelationships and the integration among that levels and components.

6.3 Recommendations

After the efforts which have been made in order to develop the targeted framework, and after presenting the above conclusions, some notes and recommendations can be summarized as bellow:

1. More emphasize on the planning process prior to the establishment of Palestine production enterprises (especially foodstuff enterprises).
2. Functional strategies formulation should be highly considered before any enterprise establishing, especially manufacturing and marketing

strategies which seem to be unavailable in the current manufacturing systems in Palestine.

3. More attention should be given when the enterprises choose their process technology and production capacity.
4. More focus should be given to supply chain choosing and planning because of the research environment special conditions.

6.4 Future works

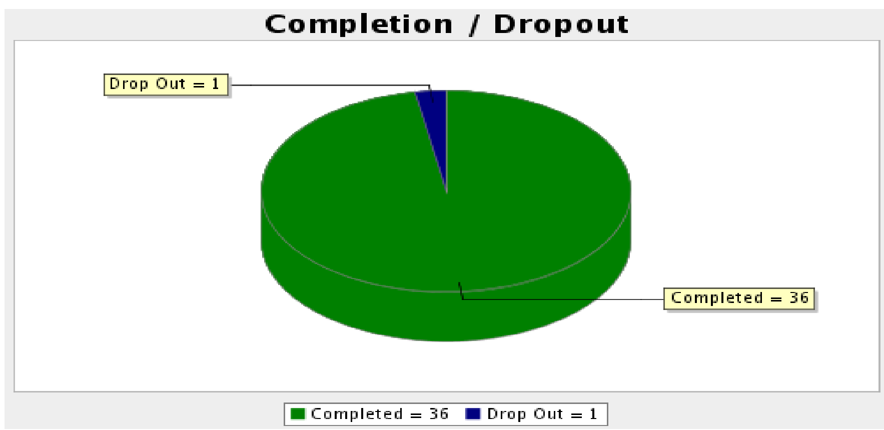
1. The framework needs to be approved and validated by implementing it in a real and actual case in research environment – Palestine.
2. The framework can be applied and customized for the other manufacturing sectors in Palestine.
3. There are some sub topics under the research title which need a specialized studies due to their importance and to overcome its weaknesses that have emerged during this research. That sub topics are supply chain, and process technology and production capacity choosing.

Appendices

Appendix A

Survey raw data

The research survey consists of 46 questions. The researcher had requested that at least 52 responses to be completed 37 surveys were returned only 36 had been completed and one response was dropped out.



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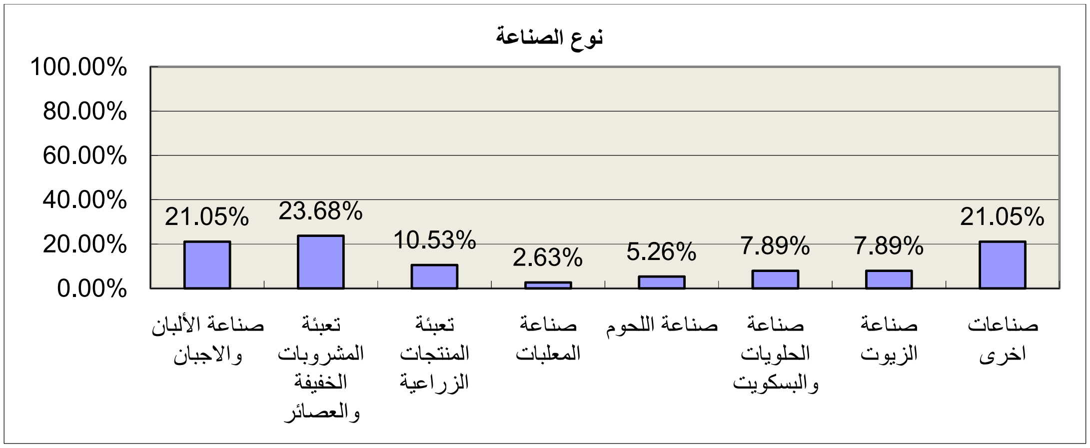
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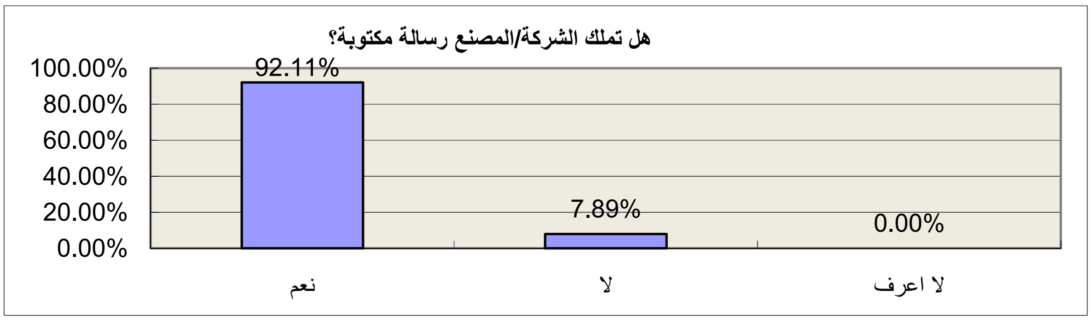
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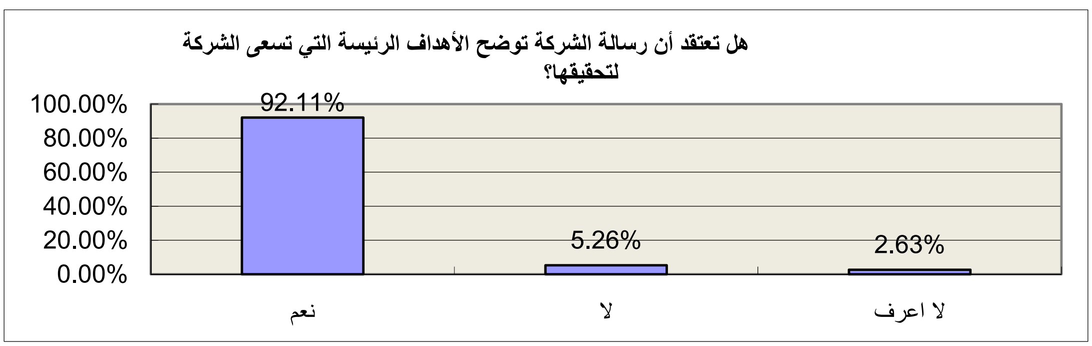
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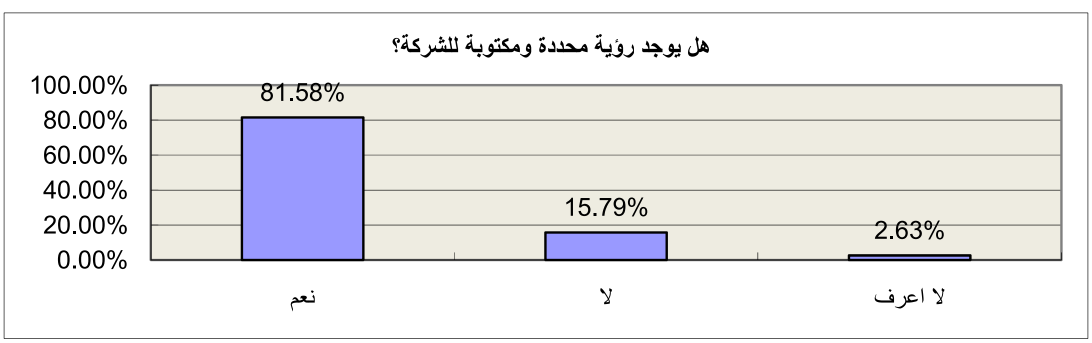
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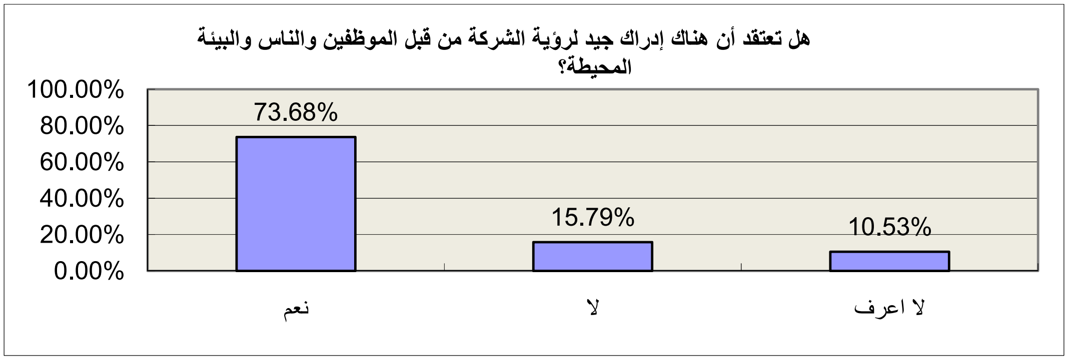
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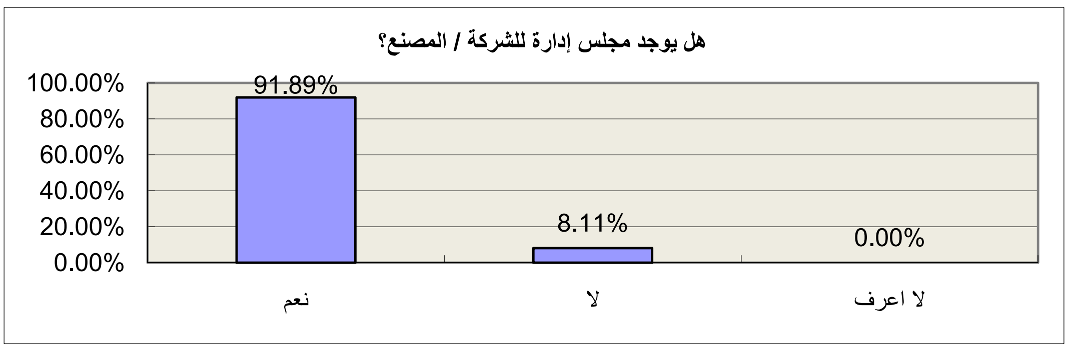
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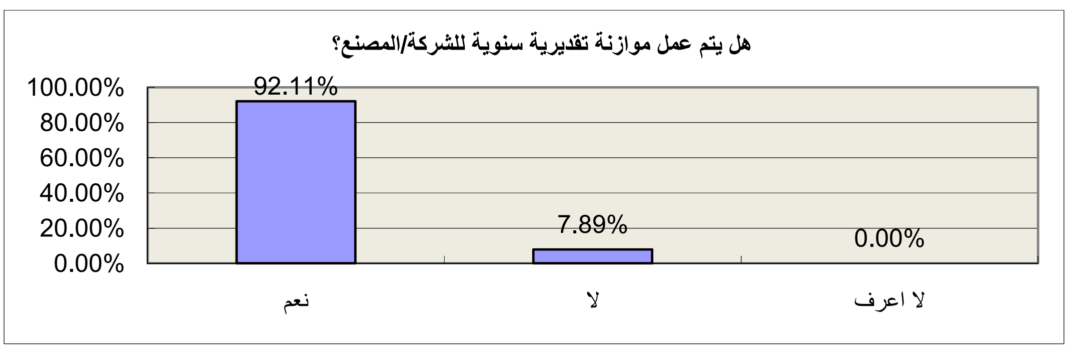
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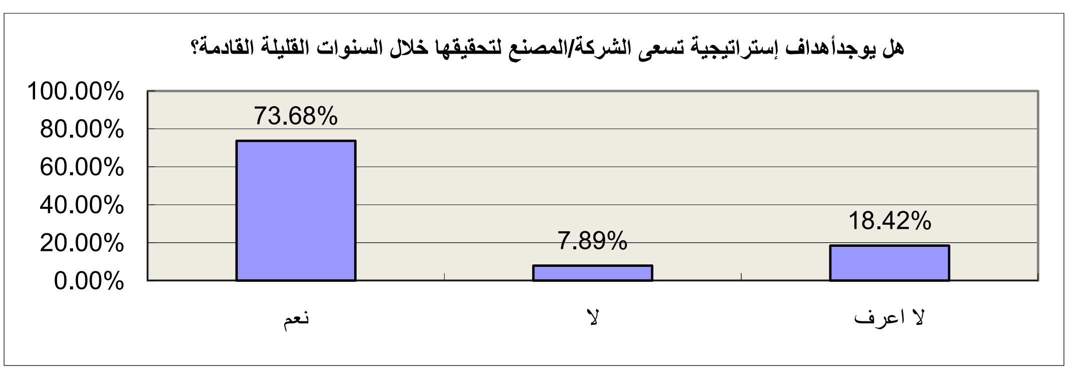
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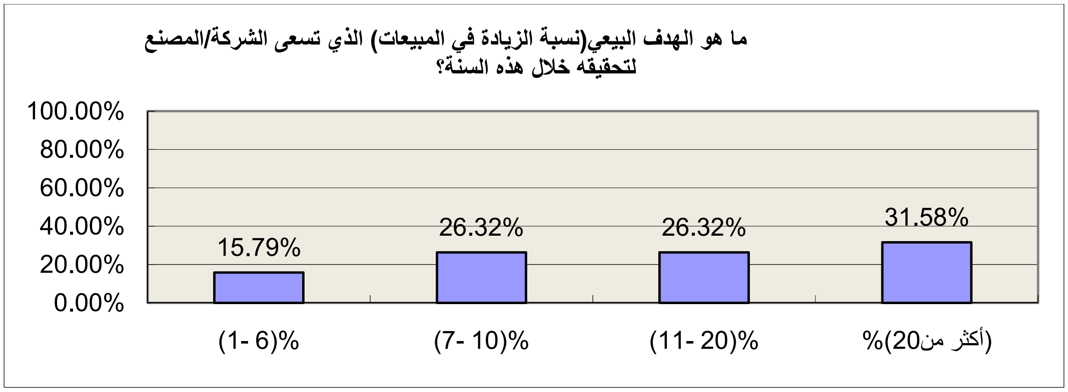
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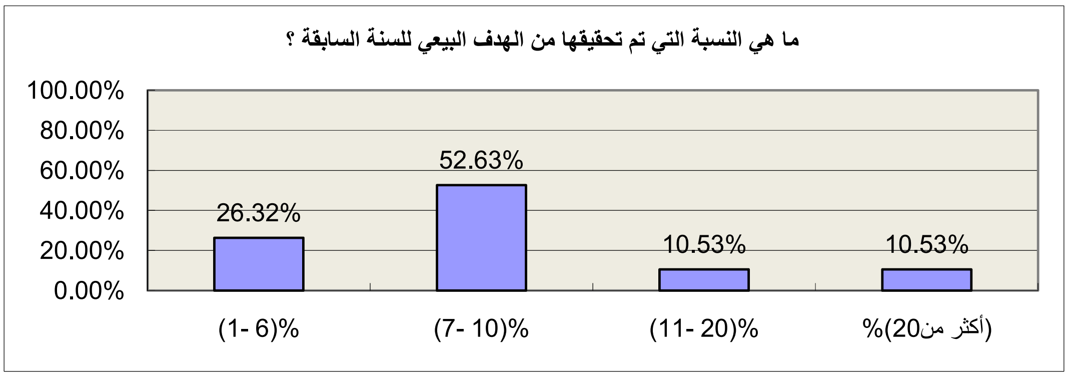
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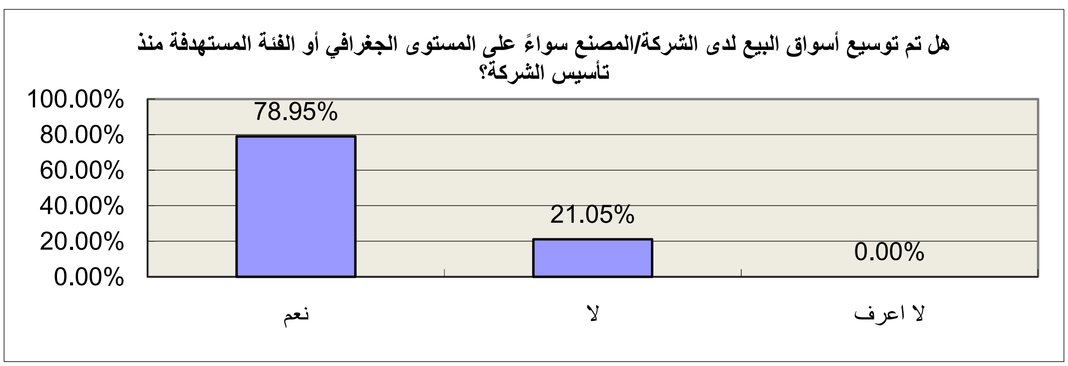
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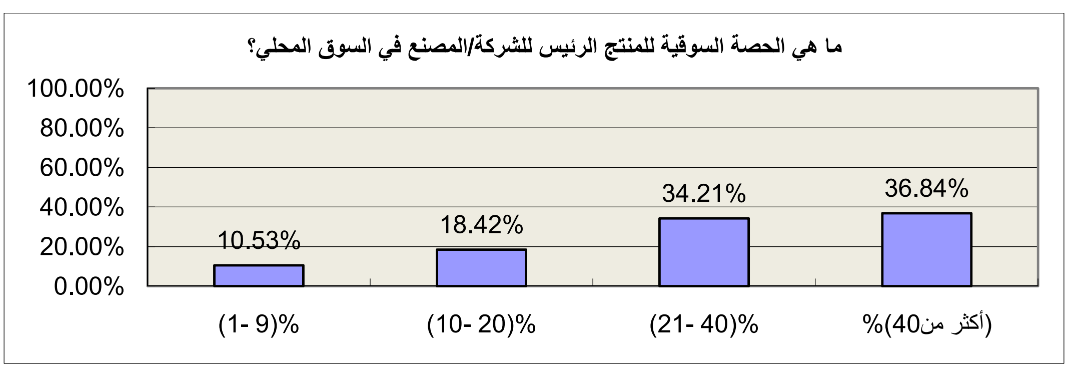
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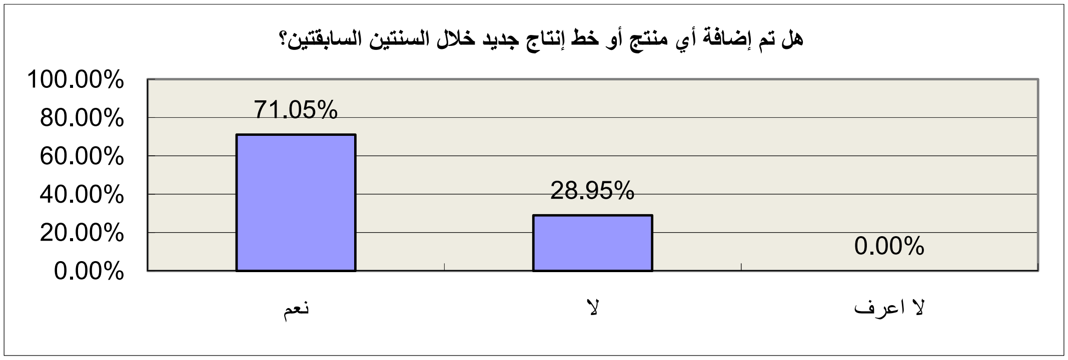
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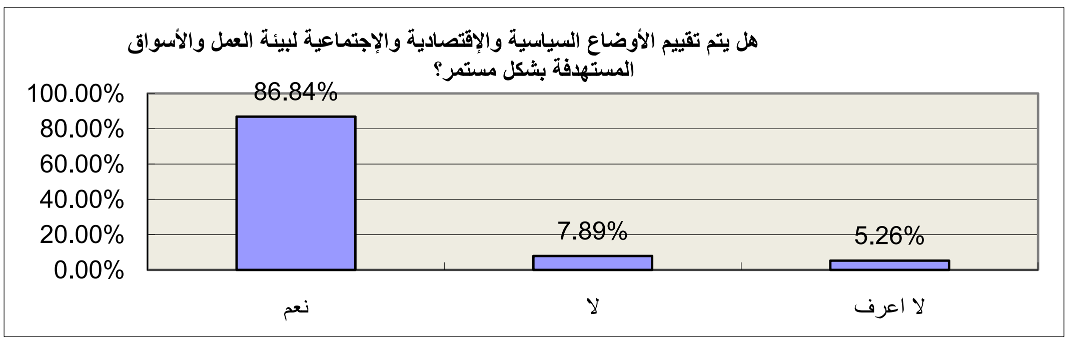
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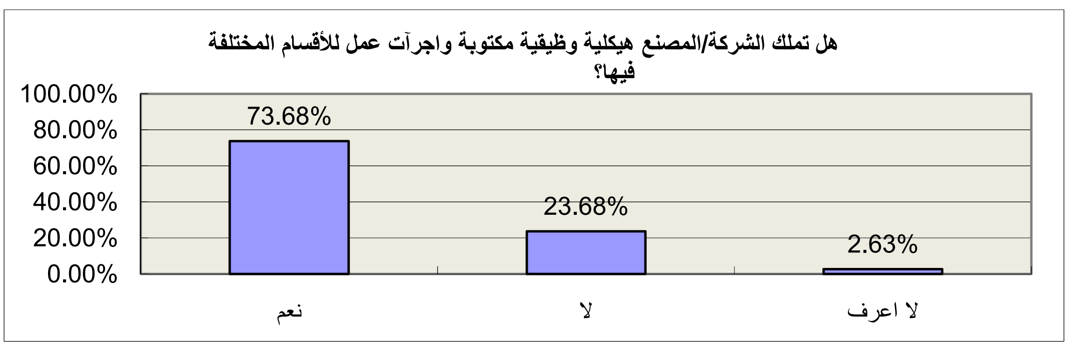
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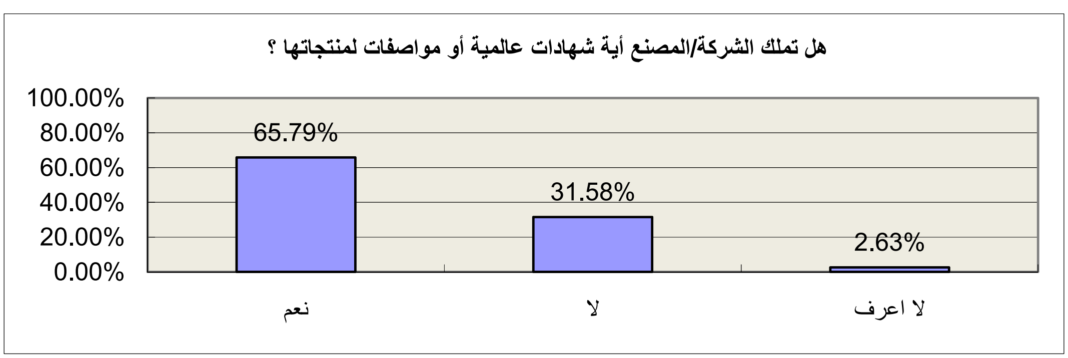
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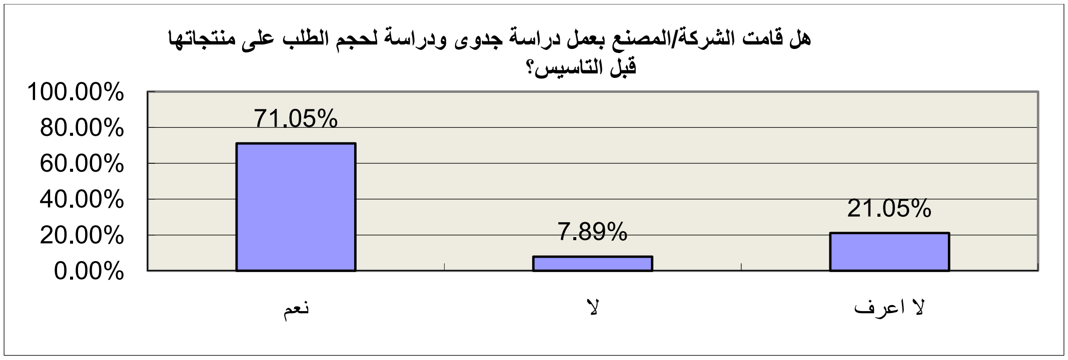
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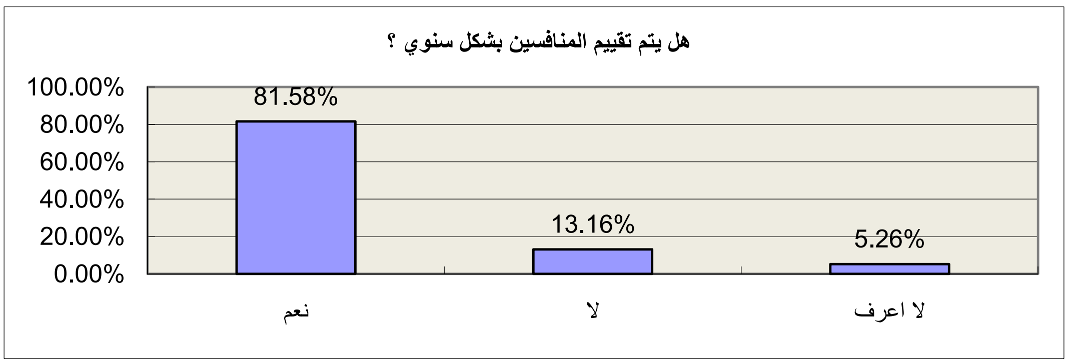
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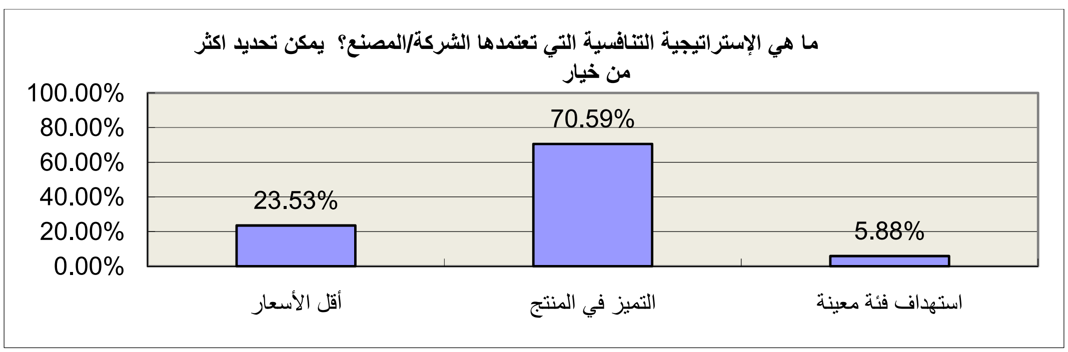
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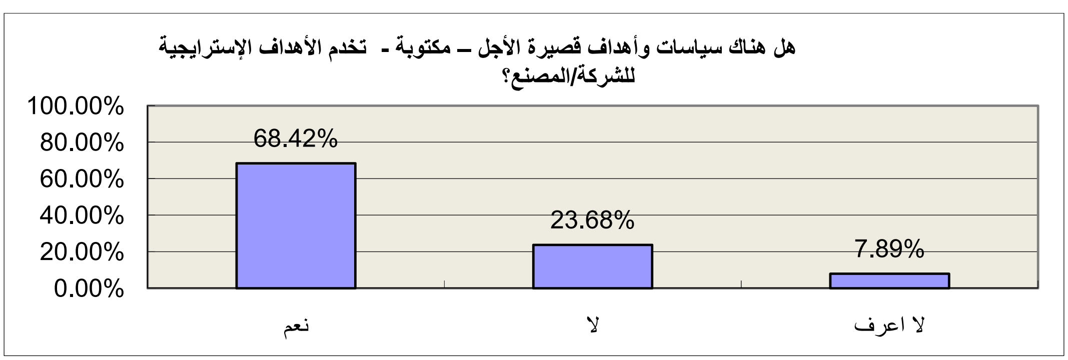
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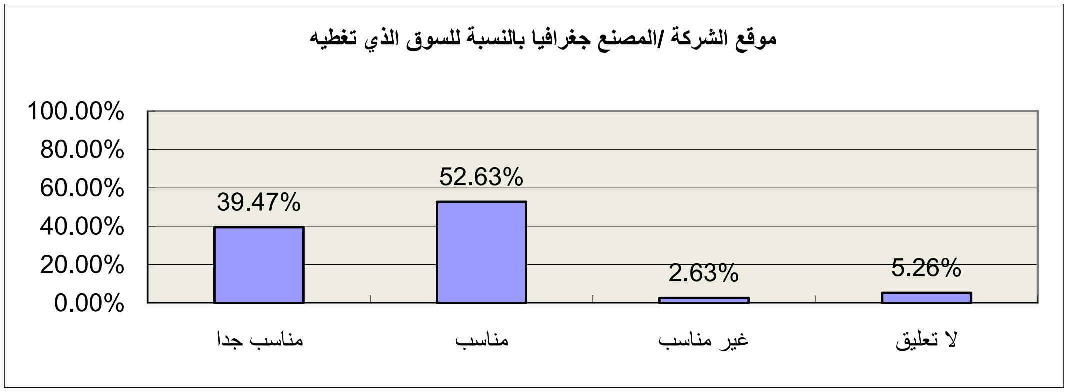
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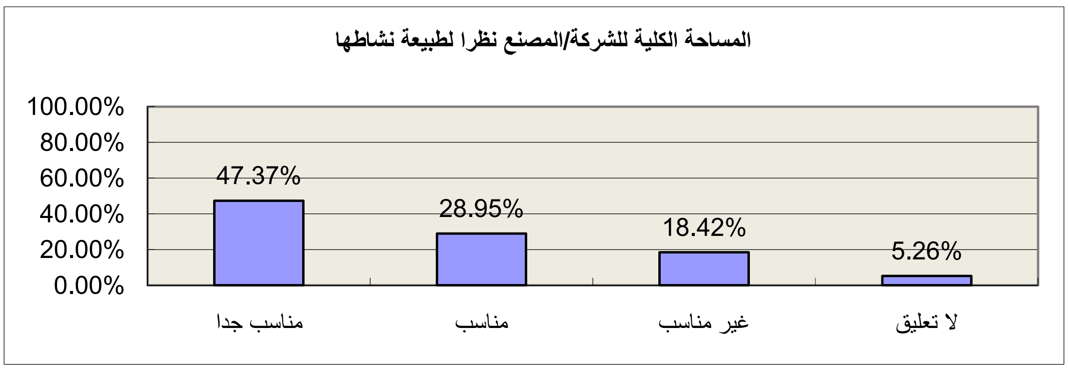
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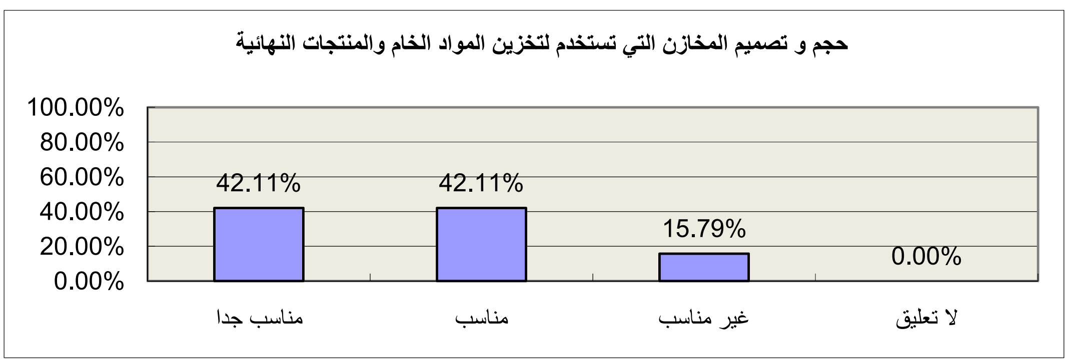
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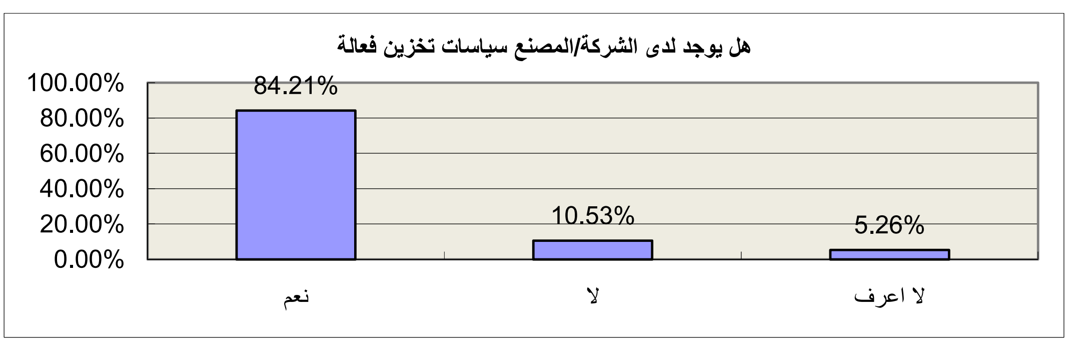
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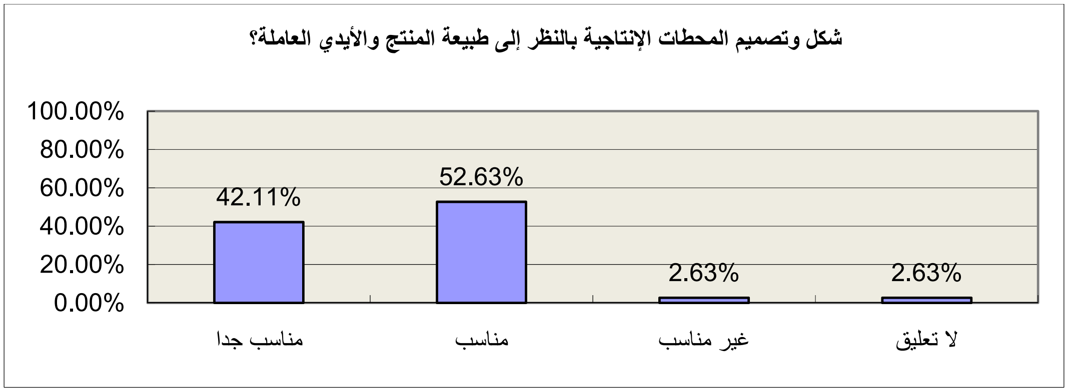
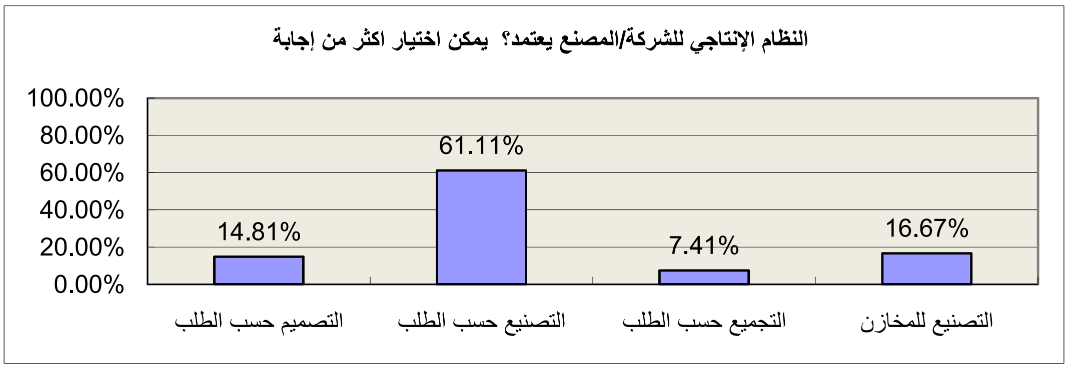
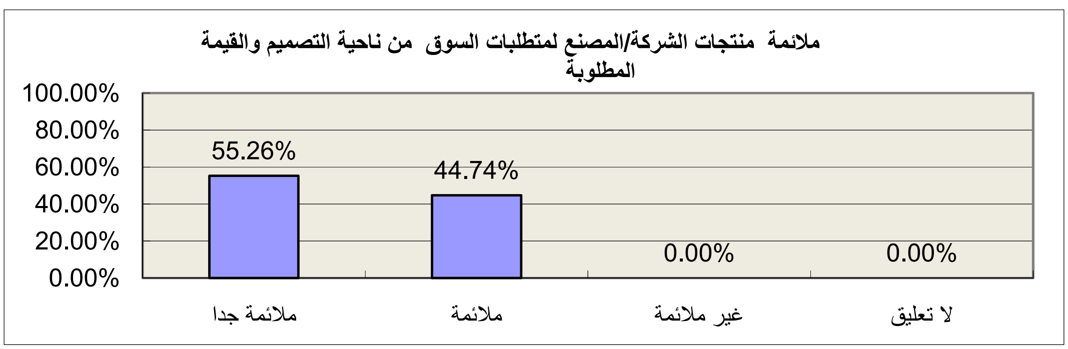
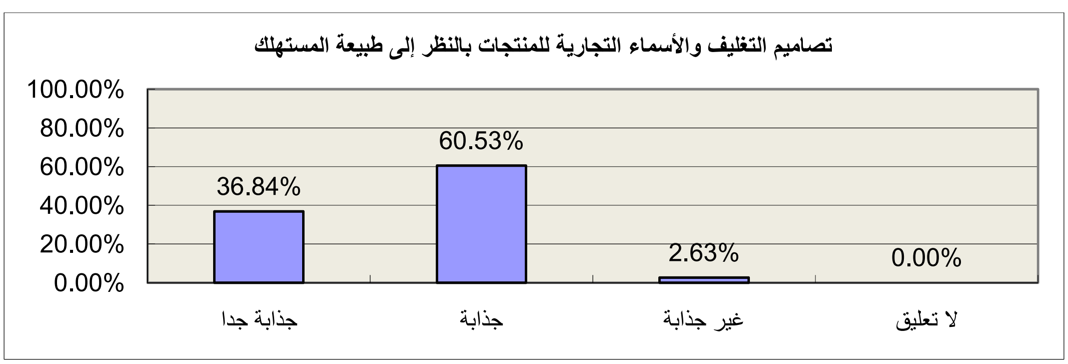
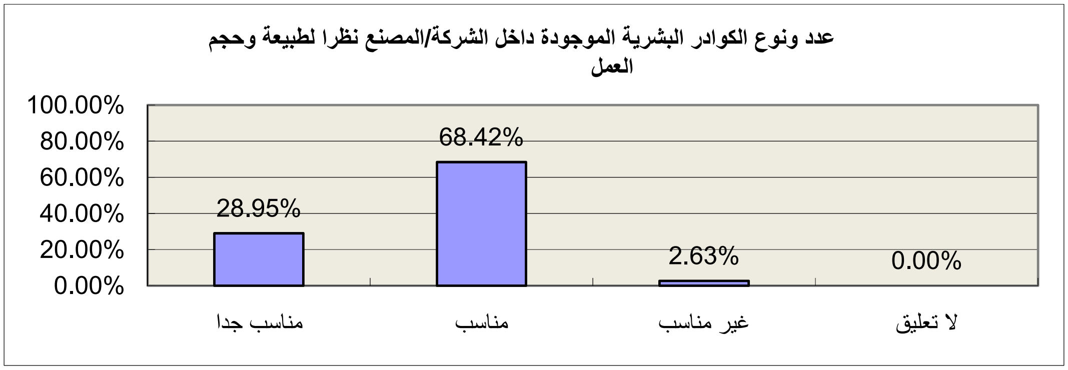
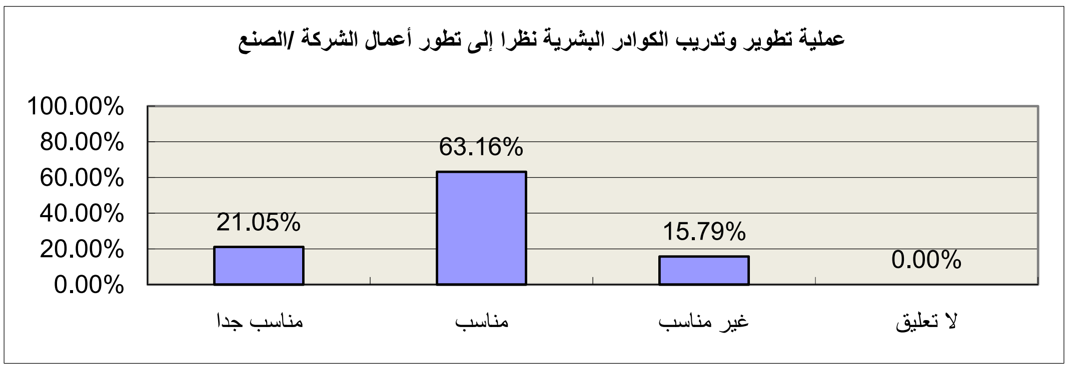

شكل وتصميم المحطات الإنتاجية بالنظر إلى طبيعة المنتج والأيدي العاملة؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
42.11%
52.63%
2.63%
2.63%
مناسب جدا
مناسب
غير مناسب
لا تعليق

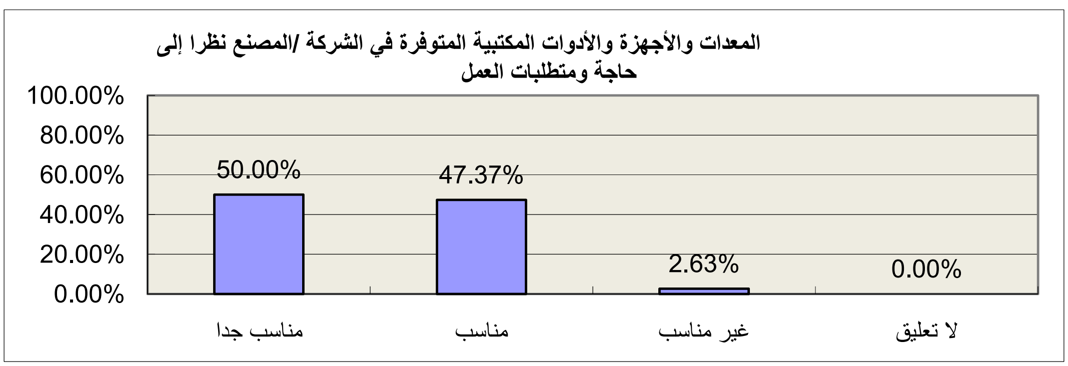

النظام الإنتاجي للشركة/المصنع يعتمد؟ يمكن اختيار اكثر من إجابة
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
14.81%
61.11%
7.41%
16.67%
التصميم حسب الطلب
التصنيع حسب الطلب
التجميع حسب الطلب
التصنيع للمخازن

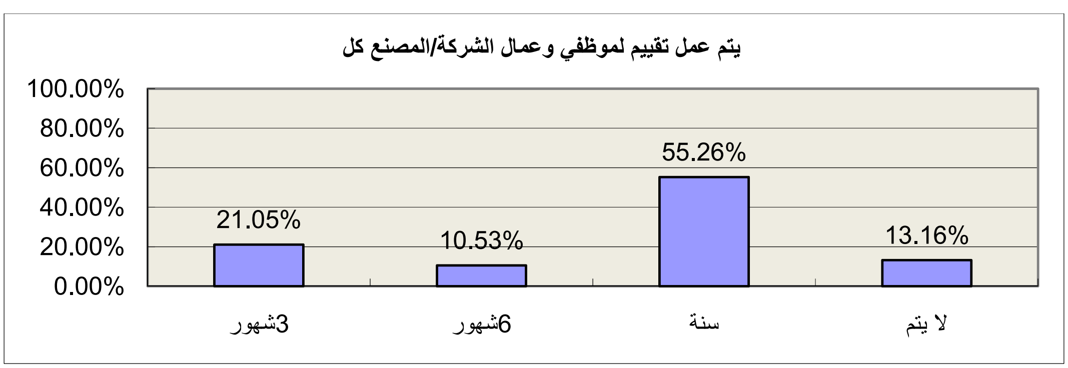

ملائمة منتجات الشركة/المصنع لمتطلبات السوق من ناحية التصميم والقيمة المطلوبة
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
55.26%
44.74%
0.00%
0.00%
ملائمة جدا
ملائمة
غير ملائمة
لا تعليق

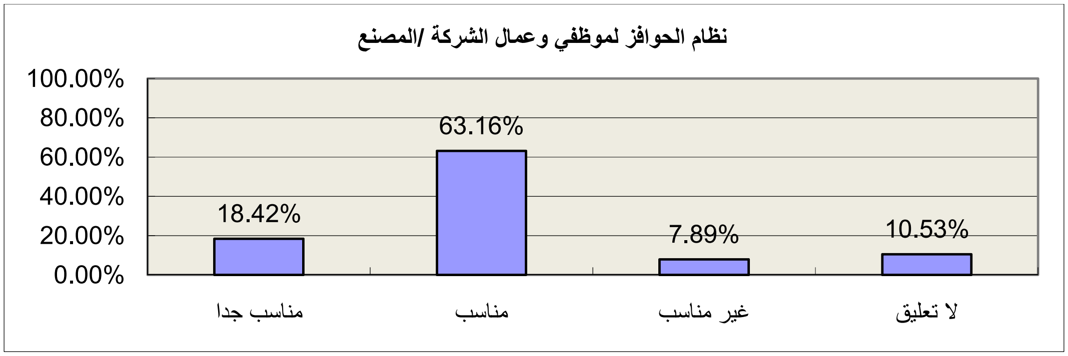

تصاميم التغليف والأسماء التجارية للمنتجات بالنظر إلى طبيعة المستهلك
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
36.84%
60.53%
2.63%
0.00%
جذابة جدا
جذابة
غير جذابة
لا تعليق

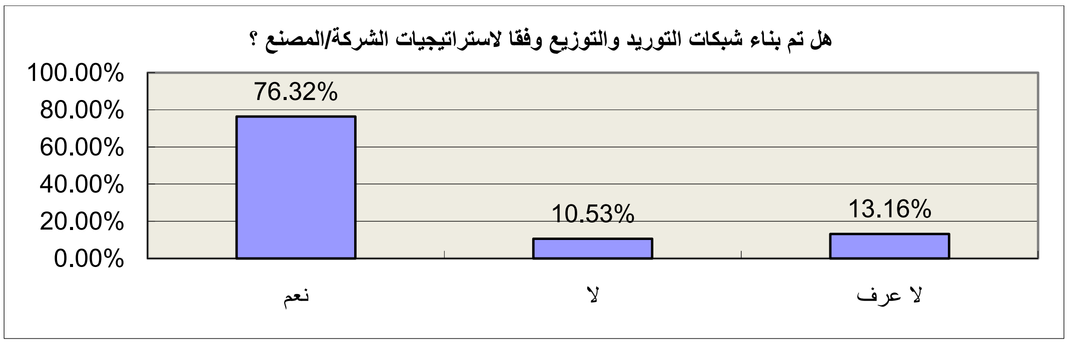

عدد ونوع الكوادر البشرية الموجودة داخل الشركة/المصنع نظرا لطبيعة وحجم العمل
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
28.95%
68.42%
2.63%
0.00%
مناسب جدا
مناسب
غير مناسب
لا تعليق

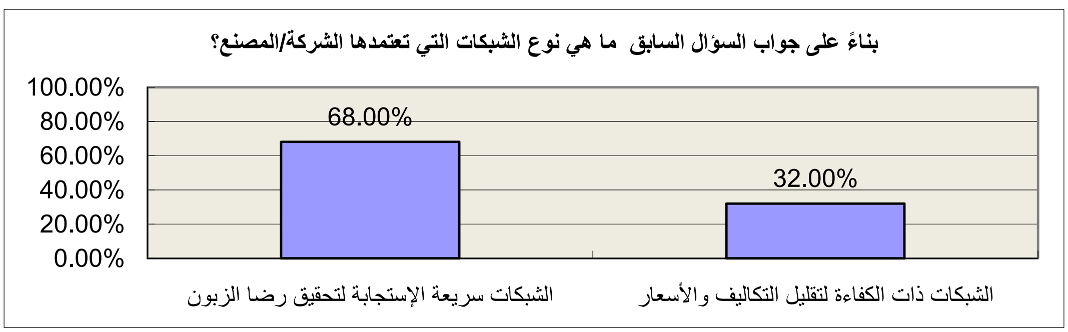

عملية تطوير وتدريب الكوادر البشرية نظرا إلى تطور أعمال الشركة /الصنع
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
21.05%
63.16%
15.79%
0.00%
مناسب جدا
مناسب
غير مناسب
لا تعليق

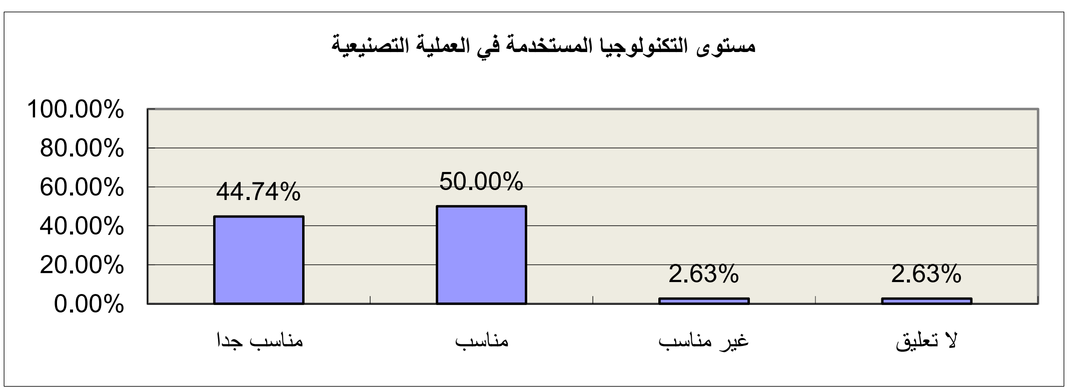

المعدات والأجهزة والأدوات المكتبية المتوفرة في الشركة /المصنع نظرا إلى حاجة ومتطلبات العمل
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
50.00%
47.37%
2.63%
0.00%
مناسب جدا
مناسب
غير مناسب
لا تعليق

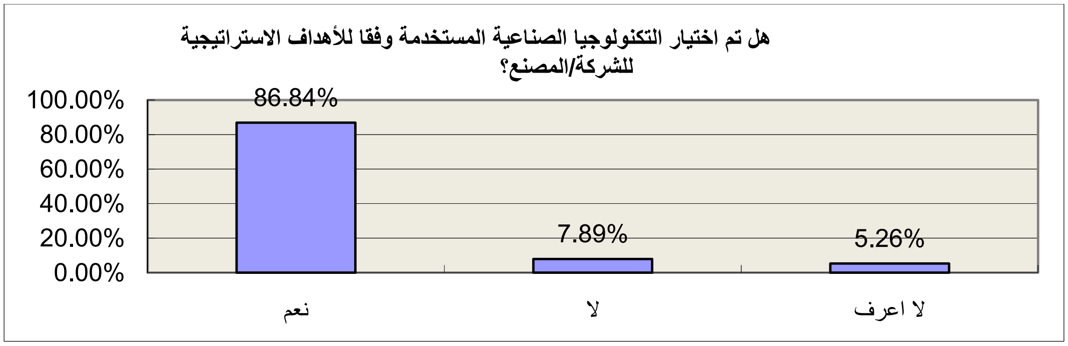

يتم عمل تقييم لموظفي وعمال الشركة/المصنع كل
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
21.05%
10.53%
55.26%
13.16%
3شهور
6شهور
سنة
لا يتم

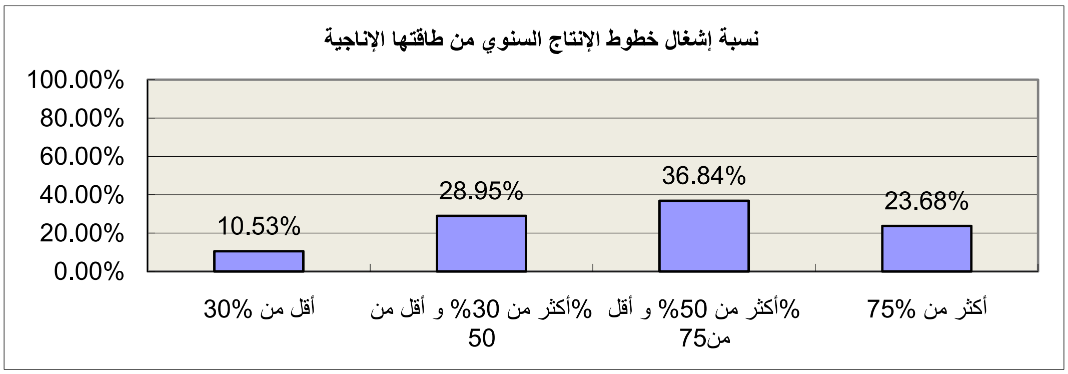

نظام الحوافز لموظفي وعمال الشركة /المصنع
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
18.42%
63.16%
7.89%
10.53%
مناسب جدا
مناسب
غير مناسب
لا تعليق

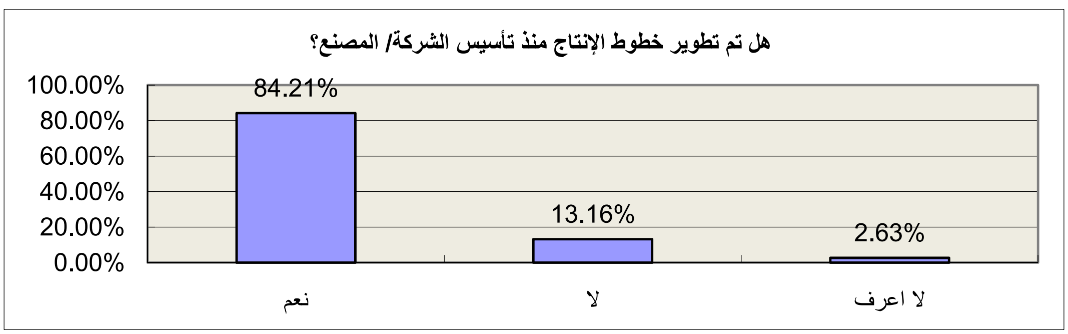

هل تم بناء شبكات التوريد والتوزيع وفقا لاستراتيجيات الشركة/المصنع ؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
76.32%
10.53%
13.16%
نعم
لا
لا عرف

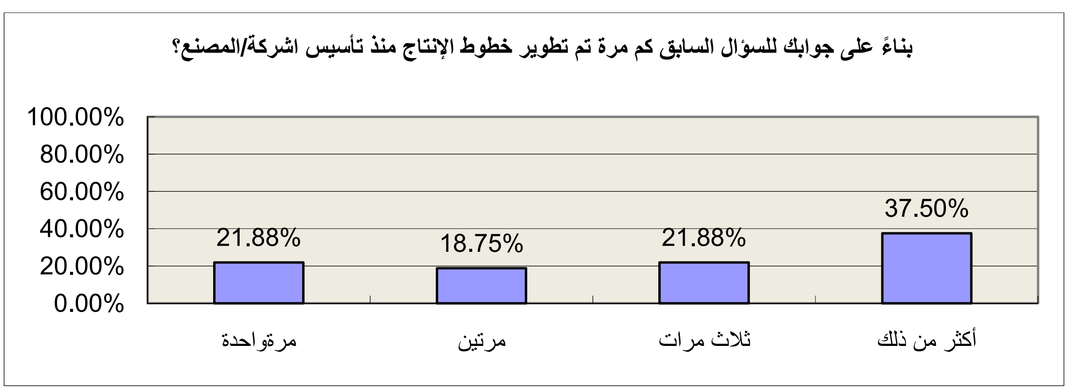

بناءً على جواب السؤال السابق ما هي نوع الشبكات التي تعتمدها الشركة/المصنع؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
68.00%
32.00%
الشبكات سريعة الإستجابة لتحقيق رضا الزبون
الشبكات ذات الكفاءة لتقليل التكاليف والأسعار

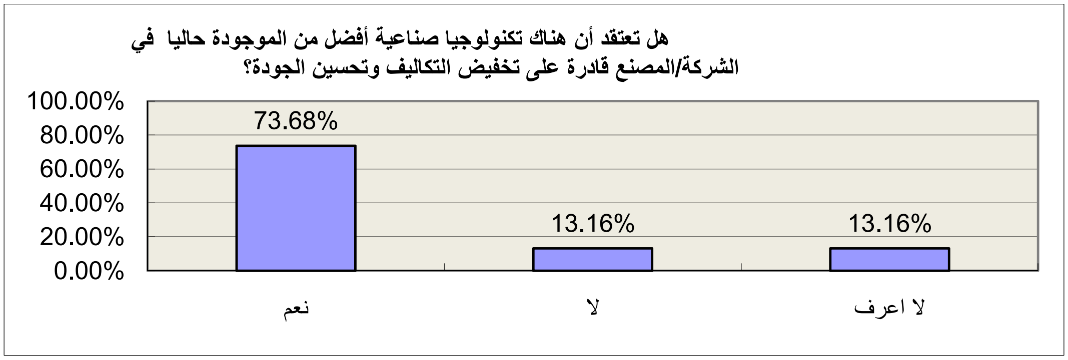

مستوى التكنولوجيا المستخدمة في العملية التصنيعية
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
44.74%
50.00%
2.63%
2.63%
مناسب جدا
مناسب
غير مناسب
لا تعليق

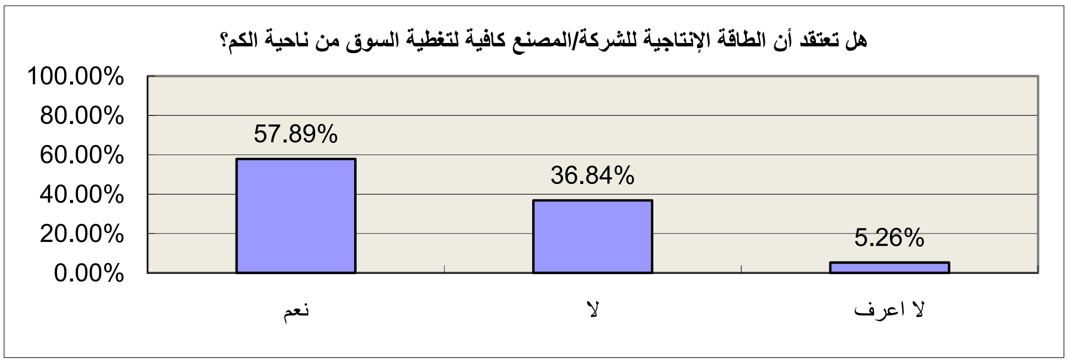

هل تم اختيار التكنولوجيا الصناعية المستخدمة وفقا للأهداف الاستراتيجية للشركة/المصنع؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
86.84%
7.89%
5.26%
نعم
لا
لا اعرف

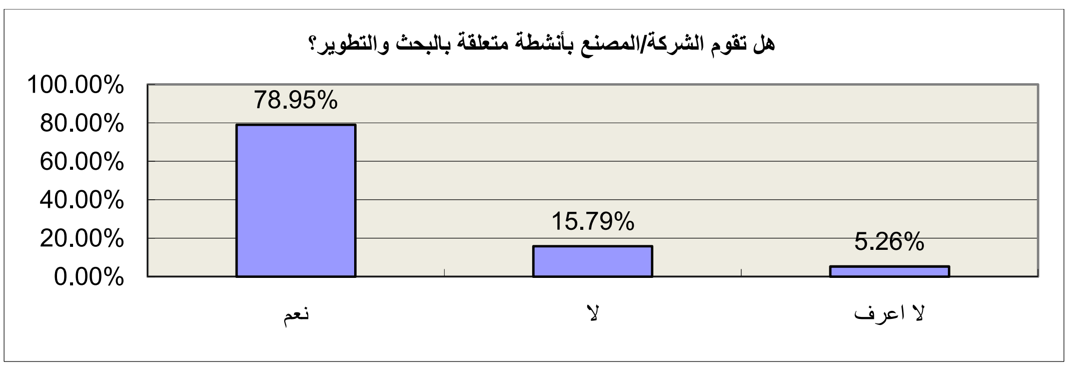

نسبة إشغال خطوط الإنتاج السنوي من طاقتها الإناجية
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
10.53%
28.95%
36.84%
23.68%
أقل من 30%
%أكثر من 30% و أقل من 50
%أكثر من 50% و أقل من75
أكثر من 75%

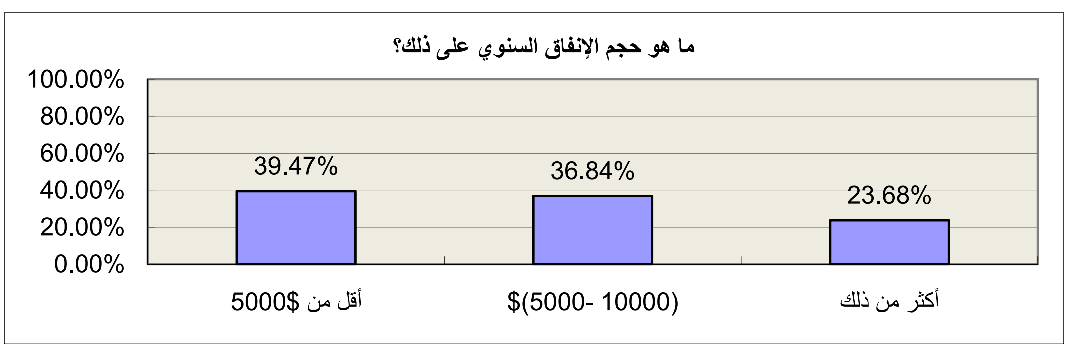

هل تم تطوير خطوط الإنتاج منذ تأسيس الشركة/ المصنع؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
84.21%
13.16%
2.63%
نعم
لا
لا اعرف

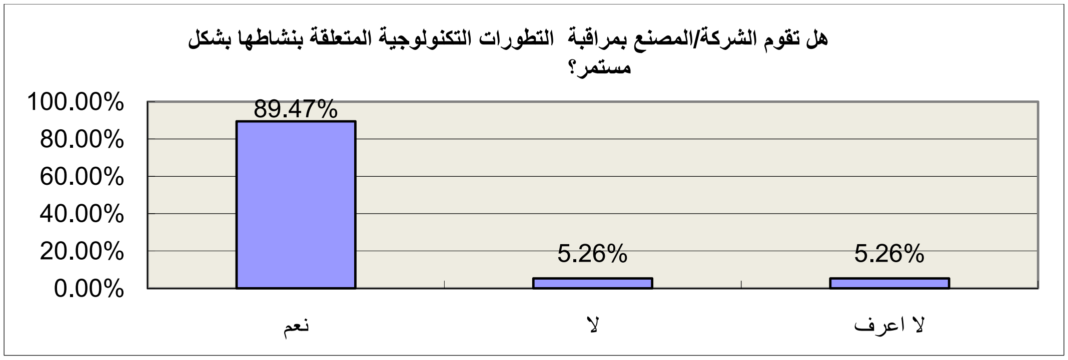

بناءً على جوابك للسؤال السابق كم مرة تم تطوير خطوط الإنتاج منذ تأسيس اشركة/المصنع؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
21.88%
18.75%
21.88%
37.50%
مرةواحدة
مرتين
ثلاث مرات
أكثر من ذلك


هل تعتقد أن هناك تكنولوجيا صناعية أفضل من الموجودة حاليا في الشركة/المصنع قادرة على تخفيض التكاليف وتحسين الجودة؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
73.68%
13.16%
13.16%
نعم
لا
لا اعرف


هل تعتقد أن الطاقة الإنتاجية للشركة/المصنع كافية لتغطية السوق من ناحية الكم؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
57.89%
36.84%
5.26%
نعم
لا
لا اعرف


هل تقوم الشركة/المصنع بأنشطة متعلقة بالبحث والتطوير؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
78.95%
15.79%
5.26%
نعم
لا
لا اعرف


ما هو حجم الإنفاق السنوي على ذلك؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
39.47%
36.84%
23.68%
أقل من 5000$
$(5000- 10000)
أكثر من ذلك


هل تقوم الشركة/المصنع بمراقبة التطورات التكنولوجية المتعلقة بنشاطها بشكل مستمر؟
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
89.47%
5.26%
5.26%
نعم
لا
لا اعرف

Appendix B

Data analysis tables and charts

Chi Square tests tables

PEARSON'S CHI-SQUARE TEST	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Group of questions to show Strategic Planning availability and effectiveness
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Criteria	If the pairs of variables are dependent, that mean; there is a relation to demonstrate the strategic planning availability, and effectiveness If the pairs of variables are independent, that mean; there is a relation to demonstrate the strategic planning unavailability, and its weaknesses
Conclusion	After making CHI-SQUARE TEST to 13 related pairs of questions, 69% of that tests showed that their was no relation between the questions pairs, which mean that the answers cant demonstrate the availability of strategic planning in the research sample, two examples of the tests illustrated below and the others can be seen in the appendices. .

Relation 1	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Did the company expand its markets since its foundation?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	4.758
Conclusion	As chi square value(4.758) not exceed alpha critical value (9.488), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning not available or not effective.

Relation 2	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Does the company have a written and applied organizational structure?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	5.949
Conclusion	As chi square value(5.949) not exceed alpha critical value (9.488), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning not available or not effective.

Relation3	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Does the supply chain have been built according the company strategies?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	5.075
Conclusion	As chi square value(5.075) not exceed alpha critical value (9.488), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning not available or not effective.

Relation 3	
First Variable	What is the competitive strategy used by the company?
Second Variables	What is the supply chain strategy used by the company?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	0.074
Conclusion	As chi square value (0.074) not exceeds alpha critical value (5.991), then the null hypothesis can't be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that the strategies used in the companies, according to their responses, are not compatible and harmonized.

A1-5-2	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Did the company release any new product since its foundation?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	11.308
Conclusion	As chi square value (11.308) exceeds alpha critical value (9.488), then the null hypothesis can be rejected, so we can say that there is a dependency between the answers of two questions and that leads to say that strategic planning available.

a1-5-4	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Does the company have any international certificates?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	3.701
Conclusion	As chi square value(3.701) not exceed alpha critical value (9.488), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning not available or not effective.

A1-5-5	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Is there any short term objectives?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	19.981
Conclusion	As chi square value(19.981) exceeds alpha critical value (9.488), then the null hypothesis can be rejected, so we can say that there is a dependency between the answers of two questions and that leads to say that strategic planning available .

A1-5-6-1	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Are the HR in the company satisfying its requirements?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	6
Critical Value fro Alpha	12.592
Chi square	10.199
Conclusion	As chi square value(10.199) not exceed alpha critical value (12.592), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning not available or not effective.

A1-5-6-2	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Are you satisfied regarding HR improvements activities?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	6
Critical Value fro Alpha	12.592
Chi square	2.022
Conclusion	As chi square value(2.022) not exceed alpha critical value (12.592), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning not available or not effective.

A1-5-8	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Did the production technology chose according to strategic plans?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	6.254
Conclusion	As chi square value(6.254) not exceed alpha critical value (9.488), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning not available or not effective.

A1-5-9-1	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	Did the company improve its production lines since it was founded?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	12.943
Conclusion	As chi square value(12.943) exceeds alpha critical value (9.488), then the null hypothesis can be rejected, so we can say that there is a dependency between the answers of two questions and that leads to say that strategic planning available .

A1-5-9-2	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	How many times the company did improve its production lines?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	6.333
Conclusion	As chi square value(6.333) not exceed alpha critical value (9.488), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning not available or not effective.

A1-5-10-2	
First Variable	Are there any strategic objectives the company aims to achieve over the coming years?
Second Variables	What is the amount of spending on R&D?
Null hypothesis	Two variables are independent
Adverse hypothesis	Two variables are dependent
Alpha level of significance	0.05
Degree of freedom	4
Critical Value fro Alpha	9.488
Chi square	3.382
Conclusion	As chi square value(3.382) not exceed alpha critical value (9.488), then the null hypothesis cant be rejected, so we can say that there is a conflict between the answers of two questions and that leads to say that strategic planning not available or not effective.

Banner tables

		Are there any strategic objectives the company aims to achieve over the coming years?		
		Yes	**No**	**Don't Know**
Dos the company have a mission statement?	**Yes**	90.63%	100.00%	100.00%
	NO	9.38%	0.00%	0.00%
	Don't Know	0.00%	0.00%	0.00%

		Are there any strategic objectives the company aims to achieve over the coming years?		
		Yes	**No**	**Don't Know**
Does the company have a written and applied organizational structure and working procedures?	**Yes**	81.25%	66.67%	57.14%
	NO	18.75%	33.33%	28.57%
	Don't Know	0.00%	0.00%	14.29%

		Are there any strategic objectives the company aims to achieve over the coming years?		
		Yes	**No**	**Don't Know**
Did the company expand its markets since it was founded?	**Yes**	84.38%	33.33%	85.71%
	NO	15.63%	66.67%	14.29%
	Don't Know	0.00%	0.00%	0.00%

		Are there any strategic objectives the company aims to achieve over the coming years?		
		Yes	**No**	**Don't Know**
Did the company release any new product since it was founded?	**Yes**	84.38%	0.00%	57.14%
	NO	15.63%	100.00%	42.86%
	Don't Know	0.00%	0.00%	0.00%

		Are there any strategic objectives the company aims to achieve over the coming years?		
		Yes	**No**	**Don't Know**
Did the company make a feasibility study in the initiation stage?	**Yes**	56.25%	100.00%	85.71%
	NO	9.38%	0.00%	0.00%
	Don't Know	34.38%	0.00%	14.29%

		Are there any strategic objectives the company aims to achieve over the coming years?		
		Yes	**No**	**Don't Know**
Did the company make any periodic evaluation to the competitors?	**Yes**	84.38%	66.67%	85.71%
	NO	12.50%	33.33%	0.00%
	Don't Know	3.13%	0.00%	14.29%

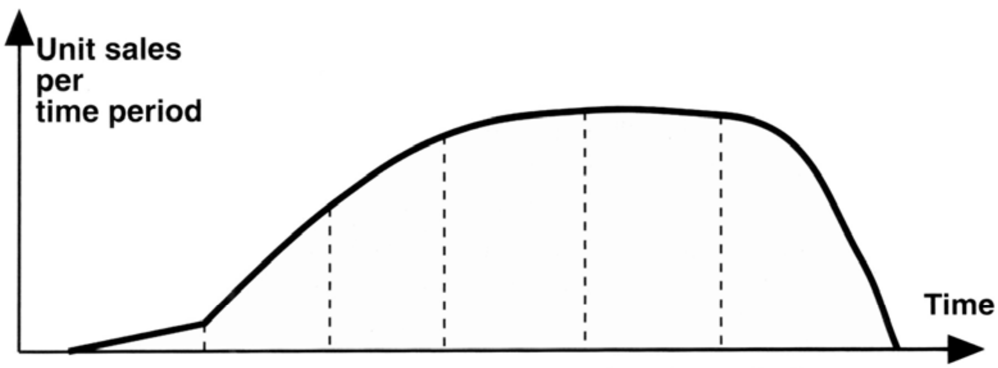
		Are there any strategic objectives the company aims to achieve over the coming years?		
		Yes	**No**	**Don't Know**
What is the production lines utilization?	Less than 30% Utilized	6.25%	66.67%	0.00%
	(30-50)% Utilized	28.13%	0.00%	57.14%
	(50-75)% Utilized	31.25%	33.33%	42.86%
	More than 30% Utilized	34.38%	0.00%	0.00%

		Are there any strategic objectives the company aims to achieve over the coming years?		
		Yes	**No**	**Don't Know**
What is the production lines utilization?	Less than 30%	15.38%	0.00%	0.00%
	(30-50)%	30.77%	28.57%	50.00%
	(50-75)%	26.92%	42.86%	50.00%
	More than 30%	26.92%	28.57%	0.00%

Appendix C:

Manufacturing System Linked to Product Life Cycle[4]

This approach advocates changing manufacturing processes based on market needs of different product life cycle stages. A product life cycle can be broken into six stages: development stage, growth stage, shakeout stage, maturity stage, saturation stage and decline. Figure 1 shows a schematic of a typical product life cycle with some details under each of the stages.



Stage:	Development	Growth	Shakeout	Maturity	Saturation	Decline
Product design	Changes rapidly	Changes slowly	Standard designs appear	Industry-wide standards	Commodity	Commodity
Sales	Low	Increase rapidly	High	Growth at rate of GNP	Growth at population growth rate	Decrease rapidly
Production volume	Low	Medium	Medium to high	High	Very high	Low
Market qualifying outputs	Innovative-ness, performance	Innovative-ness, flexibility, performance	Quality, flexibility, performance	Cost, quality	Cost, quality, delivery	Quality, flexibility
Best production system	Job Shop	Batch flow, FMS, JIT, OP line flow	OP line flow, JIT	EP line flow, JIT	Continuous flow	Job shop, batch flow
Profit per unit of product	Negative	Low to medium	Medium	Low	Very low	Negative

Figure 1: Stages in Product Life Cycle[5]

[4] Hayes, R.H. and S.C. Wheelwright, "Link Manufacturing Process and Product Life Cycles"
[5] Miltenburg, J., Manufacturing Strategy

Hayes and Wheelwright introduced the famous product-process matrix53 suggesting a strong link between manufacturing system capability needed and the current stage of product in the product life cycle. Several other authors have since endorsed this concept in various forms.

In effect, Hayes & Wheelwright linked the product life cycle to the "process life cycle". A process life cycle is the change a manufacturing processes goes through as the product goes through its life cycle. A process life cycle starts with a "fluid stage" (highly flexible but not cost efficient) and moves towards higher levels of standardization, mechanization and automation. Hayes and Wheelwright found that manufacturing processes are highly flexible and inefficient during the early stages of product life. As the product matures in the market and a stable design is established the focus is gradually switched towards efficiency and higher levels of mechanization and automation.

The product-process matrix developed by Hayes and Wheelwright is given in Figure 2: Product Process Matrix. The matrix has two primary regions, the diagonal position and off-diagonal position. A typical strategy can be to stay on the diagonal by changing the manufacturing system based on the product stage. This allows for a good match between manufacturing capability and market demand. On the other hand, a company might choose to stray from the diagonal, at its own risk, to fill a niche market. An excellent example would be the automobile manufacturer, Rolls Royce. The company has chosen to use craft manufacturing even when the market demand is too high for a craft based system.

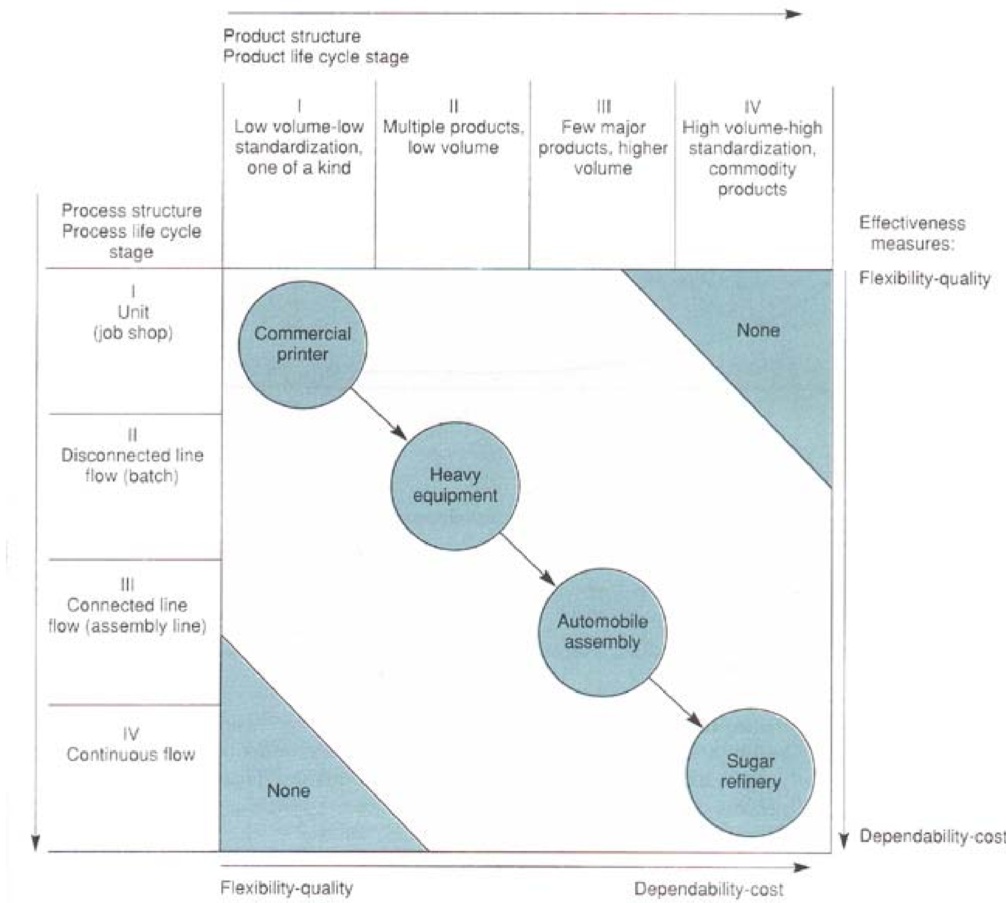


Figure 2: Product Process Matrix[6]

This matrix is a useful guide to select an appropriate manufacturing system based on the maturity of the product. For a brand new product entering a new market, the matrix suggests that one should pick a highly flexible manufacturing process. In evaluating current business performance, a company can use the matrix to locate the product stage on the matrix and verify if the manufacturing processes being used are appropriate for that stage. A competitive analysis can also be performed using the matrix to analyze a competitor's performance and manufacturing strategy. Likewise, the tool can also be used to determine whether multiple products can be manufactured in the same facility or separate

6 Hayes, R.H. and S.C. Wheelwright, "Link Manufacturing Process and Product Life Cycles"

facilities/production lines are needed. This is especially important if the different products offered are at different stages of product life cycle.

This tool also calls for a unique manufacturing system/process for each stage of the product life cycle. This supports Skinner's focused factory approach. Skinner advocates product focus but Hayes and Wheelwright take it one step further and suggest a strategy to select an appropriate manufacturing system for the selected product. It is important to note that manufacturing process is a dynamic process. It changes as the product changes. Therefore, one should avoid selecting a "company standard manufacturing system," instead one should continuously evaluate the current manufacturing system to verify the fit between product demand and manufacturing capabilities.

Appendix D

Industry Life cycle stages[7]

A typical industry life cycle might be described by four stages: a start-up stage, characterized by extremely rapid growth; a consolidation stage, characterized by growth that is less rapid but still faster than that of the general economy; a maturity state, characterized by growth no faster than the general economy; and a stage of relative decline in which, the industry grows less rapidly than the rest of the economy, or actually shrinks.

1. **Start-Up Stage**: The early stages of an industry are often characterized by a new technology or product such as personal computers in the 1980s, or bioengineering in the 1990s. At this stage, it is difficult to predict which firms will emerge as industry leaders. Some firms will turn out to be wildly successful, and others will fail altogether. Therefore, there is considerable risk in selecting one particular firm within the industry.
2. **Consolidation Stage:** After a product becomes established, industry leaders begin to emerge. The survivors from the start-up stage are more stable, and market share is easier to predict. Therefore, the performance of the surviving firms will more closely track the performance of the overall industry. The industry still grows faster than the rest of the economy as the product penetrates the marketplace and becomes more commonly used.

[7] Yang Yang. "what are the industry life cycle." EconGuru Economics Gide. 18 Oct. 2010 < http://www.econguru.com/industry-life-cycles/>.

3. **Maturity Stage:** At this point, the product has reached its full potential for use by consumers. Further growth might merely track growth in the general economy. The product has become far more standardized, and producers are forced to compete to a greater extent on the basis of price. This leads to narrower profit margin and further pressure on profits.
4. **Relative Decline:** In this stage, the industry might grow at less than the rate of the overall economy, or it might even shrink. This could be due to obsolescence of the product, competition from new products, or competition from new low-cost suppliers.

Appendix E

Manufacturing System Design Inputs[8]

Manufacturing System Design inputs "Considerations" can be classified into four main Categories:

1. Enterprise Needs/Objectives/Strategies

This category includes any considerations that originate at the enterprise management level. Since the manufacturing system is a subsystem of the whole enterprise system, these factors must be considered highly to ensure proper system-subsystem alignment in objectives. These factors are the goals of manufacturing system itself. Stakeholder satisfaction, for example, is a corporate goal, which in turn becomes the goal of a manufacturing system. The enterprise needs or strategies can have very strong influence on how the manufacturing system is designed. The manufacturing system design team must take these factors under consideration to help the enterprise satisfy its goals.

2. External Factors

The enterprise does not have complete control over these factors, yet they must be accounted in order to achieve the enterprise and manufacturing system goals. It is difficult to determine exactly how much control an enterprise has on these items. Market uncertainty and government regulations are two examples of external factors.

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[8] Amanda Vaughn, Pradeep Fernandes, and J. Tom Shields. "Manufacturing System Design Framework Manual". 2002

It can be argued that over time the enterprise can have enough influence over market dynamics due to systemic effects and on regulations through lobbying. It is assumed here that the time between a request for change (in the case of regulation) and the subsequent approval is longer than the time available to design and implement the manufacturing system.

These external factors often determine location of the plant, worker composition, and size of the manufacturing operation. Some considerations such as offset requirements might require a company to open up a manufacturing plant in a given place to gain governmental support or open a plant in a different country to be able to sell products in that country. Therefore, the “external” factors act truly external to the manufacturing system design decisions. Manufacturing system designers must, however, make design decisions concerning compliance realizing that decisions may affect other enterprise strategies.

3. Controllable Factors

The enterprise or the decision body has enough control over these factors to make strategic decisions based on them. Product mix, for example, is such a factor where a company can decide the number of products it will offer. If there is a demand for 5 different versions of the product, the company can decide to offer all 5 versions or offer only 3 based on some strategy. From Table 1, investment, product quality and worker skill level are some other examples of these factors. It should be emphasized that the enterprise might have more control over some of the controllable factors than on others.

Nevertheless, the decision-makers have more decision authority over controllable factors than over external factors. The effect of making a hasty choice on these factors might have a relatively insignificant effect on the manufacturing system compared to the global and relatively significant effect that can be expected by not complying with some of the external factors such as government regulations.

4. Constraints/Targets

Constraints and goals are set by the management or the decision body to ensure that the manufacturing system remains within the established boundaries of corporate standards for financial and manufacturing system performance. The constraints typically limit the design possibilities but allow the manufacturing system to comply and contribute to enterprise system objectives. This category also covers both financial and physical performance goals. Table 1 shows the factors considered to be constraints to the design activity. As mentioned above, the corporation has varying levels of control over the factors within the "controllable factors" category.

The level of control assumed can be very subjective depending on the corporation. Similarly, the distribution between "external factors" and "controllable factors" also required human judgments. The enterprises will have to set their own boundaries on all of these categories and sort items accordingly. Some of the items considered here as controllable might qualify as external depending on the context. Thus, it is important to consider these categories in context of your business. the corporation can control the level of importance (quantitatively or qualitatively) given to the "controllable factors."

5. Major Factors in Manufacturing System Design

Even though all of the factors that are mentioned in Table 1 are valid, not all of them affect the manufacturing system design directly. This list of factors can be reduced to a manageable level by retaining only the factors that directly affect manufacturing system design. For example, the offset requirements might change the location of a plant but does not necessarily change the design of the plant itself. Similarly, careful investments and efficient manufacturing processes achieve affordability. The core input is the investment and not affordability. Based on this thinking, the above list was reduced to the following factors:

- Market Uncertainty
- Product Volume
- Product Mix
- Frequency of Changes
- Complexity
- Process Capability
- Worker Skill
- Type of organization
- Time to first part (a constraint)
- Investment (a constraint)
- Available/Existing Resources (a constraint)

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اشراف

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قدمت هذه الأطروحة استكمالاً لمتطلبات درجة الماجستير في الادارة الهندسية بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين

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الملخص

يهدف هذا البحث إلى تطوير إطار عام لتصميم أنظمة التصنيع المتكاملة التي تتلائم مع البيئة البحثية المختارة, وهي البيئة الصناعية الفلسطينية بما فيها من ظروف خاصة تتحكم بمدخلات ومخرجات أي نظام تصنيعي, وقد اختار الباحث قطاع الصناعات الغذائية كحالة بحثية يمكن اعتبارها والقياس عليها, ويهدف أي نظام صناعي إلى تحقيق الأهداف الاستراتيجية التي تُنشأ الشركات والمؤسسات من أجل تحقيقها, وتعاني الانظمة التصنيعية التي تعمل حاليا في البيئة الصناعية الفلسطينية وتحديدا قطاع الصناعات الغائية من العديد من المشاكل التي تحد من غمكانية تحقيق تلك الاهداف التي يصبو المستثمرين إلى تحقيقها.

استخدم الباحث كلا المنهجيتين البحثيتين- الكمي والنوعي- لإتمام عمله البحثي, حيث قام بإجراء ثلاث مقابلات مباشرة مع ممثلين لشركات شملها البحث, إضافة إلى استخدام طريقة الإستبانة الإلكترونية التي تم تصميمها و توزيعها من خلال البريد الإلكتروني لكل من افراد العينة البحثية والتي هي عبارة عن 52 منشأة صناعية متخصصة في تصنيع المواد الغذائية, وقد أُعيدت 36 استبانة مكتملة, حيث بلغت نسبة الإستجابة 69% من العينة المستهدفة.

بعد تحليل المعلومات الواردة من خلال الإستبانة والمقابلات المباشرة أظهرت النتائج أن الأنظمة التصنيعية في المنشئات الغذائية الفلسطينية تعاني العديد من المشاكل ومن أهمها ضعف عملية التخطيط والتصميم التي تسبق انشاء هذه الأنظمة حيث أن 62% من العينة البحثية افادو بعدم وجود اهداف استراتيجية مكتوبة و واضحة لديهم, اضافة إلى وجود خلل واضح في عملية الربط بين احتياجات السوق المستهدف والقدرة الانتاجية التي يتم اختيار النظام الانتاجي لتحقيقها مما يعني أن هذه الأنظمة الانتاجية المختارة لا يتم اشغالها بالكامل حيث أن النتائج اظهرت بأن اكثر من 40% من افراد العينة البحثية يستغلون اقل من 50% من القدرة الانتاجية لمنشئاتهم.

و قد قام الباحث بتطوير هذا النموذج تحت عنوان تصميم أنظمة التصنيع الغذائي في فلسطين, وهو هبارة عن اداة تساعد مصممي أنظمة التصنيع في البيئة البحثية من خلال (1) تقديم فهم واضح لمكونات النظام التصنيعي ومستوياته المختلفة (2) ربط النشاطات التكتيكية التي تنفذ في المستوى التشغيلي للنظام مع المتطلبات و الاهداف بعيدة الاجل "الاستراتيجية" (3) توضيح اليات ومواطن الترابط والتكامل بين مكونات هذا النظام وذلك من اجل تمكين اصحاب هذه الأنظمة من تحقيق الاهداف التي يسعون إلى تحقيقها وتحقيق الفائدة القصوى من خلال تقليل التكاليف و رفع الجودة وتحقيق الاستغلال الامثل للنظام الانتاجي و تلبية رغبات وحاجات الزبائن على اكمل وجه, وقد قام الباحث ايضا بتطوير الية عمل لتنفيذ وتطبيق هذا النموذج في البيئة البيحثية.