Applying the just-in-time production system in developing countries: lessons learnt from Japan and the West

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University of Wollongong

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Applying the Just-in-Time Production System in Developing Countries:
Lessons Learnt from Japan and the West

A thesis submitted in partial fulfilment of
the requirements for the award of the degree

Master of Total Quality Management (Honours)

from

UNIVERSITY OF WOLLONGONG

by

Lukman Sukarma

Department of Mechanical Engineering
1997
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<td>CE</td>
<td>Concurrent Engineering</td>
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<tr>
<td>CM</td>
<td>Cellular Manufacturing</td>
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<td>CIM</td>
<td>Computer Integrated Manufacturing</td>
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<td>DAC</td>
<td>the Development Assistance Committee</td>
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<td>DCs</td>
<td>Developing Countries</td>
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<tr>
<td>EOQ</td>
<td>Economic Order Quantity</td>
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<td>FMS</td>
<td>Flexible Manufacturing Systems</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GNP</td>
<td>Gross National Product</td>
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<td>GT</td>
<td>Group Technology</td>
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<td>IBM</td>
<td>International Business Machines</td>
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<td>IEBM</td>
<td>International Encyclopedia of Business and Management</td>
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<td>IF</td>
<td>the Integrated Factory</td>
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<td>ISIC</td>
<td>International Standards of Industry Classification</td>
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<td>JIT</td>
<td>Just-in-Time</td>
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<td>JUSE</td>
<td>Union of Japanese Scientists and Engineers</td>
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<td>LDCs</td>
<td>Lesser Developed Countries</td>
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<td>LP</td>
<td>Lean Production</td>
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<td>MNCs</td>
<td>Multi National Companies</td>
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<td>MRP</td>
<td>Material Requirements Planning</td>
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<td>Manufacturing Resource Planning</td>
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MPS  Master Production Schedule
NICs  New Industrialised Countries
OEMs  Original Equipment Manufacturers
OPT  Optimised Production Technology
PDCA  Plan-Do-Check-Action
PIQS  Practical Industrial Quality Systems
QCC  Quality Control Circles
QCOM  Quick Changeover Manufacturing
ROTA  Return to Total Asset
SPC  Statistical Process Control
SQC  Statistical Quality Control
SUR  Set up Reduction
SMED  Single Minute Exchange of Die
TPI  Total People Involvement
TPM  Total Productive Maintenance
TPS  Toyota Production System
TQ  Total Quality
TQC  Total Quality Control
TQM  Total Quality Management
UNCTAD  the United Nations Conference on Trade and Development
US  the United States
WCM  World Class Manufacturing
WIP  Work in process
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Abstract

This study embodies a critical analysis on the possibility of implementing JIT in manufacturing firms in developing countries (DCs), with the aim of developing guidelines for implementing JIT in the environment of DCs. But, due to the broad scope of the targeted population, only general guidelines can be presented. These include productivity improvement, the management of quality, the management of production and inventory, and building supplier relationships.

To accomplish this objective, this study commences with a theoretical-based discussion of the philosophical foundation of JIT and an exploration of the characteristics of DCs. This is followed by an investigation of JIT implementation in Japan and the West, as well as its possible application in DCs. This exploration provides useful information for developing models for JIT implementation in DCs, and on issues relating to the creation, development, refining, and diffusion of the JIT system. In order to carry out future research, a questionnaire is also devised to measure the effectiveness of JIT implementation in DCs.

It is concluded that companies in DCs wishing to improve productivity and quality must implement the JIT system for their survival. They need not necessarily follow the same path in implementing JIT as those followed by the Japanese or Western companies, since they are confronted with a different environment to both these groups. Instead, they should develop strategies utilising local strengths in combination with Western and Japanese experiences rather than imitate them. However, many lessons can be learnt from the industrialised countries' experiences in adopting or implementing JIT, such as pursuing the universal approach to managing for quality as proposed by Juran,
learning from Western organisations’ failures in implementing TQM in order to understand the reasons and develop solutions, as well as pursuing Japanese ways of improving productivity by inviting employees’ participation, of effectively managing production and inventory, and of building supplier relationships.
Chapter 1
Introduction

1.1. **Background**

The Just-in-Time (JIT) production system or "JIT manufacturing," successfully implemented by Japanese manufacturers after the second world war, proposes a better alternative to traditional methods for simultaneously pursuing quality improvement, cost reduction, and shortened delivery times. These advantages have been exploited by Japanese companies to dominate global markets with quality products and competitive prices, ranging from electronics to automobiles. In response to Japan's competitive success, many firms in the West have reacted by adopting this promising production management system. According to, for example, Groeber and Merz (1994), JIT manufacturing is one of the latest Japanese management techniques to be adopted and implemented by Western companies. In this thesis, the terms 'JIT manufacturing,' or 'the JIT production system,' or 'the JIT system' are interchangeable.

The benefits of JIT are described by several authors (Buffa, 1984; Cheng 1988; Hutchins, 1988; Monden 1983; Schonberger, 1982, 1986; Sandras, 1989; Voss and Robinson, 1987; Clarke and Mia, 1993; and White, 1993). These benefits include higher productivity; improved relations with suppliers; savings because of low inventory stocks needed; and crucially, the highlighting, and the elimination of, underlying problems formerly disguised by the buffer system. Furthermore, Schonberger (1986: ix) reports that the new world class manufacturing method results in 'defect rates cut tenfold and more; manufacturing lead-times cut twentyfold in a number of cases; triple the sales volume in half the plant space'.
However, little is offered in the way of empirical confirmation which supports the proposition that these results do indeed have a positive effect on the financial welfare of the implementing firms. The article by Inman and Mehra (1992) reveals that manufacturing firms utilising this philosophy obtain a significant effect on the level of financial success. The financial benefits are calculated based on the seven gains: down time reduction, inventory reduction, workspace reduction, increased quality, increased labour utilisation, increased equipment utilisation, and increased inventory turns.

In contrast, pessimists worry at the negative consequences of JIT. They question whether the JIT system is an operation that leads to job losses, work intensification, higher levels of stress on workers, longer working hours (based on Japanese practices), and take off any slack in the system which workers might formerly have used to gain some respite from constant work. Turnbull (1988: 18), for example, observes the negative effects of JIT. Japan’s job security in terms of ‘life-time employment’ as a compensation for job flexibility and work intensification, he argues, is ‘neither legally nor contractually guaranteed’; and is, in fact, dependent upon the continued economic success of the company which is no different from the life-long employment practiced by some British firms.

For many decades, manufacturers in the West were accustomed to deal with production methods and problems as a legacy from the mass production system and worked within those parameters to optimise their goals. Conversely, Japanese put more endeavour on improving Western-imported techniques of production management, inventory control, product design, and process planning and control. As noted by many authors, the Japanese efforts have reaped tremendous results in attaining a high level of quality and productivity.
Not only are companies in Western industrialised countries tempted to use Japanese techniques, but firms in developing countries are even more eager to experiment with them. The features of JIT and TQC that would appeal to most developing countries are the basic simplicity and the ease of use for unexperienced employees and the small capital investment required (Ebrahimpour and Schonberger, 1984). In response to the need for developing countries to develop production systems suitable to local conditions, many firms in developing countries are beginning to study and implement Japanese manufacturing techniques with some modifications – see (Cheng, 1988) for Hong Kong and (Lawrence and Lewis, 1996) for Mexico.

There is no doubt that JIT implementation in developing countries will encounter most of the problems experienced by Western manufacturers. In anticipating the difficulties, therefore, the mission of this study is to suggest some models for the successful implementation of JIT in developing countries. Empirical studies of JIT implementation in Japan and in the West as well as the exploration of the strengths and weakness of firms in developing countries are useful in attaining this objective. The literature survey will, in turn, be used as illustrations for implementing the JIT manufacturing in developing countries.

Finally, an instrument is required to measure the effectiveness of JIT implementation. Consequently, a questionnaire designed for assessing the effectiveness of JIT implementation in developing countries has been devised in this research. In fact, the need for such an instrument for designing a comprehensive performance measurement system for JIT implementation is indicated as desirable in several articles (Goyal and Deshmukh, 1992; and Crawford and Cox, 1990).
1.2. Objectives

The objectives of this study are:

- To understand the similarities and differences of JIT implementation in Japan and in the West in the framework of developing guidelines for the successful implementation of the JIT production system in developing countries.

- To develop a questionnaire for assessing the effectiveness of JIT implementation in manufacturing firms in developing countries.

1.3. Methodology

The research was carried out by critically examining textbooks, journals and case studies from numerous sources and, from there, analysing manufacturing and management practices of JIT implementation in Japan and in the West with the purpose of developing guidelines for the successful of JIT implementation in developing countries. The empirical studies were also compared with the theoretical framework to establish if there was any deviation between theory and practice and to understand the reasons for these. Finally, this study gathered information for the development of a questionnaire designed to measure the effectiveness of JIT implementation in developing countries.

1.4. Organisation of the Study

Chapter 1 outlines the background, importance and objectives of the study. In Chapter 2, the philosophical foundation of JIT manufacturing is explored. This includes the definition of the JIT production system, its unique characteristics, and JIT supporting tools and techniques. This is followed by an examination of the characteristics of developing countries in Chapter 3. The evolution of JIT
encapsulating the history of JIT, the perspective of JIT manufacturing within the emergence of new manufacturing strategies, role of manpower, strategies for implementation, and JIT implementation in Japan and in the West as well as its possible application in developing countries, is presented in Chapter 4. Then, based on the experiences of both Japan and the West, Chapter 5 addresses the issues relating to the development of guidelines for implementing JIT in developing countries. Summaries of the results, conclusions, contributions, and recommendations for future research are provided in Chapter 6. Finally, a questionnaire for measuring the effectiveness of JIT implementation in developing countries is presented in the appendix.

Figure 1 provides an illustration on how the successful implementation of the JIT system by manufacturing firms in developing countries can be achieved. The successful implementation of JIT in developing countries requires models or guidelines (Chapter 5). These models have to be equipped with an instrument for measuring the effectiveness of JIT implementation. To accomplish this task, an appendix provides a questionnaire for JIT implementation by manufacturing firms in developing countries. Furthermore, the suggested models are developed through investigations of the philosophy of the JIT production system (Chapter 2), the characteristics of developing countries (Chapter 3), and the evolution of JIT manufacturing (Chapter 4). Finally, the models need to be re-developed over time to accommodate changes experienced by developing countries. For example, improvements in the standard of education will not only result in a more educated work force but also more demanding customers.
The Objective:
Successful implementation of the JIT production system by manufacturing firms in developing countries.

Chapter 2: Philosophy of the JIT production system

Chapter 3: Characteristics of Developing Countries

Chapter 4: Evolution of the JIT Production System

Chapter 5: Suggested models for implementing JIT in developing countries:
- Management of quality
- Productivity improvement
- Management of production and inventory
- Building supplier relationships

Appendix: A questionnaire for JIT implementation by manufacturing firms in developing countries

Figure 1: Framework of the Study
Chapter 2
Philosophy of the Just-in-Time Production System

2.1. Introduction

The terminology ‘World Class Manufacturing’ appeared for the first time when Schonberger (1986) had to give a name to new methods of manufacturing developed and perfected by Japanese companies after the second world war (Harrison, 1994) which were characterised by the rejuvenation of manufacturing operations through participatory leadership, industrial democracy, quality circles, and quality-of-work-life programs. Another label for those techniques of manufacturing which originated from Japan, was provided by the Massachusetts Institute of Technology in its five million dollars and five year study on the worldwide automotive industry in 1985. The label was ‘Lean Production,’ a term used to describe a new system of production utilising less of everything compared with the traditional ‘mass production’ system (Womack et al., 1990)

The new methods of manufacturing originated in the Toyota Production System (TPS) in Japan, when Taiichi Ohno, the then vice-president of Toyota Motor Company, contemplated to creating a system of production in which ‘the right parts needed in assembly reach the assembly line at the time they are needed and only in the amount needed’ (Ohno, 1978: 4). For this reason, Ohno called this system ‘Just-in-Time,’ which was actually one of the two pillars of TPS. Another pillar was autonomation or ‘automation with a human touch.’ In his work, Ohno was supported by Shigeo Shingo, a consultant who among other things ran training courses in industrial engineering at this company from 1955 to 1981.
In this chapter, the definition and characteristics of the JIT system which have resulted from an investigation of various sources will be discussed. This involves JIT philosophy, its unique characteristics, and the tools and techniques used in its implementation.

2.2. Definition of the JIT Production System

In line with its global recognition, the definition of the JIT production system has been continuously changed by many authors depended upon their own interests. According to Goyal and Deshmukh (1992: 18), the contemporary definitions focus on JIT as an approach to minimise waste in manufacturing, or more generally aiming at reducing inventory as an effort to enhance the competitiveness of the products. Alternatively, other definitions describe JIT manufacturing as the coordination and synchronisation of the movement of completed work from the upstream operation (finished product assembling) to the start of the work at the successive downstream operation (raw material procurement). It seems that all authors agree that JIT is more than a collection of production techniques. Japan Management Association (1989: 23), for example, summarises JIT as ‘a system of production based on the philosophy of total elimination of waste, that seeks the utmost rationally in the way we make things.’

More comprehensive explanations about JIT manufacturing can be found in Harrison (1992), Hirano (1987) in the form of pictorial guidance, and the Kaizen Institute of Japan in the form of videos. Also, Maskell (1989) provides extensive coverage about the steps required to implement the JIT philosophy. These explications also illustrate the differences between JIT manufacturing that have been practiced by Japanese manufacturers for more than three decades and the traditional methods of manufacturing that are still being operated by many
Western companies. Unlike many other writings about JIT, these authors describe ‘world-class JIT techniques’ in sufficient detail to demonstrate how they can be applied in developing excellent companies.

According to Harrison (1992), the JIT production system is defined as a combination of a set of beliefs which in turn are supported by three basic elements of JIT/TQ and is furnished with a series of tools and techniques which are the weapon for cutting out the waste. The three basic elements of JIT/TQ are elimination of waste, Total Quality, and people preparation.

There are two core beliefs of JIT. One core belief is concerned with the achievement of ‘the excellent company.’ This view assumes that ‘the rate at which excellence is achieved depends on the rate at which a company can improve relative to its competitors, and continue to improve faster than they can’ (Harrison, 1992: 32). No matter how fast a company can improve, it will not become an excellent company unless it progresses faster than its competitors do. Another core belief is that a company ‘cannot achieve such excellence through good management alone,’ instead, an excellent company will be required to develop its members to their full potential which will enable them to handle the more challenging tasks which result from improvements and to contribute their creativity towards further improvements.

In supporting these core beliefs, JIT techniques and tools are necessary for the elimination of waste, total quality is required to develop the organisation, and people preparation is needed to grasp the new challenges and opportunities created from improvement. The aim of waste elimination over time is to reduce gradually the non-value added activities and to enrich the value-added.

Different authors, however, mention different JIT supporting tools and techniques. Harrison (1992: 51) classifies JIT techniques into three areas:
1. *In company JIT*: conversion of the business into a JIT processing facility;

2. *Inter company JIT*: extension of the JIT system to relationship between customers and suppliers;

3. *Supporting mechanisms*: systems, procedures, and policies which support JIT/TQ.

The philosophy of the JIT production system can be simplified as follows:

**Set of beliefs:**

- In order to become excellence, the company must progress faster than that of competitors
- The creativity of company members is a vital input in the improvement process

![Diagram of JIT Tools and Techniques](image)

**Figure 2: Framework of JIT Philosophy**

*Source: Harrison (1992)*
2.3. **Three Basic Elements of JIT**

The first basic element of JIT is waste elimination. The idea for the elimination of all forms of waste was determined for the first time by Taiichi Ohno, the man who pioneered Toyota’s unique system, when he was confronted with the need to develop a system for manufacturing small numbers of many different designs of automobiles. To do this, he classified the waste incurred in the production process into seven categories (Imai, 1986: 89):

- *Overproduction*: producing more than needed by the next process;
- *Waiting time*: materials, machines, or manpower have to wait for performing value-added jobs;
- *Transport*: waste caused by movement of materials before being processed;
- *Process*: waste caused by poor design and maintenance;
- *Inventory*: waste intended to hide production problems such as equipment breakdowns, lengthy set-up time, large batch sizes, and poor coordination between processes;
- *Motion*: waste caused by performing unnecessary motion; and
- *Defective goods*: waste caused by producing defective goods.

It has been proven that the concept of waste elimination applies not only to manufacturing systems, but also applies equally to administration and service environments.

Total quality (management), the second basic element of JIT, has been evolving rapidly since the early 80s. In the 1970s, simple inspection activities were replaced or supplemented with quality control, then quality assurance was developed and refined, and now many companies are working towards
managing and monitoring quality through inviting total participation of employees from product development to product delivery with the objective of meeting customer satisfaction (Dale et al., 1994: 4). In BS.4778: Part 2 (1991), TQM is defined as:

"A management philosophy embracing all activities through which the needs and expectations of the customer and the community, and the objectives of the organisation are satisfied in the most efficient and cost effective way by maximising the potential of all employees in a continuing drive for improvement."

In summary, TQM is both a philosophy and a set of guiding principles for developing the mutual cooperation of everyone in an organisation and associated business processes to manufacture products and services which meet the needs and expectations of customers. In relation to the concept of becoming an ‘excellent company,’ TQM goes hand in hand with the JIT system so that the two strategies complement each other, and hence, Harrison (1992) preferred to describe the system as JIT/TQ.

There is a large body of literature specifically written about TQM, and each author proposes a particular definition and mentions key elements of TQM based on his/her own perception. Harrison (1992: 45), for example, emphasises the following six aspects to be ingredients of building total quality culture into an organisation desiring to pursue the JIT system:

- **Management leadership** for ensuring that the company’s advancement is in the right direction for the future and consistent over time;

- **Integration of efforts** through ‘orchestrating’ all processes in the company as a sequence of customer-supplier relationships in such a way that every department in the company has a responsibility to submit quality results to the next process;
• *Prevention of defects* through detecting them at the source;

• *Detection of defects* though making problems visible and utilising error-proof devices (poka-yoke);

• *Ownership of a process* though laying down responsibility for the accuracy of the process and its output to the person who is carrying it out, not with the third party like inspection or rectification personnel;

• *Developing a habit of improvement* throughout the organisation by instilling an understanding among the employees that ‘*perfection is always worth pursuing.*’

People preparation is the third basic element and the starting point for supporting the JIT/TQ philosophy. Hiring the ‘whole person’ is the main characteristic of Japanese-style management. In this sense, the person’s brain, senses and potential are fully stimulated in order to develop themselves and the organisation. Harrison (1992) mentions the following aspects as crucial for preparing the people to pursue JIT objectives:

• *Discipline:* to enforce standards which are critical to safety, environment and quality;

• *Flexibility:* to expand responsibilities through training people in new skills (job rotation) and removing barriers to flexibility (grading structure and restrictive practices);

• *Equality:* to throw away unfair and divisive personnel policies;

• *Autonomy:* to delegate increasing responsibilities to people involved in direct activities of the business such as line stop authority, material scheduling, data gathering, and problem solving;
• Development of personnel: to create more company members who can support the rigours of being part of an excellent company;

• Quality of working life: involvement, security and enjoyment;

• Creativity: to harness everyone’s contribution to solving problems and improving methods. In this case, Kondo (1989) proposes four steps for making work more creative:

1. Work instructions should make it clear what is the aim of the job;
2. Foster development of people’s sense of responsibilities for what they do;
3. Give time for the creation of ideas; and
4. Let the ideas grow and come to fruition.

2.4. JIT Tools and Techniques

In actualising JIT objectives, the implementing companies must be equipped with tools and techniques both for realising world-class manufacturing and struggling against the war of waste elimination. There are no two identical applications of the techniques among implementing JIT companies. Every JIT firm will take its own path depending upon the type of company, the manufacturing strategy, and the market situation (Maskell, 1989: 31). A company with cash-flow difficulties, for example, will lay stress on the application of techniques that provide direct inventory reduction. In summary, the JIT approach must match the manufacturing strategy of the company.

Many authors have proposed a different set of tools and techniques depending upon their interests and stresses. Moreover, Harrison (1992: 51) divides JIT core techniques into two categories:
• JIT1: techniques and tools required to prepare the facility for materialising manufacturing excellent capabilities such as reaction speed, low cost, short lead time, and high quality manufacture.

• JIT2: techniques and tools required for an organisation to carry forward on continuous efforts of eliminating wastes.

In addition to those proposed by Harrison (1992), this thesis also adds another group of JIT techniques as stated in MECH 960 – Industrial Quality Management – lecture notes from the Department of Mechanical Engineering, Wollongong University (Arndt, 1994), as well as those in the Kaizen videos.

2.4.1. JIT1 Techniques

Harrison (1992) mentions six techniques in this group which are useful to develop WCM expertises:

• Design

Design is the heart of value-adding activities. According to Suh (1990), design is the epitome of the goal of engineering which facilitates the creation of new products, processes, software, systems and organisations by which engineering contributes to society by satisfying its aspirations and needs. In a JIT environment of producing instantaneously with perfect quality and no waste, design is considered to be a compulsory activity aiming at total cost reduction.

• Focus

According to Skinner (1985: 72), 'focused factory' or product-based manufacturing cells mean two things: learning to focus each plant on limited, manageable sets of products, technologies, volumes, and markets;
and learning to structure basic manufacturing policies and supporting services so that they focus on one explicit manufacturing task instead of many inconsistent, conflicting implicit tasks. Furthermore, he adds that a factory focused on a narrow product mix will always be better than the non-focused or conventional plant, which attempts a broader mission. The JIT system requires a focused factory since it is based on the concept that competence can be cultivated through simplicity, repetition, experience, and homogeneity of tasks. Such congruence of tasks, in turn, can produce a system that does the important but limited things very well.

- **Layout and Flow**

This technique, achieved by moving machines and processes closer together whenever the opportunity exists, can be considered as an endeavour to eliminate or reduce waste due to unnecessary movements. This effort, which follows logically from the concept of the focused factory, aims at rationalising and simplifying production flow in such a way that makes it possible to convert batch into repetitive manufacture; and hence, reap the benefits of applying JIT production techniques (Gibson et al., 1995: 183). The reorganisation of a plant through the rationalisation and grouping together of similar products, parts and processes is one of the applications of group technology (GT).

- **Small machines**

This technique means that whenever possible, it is better to install several small machines instead of one large machine. The reasons for this choice are that small machines are easy to maintain, produce better quality over time (often by installing error-proof devices), are easier to move to accommodate flexible layout as required by JIT manufacturing, and have
less risk of making errors in investment decisions (Harrison, 1992: 55). In addition, small machines have another advantage in the form of ‘mastery of fundamentals comes first’ (Hall, 1987), so that factories have an opportunity to learn fully about quality, maintenance, and operating disciplines before attempting a further level of improvement.

- **Total Productive Maintenance (TPM)**

TPM can be seen as the logical extension of TQC/TQM (Arndt, 1995). Similar to the spreading of responsibility for attaining quality to everybody in the company, the JIT system challenges everyone to take responsibility for maintenance in the achievement of zero breakdown. In addition to operating the machine, operators perform cleaning and housekeeping, proper to machine operation, developing enhanced awareness of potential problems, as well as carrying out routine maintenance activities. The aim of TPM is to increase the equipment up time towards the ideal of zero breakdown. This condition is required in a JIT environment. As a result of buffer stock removal, the JIT system has no tolerance for down time for any work center, so the machines must be maintained constantly in order to approach the condition of zero breakdown.

- **Set up Reduction (SUR)**

Reducing set up time is the key to improving flexibility without losing capacity, and hence reducing inventories and lead times. SUR is crucial in the JIT system, since it will enhance the capability of responding to instant demands and the production of a large variety of products in small volumes. This activity is also an excellent opportunity for striving for the sense of ownership of the projects among shop floor teams, and placing improvement responsibility upon them.
Shingo (1987) provides guidelines to convert set-up-time reduction into a single minute exchange of die (SMED) set up, as follows:

- **Preliminary stage**: internal and external setups are not separated;
- **First stage**: internal setup is clearly separated from external setup;
- **Second stage**: elements previously considered part of internal setup are converted to external setup;
- **Third stage**: each elemental operation of internal and external setup is relentlessly improved.

### 2.4.2. JIT2 Techniques

Harrison (1992) proposes eight techniques in this group which are useful to keep up continuous efforts of waste elimination:

- **Total People Involvement (TPI)**
  
  TPI means the condition where company members devote all their abilities to the benefit of the company as a whole. In order to achieve this, workers must be trained, capable and motivated to take full responsibility for all aspects of the job under their authority.

- **Flow Scheduling**
  
  The aim of this technique is to create the conditions whereby parts are flowing in an orderly and continuous manner and do not stop at all during the process of manufacturing. Successful scheduling can be measured from the ratio of value-added time to total time, or the total flow length of parts or subassemblies. In a JIT environment, material movements and productions are controlled by *Kanban* or signals or cards.
• **Inventory Reduction**

The JIT system attempts to remove the buffer inventory with the aim of making problems, hidden by the inventory, more visible. The reduction in batch sizes will bring about several advantages: reduced production lead times, earlier recognition of defects and less rework, less WIP, and improved flexibility. Therefore, the JIT system strives for attaining fewer and fewer batch sizes until approaching the size of one.

• **Process Improvement**

Process improvement is the key in realising total quality. According to Taguchi (1979), quality losses are not only caused by defects but also due to variability. As an effort to minimise losses to society or to increase the quality of the product, therefore, manufacturers have to carry on a continuous improvement program in the form of incessant reduction in the variation of product performance characteristics about their target values.

• **Visibility**

Visibility of processes, problems, and improvement projects are the main characteristics of JIT systems. In this circumstance, company members are encouraged to contribute all their abilities to the benefit of the company as a whole, and total people involvement will be easier to be realised.

• **Enforced Improvement**

This technique aims at creating a situation where process improvement will progress automatically. In the JIT system, the removal of the buffer inventory will inevitably expose problems which used to be hidden (like an iceberg) due to large WIP, and consequently, will enforce problem solving.
• **JIT/MRP/OPT**

JIT is an excellent method of shopfloor control. Material Requirements Planning (MRP) is a computerised materials management system aimed at minimising inventories by working out time-phased material requirements from the Master Production Schedule (MPS). Optimised Production Technology (OPT) is a philosophy combined with a computerised system of shop scheduling and capacity planning. There is no doubt of the compatibility between MRP and JIT (Maskell, 1989: 17). Examples of the successful combination of MRP II and JIT can be found in Maskell (1989: 19-22). In these illustrations, Nissan and Xerox are mentioned as the astute companies able to perform the combination. Combining JIT, MRP and OPT would be both challenging and promising.

• **Comakership**

Comakership is the terminology invented by Harrison (1992: 65) to depict mutual cooperation between OEMs and their suppliers quickly and accurately in response to market changes. In attaining the JIT mission, comakership is crucial in meeting the JIT delivery with perfect quality.

2.4.3. **Other JIT Technologies**

The following list of techniques are taken from lecture notes of MECH 960 – Industrial Quality Management – at Wollongong University (Arndt, 1994), as well as from the Kaizen Institute of Japan. Some have already been discussed, the following additional points can be added to the previous list to form a complete set of JIT techniques.
• **Push vs. Pull production systems**

The push system relies on the production of a sales forecast, and is followed by generating capacity planning and scheduling, materials purchase, work orders, etc., with materials being ‘pushed’ at the factory floor – and finished products out from it. This method often results in inventory. On the other hand, the pull production system is initiated by the customers’ orders, which progressively ‘pulls’ finished products out of the factory, with each stage of the production process progressively ‘pulling’ work pieces from the previous process/stage.

• **TAKT time**

TAKT time is the time required to make one finished product from start to finish. With typically U-shaped layout, one operator completes the whole job him/herself. It is simply calculated using the following formula:

\[
\text{TAKT time} = \frac{\text{Daily operating time}}{\text{Required quantity per day (unit)}}
\]

TAKT time is determined by sales records (customers). Hence, the waste arising from overproduction can be removed through the use of TAKT time.

• **One-piece-flow production**

This technique simply means that one piece is made at a time, i.e. the operator moves from station to station within the cell, usually in a U-shaped layout, all within the constraints of TAKT and cycle times. This is useful in enhancing a sense of ownership of the job.
• **U-shaped line formation**

As explained before, this formation is required to minimise the movement of operators and materials and also supports visual improvement management.

• **Shojinka** or flexible manpower utilisation on the line

Shojinka means using just the right number of people required by the pull production schedule. This technique, in contrast with the concept of ‘fixed number of workers,’ utilises flexible manpower, where operators are added or subtracted to the line/cell, depending on demand. This is very useful in anticipating demands up or down.

• **Multi-process operation**

This technique means that JIT manufacturing prepares or trains employees to be capable to perform all the operations within a cell.

• **Skill display boards**

A skill display board is a matrix showing the relationship between workers and their skills, as follows:

<table>
<thead>
<tr>
<th>Names</th>
<th>Skills</th>
<th>Grinding</th>
<th>Machining</th>
<th>Chiselling</th>
<th>...</th>
<th>Drilling</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>□</td>
</tr>
<tr>
<td>B</td>
<td>□</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>C</td>
<td>●</td>
<td>□</td>
<td>●</td>
<td>○</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>D</td>
<td>●</td>
<td>●</td>
<td>□</td>
<td>●</td>
<td>●</td>
<td>□</td>
</tr>
</tbody>
</table>

- ● Grade A
- ○ Grade B
- □ Grade C
This technique is useful to make a schedule of workers who will perform a certain jobs or projects.

- **Levelling of production**

This technique means developing a mixed model, a balanced production schedule to accommodate the JIT objective of ‘making today what the customer ordered today’, which means that the material flow throughout the supply chain must be synchronised, i.e. cycle time must be balanced.

- **Set-up Kaizen**

To realise production leveling, frequent changeover (set up) between models or runs must be performed quickly (QCOM – Quick Changeover Manufacturing).

- **Jidoka (autonomation)**

Jidoka or ‘automation with a human touch’ is a concept to control all defects automatically by installing devices (e.g. sensors) that can detect defects or abnormalities, and hence automatically stop the line (not just an individual station as practiced by traditional manufacturing) when they occur. This technique is a means of disclosing any occurring of problems and facilitates an enforced improvement by everyone on the shopfloor.

- **Standard work**

Standard work means that the work procedure within each cell must be standardised to prevent waste caused by variation. This procedure must be fully understood by the operators. Standardising procedures are important in the JIT system as a basis for making further improvements.
• **Parts supply and Kanban**

Kanban is the basis of pull scheduling, since it assures that the preceding operation only supplies and makes as much as is needed by the succeeding operation, just in time when for it is needed.

• **Visual management**

Visual management means the technique for providing information and instruction about the elements of a job in a clearly visible manner so that the worker can maximise his/her productivity. For example, errors, abnormalities as well as control can be visualised to encourage and enforce shopfloor workers to make improvements. Kanban is one form of visualisation of material flow control. Other visualisations are housekeeping, cleanliness, etcetera.

• **5S and housekeeping**

‘Do the simple things right’ is the pre-requisite to become an excellent company. To enable doing basic things right, JIT company organises the workplace according to the concept of 5S:

1. Seiri - sorting: separate items into necessary and unnecessary groups and then dispose of those which are no longer used;
2. Seiton - orderliness: store materials/items in their proper place to ensure they are immediately available when needed;
3. Seiso - cleaning: keep items and the workplace in which they are stored and used clean at all times – cleaning and checking;
4. Seiketsu-cleanliness: ensure equipment, working areas and thoroughfares are always in a clean and tidy to provide safe working conditions;
5. Shitsuke - participation: participate in the above.
• **Quality assurance**

Through the above techniques, quality assurance is really a built-in feature of the JIT system. Where quality is being assured, errors/defects are prevented at the source as soon as they arise.

### 2.5. Differentiating Characteristics of JIT

Having now discussed JIT philosophy in some detail, the next important issue covered in this section is to explore the differences between JIT and traditional systems. This can be started by making a comparison between two contrasting approaches to progress between Japanese and Western companies. Japanese firms generally favour the gradualist (Kaizen) approach while Western counterparts prefer the great leap (Innovation) approach. Imai (1986: 24) compares the differentiating features of Kaizen and Innovation in Table 1.

It can be seen from the table that one big difference between Kaizen and Innovation is that while Kaizen does not necessarily call for a large financial investment to implement it, it does demand a great deal of continuous effort and everybody’s commitment to realise it. This makes sense because Innovation relies more on technology breakthrough, new inventions, and new theories, whereas Kaizen rests more on tapping people’s creativity by utilising conventional know-how and experience. Furthermore, the Kaizen approach is more dependent on collectivism and group efforts as opposed to individualism and individual effort demanded by Innovation. Thus, it can be inferred that Kaizen is the more suitable production system for developing countries because these countries cannot supply large amounts of capital, skilled manpower, and advanced technologies, as demanded by the traditional manufacturing but they are accustomed to working in groups, which is essential to the Kaizen method.
<table>
<thead>
<tr>
<th></th>
<th>KAIZEN</th>
<th>INNOVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Effect</td>
<td>Long-term and long lasting but undramatic</td>
<td>Short-term but dramatic</td>
</tr>
<tr>
<td>2. Pace</td>
<td>Small steps</td>
<td>Big steps</td>
</tr>
<tr>
<td>3. Time frame</td>
<td>Continuous and incremental</td>
<td>Intermittent &amp; non-incremental</td>
</tr>
<tr>
<td>4. Change</td>
<td>Gradual and constant</td>
<td>Abrupt and volatile</td>
</tr>
<tr>
<td>5. Involvement</td>
<td>Everybody</td>
<td>Select few ‘champions’</td>
</tr>
<tr>
<td>6. Approach</td>
<td>Collectivism, group efforts, and systems approach</td>
<td>Rugged individualism, individual ideas and efforts</td>
</tr>
<tr>
<td>7. Mode</td>
<td>Maintenance &amp; improvement</td>
<td>Scrap and rebuild</td>
</tr>
<tr>
<td>8. Spark</td>
<td>Conventional know-how and state of the art</td>
<td>Technological breakthrough, new inventions, new theories</td>
</tr>
<tr>
<td>9. Practical requirements</td>
<td>Requires little investment but great effort to maintain it</td>
<td>Requires large investment but little efforts to maintain it</td>
</tr>
<tr>
<td>10. Effort orientation</td>
<td>People</td>
<td>Technologies</td>
</tr>
<tr>
<td>11. Evaluation criteria</td>
<td>Process and effort for better results</td>
<td>Results for profit</td>
</tr>
<tr>
<td>12. Advantage</td>
<td>Works well in slow growth economy</td>
<td>Better suited to fast growth economy</td>
</tr>
</tbody>
</table>

Table 1 : Features of Kaizen and Innovation
Source : Imai (1986: 24)

More specific differences between the JIT and the traditional production system can be observed from Table 2. These differences can be classified further into three broad aspects: people preparation, quality consideration and supplier relationship.

The obvious contrast between JIT and traditional manufacturing relates to the development of the employees. As a heritage of the mass production system, traditional manufacturing considers workers as one of the production factors that need to be utilised fully to produce as many outputs as possible. Consequently, management has to find a more organised and planned way to assign tasks to the employees for a duration of time so that they know what they should be doing during their working time.
<table>
<thead>
<tr>
<th></th>
<th>Traditional System</th>
<th>JIT Production System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>People Preparation</strong></td>
<td>1. Hire part of person</td>
<td>1. Hire the whole person</td>
</tr>
<tr>
<td></td>
<td>2. Perform part of the jobs and submit them to the next process</td>
<td>2. Control and own the whole jobs</td>
</tr>
<tr>
<td></td>
<td>3. Little responsibility for quality</td>
<td>3. Full responsibility for quality</td>
</tr>
<tr>
<td></td>
<td>4. Have a specialised skill</td>
<td>4. Have multi-skills</td>
</tr>
<tr>
<td></td>
<td>5. Encourage individual performance</td>
<td>5. Encourage teamwork</td>
</tr>
<tr>
<td><strong>Quality Consideration</strong></td>
<td>1. Management feels, it is difficult to introduce changes for improvement</td>
<td>1. Management feels, it is not difficult to introduce changes for improvement</td>
</tr>
<tr>
<td></td>
<td>2. QC manager is responsible for quality with little support from top management</td>
<td>2. Every department is responsible for quality with high support from top management</td>
</tr>
<tr>
<td></td>
<td>3. QC expertise belong to engineers</td>
<td>3. QC expertise belong to all employees</td>
</tr>
<tr>
<td></td>
<td>4. Training for quality only for quality specialist</td>
<td>4. Training for quality for all employees</td>
</tr>
<tr>
<td></td>
<td>5. Improvement is designed by engineers with little input from shopfloor workers</td>
<td>5. Each worker is encouraged to contribute ideas for improvement through QC circles</td>
</tr>
<tr>
<td><strong>Supplier Relationship</strong></td>
<td>1. Adversarial relationship between OEMs and suppliers</td>
<td>1. Cooperation relationship between OEMs and suppliers</td>
</tr>
<tr>
<td></td>
<td>2. Multiple sourcing</td>
<td>2. Single or few sourcing</td>
</tr>
<tr>
<td></td>
<td>3. Selection of suppliers based on price</td>
<td>3. Selection of suppliers based on quality or location</td>
</tr>
<tr>
<td></td>
<td>4. Suppliers are not involved in quality assurance, product development, material specifications, and manufacturing processes</td>
<td>4. Suppliers are involved in quality assurance, product development, material specifications, and manufacturing processes</td>
</tr>
<tr>
<td></td>
<td>5. OEMs do not provide performance measurement and feedback to suppliers</td>
<td>5. OEMs do provide performance measurement and feedback to suppliers</td>
</tr>
<tr>
<td></td>
<td>6. OEMs set delivery schedules without consultation with suppliers</td>
<td>6. OEMs and suppliers set delivery schedules together</td>
</tr>
<tr>
<td></td>
<td>7. Little communication between OEMs and suppliers</td>
<td>7. Maintaining communication between OEMs and suppliers</td>
</tr>
</tbody>
</table>

Table 2: Differentiating Characteristics between JIT and Traditional Systems
Source: Adapted from Various Sources (such as Harrison, 1992; Imai, 1986, etc.)
As noted by Nersesian (1993: 37):

"The Japanese have succeeded in tapping the brains in addition to the brawn of their work force. The rest of the world is working on the old model that workers are hired for their brawn – that is, they are hired to man a machine, do what they are told, and be measured against performance standards set by a stopwatch."

The above statement needs further clarification since many companies outside Japan are now employing employees' participation programs as an effort to cultivate their full potential and creativity.

In the traditional system, a company hires only that part of the worker's capability for doing exactly the assigned tasks within the time provided. A worker has little responsibility for assuring the quality of the product, tends to have specialised skills, and is more concerned with individual effort instead of a team performance. The JIT system, on the other hand, hires workers as complete persons with full recognition of their potential and limitations. Consequently, each employee is accountable for controlling and owning the whole job, and hence, has a responsibility for assuring quality. To perform a number of jobs effectively, every employee is furnished with multi-skill training and encouraged to accomplish the job as a part of team.

In organising the achievement of quality, the traditional system separates the planning and execution of tasks. This leads to high barriers between management and employees, as well as between departments. As a result, the introduction of programs for quality improvement will always encounter resistance from trade unions. In this system, quality is a matter of technical practice, and training for quality is only for quality specialists, hence it is almost impossible to call for input from workers who are really doing the job. On the contrary, JIT companies do not experience any difficulty in introducing changes
for improvement because employees believe that it will result in prosperity for the company and, hence, all employees as well. Since everybody is responsible for quality, training for quality will be provided to every worker. Accordingly, every worker can contribute his/her ideas for improvement both in his/her own workplace or throughout the company.

In the traditional system, an adversarial relationship between Original Equipment Manufacturers (OEMs) and suppliers is common, because both OEMs and suppliers conduct transactions based only on price without caring about developing long term relations. Therefore, multiple sourcing is preferred by OEMs as an effort to obtain the lowest bid. Also, there is no attempt to involve suppliers in attaining quality, there is little feedback on suppliers’ performance, no consultation for setting up delivery schedules, and there is little communication between the OEMs and suppliers. To overcome this problem, Deming (1986: 31) suggested to ‘end the practice of awarding business on the basis of price tag alone,’ because price has no meaning without a measure of the quality being purchased (Shewhart, 1986).

Cooperative relationships between OEMs and suppliers, on the other hand, characterise JIT manufacturing operations. As an attempt to develop long term relations, OEMs favour single or few sources rather than multiple sourcing. Therefore, selection of suppliers is determined by quality or location. In attaining quality products, OEMs invite the involvement of suppliers in quality assurance, product development, material specifications, and manufacturing processes. In addition, OEMs also provide performance measurement and feedback to suppliers, set delivery schedules together, and maintain close communication. This discussion illustrates how JIT manufacturing extends quality responsibility throughout supplier chains for mutual benefits between OEMs and suppliers.
2.6. Conclusion

It has been demonstrated that the JIT production system is not only a collection of techniques, as argued by several practitioners, but a production philosophy that seeks for continuous reduction in costs through developing capabilities in manufacturing excellence and consistencies in waste elimination. JIT differs from the traditional system in terms of people preparation, quality consideration, and supplier relationships. The success of JIT implementation is more dependent on cultivating workers' creativity, managing quality by involving all employees, and developing trust with customers and suppliers, rather than relying on technology breakthrough.

What should manufacturing firms in developing countries do to implement the JIT production system? To answer this question, it is required to know the characteristics of developing countries. The next chapter attempts to explain these issues.
Chapter 3
Characteristics of Developing Countries

3.1. Introduction

This chapter analyses the characteristics of developing countries to examine their suitability for implementing JIT. It covers the definition and the increasing importance of these emerging nations in the international business world, their business environment, and the industrialisation processes of these countries in order to be able to analyse the types of industries which exist, the industrial infrastructure, and the availability and the level of education of their work-force.

3.2. Definition and Importance of Developing Countries

The term ‘developing countries’ is a general conceptual label for a group of nations with many diverse characteristics, most are located in Africa, Asia, Latin America, and the Caribbean (Matanmi, in IEBM – International Encyclopedia of Business and Management, 1996: 1966). Originally, the list of developing countries was provided by the Development Assistance Committee (DAC) as a guidance for DAC members’ statistical reporting, and has acquired international significance. Besides, the Dictionary of Development (1990: 310) defines a developing country as ‘a country in which large segments of the country are still comparatively underdeveloped and the majority of the population is very poor’. More explicitly, the Oxfam Handbook of Development and Relief, Volume 3 (1995: 10), provides the list of developing countries as illustrated in Table 3.
Table 3 : List of Developing Countries

Although variations in per capita income are very great, most developing countries have economies based on the export of raw materials. The experience of economic development in the world economy has been mixed. Sub-Saharan Africa has experienced poor economic growth performance since the 1960s, but South-east Asia has recorded high and sustained rates of economic growth. However, infrastructure for developing nations (transportation, social service, educational system, etc.) is generally inadequate for their needs. Other acknowledged labels also exist, such as ‘lesser developed countries’ (LDCs), ‘newly industrialised countries’ (NICs), ‘Third World Nations’ and ‘emerging economies’. In this work, the term ‘developing countries’ or DCs is used interchangeably throughout the thesis.

Since DCs have so many diverse attributes, each researcher in this area of study has provided a different interpretation, according to the view point of the article. Yesufu (1966: 90-91), for example, mentions the following factors constructing the index of ‘under-development’: low average per capita national
income, low standard of living and social welfare, an unbalanced economic structure, and general poverty of the population. Likewise, Bean (1994: 208) has broadly characterised DCs in terms of per capita gross domestic product (GDP) levels, increasing social and political modernisation and predominant spatial and geographical location. Thus, developing nations, on the whole, demonstrate various development needs and gaps with all the associated ramifications for their social-economic life, particularly when the international parameters are applied.

In the process of development, however, many DCs have achieved growing importance in the global business arena. Almost 80 percent of the world’s consumers originate from these nations, and it is generally thought that almost all of the population-based market expansion in the twenty first century will occur in these countries. Finally, the proliferation of business opportunities and the growing competitive importance of these emerging economies have transformed them into a priority item on the agenda of focused thinking business executives.

3.3. Developing Countries’ Business Environment

In order to analyse the suitability of JIT implementation in DCs, it is important to understand the environmental forces influencing the conducting of business in DCs: The contexts of DCs are highly complicated, continually in flux, and highly diverse. Consequently, a standard blueprint of a developing country’s business environment is not feasible because it falls at varying points on the development continuum and has heterogenous contexts (Kohn and Austin in IEBM, 1996).

Fortunately, the above authors provide a comprehensive framework to understand how the environmental factors tend to differ among DCs, and
between developing and developed countries, so as to better grasp the nature of the business environment and to indicate the likely directions of change as individual countries develop. Table 4 shows the comparative environmental factors as countries improve their levels of GNP per capita. The four factors are economic, political, cultural, and demographic.

### 3.3.1. Economic Factors

Per capita GNP is the most often quoted economic factor to define a country’s economic level of development. The World Bank defines developing countries as those which have low- and middle-income economies. This criterion results in a wide range of income levels, from per capita GNP under US$100 to over US$8,000. This indicates different levels of demand among DCs and illustrates one element of the diversity among these countries. The other economic factors can be derived from the levels of income (per capita GNP).

Low income countries are characterised by their high economic dependence on their natural resources; unfortunately, their availability are still under-developed. In their attempts to progress to higher income nations, these countries will lessen their economic dependence on and develop the availability of their natural resources. Furthermore, the scarcity of skilled human capital makes it difficult to implement complex projects; hence, any designing and implementing production systems must take into account these facts. Special attention needs to be paid to human resource development. The abundance of low-cost labour have put these countries in a comparatively better position for the manufacture of labour-intensive products, and accordingly, creates the need for them to adapt production technologies.
<table>
<thead>
<tr>
<th>Economic Factors</th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-importance to economy</td>
<td>high</td>
<td></td>
<td>lower</td>
</tr>
<tr>
<td>-availability</td>
<td>under-developed</td>
<td></td>
<td>developed</td>
</tr>
<tr>
<td>Labour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-skilled human capital</td>
<td>scarce</td>
<td></td>
<td>abundant</td>
</tr>
<tr>
<td>-% workforce in</td>
<td>&gt;60%</td>
<td>± 40%</td>
<td>&lt;15%</td>
</tr>
<tr>
<td>Capital</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-GNP per capita (US$)</td>
<td>&lt;$1,000</td>
<td></td>
<td>&gt;$15,000</td>
</tr>
<tr>
<td>-saving rates</td>
<td>low</td>
<td>high</td>
<td>somewhat high</td>
</tr>
<tr>
<td>-income inequality</td>
<td>medium</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>-financial institutions</td>
<td>weak</td>
<td></td>
<td>strong</td>
</tr>
<tr>
<td>-inflation</td>
<td>moderate</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>-capital flight</td>
<td>outflow</td>
<td></td>
<td>inflow</td>
</tr>
<tr>
<td>Foreign Exchange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-exchange rate volatility</td>
<td>low</td>
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<td>low</td>
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<td>-trade deficits</td>
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<td>high</td>
<td>low</td>
</tr>
<tr>
<td>-range of exports</td>
<td>narrow</td>
<td></td>
<td>broad</td>
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<td>-debt service burden</td>
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<td></td>
<td>low</td>
</tr>
<tr>
<td>-concessional foreign aid</td>
<td>recipient</td>
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<td>donor</td>
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<tr>
<td>Infrastructure</td>
<td></td>
<td></td>
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<tr>
<td>-physical infrastructure</td>
<td>weak</td>
<td></td>
<td>strong</td>
</tr>
<tr>
<td>-information availability</td>
<td>low (unreliable)</td>
<td></td>
<td>high (reliable)</td>
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<td>Technology</td>
<td></td>
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<td></td>
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<tr>
<td>-technology flows</td>
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<td></td>
<td>supplier</td>
</tr>
<tr>
<td>-sophistication</td>
<td>low</td>
<td></td>
<td>high</td>
</tr>
<tr>
<td>-industry structure</td>
<td>dualistic</td>
<td></td>
<td>unitary</td>
</tr>
<tr>
<td>Political Factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-instability</td>
<td>high</td>
<td>medium</td>
<td>low</td>
</tr>
<tr>
<td>-political institutions</td>
<td>weak</td>
<td></td>
<td>strong</td>
</tr>
<tr>
<td>-international links</td>
<td>dependent</td>
<td></td>
<td>more autonomy</td>
</tr>
<tr>
<td>Cultural Factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-social structures</td>
<td>more rigid</td>
<td></td>
<td>less rigid</td>
</tr>
<tr>
<td>-religious influence</td>
<td>stronger</td>
<td></td>
<td>weaker</td>
</tr>
<tr>
<td>-gender roles</td>
<td>very distinct</td>
<td></td>
<td>less distinct</td>
</tr>
<tr>
<td>-languages</td>
<td>high diversity</td>
<td></td>
<td>low diversity</td>
</tr>
<tr>
<td>Demographic Factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-annual pop. growth rate</td>
<td>approx. 2%</td>
<td>approx. 1.5%</td>
<td>approx. 0.5%</td>
</tr>
<tr>
<td>-age structure</td>
<td>young</td>
<td></td>
<td>young</td>
</tr>
<tr>
<td>-life expectancy</td>
<td>approx. 60 years</td>
<td>approx. 68 yrs</td>
<td>approx. 77 yrs</td>
</tr>
<tr>
<td>-urbanisation (% total pop.)</td>
<td>approx. 30%</td>
<td>approx. 60%</td>
<td>approx. 80%</td>
</tr>
<tr>
<td>-urbanisation (growth)</td>
<td>approx. 4.7%</td>
<td>approx. 3.2%</td>
<td>approx. 0.8%</td>
</tr>
</tbody>
</table>

Table 4 : Summary of Environmental Factors
Source : International Encyclopedia of Business and Management, 1996
DCs also experience capital scarcity and low income levels that limit their ability to satisfy the demand for capital and often prohibit the existence of mass markets. The combination of low income and low savings brings about the necessity of creating special marketing practices, where consumer credit and specialised product design play a central role. The deleterious effects of high inflation has lessened the opportunities to finance projects. In addition, capital scarcity in DCs has often been intensified by capital flight and money devaluations that exacerbate the instability in their currencies. Exchange instability will, in turn, cause narrow export bases and persistent trade deficits.

The DCs’ business environment is made more difficult by the lack of infrastructure and technological capabilities. Although, more opportunities are created by this inadequate infrastructure, projects become more costly when there is a need to include access roads, electric generators, water treatment facilities, etc. Furthermore, the low technological level requires businesses to seek appropriate technology. In the later case, key issues are technology transfer and adaptation and coping with the tensions that develop between sophisticated installations and the surrounding low technology environment.

3.3.2. Political Factors

In addition to the economic factors mentioned above, doing business in DCs must also take into account political factors, since one attribute of many, although not all, DCs is political instability. This often creates uncertainty, increases indirect costs, interferes with business planning activities, and leads to bureaucratic bottlenecks. Also, even though the business environment in DCs is influenced by the ideological struggle between socialism and capitalism, the effect of nationalism frequently overshadows the debate. Finally, institutional
weaknesses in LDCs often leads to arbitrariness in decision making, and pressures for bribery to secure permits and approvals.

3.3.3. Cultural Factors

While cultural factors are very complex phenomena, several aspects lend themselves to analysis and understanding. The social structure and dynamics can be investigated in terms of attitudes towards others (individualism vs. collectivism), the structure of relationships (hierarchical vs. egalitarian), and decision making mechanism (autocratic vs. participatory). Understanding society’s attitudes towards human nature and towards time and space is very important in order to translate them into appropriate actions. Besides, these actions are likely to be most suitable when taking into account religious, linguistic, and gender characteristics and sensitivities.

3.3.4. Demographic Factors

Demographic factors that need to be considered in understanding the business environment include population growth rates, age structure, urbanisation and migration, health facilities and education. High growth in the population will create market opportunities, specially for basic consumer goods. Information about age structure can be utilised to determine the possibility of restriction in the saving rates, the situation of the labour force and, in turn, the need for training and education. Urbanisation and migration figures can be beneficial for understanding the shift of investment from agriculture to non-agriculture sectors, to forecast the supply of labour and the demand of facilities. Finally, the availability of health facilities and the estimates of life expectancy provide a reflection of a country’s success in overcoming health problems, and are very useful for managers to devise programs dealing with health care and
supplementary food. These programs can boost worker productivity, increase employees’ loyalty, and may result in competitive advantage.

3.4. Industrialisation in Developing Countries

According to The New Palgrave: A Dictionary of Economics, industrialisation is a process which generally follows the essential characteristics of an unambiguous industrialisation process. First, the increasing of the proportion of the national income derived from manufacturing activities and secondary industry. Second, the increasing of the proportion of the working population engaged in manufacturing activities and secondary industry. Also, the subsequent attributes, which are derived from experience in Great Britain, are often associated with industrialisation or what Kuznets (1966) called ‘modern economic growth’: a narrowing and ultimate closing of the gap between productivity per head in the secondary sector and the primary sector (that is, agriculture, forestry and fishing); continual changes in the methods of production; the fashioning of new products; rise in the proportion of population living in towns; and changes in the relative ratios of expenditures on capital formation and consumption, and so on.

What is experienced by DCs are continual attempts to change their methods of production. In this case, the development of a suitable production system is affected by the post-colonial impact, nationalism, post-colonial states and crises of development, a determined role for government, coupled with political problems and instability (Matanmi in IEBM, 1996: 1966). In recent decades, the influence of Western and Japanese production methods in shaping developing countries’ production techniques is also apparent, especially after the 80’s, because many of these countries receive assistance from the industrialised countries, either via loans or direct investment.
The industrialisation process in developing countries can also be examined from the distribution of labour force by kind of economic activities in Table 5.

<table>
<thead>
<tr>
<th>Region</th>
<th>Agriculture</th>
<th>Industry</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing countries</td>
<td>70.7 59.0</td>
<td>11.2 16.0</td>
<td>18.0 25.0</td>
</tr>
<tr>
<td>by region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- America</td>
<td>47.9 34.5</td>
<td>20.0 22.5</td>
<td>32.1 43.0</td>
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<tr>
<td>- Africa</td>
<td>78.8 67.8</td>
<td>7.6 14.0</td>
<td>13.5 18.1</td>
</tr>
<tr>
<td>- West Asia</td>
<td>67.7 47.2</td>
<td>14.5 21.8</td>
<td>17.7 31.0</td>
</tr>
<tr>
<td>- Other Asia</td>
<td>73.3 62.8</td>
<td>10.2 14.5</td>
<td>16.5 22.8</td>
</tr>
<tr>
<td>Developed countries</td>
<td>28.4 12.3</td>
<td>34.6 39.5</td>
<td>37.0 48.2</td>
</tr>
</tbody>
</table>

Table 5: Sectoral Distribution of Labour Force (%)

Table 5 reveals that the proportion of the working population engaged in both industry and services has increased considerably for DCs from 1960 to 1980, even though the agricultural sector still dominates the absorption of the labour force. The proportion of the labour force occupation by region, indicates that West Asia has the most advanced structural changes in the industrial sector, whereas Latin America has achieved significant progress in the service sector. In developed countries, the growth of the shift from agriculture to non-agriculture sectors is not so large, except that agriculture shows a notable decrease in labour absorption during that period.

Another way to observe the process of industrialisation in DCs is to understand the types of industry existing in these countries. This can be done by observing the distribution of world value added in every branch of industry. Tables 6a and 6b summarise the progress of developing countries in competing with industrialised countries to seize the manufacturing value-added formerly
dominated by those advanced nations. There are 24 classifications (ISIC) or branches of industries in this figure, with the period of recording from 1980 to 1993. DCs are divided into new industrialised countries (NICs) and others, whereas industrialised countries are not classified further since the analysis is focused on the progress of DCs in coping with industrialisation. In the original source, the industrialised countries are divided into Eastern and Western Europe, Japan, and North America.

In general, there is a tendency that the proportion of manufacturing value added of industrialised nations declined between the 80’s and 90’s. Still, several branches of industries remain dominated by industrialised countries, such as ISIC 37 (iron and steel) and 38 (machinery). These types of basic industries demand a high level of technology, expertise and huge amounts of capital. Industries that mostly utilised natural resources, such as petroleum refineries and tobacco, have value-added distributed equally between industrialised and developing countries. Industries employing low level technology and absorbing excessive amounts of but unskilled human resources, such as textiles, wearing apparel, leather and fur products, and footwear will automatically move from industrialised to developing countries due to increased labour cost in industrialised nations.

Finally, as explained in the previous section the lack of infrastructure and technological capability has made the DC’s business environment less competitive, since more investment is allocated to improve the infrastructure, hence, projects become more costly. The effort of DCs in the process of industrialisation still faces many obstacles, therefore, the choice of a suitable production system is required to accelerate progress.
<table>
<thead>
<tr>
<th>Branch (ISIC)</th>
<th>Year</th>
<th>Industrialised Countries</th>
<th>Developing countries</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>All countries</td>
<td>NICs</td>
<td>Others</td>
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<td>Food products (311/312)</td>
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<td>81.7</td>
<td>18.3</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>1985</td>
<td>80.9</td>
<td>19.1</td>
<td>9.6</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>1993</td>
<td>77.5</td>
<td>22.5</td>
<td>11.1</td>
</tr>
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<td>17.6</td>
<td>7.2</td>
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<tr>
<td></td>
<td>1985</td>
<td>80.9</td>
<td>19.1</td>
<td>7.8</td>
</tr>
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<td></td>
<td>1990</td>
<td>78.8</td>
<td>21.2</td>
<td>8.4</td>
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<td></td>
<td>1993</td>
<td>74.4</td>
<td>25.6</td>
<td>9.1</td>
</tr>
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<td>32.3</td>
<td>8.4</td>
</tr>
<tr>
<td></td>
<td>1985</td>
<td>62.4</td>
<td>37.6</td>
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<td>1990</td>
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<td>40.9</td>
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<td>1993</td>
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<td>10.9</td>
</tr>
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<td>22.0</td>
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<td>23.4</td>
<td>13.4</td>
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<td></td>
<td>1993</td>
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<td>16.4</td>
</tr>
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<td>84.9</td>
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<td>9.4</td>
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<tr>
<td></td>
<td>1985</td>
<td>83.3</td>
<td>16.7</td>
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<td>18.6</td>
<td>11.6</td>
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<td>1993</td>
<td>78.8</td>
<td>21.2</td>
<td>11.9</td>
</tr>
<tr>
<td>Leather and fur products (323)</td>
<td>1980</td>
<td>82.2</td>
<td>17.8</td>
<td>11.1</td>
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<td></td>
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<td>80.2</td>
<td>19.8</td>
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<td>78.9</td>
<td>21.1</td>
<td>13.0</td>
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<td>1993</td>
<td>76.5</td>
<td>23.5</td>
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<td>77.4</td>
<td>22.6</td>
<td>13.4</td>
</tr>
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<td>Wood and cork products (331)</td>
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<td>85.2</td>
<td>14.8</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td>1985</td>
<td>84.8</td>
<td>15.2</td>
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<td>83.2</td>
<td>16.8</td>
<td>8.2</td>
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<td>89.5</td>
<td>10.5</td>
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<td>16.4</td>
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<td>80.7</td>
<td>19.3</td>
<td>12.3</td>
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<td>Other chemicals (352)</td>
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<td>81.7</td>
<td>18.3</td>
<td>10.6</td>
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<td>1993</td>
<td>58.1</td>
<td>41.9</td>
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</table>

Table 6a: Distribution of World Value-Added (%), Selected Branches and Years *)

*) At constant price 1980
<table>
<thead>
<tr>
<th>Branch (ISIC)</th>
<th>Year</th>
<th>Industrialised Countries</th>
<th>Developing countries</th>
<th>World</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>All countries</td>
<td>NICs</td>
<td>Others</td>
</tr>
<tr>
<td></td>
<td></td>
<td>87.8</td>
<td>12.2</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>1985</td>
<td>86.0</td>
<td>14.0</td>
<td>7.6</td>
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<td>1990</td>
<td>84.8</td>
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</tr>
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<td></td>
<td>1993</td>
<td>78.0</td>
<td>22.0</td>
<td>11.3</td>
</tr>
<tr>
<td>Products of petroleum and coal (354)</td>
<td>1980</td>
<td>83.7</td>
<td>16.3</td>
<td>10.4</td>
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<td>1990</td>
<td>80.0</td>
<td>20.0</td>
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<td>75.5</td>
<td>24.5</td>
<td>12.9</td>
</tr>
<tr>
<td>Rubber products (355)</td>
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<td>86.4</td>
<td>13.6</td>
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</tr>
<tr>
<td></td>
<td>1985</td>
<td>86.6</td>
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<td>86.4</td>
<td>13.6</td>
<td>9.5</td>
</tr>
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<td>16.3</td>
<td>10.4</td>
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<td>1985</td>
<td>83.5</td>
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<td>1993</td>
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<td>24.5</td>
<td>12.9</td>
</tr>
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<td>86.4</td>
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<td></td>
<td>1985</td>
<td>86.6</td>
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<td>1993</td>
<td>86.4</td>
<td>13.6</td>
<td>9.5</td>
</tr>
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<td>Glass (362)</td>
<td>1980</td>
<td>86.8</td>
<td>13.2</td>
<td>8.8</td>
</tr>
<tr>
<td></td>
<td>1985</td>
<td>85.2</td>
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</tr>
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<td></td>
<td>1993</td>
<td>81.5</td>
<td>18.5</td>
<td>9.3</td>
</tr>
<tr>
<td>Other non-methalic mineral products (369)</td>
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<td>81.9</td>
<td>18.1</td>
<td>10.2</td>
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<td>10.0</td>
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<td></td>
<td>1990</td>
<td>78.9</td>
<td>21.1</td>
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<td></td>
<td>1993</td>
<td>74.1</td>
<td>25.9</td>
<td>11.6</td>
</tr>
<tr>
<td>Iron and steel (371)</td>
<td>1980</td>
<td>89.1</td>
<td>10.9</td>
<td>8.3</td>
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<tr>
<td></td>
<td>1985</td>
<td>87.3</td>
<td>12.7</td>
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<td></td>
<td>1990</td>
<td>85.0</td>
<td>15.0</td>
<td>10.8</td>
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<td>1993</td>
<td>81.4</td>
<td>18.6</td>
<td>13.0</td>
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<tr>
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<td>1980</td>
<td>90.2</td>
<td>9.8</td>
<td>4.5</td>
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<tr>
<td></td>
<td>1985</td>
<td>88.8</td>
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<td>1993</td>
<td>86.6</td>
<td>13.4</td>
<td>5.8</td>
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<tr>
<td>Metal products (381)</td>
<td>1980</td>
<td>89.2</td>
<td>10.8</td>
<td>7.3</td>
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<td></td>
<td>1985</td>
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<td>1993</td>
<td>87.1</td>
<td>12.9</td>
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<td>1980</td>
<td>94.9</td>
<td>5.1</td>
<td>4.1</td>
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<td>1993</td>
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<td>Electrical machinery (383)</td>
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<td>91.7</td>
<td>8.3</td>
<td>6.1</td>
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<td>1985</td>
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<td>1993</td>
<td>87.5</td>
<td>12.5</td>
<td>8.9</td>
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<tr>
<td>Transport equipment (384)</td>
<td>1980</td>
<td>91.8</td>
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<td></td>
<td>1993</td>
<td>89.2</td>
<td>10.8</td>
<td>6.7</td>
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</tbody>
</table>

Table 6b: Distribution of World Value-Added (%), Selected Branches and Years *)

*) At constant price 1980

3.5. Conclusion

DCs exhibit various development needs and gaps in all ramifications of social-economic life. Thus, different authors present different attributes in an attempt to provide a generalised pattern depicting the true characteristics of these nations. However, it is generally agreed that DCs have achieved growing importance in the global business arena.

In designing and implementing production system in DCs, at least four environmental factors need to be considered: economic, political, cultural, and demographic. These factors are, in turn, influenced by the development level of the country, for example, in terms of income per capita. Lastly, the effort of DCs in the process of industrialisation still faces many obstacles, therefore, the choice of a suitable production system is required to accelerate the progress.

Knowledge about JIT manufacturing and characteristics of DCs is not sufficient to develop guidelines for implementing JIT in DCs. Additional information regarding the historical development of JIT, its diffusion, its key issues, and its implementation in industrialised countries will be of great importance for devising models for JIT implementation in DCs. These matters are presented in the next chapter.
Chapter 4

Evolution of the JIT Production System

4.1. Introduction

As the level of complexity increases, so does the nature and degree of international competition. Many companies throughout the world have commenced looking at radical new ways of manufacturing. However, many discussions extol the merits of particular approaches such as JIT, MRP, or LP, with little or no regard as to how the elemental features of the method being promoted compare with other current methods. In fact, many characteristics of the so-called different methods turn out to be similar (Storey, 1994: 4). In the case of the development of new manufacturing methods, speculation has often progressed faster than actual practice. Furthermore, research-based knowledge has also seriously lagged behind the actual development and installation (Storey, 1994: 1)

The recent exploration on manufacturing innovations, such as JIT or TQM, by the West has been thought by many authors to be an emulation of the successful Japanese model; and hence the label 'Japanisation' has been coined (Oliver and Wilkinson, 1992; Turnbull, 1986, 1988). Unfortunately, the adoption of Japanese manufacturing techniques by Western companies, has only occurred as a consequence of that country's dominance in the world market (Schonberger, 1982: 83). For his effort in explaining the emergence of the new production method, the two works by Schonberger (1982, 1986) are frequently cited in many discussions concerning the new methods of manufacturing. The Japanese manufacturing techniques, he argues, seldom contrast significantly
with those of the Western world (Schonberger, 1986: ix). In fact, these types of World Class Manufacturing practices can be witnessed presently in Western companies.

In their five million dollar and five year study, Womack et al (1990) characterised the search of finding new ways of manufacturing as the emanation of 'Lean Production,' the production method which 'combines the advantages of craft and mass production, while avoiding the high cost of the former and the rigidity of the latter' (Womack et al., 1990:13). Unfortunately, all the champions of 'lean production' are headquartered in one country – Japan (Womack et al., 1990:12). As will be seen in later discussion the above features are all embodied by JIT manufacturing. Moreover, lean production methods can not be performed simply by superimposing them on the existing mass production systems. Accordingly, the adoption of lean production will transform everything in almost every industry – choices for customers, the nature of work, the fortune of companies, and, ultimately, the fate of nations (Womack et al., 1990: 12).

The previous explanations confirm that JIT manufacturing is just one of the new methods within a series of arrays of compounded manufacturing strategies. Thus, the discussion of JIT can not be separated from the overall manufacturing debate. In this chapter, therefore, the discussion begins with the evolution of JIT within the overall manufacturing strategies. Particular attention is given to the comparison between JIT and the post-modern factory. After tracing the JIT history, the essence of JIT manufacturing is explained in great detail. This covers JIT philosophical debates, the roles of manpower, as well as the strategies for JIT implementation. Finally, the chapter is concluded by addressing JIT implementation in Japan and in the West and its possible application in developing countries.
4.2. JIT and the Emergence of New Manufacturing Strategies

The evolution of a new method of manufacturing basically happens due to a recognised need to replace an existing, inefficient system with one which will operate in a more efficient manner. In response to the limitation of talented workers and increasing demands for industrial products, craft production, for example, was replaced by a mass production system which was characterised by 'the complete and consistent interchangeability of parts and the simplicity of attaching them to each other' (Womack et al, 1990:27) The division of labour was the fundamental idea behind the latter system. Accordingly, management had the ability to control workers through assigning certain tasks to them for a duration of time so that 'the workers knew what they would be doing when they awoke in the morning' (Nersesian, 1993: 43). Through interchangeable parts and labour, the level of productivity multiplied considerably. It was reported by journalists Horace Arnold and Fay Faroute in 1915 that automobile production increased in productivity by applying moving-assembly-line (mass-production) instead of stationary (craft production) techniques (Womack et al, 1990: 28).

While Ohno and Mito (1986: 2) observe that the planned mass production of the Ford system resulted in waste along every step of the production process, everybody knows that this system made America the leader in both production and management practices in the first half of this century. The superiority of this system during those times can be deemed to be a result of the overwhelming demand for products at a price, not high quality American products. Therefore, as the loci of producers have spread throughout the world and consumer pressures for quality products have increased, the desire for mass production goods diminishes. One of the most wide-ranging reasons for replacing mass production techniques with the new methods is that the level of utilisation of the former has reached the end of its life cycle and is being supplaned by some new
forms such as 'Lean Production' (Womack et al., 1990), 'Kaizen' (Imai, 1986), or 'post-Fordism' (Roobeck, 1987; Kenney and Florida, 1993).

Storey (1994: 5) summarises the main characteristics of the new manufacturing methods as follows:

<table>
<thead>
<tr>
<th>Methods</th>
<th>Main characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>JIT Just-in-Time</td>
<td>Elimination of buffer stocks; delivery of materials and sub-assemblies just in time to be worked on</td>
</tr>
<tr>
<td>TQM Total Quality Management</td>
<td>Full participation of every function and person in the organisation in producing goods and services to their customers' requirements; continuous process improvement; application of relevant techniques to support the above (e.g. SPC)</td>
</tr>
<tr>
<td>LP Lean Production</td>
<td>Teamwork; continuous improvement; zero defects; JIT; the integration of suppliers</td>
</tr>
<tr>
<td>MRP Materials Requirement Planning</td>
<td>A materials control system based on forward production plan</td>
</tr>
<tr>
<td>MRPII Manufacturing Resource Planning</td>
<td>An integrated approach to production planning and control using a computer-based information system which also carries far-reaching organisational change implications</td>
</tr>
<tr>
<td>CIM Computer Integrated Manufacturing</td>
<td>A computer-based system which integrates all elements in the manufacturing process from product design to distribution</td>
</tr>
</tbody>
</table>

Table 7: The Main Characteristics of New Manufacturing Methods
Source: Storey (1994: 5)

Concerning the emergence of the new manufacturing methods, Storey (1994: 5) comments that 'while it is possible on the one hand that the myriad of the manufacturing techniques may indeed share many common characteristics it is also possible that the terms themselves suggest internal consistency which in reality is lacking.' Whereas with respect to the intensity of competition,
Wheelwright and Hayes (1985) state that 'the secret weapon of the competition is based not so much on better product design, marketing ingenuity, or financial strength as on something much harder to duplicate: superior overall manufacturing capability.' All the methods have to be applied appropriately in order to attain 'world class manufacturing.'

This section is concluded by addressing the debate about the relative merits of JIT and MRP. Interesting discussions comparing JIT and MRP methodologies can be read in Karmarkar (1989), Maskell (1989) and Myazaki (1992). The first and second authors argue that the debate of JIT and MRP should be ended and clarified, since both methods are compatible and have their own strengths and weaknesses. Myazaki (1992: 266) summarises the crucial differences as follows:

"The production processes in JIT are divided into series of distributed production stages autonomously managed by Kanban operations. As a result, each lead time between adjacent stages can be reduced much less than the lead time of combined manufacturing stages. This can effectively work to take account of unexpected changes, in plan, such as changes in product design, etc. If the production processes are managed as a whole, like MRP, the changes in plan can hardly be resolved, as the production order has already been released to the first manufacturing process. As described earlier, very few companies in the real world can completely avoid unexpected changes in plan. The substantial difference between JIT and MRP, therefore, exists in the treatment of production processes: distributed production process which are autonomously managed under JIT and the total management of the whole processes under MRP."

The major flaw of the MRP system is in its assumption of a fixed production environment with fixed lead times, which gives no incentive for completing work faster than the fixed standard determined by MRP. Its unnecessarily complex and centralised nature is another big problem with MRP which may bring about difficulties to adapt production activities to take into account sudden changes in plans since the production order has already been
released at the first process stage in advance of the lead time (Myazaki, 1992: 266). The Kanban operation too, is not without its difficulties, especially when it is forced to operate in complex operations where variations are too great or too intractable to be disciplined easily (Karmarkar, 1989: 214). A hybrid system combining the innovative 'kanban' pull systems and computer driven 'MRP II' push systems is therefore required to accommodate today's manufacturing challenges. Many companies now attempt to combine the strengths of JIT's distributing self-governing production process and MRP computer driven application of the total management of the whole process. For example, leaders in advanced computer application and MRP II – Toyota and Hewlett-Packard – have implemented the JIT and Kanban system successfully. In this case, both MRP II and Kanban are required as shopfloor devices. Now that the evolution of JIT within new manufacturing methods has been addressed, it is the appropriate time to compare JIT and Drucker's postmodern factory in the following section.

4.3. JIT and the Postmodern Factory

Drucker (1990) is an important contributor to the development of manufacturing theory. He claims that the 'postmodern' factory will not be mechanical though there will be plenty of machines, rather it will be conceptual – the product of four principles and practices that together constitute a new approach to manufacturing: Statistical Quality Control (SQC), a new accounting method, modular organisational forms, and a systems approach. Although they are developed and promoted separately, they are nevertheless 'synergistic'. 'But only together, they tackle the conflicts that have most troubled traditional, twentieth century mass production plants: the conflicts between man and machines, time and money, standardisation and flexibility, and functions and systems' (Drucker, 1990: 60).
The first principle is SQC 'a rigorous and scientific method of identifying and promoting the quality and productivity that can be expected from a given production process in its current form so that control of both attributes can be built into the process itself' (Drucker, 1990: 48). In addition, SQC is a quick technique for locating and improving malfunctions of a tool, identifying the impact of any change on the performance of the entire process, and specifying where and how the quality and productivity of the entire process can be improved continuously. According to many sources, the achievement of high-productivity by the Japanese has mostly resulted from social changes brought about by SQC (Imai, 1986).

The second principle of the postmodern factory is the application of a new accounting method. In the JIT manufacturing environment, the accounting system will need to redefine how production will be monitored and how the account payable function will support purchasing and suppliers. Drucker (1990: 50-54) suggests the necessity of new accounting practices because the current manufacturing cost accounting, on which modern manufacturing industry rests, has acute limitations. Firstly, the traditional cost accounting method builds its assumptions on the realities of 1920s which are no longer valid. Secondly, the successful criteria of a change in a process or method is mostly explained in terms of labour cost savings, as opposed to Kaizen-process-oriented thinking. Thirdly, even more serious shortcoming for quality improvement, the measures of the effectiveness of an activity only account for the costs of producing and ignore the costs of non-producing. This is in contradiction with the notion that the costs of quality incorporate 'the loss of productivity and increased operating costs resulting from defective material or late material arrival' (Lubben, 1988: 77). Finally, traditional cost accounting assumes the factory is an isolated entity, which separates product improvement from product or process innovations.
To overcome these restrictions, Lubben (1988: 77) suggests three basic changes in accounting methods required by JIT operations:

1. To establish accounting policies and procedures necessary to support JIT suppliers and customers;
2. To involve accounting in the negotiation of contracts with suppliers;
3. To monitor the impact of JIT on the company’s performance.

The third principle that makes up the new approach to manufacturing is modular organisational forms (Drucker, 1990: 54). A 'flotilla' consisting of modules centred either around a stage in the production process or around a number of closely related operations, is required by the prospective factory as a response to greater flexibility of the whole process. This concept will provide each module with the benefits of standardisation as a requirement for low cost manufacturing. The materialisation of this practice requires more than a radical change in the factory's physical structure. A distinct information network will be required, where departments will have to think through what information they owe to whom and what information is needed from whom (Drucker, 1990: 55).

A systems approach is the last concept necessary for transformation to the future factory (Drucker, 1990: 56). Unlike Henry Ford's factory which controlled the entire process of making and moving all the supplies and parts needed by his gigantic plant River Rouge, the new manufacturing system is not controlled at all. Instead, the new system perceives the plant as little more than a wide site in the manufacturing network. Similarly with Marks and Spencer, the British retail chain which designed the first such system in the 1930s, the postmodern factory designates one manufacturer to make each product under contract, works with the manufacturer to produce the right merchandise with the right quality at the right place, and finally organises just-in-time delivery of the finished products to
its store. The overall activities are managed by a strict forecast as to when the goods will move off the store's shelves and into customers' shopping bags (Drucker, 1990: 56).

Does the JIT factory embrace all the four principles of the post-modern factory? As discussed in chapter 2, JIT manufacturing is more than simply a production system. It is one of the manufacturing methods previously mentioned which plays a crucial role in shaping the future competitive edge of a company. The goal of JIT is to find practical ways to create the effect of an automated industry which will come as close as possible to the concept of ideal production: 'produce products the customers want; produce products only at the rate the customers want them; produce with perfect quality; produce instantly; produce with no waste of labour, material, or equipment; and produce by methods which allow for the development of people' (Hall, 1983: 2). This statement emphasises that JIT implementing companies should adhere to the four principles of the postmodern factory in addition to the JIT techniques. In fact, some of the principles of the post-modern factory such as SQC, modular organisation, and a systems approach are also part of the JIT techniques.

4.4. History of JIT

The invention of the JIT production system can not be separated from the evolution of Japanese manufacturing techniques as a whole and particularly the Toyota Production System (TPS). The pressure to catch up with American automotive industries by imitating their mass production techniques and at the same time incorporating Japanese research and creativity to develop a production method that suits the Japanese environment, can be claimed as the main driver for the creation of TPS (Ohno, 1978: 91). In fact, this idea was originally envisioned by Toyoda Kiichiro, the founder of the Toyota, in 1933.
when he announced the goal to develop domestically produced cars for the general public. At that time, he said ‘*We will learn American-style mass production methods but will not imitate them blindly. In the spirit of research and creativity, we will conceive a production system in keeping with the resources of our country*’ (Ohno and Mito, 1986: 27). This statement was believed to be the origin of Toyoda Kiichiro’s idea of the just-in-time system.

During the era of ‘big guns and warships,’ where anything made could be sold, producers simply passed on to retailers whatever they felt like producing. There was no real challenge to devise another system to replace the existing mass-production one. In addition, the Max-Silberston curve had been frequently used in rationalising the mass-production system in the automobile industry. According to this principle, until a certain point is reached, the cost of an automobile decreases drastically in proportion to the increase in quantities produced (Ohno, 1978: 2). Based on this belief, repetitive manufacturers in the past usually endeavoured to reduce the cost per unit by installing single-purpose machines which can produce large numbers of standard products.

This method of manufacturing, in turn, demands a huge amount of capital to purchase machines and computers for coordinating the production flow, and last but not least, to supply large amount of buffer stocks in order to smooth the production. One pioneer of this concept, the Ford Motor Company, for example, failed to maintain its market share due to its lack of capability to readjust the rigidity created by heavy investment in cost minimisation of obsolete equipment (Johnson and Scholes, 1989). In addition, the mass-production system cannot accommodate the fluctuations of demand and the demand of various models. The first will bring about the necessity for a large work-in-process inventory, while the latter can lead to the need for frequent and costly machine set-up.
In response to the above circumstances, Taiichi Ohno, the main deviser of the JIT production system, contemplated a system of flow process in which ‘the right parts needed in assembly reach the assembly line at the time they are needed and only in the amount needed’ (Ohno, 1978: 4). The fundamental principle of JIT is ‘an extremely rational approach to eliminating waste and constitutes the basic philosophy of the Toyota production system’ (Ohno and Mito, 1986: 9). By this system, work-in-process or buffer inventory can be made as minimal as possible. This idea came to Ohno when he observed the supermarket in the US. The supermarket is where customers go to buy exactly what they need and when they need it. This idea can be restated as follows:

“Assume the supermarket is the preceding process in the production line. The subsequent process (the customer) goes to the supermarket to get exactly what it needs (in the case of automobile assembly plant, auto parts) when it needs it. What should the preceding process then do? It must replenish that which has been withdrawn by the subsequent process. By climbing back up the hill of the production process in this way, the smooth flow will be realised” (Ohno and Mito, 1986: 16).

It is apparent that in order to maintain a small work-in-process inventory, the subsequent process must go to the preceding process to pull exactly what it needs, and the preceding process produces the amount that has been pulled by the subsequent process. Harrison (1994: 178-9) encapsulates the difference between mass production and JIT manufacturing as follows:

**Mass production:**

“Manufacture is decoupled from the market by means of a buffer of finished product inventory. A stable manufacturing environment is thereby created wherein large batch sizes are possible. High inventories (raw materials, WIP, and finished goods) are therefore characteristic of this approach to manufacture. Often, the very item which the customer wants is unavailable, and the stock replenishment is relatively long. Traditional Mass Production is also characterised by work segmentation, standardisation methods, and firm discipline imposed through a hierarchical organisation.”
Just-in-Time:

“Manufacturing and distribution are interfaced closely with the market. Throughput times must therefore be relatively short so that demand can be met quickly. So batch sizes and finished product inventories must be relatively small. The manufacturing facilities must be flexible - that is, it must be able to change what is done quickly. It must also be possible to pass on what is needed quickly from one process to the next. Order cycle times are relatively short, and the facility takes on more and more 'make-to-order' rather than 'make-to-stock.'”

The Toyota production system had evolved for almost thirty years before getting much world wide attention until the successful domination by Japanese companies of the global market with high quality and low cost products. This was similar to the progress of the mass production system, which was pioneered by the Ford Motor Company, until it became the world leader in manufacturing. TPS had been characterised by full experimentation in many aspects of its components (see Figure 3). The abolition of the intermediate warehouse had already commenced in 1949. However, it was not until 1958 that ware-house withdrawal slips were completely removed. Similarly, it took 14 years (1948 to 1962) to experiment with the pull system utilising the Kanban system until it was adopted company wide. Contrary to this, experimentation on pallet Kanban ended in failure.

Even though Toyota, for more than two decades, constantly experimented with JIT manufacturing, it was not until the oil crisis in 1973 that many companies learnt about this system. As Ohno commented: ‘For years I had taken every opportunity to explain the thinking behind the new manufacturing technology and define exactly what Toyota system was – but I never received a positive response’ (Ohno and Mito, 1986: 8).
Figure 3: History of the Toyota Production System

Source: Ohno (1978)
The oil crisis was the catalyst that alerted manufacturers to the fact that the era of ‘big guns and warships’ was no longer in existence. Also, the curve of Maxcy-Silberston had proven its validity only during the era of high growth. In the period of slow growth, the merits of mass production lessened drastically or diminished, hence, a production system aimed at increasing lot sizes is not practical any more.

In addition to creating all kinds of waste, the Ford-style mass production system had no ability to adapt to the diversity of demand. TPS, on the contrary, was originally conceived to produce small quantities of many types of cars suitable for the Japanese environment. Hence, it is on this capability, that in its later development, this modern production system has evolved to develop its capacity to meet the challenge of diversification. In contrast to the mass production system which does not have the ability to respond easily to change, TPS is very elastic and can accommodate difficult conditions imposed by diverse market demands (Ohno, 1978: 37).

Japanese automobile manufacturing plants, including those of the parts and component suppliers, are now applying TPS to manage their production flow and inventory control systems. TPS is more than just a production and inventory planning and control system analogous to MRP. It permeates every aspect of the production process, such as process design, job design and standardisation, economic lot sizes, accelerated set-up times, just-in-time production, autonomination, Kanban, Jidoka, Andon, and Yo-i-don (Pegels, 1984: 3). It is clear that initially JIT production is just one aspect of the TPS. In the process of spreading throughout industries world wide, however, the label ‘Just-in-Time’ is preferred to the Toyota Production System. The framework of JIT philosophy by Harrison (1992), described in chapter 2, confirms the conjecture that JIT is another label for TPS.
4.5. *Trends in Competitive Strategies*

In accordance with the mission of this study for exploring the possibility of implementing JIT manufacturing in DCs, this section discusses the trend of a generic manufacturing strategy employed by companies. According to Gibson et al. (1995), most successful firms have a tendency to transform in rather similar manners, in terms of how they move over time, along their generic strategies. In this case, there are significant differences between the Japanese and the Western companies, as illustrated in Figure 4. In this figure, Gibson et al. (1995) exclude Australia from the group of Western countries into a category of its own. The writer appends developing countries in the figure solely based on the writer’s own judgement.

![Figure 4: Trends in Competitive Strategies](image)

The trend commenced in the 1960s when practically all manufacturers were pursuing low cost as their generic strategy. This was a logical consequence of the influence of mass production principles that companies seek to achieve efficiencies and cost reduction through the production of large quantities. Realising the inefficiency of the mass production system, especially in coping with inventory reduction, in the 1960s several Japanese firms following Toyota
and its suppliers, had already conducted experimentations of JIT manufacturing for more than a decade. It was not a coincidence when, in the 1970s, Japanese companies, once they had accumulated expertise on JIT production, initiated the undertaking of quality/service based strategy.

In the early 1980s, after Japan's domination in the world market with high quality and low cost products, many companies in Europe and the US commenced embarking on a quality/service strategy (Schonberger, 1986: 83). At the same time, Japanese counterparts started to pursue a flexibility/innovation strategy. Australia's search for quality had just begun in 1984 when Bob Hawke, then Prime Minister, was pleased to announce the beginning of the 'Australia for Quality' campaign after the decline of Australian firms' productivity and the diminishing of their competitiveness in the last two decades (Sprouster, 1984). Quality movements in developing countries have only recently been initiated. For instance, Indonesian Total Quality Management was only established in 1994.

It is apparent from the above discussion that the JIT production system is now experiencing modifications and diffusions throughout the world. But what actually constitutes JIT? The following sections are focused on explaining in great detail the essence of JIT.

4.6. The Essence of JIT

4.6.1. JIT as a Philosophy

Originally, JIT was invented as a response to the pressure to catch up with the American automotive industries by imitating their mass production techniques and at the same time incorporating Toyota-style research and creativity to develop a production method that suits the Japanese environment.
Heiko (1989) observed that JIT is ‘neither the creation of an academic community nor a development of consulting firms.’ Likewise, Schonberger (1982:17) maintained that JIT is Toyota’s response to managing its own internal operations and relationships with its suppliers.

After the adoption of JIT or Japanese manufacturing techniques in general by many firms worldwide, many authors attempted to explain the meaning of JIT. Each person gives his/her own perception. For example, Hutchins (1988: xv) interprets JIT as a process ‘capable of instant response to demand without the need for any overstocking in expectation of the demand being forthcoming or as a result of inefficiencies in the process.’ Harper (1985) described JIT as ‘the hottest and most controversial subject facing manufacturers and distributors’; while others declare JIT is a ‘complicated philosophy’ (Westbrook, 1987; Sohal, et al., 1989; Safayeni, et al., 1991). Notwithstanding, based on his research, Storey (1994: 6) observes that some managers in manufacturing organisations regard JIT as ‘a near total system of continuous improvement,’ while others simply consider it as essentially the ‘Kanban pull system.’ As previously noted, the contemporary explanation of JIT converges on an approach of eliminating waste throughout the process of production through cultivating the creativity of people.

Furthermore, a review by Sohal et al. (1989) claims that JIT is essentially ‘more of a philosophy than a series of techniques, the basic tenet of which is to minimise cost by restricting the commitment to expenditure in any form, including manufacturing or ordering materials, components, etc. until the last possible moment.’ Likewise, the author of ‘Japanese Manufacturing Techniques’ describes JIT as a system designed ‘to produce and deliver finished goods just in time to be sold, subassemblies just in time to be assembled into finished goods, and purchased materials just in time to be transformed into
"As a result of their patchwork evolution, many companies have the opportunity to significantly improve their overall manufacturing performance by taking a total system viewpoint and integrating optimising procedures and processes for the purpose of preventing waste and inefficiency. The positive result of this effort will be a reduction in the overall cost of manufacturing and improved company profits through reduction or elimination of specific type of overhead."

"A term that has recently become popular to describe the type of system that results from taking a 'total system integration' approach is Just-in-Time (JIT). The term is meant to convey the idea that the three major elements of manufacturing – capital, equipment, and labor – are made available only in the amount required and at the time required to the job."

Similar to the earlier conclusion, the above discussion shows that the JIT production system is merely Western terminology for the Toyota production system, which embodies a series of techniques for continuous improvement and waste elimination which has originated from, and is re-exported to, Western industry after some innovations by the Japanese. The major contribution made by the Japanese is the involvement of employees and the total system approach in the realisation of just-in-time production.

4.6.2. Role of Human Resource

4.6.2.1. The Importance of Human Resource

The human resource plays a crucial role in implementing JIT philosophy. The people-based Kaizen approach to manufacturing improvement is now realised by most industrialised countries to be as important as the use of technology.
(Arndt, 1990). In fact, the biggest difficulty for companies attempting to shift into JIT is associated with cultural mores, and hence poses difficulties for human resources management, to accommodate the requirements of JIT environment.

In learning the secrets of the successful Japanese companies, one of the most frequently mentioned factors is the attitudes of workers: their loyalty, dedication, motivation, high performance and cooperation. It seems that there is no chance to move to the JIT system unless the company can encourage workers to embrace the above attitudes. Looking at the evidence of successful of Western firms able to adopt JIT system, such as IBM, Black and Decker, and Delta, Manoochehri (1985: 26) contends that while culture is considered a dominant factor affecting employees’ attitudes toward work, the primary factor is the management system and the work environment, which are designed and developed by management. The adoption of the JIT system, furnished with the two sets of beliefs, the three basic elements, and a series of techniques, had enabled those three companies to create a work environment that fosters the workers’ contribution.

In attaining the JIT mission of “instantaneously meeting customers’ demand, with perfect quality and no waste,” Manoochehri (1985:26) adds, there is no doubt that the company requires cooperative workers. Industrial relations, therefore, should be based on trust, loyalty, and concern. The removal of buffer stock, along with the allowable small batch sizes in the JIT system, has further driven the company to rely on employees’ high performance, dedication, longer working hours, and multi-skilling, in order to be responsive to manufacturing disturbances. It is clear from the discussion that JIT companies have to ‘hire the whole person’ as the Japanese firms do, in order to be able to tap ‘the brains in addition to the brawn of their work force’. What do Japanese companies do in
managing human resources? And, can their methods be transferred in other environments? The following sections will explain these matters.

4.6.2.2. Managing Human Resource at Nissan

The philosophy of ‘hiring the whole person’ is still ambiguous if there is no explanation about supporting personnel plans and policies which help facilitate the realisation of the JIT mission. In the section discussing the definition of JIT philosophy, this thesis has already explained the importance of people preparation (page 28) in order to be able to support the JIT beliefs for becoming an excellent company. In essence, abstracted from Japanese methods used as a model for Nissan’s plant, Wickens (1987) mentions three personnel policies or the ‘Nissan Tripod’ in the development of people in the JIT system:

1. **Teamworking and commitment**: Everyone works in the same direction so that the thinking of most people is in line with the wanted company culture;

2. **Quality**: There is absolute commitment at every level that quality is the prime objective;

3. **Flexibility**: All jobs should be expanded as much as possible, to the extent of employees’ capabilities.

According to the framework of JIT philosophy (Figure 2), the most fundamental belief is the potential of individual contributions to be a crucial input for continuous improvement. As safety stock is not available, and the operation works on a shorter supply, the problem at one process becomes the problem of the whole plant. Other workers in the plant will not abandon the problem and leave the operator to fix the problem alone. Hence, teamworking is a natural consequence of JIT disciplines and becoming an essential part of company culture. Furthermore, since problems are now more visible, the need
for improvements can not be postponed and they are naturally enforced by the JIT system in an attempt to prevent their recurrence.

One of the key issues in fostering teamwork and commitment is the Deming’s eighth advice of fourteen points: ‘*drive out the fear from the work force*’ (Deming, 1986). Upon this advice, Nersesian (1993: 67) provides a clear analysis how Japanese (JIT) and the Western (traditional) management practices contradict each other in handling this issue. In banishing the greatest fear of the work force (being laid off), Japanese companies are accustomed to the practice of *heiretsu*, permitting the companies to shift workers from one industry to another. It is considered a management responsibility to look after the social welfare of its workers. This situation makes workers comfortable with change. Workers view the installation of a robot, for example, as a means of releasing monotony, and something that would result in more interesting jobs for them. Furthermore, when training is needed to upgrade their capability, it is made available. In summary, they consider themselves as part of an extended family.

On the contrary, American companies fail to drive out the fear of their work force. The installation of robot is viewed in terms of who will lose their jobs. In fact, this is not the only fear that pervades the system. Fear of reprisal occurs when workers are made cooperative through intimidation. Making a suggestion that does not prove workable may lead to punishment (fear of failure). Poor results in PDCA experiment may result in fear of being the bearer of bad news. Fear of not knowing what is going on, may lead to suspicion. Lastly, there is an excellent comment of fear of changes made by Niccolo Machiaveli in 1514 (Nersesian, 1993: 67):
“It should be borne in mind that there is nothing more difficult to arrange, more doubtful of success, and more dangerous to carry through than initiating changes. The innovator makes enemies of all those who prospered under the old order, and only lukewarm support from those who would prosper under the new. This support is partly from fear of their adversaries, who have the existing laws in their side, and partly because men are generally incredulous, never really trusting new things unless they have tested them by experience.”

To spread quality commitment at every level, there are several good points to be learnt from the Japanese methods, one of them is Quality Control circles (QCC). These circles were started in 1962 under JUSE (Union of Japanese Scientists and Engineers) auspices with the intention to build cheerful and prestigious places to work. At that time, QCC were not formed for the purpose of improving productivity and quality control. The circles were established by the employees upon their initiative to make work more meaningful and worthwhile. Since QC circle activities were voluntary, management did not force them on employees. The meetings took place either during working hours or after work. However, as they developed QCC had succeeded in contributing considerable improvements which originated from workers’ initiatives (Imai, 1986). It is considered that QCC was the first Japanese method to be exported overseas in the early 1980s (Harrison, 1992: 9), even though its application in Western companies turned out to be unsuccessful.

In realising the third stage in the Nissan Tripod in the preparation of people, where all jobs should be enlarged as much as possible to the extent of its employee’s capabilities, Western companies usually face difficulties due to explicit job descriptions. Japanese companies, dealing with developing mutual understanding among workers and reducing a conflict of job areas, provide more flexible job descriptions (Imai, 1986). This effort is not intended to reduce the number of workers, but to increase productivity, and consequently, to gain more profit and to create more jobs. Before commencing a plan for productivity
improvement, for example, Japanese management always attempts to assure workers that the improvement will result in 'baking a bigger pie' instead of 'fighting over how to divide the pie'. This is the thing that Western industry must learn from the Japanese.

4.6.2.3. Transforming Japanese Methods into Western Success

As opposed to Schonberger (1986)'s fourth lesson that 'culture is no obstacle,' Harrison (1992) considers cultural differences between Western and Japan to be a major obstacle to transforming Japanese management to the West. Although some evidence has been given to support the claim that Japanese manufacturing techniques undoubtedly work in Western settings, the capability to apply such beliefs and techniques to compete with Japan-based companies requires recognition of Western cultural strengths and weaknesses.

In coping with this problem, Murata and Harrison (1991) propose how winning behaviour from company members can be developed by implanting Western cultural attributes on to the essential points which have made Japanese companies successful (see Table 8).
### Table 8: Transforming Japanese Methods into Western Success

Source: Murata and Harrison (1991)

#### 4.6.3. Strategies for Implementation

##### 4.6.3.1. Barriers to Implementing New Manufacturing Techniques

Sohal et al. (1989: 23) suggest that the JIT methodology and philosophy have much to offer to the West. However, many differences exist between the two cultures, and the implementation of JIT outside Japan, in the West as well as in developing countries, has to take into account the local factors, such as labour relations, existing management styles and agreements (Harber et al., 1990: 21). Also, Voss (1988: 60) indicates that there are two kinds of successful implementation of a manufacturing philosophy: technical and business. Based on his empirical studies, he adds that technical success does not necessarily lead
to realisation of business success. He therefore proposes a new area of study regarding ‘the management of the adoption of inventions, or implementation.’

The issue of JIT implementation has been reviewed by several authors (Lee and Ebrahimpour, 1984; O'Grady, 1988; Harber et al., 1990; Safayeni et al., 1991; Inman and Mehra, 1993; Markham and McCart, 1995). Before addressing specific aspects of JIT implementation, this section commences with explaining five barriers for implementing new manufacturing techniques as described by Storey (1994: 12-15):

**First**, the barriers of treating the new approaches as merely a series of technical dilemmas;

The tendency for the majority of companies in the West to treat the new methods in a one-sided technical way is mentioned by several researchers as well as practitioners (Aggarwal and Aggarwal, 1985; Voss, 1988; Kinnie and Staughton, 1991). As described previously, the Japanese competitive position does not stem from superiority and higher levels of automation, rather it is the source of flexibility in production system which is their organisational characteristic.

**Second**, the need to achieve integration;

Integration of new manufacturing methods into the existing systems can be considered as a crucial barrier that should be managed properly. In relation to the installation of JIT, Safayeni et al. (1991: 36), based on their studies on JIT implementation in North American industries, conclude: ‘organisations cannot maintain the same structure, same habits, same performance evaluation systems and simply add JIT to the existing practices and events in the organisational systems and expect it to work.’ Also, Peters (1987: 118) observed that ‘most just in time experiments have failed to reach their
potential, not because of inadequate computerisation, but because of a fundamental failure on the part of participants to understand the new attitudes of trust, cooperation and mutual investment.' The above statements indicate that organisational restructuring as well as employees’ education and training are the pre-requisite for successful implementation of JIT.

Third, the need for premium levels of positive commitment and high level of competence from employees;

Bringing about changes in attitude and commitment are recognised as a major challenge in implementing JIT manufacturing. As stated by Huczynski and Buchanan (1991: 342) that 'advanced manufacturing technology makes skill and commitment more important, not less.' Some misunderstanding on this matter, hence, can bring about investing in more advanced technology as a way to reduce dependency upon human resource.

Fourth, the need for alteration to conventional practice which extends beyond the point of production right up the production chain;

It will be discussed later that the need for these changes is also experienced by JIT manufacturing firms. According to Bessant and Haywood (1986), the FMS implementation demands modifications in new production lay-outs, cellular methods, total quality processes, redirecting marketing to exploit the flexibility of FMS, new arrangements with suppliers, new design and so on.

Fifth, the need for a change in company culture;

Lee and Ebrahimpour (1984), Ansari (1986), and Helms et al. (1990) have identified critical success factors for the implementation of JIT and similar new manufacturing approaches. The significance of appropriate corporate culture has been emphasised by all of them. Also, they all agree that
Japanese culture is congruent with the manufacturing methods, the adoption of similar cultural attributes is thus recommended for its successful implementation.

4.6.3.2. Development Stages for JIT Implementation

JIT manufacturing is interpreted differently by many authors. Each proposes different steps of implementation to the others. This section will discuss five stages for developing the JIT/TQ company (Harrison, 1992). This is followed in the subsequent sections by addressing steps for implementing the JIT system (Maskell, 1987).

According to Harrison (1992), JIT implementing companies, in general, will experience five stages of development towards the ideal JIT (see Table 9).

<table>
<thead>
<tr>
<th>JIT Emphasis</th>
<th>Stages</th>
<th>TQ Emphasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do we compete?</td>
<td>Stage 1</td>
<td>Set the goals today to be in business tomorrow</td>
</tr>
<tr>
<td>Role of JIT</td>
<td>Business strategy issues</td>
<td>What Deming's fourteen points mean in our company</td>
</tr>
<tr>
<td>Initial game plan</td>
<td></td>
<td>Plan the transformation process</td>
</tr>
<tr>
<td>Safety</td>
<td>Stage 2</td>
<td>Work on attitudes (&quot;them versus us&quot;)</td>
</tr>
<tr>
<td>Housekeeping</td>
<td>Basic disciplines</td>
<td>Work on disciplines</td>
</tr>
<tr>
<td>Quality standards</td>
<td></td>
<td>Identify key health and safety and quality standards</td>
</tr>
<tr>
<td>Process capability studies</td>
<td>Stage 3</td>
<td>Training and PS techniques</td>
</tr>
<tr>
<td>Bring process under control</td>
<td>Process control</td>
<td>Involvement of all personnel in improvement activities (QCCs, SGIA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supplier QA</td>
</tr>
<tr>
<td>Design for manufacture</td>
<td>Stage 4</td>
<td>Continuous process improvement</td>
</tr>
<tr>
<td>JIT techniques</td>
<td>Eliminate waste</td>
<td>Internal customer feedback</td>
</tr>
<tr>
<td>Involvement of suppliers</td>
<td></td>
<td>Supplier process improvement</td>
</tr>
<tr>
<td>Error proofing</td>
<td>Stage 5</td>
<td>Control embedded within and driven by the organisation</td>
</tr>
<tr>
<td>Automatic condition monitoring</td>
<td>Eliminate errors at source</td>
<td></td>
</tr>
</tbody>
</table>

Table 9 : Developing JIT/TQ
Source : Harrison (1992: 4)
In each stage of developing the JIT/TQ culture, companies will place a different emphasis on JIT and TQ. Since Japanese companies have already developed TQ culture under the auspices of Deming and Juran for more than thirty years, there seems to be no reason for them to implement TQ before struggling with JIT development.

The table indicates the need for an early preparation stage to be technique specific, after the company has settled its business strategy issues. For example, stage 2 (introduce basic disciplines) and stage 3 (process control) require the implementation of specific techniques like housekeeping, safety and quality standards. Preparation of the accompanying attitudes which ensure the new discipline stick is also important, since they become the norm for everyone. This is then followed by the elimination of waste by applying design and JIT techniques and the involvement of suppliers into quality assurance and product development. At the last stage (elimination of errors at the source), the detection and elimination of errors are incorporated through devising a method that can prevent the process from performing any other way than the right way.

While in the above figure, JIT and TQ are separated into different columns, in reality they take place in a parallel and intertwined manner. However, it should be considered that JIT development activities should not run ahead of TQ development (Harrison, 1992: 234). That is why, Japanese companies are easier to shift to the JIT system because they have already been practicing TQ since the 1950s. The new standards of tidiness and cleanliness become a source of pride to show to visitors. Also, new attitudes towards safety and quality processes will help to prepare the foundation for the war on waste. Furthermore, training in problem-solving techniques equips company members to take over greater responsibility for the work they do. Once a satisfactory commencement has been made on basic discipline and process control, testing
and implementing the new method on the pilot project can be launched. It requires at least two years to change from a traditional to a JIT/TQ company.

A more down to earth explanation concerning the transformation into a JIT company is given by Maskell (1989). He mentions six steps required to develop competences needed by JIT companies for tackling waste elimination, quality improvement, and customer satisfaction. Each step deals with one area of application of the previously mentioned techniques. A combination of techniques may be set to work one at a time or all at once, and not necessarily in any given order. Nevertheless, addressing all six areas thoroughly would be the ultimate goal for any implementing JIT company.

4.6.3.3. Planning the Projects

In a JIT environment, planning basically falls upon the formulation of strategies, setting of goals, and a bias for action for implementing the strategies and goals. It is important that all planning must be developed with the full cooperation, understanding and participation of the company’s line managers, allowing all employees to be involved in the planning process (Maskell, 1989: 33).

- The Planning Process

While the idea of JIT manufacturing is not difficult to comprehend, putting it into practice is a great challenge. Companies equipped with a bias for action will be successful in implementing JIT philosophy. Here, the planning process consists of five steps (Maskell, 1989: 34-39)

**Step 1: Defining the Manufacturing Business Strategy**

Since manufacturing is just one part of business, senior managers need to develop a manufacturing strategy congruent with the broader goals of the
company. There is no unique business strategy, each company pursues the strategy corresponding with that demanded by its environment. Manufacturing strategy will, in turn, be significantly affected by its corporate business strategy.

**Step 2: Outline the Scope of the Manufacturing Strategy**

The senior managers then define the scope of the manufacturing strategy, after knowing where manufacturing plans fit within the corporate business strategy. JIT manufacturing cannot be seen in isolation, but must be viewed in the framework of the entire manufacturing operation, including procurement, production distribution, and even product development (design engineering). Thus, JIT concepts encompass not only shop-floor control, but extend to a company-wide approach.

**Step 3: Perform Self-Assessment**

It is crucial for a company to have a clear view of its current manufacturing capability in order to plan for the future set of goals that it wants to achieve. Also, just as important is to create a common awareness of the current strengths and weaknesses. JIT implementation commences with an education program to accomplish this ideal among all employees. Every area of manufacturing needs to be examined. This includes, but is not limited to, manufacturing or production, inventory, logistics, and engineering.

Self-assessment can be carried out by line managers, department personnel, and also by senior managers. This kind of evaluation can be beneficial for gaining an accurate understanding of the capabilities of the primary competitors. Most appropriate information is actually available in published reports, articles, and financial statements. However, utilising
outside consultants can be valuable at this stage, since assessing its own capabilities is usually very difficult. Competitive benchmarking, a method of examining the strengths and weaknesses of competitors through identifying the best practice of certain aspects of business, is another alternative of assessment currently pursued by some companies.

**Step 4: Chart the Future Path**

This is a logical consequence of pursuing progress. Goals vary, depending upon the company’s strategies and objectives, but determining keys aspects of manufacturing strategy and setting some targets for the future are very important. In this way, everyone in the company has a clear view of what is expected. Furthermore, the expectations must be practical and achievable and must provide progressive improvement over the next few months or years.

**Step 5: Develop an Action Plan**

The consequences of JIT implementation are far-reaching and radical in the sense that it will bring about significant changes in people preparation, relationship with suppliers, and quality considerations. Therefore, the active participation of all the manufacturing personnel is required to ensure its success. In this case, the action plan is developed to coordinate the various activities that comprise the JIT implementation.

- **Putting the Plan into Action**

As the planning process is completed, many senior managers lose enthusiasm for JIT manufacturing due to the requirement for investment and significant alterations in every aspect of manufacturing conduct. Commitment from all levels of the organisation from senior managers to shop-floor operators, for
example, is a prerequisite for successful JIT implementation. There are six steps involved in putting the plan into action (Maskell, 1989: 39-42):

**Step 1: Assign How-To's to Each Department**

Each department affected by changes as a result of JIT implementation is provided with how-to’s and tools in order to manage the changes in planned direction. Also, managers will need to be educated in the concepts of JIT and as to understand why the company has to take this path in order to be able to implement the change.

**Step 2: List Actions Required and Gain Commitment in Each Department**

Make a list of specific actions needed to implement the how-to’s in each department.

**Step 3: Gain Employee Commitment**

It is important to involve employees in the decision making process and have their ideas included in the program. In this way, a great degree of commitment throughout the entire company can be achieved. The process of commitment-building may take time and requires a considerable amount of training.

**Step 4: Determine a Series of Project**

A project is a media for addressing a significant issue to be solved. The delineation of individual task within each department makes overlapping tasks between departments become clear. By having departments review their tasks and form them into a series of assignable projects, estimates of the time and costs involved in each project can be made.
**Step 5: Assign Priorities**

Having constraints of time and money, the company has to make decisions regarding which projects are to be completed first and who should be responsible for each project.

**Step 6: Create Project Teams**

In this case, the teams should have people from many different departments within the company, including production, quality control, design engineering, procurement, cost and management accounting, marketing and distribution.

4.6.3.4. **Preparing the People**

This issue, most companies find, is the biggest challenge. This has already been discussed in explaining one of the three basic elements supporting JIT philosophy, and re-emphasised in addressing the role of manpower. As the company shifts into the JIT, the roles and responsibilities of people will also change, and often radically. Maskell (1989: 45-54) places emphasis on the following five distinct ‘people issues’ in preparing the people:

- **Education**

  As explained before on several occasions, education in the broadest sense, can be beneficial in implementing JIT, particularly in outlining JIT ideals among the company members and making them understand the changes that are going on in the company. Some firms provide different means of education in JIT techniques, but the best way is by ‘cascading’ through managers within the company (managers become the trainers for their subordinates). In this case, Peters & Waterman (1982) emphasise the need for a ‘champion’ – a person who pushes innovations through to a successful completion.
• **Transfer of Responsibilities**

This technique means that authority and responsibility are deliberately moved down the chain of command for the purpose of allowing shop-floor employees to contribute their creativity in the quest for productivity, problem solving, and quality, since the best person to find methods of improvement is the person who spend days, months, and years doing the job. In this case, the role of experts and specialists are only for providing advice for special skills.

• **Cross-Training and Flexibility**

This technique is an important effort for achieving flexible operation so that the factory can produce a large variety of small volumes. In JIT plants, specialists are encouraged to become generalists so that they can finish the whole job or can move to an area of need and be effective quickly.

• **Participation Groups**

Participation groups, in the form of quality circles, for example, can be valuable within JIT companies because the JIT atmosphere of improvement and participation allows ideas and suggestions to be put into practice. Ideally, the team contains members from many different departments of the company, and at least in the early stages, has some clear goals.

• **Motivation and Incentives**

Motivating people at the shopfloor is the biggest challenge faced by JIT companies. By making all employees aware of changes occurring in their company (through education as explained above), the effort of motivating employees has partly proceeded. The managers’ task in creating incentives for improvement is to reinforce the atmosphere of trust and mutual respect.
4.6.3.5. **Production Process**

In pursuing its objectives, the JIT production system offers various techniques to improve the manufacturing process. As has already been discussed, JIT ideas may conflict with traditional methods of manufacturing. This section mentions six techniques of production required to move into JIT (Maskel, 1989: 55-95):

- **Shop-floor Layout**

  The shortcomings of traditional manufacturing are obvious in terms of the long-distance products travel during production. Production personnel become specialists in a particular type of task within the factory, and the complexity of control procedures. In an effort to overcome these problems, the JIT system proposes cellular manufacturing by way of grouping activities into work cells in such a way that it results in a degree of repetition in the manufacturing process. Cellular manufacturing has some advantages: personnel can be cross-trained and in turn provide greater flexibility; the production rate can be adjusted by the quantity of people within the cell; a production cell can be made into a responsibility center through assigning quality responsibility to the personnel; quality problems can be identified very early; and finally, production cells frequently utilise less space.

- **Set up Time Reduction**

  Three primary reasons underlying why set up time reduction must be introduced: lot sizes can be reduced; lead times can be made shorter; and flexibility can be enhanced. This concept does not agree with Economic Order Quantity (EOQ) formula because the assumptions contained within this formula are often invalid and misleading. Indeed, systematic reduction and elimination of large lot sizes become a continuous effort of JIT companies.
• **Inventory Pull System**

A JIT approach converts traditional shop-floor control from a push system to a pool system for controlling inventories of materials and sub-assemblies. One benefit of this system is that shop-floor systems are very much simplified. Dispatch lists, input/output reports, and detailed production activity reports are no longer required.

• **Uniform Plant Loading**

Unbalanced loading will cause queues to build up, causing in turn, high inventories and long lead times. Also, there are many intangible effects which result from variation in loading: large queues cause confusion and operators may have to decide which job to work on from a range of available work orders.

• **Design for Manufacturability**

In JIT manufacturing, product development becomes the initial source of cost reduction. The approach to product design falls into three categories: customer awareness, integration with manufacturing, and quality design in the product. Rather than trusting the highly skilled but possibly out of touch design engineers, a JIT manufacturer requires cooperation between design engineers with customers and production engineers.

• **Visibility**

Visibility is a major thrust in JIT manufacturing because this technique can draw instant attention to a problem so that it can be resolved immediately. Since written communication sometimes does not clearly identify important issues, JIT manufacturers utilise visual signals to inform employees of such
things as the production plan, quality levels achieved, machine breakdowns, and inventory control criteria.

4.6.3.6. **Procurement and Suppliers**

Maskell (1989: 97-110) contends that companies converting to JIT, especially assemblers of finished products such as car manufacturers, will find it necessary to change their procurement practices. The changes involve the relationship with suppliers, supplier reduction, supplier certification, and delivery logistics. The relationship with suppliers can no longer be adversarial and driven by the price tag only but should be based on mutual understanding.

Developing close relationships with too many suppliers is difficult. Therefore, the best approach is to restrict suppliers to those with whom the manufacturer has developed close relationships on the basis of quality and delivery reliability. The benefits of single or few suppliers rather than multiple sourcing are that a huge amount of time and effort can be saved.

As a consequence of plunging into a single sourcing, the assessment of a supplier’s performance should be based on quality, reliability and flexibility. These assessments result in suppliers being certified to supply a component or subassembly. Thus, the criteria for certification should include continuous improvement. In this case, continuous evaluation and monitoring of suppliers’ performance over a period of time are required. Even after a supplier has gained full certification, the manufacturer still continues to work with the supplier to increase quality, reduce costs, improve deliveries or reduce batch sizes.

While single sourcing helps with delivery logistics when suppliers are delivering larger quantities, the delivery of smaller quantities frequently required by JIT systems creates a complex logistics problem. However, it is a resolvable
situation. Many companies have established sophisticated delivery networks that entail daily pick-ups from local suppliers. One of the most interesting points of JIT development in Western companies has been the innovation concerned with solving JIT delivery problems. Finally, it should be borne in mind that decisions regarding delivery logistics have to take into account the key issue of JIT, that is, total cost reduction in the provision of materials.

**4.6.3.7. Quality**

A fundamental belief of JIT manufacturing is that continuous quality improvement is a pre-requisite of becoming an excellent company. But ‘quality’ is a complex and multifaceted concept. Some quality exponents attempt to provide a definition of quality, such as ‘fitness for use’ (Juran, 1988); ‘conformance to requirements’ (Crosby, 1979); ‘eight dimensions of quality’ (Garvin, 1984); ‘the loss imparted to the society from the time a product is shipped’ (Taguchi, 1980); and ‘anything that can be improved’ (Imai, 1986).

Table 10 illustrates the difference in approach to quality between JIT and traditional manufacturing. As explained in the table, the fundamental difference between the two approaches lies in the fact that the latter method attempts to involve all employees as much as possible in the effort to guarantee quality.

Since the source of quality is customers, strategy for quality improvement must commence from the customers’ perception of quality. The next step is the evaluation of market opportunities due to improved product quality. It is then required to define the quality of the product quantitatively; and to find practical ways of measuring it. Finally, before devising quality improvement programs and putting them into action, setting targets and attainable timetables for quality improvement is indispensable.
Traditional | JIT Manufacturing
---|---
Higher quality is expensive | Higher quality saves money and increases profits due to less variations, scraps, rework and waste, and in turn enhance customer satisfaction
Some defects are acceptable | No defects are acceptable
Buy from the lowest bidder | Buy for quality and reliability
Separate inspection department | Build inspection into each stage of production
Quality control department is responsible for insuring quality | Everyone is responsible for quality
Quality engineering department is responsible for solving quality problems | Quality problems are resolved on the shopfloor by the operators and supervisors
Quality is measured by quality engineers using complex statistical analysis | Quality is measured by operators on the shopfloor utilising statistical control charts

Table 10: Differences in Approach to Quality between JIT and Traditional Manufacturing

Source: Maskell (1989: 112-3)

The JIT approach always seeks to solve production problems at the source through continuously performing the Deming wheel (PDCA cycle) until the root cause is uncovered. There are three major sources of poor quality within a manufacturing environment: design, suppliers, and production. Various studies reveals different results concerning each contribution to poor quality. However, a generally accepted approximation asserts that design, suppliers, and production respectively contribute 40, 30, and 30 percent of quality problems (Maskell, 1989).

The following five actions are mentioned in Maskell (1989) as primary mechanisms of JIT practices in assuring quality:
• **Immediate Feedback**

Assigning responsibility for quality to shopfloor workers can be regarded as creating a mechanism for allowing immediate feedback, because the workers have the capability to identify and then solve problems as they occur without waiting for assistance from quality specialists as in the traditional companies.

• **Fail-Safe**

JIT companies attempt to implement fail-safe mechanisms by designing the production process so that it is impossible to make something wrong or by detecting a defect instantly and then warn the operator.

• **Participation Groups**

Participation groups are developed to assist with the resolution of quality problems, since many people are better than one when it comes to problem solving, particularly when the group members originate from diverse departments. The purpose is to bring together a team of people who can address quality issues that have been identified through SPC, Pareto analysis, and day-to-day observation.

• **Supplier Quality**

Attacking quality at the source can be facilitated through developing close relationships with suppliers so that manufacturers are able to maintain the quality of their raw materials and components.

• **Design for Quality**

Another effort to dealing with quality at the source is by developing quality into product through designing product that not only meets final
customer needs but also complies with the requirements of manufacturing/production, distribution, and sales.

4.6.3.8. **Software Support**

In relation to the transition from traditional to JIT manufacturing, there are a number of areas where manufacturing software changes can assist in the quest for manufacturing excellence. In this case, Maskell (1989: 129-42) suggests the utilisation of software in the following eight areas:

- **Back-flushing**

  Back-flushing means that the quantity of the component inventory required to build the final assembly is automatically deducted from the quantities previously on hand. The success of back-flushing demands that the production process must be consistent and bills of materials must be accurate. Also, production cycle times must be short enough so that detailed records in a work-in-process inventory are not necessary. Whereas, any scrap or rework quantities have to be separately reported, if they do occur. Companies that have made considerable progress with JIT will not find it necessary to perform these transactions precisely.

- **Pull Card Printing**

  This technique is useful when there is some flexibility in the production process, and the details of final assembly schedule change considerably from day to day or week to week. By producing a pull card printing each day or each shift, a good practice is created for ensuring the manufacturing of right parts and assemblies at the right time without the need for complex inventory planning and control systems. In a situation where production requirements do not fluctuate significantly, this technique is not needed.
• **Work Orderless Scheduling**

In traditional manufacturing, work orders are utilised because production processes have long lead times, so that the task of keeping track of jobs on the shop floor becomes very complex. On the contrary, in JIT manufacturing, where lead times have been significantly reduced, work orders are no longer necessary because the task of keeping track of the jobs is kept very simple because of the reduction in the number of jobs. Also, the need to account for a work-in-process inventory disappears when the amount of WIP is reduced.

• **Rate-based Scheduling and Levelised Loading**

While the MRP system is used to determine the required additional components or subassemblies and to recommend work orders to be published to satisfy that need, the JIT system has a levelised or uniform production plan allowing products to move smoothly throughout the plant so that production rates can be adjusted to match customer needs. Planning a levelised production for the whole factory requires a review of the entire production process of a product rather than individual production steps. Hence, levelised loading software becomes important when more complex production processes are involved, or when there is a wide range of finished products, or when production flexibility is required.

• **Supplier Control and Scheduling**

JIT manufacturers seek suppliers based on their reliability, quality, and delivery history. Procurement software can be helpful for maintaining information about the status, quality and reliability of suppliers. It is necessary that the software can track the process of receiving and the inspection of components and subassemblies and retain the integrity of
receiving lot numbers through inspection and onto the shop floor. Finally, the procurement and inventory software should provide reports that monitor the performance of each supplier in each of these areas.

- **Accounts Payable**

As a consequence of delivering smaller quantities more frequently, there are more supplier invoices that need to be processed in accounts payable. This increase can be a significant burden on the accounts payable department, and the software can help alleviate the problem.

- **Quality Measurement and SPC**

JIT software should also be able to monitor quality criteria automatically, because quality is central to a JIT environment. In this case, many software packages are available, including some sophisticated on-line, real-time process control systems and statistical process control systems.

- **Performance Measures and Cost Accounting**

It is widely agreed that traditional methods of measuring performance are not relevant to the JIT system. Some experts, such as Lubben (1998) observe the future of manufacturing costing is moving towards methods that are currently favoured by process manufacturers. While others believe that financially-based performance measures are not relevant and that the task of management accountants and manufacturing managers is to come up with non-financial measures that are truly relevant to production activities. Non-financial standards currently in use include: quality measures, inventory turns, delivery performance to customers, lead times and throughput times, ratio of productive time to cycle time, and return on total assets (ROTA).
Maskell (1989) has explained six strategies for moving into JIT. The primary aim of these methods, which have been developed utilising a quite different philosophy of manufacturing from that found within the traditional factory, is to overcome the root causes of waste. This approach has merit. The emphasis on waste elimination and quality improvement associated with JIT goes much further than an old-fashion stock reduction project or an efficiency study. A long term commitment to excellence and quality in every aspect of the business, including shopfloor and personnel management, purchasing, and product design, characterises an effective waste reduction program in JIT.

The precise method of applying JIT techniques largely depends upon the company, the manufacturing strategy, and the market situation. An inventory reduction program, for example, is very much needed by companies experiencing financial difficulties. Firms wishing to enhance customer service will undoubtedly utilise expensive computer software for achieving their service faster and convenience. Whatever methods apply, people preparation, as advocated by Harrison (1992) and Maskell (1989), is a major determinant of the success of all JIT techniques.

Japanese firms do not seem to encounter major problems in implementing JIT due to the people preparation inherent in their quality culture. The question arises, how do companies outside Japan adapt JIT requirements in actual practice?. The next section deals with JIT implementation in Japan and in the West, as well as its prospective application in DCs. Hence, lessons learnt from this discussion will be helpful in suggesting means of implementing JIT in DCs.

4.7. JIT Implementation

4.7.1. JIT Implementation in Japan and in the West

This section discusses three points. The first is the applicability of Japanese production methods in the West. It is followed by an examination of the effect of
culture in JIT implementation. Lastly, a comparison between management control systems in Japan and the West is discussed. In those cases, the West is represented by the United States due to the availability of information.

4.7.1.1. The Applicability of Japanese Methods in the West

Plenert (1985) has reviewed the Japanese production methods for the purpose of analysing the applicability of these techniques in the United States. He concluded his study by recommending 16 specific methods to be applied in the Western environment (see Table 11). This figure considers the desirability, usefulness, and potential for savings provided in each technique.

<table>
<thead>
<tr>
<th>Recommended Techniques</th>
<th>Desirable</th>
<th>Usable</th>
<th>Cost reductions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Material</td>
</tr>
<tr>
<td><strong>Facility Planning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared resources</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Smaller factories</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Technology specialisation</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Production Planning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product sequencing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>In-line quality control</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Just-in-time or Kanban</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Split shifts</td>
<td>Yes</td>
<td>Yes</td>
<td>?</td>
</tr>
<tr>
<td>Lifetime vendors</td>
<td>Yes</td>
<td>Yes</td>
<td>?</td>
</tr>
<tr>
<td><strong>Management Style</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management circles or bottom-up</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statistical management</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Long-run planning</td>
<td>Yes</td>
<td>Yes</td>
<td>?</td>
</tr>
<tr>
<td><strong>Employee Relations</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime employment</td>
<td>Yes</td>
<td>?</td>
<td>No</td>
</tr>
<tr>
<td>No nepotism</td>
<td>Yes</td>
<td>?</td>
<td>No</td>
</tr>
<tr>
<td>Profit bonuses</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Morale programs</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Employee rotation</td>
<td>Yes</td>
<td>?</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 11: Evaluation of the Sixteen Recommended Techniques
Source : Plenert (1985)
The methods are grouped into four major categories: Facilities Planning; Production Planning; Management Style; and Employee Relations. According to Plenert (1985), all three facility planning techniques used by the Japanese have validity in the United States. The easiest to implement is the shared resource concept. The smaller factory concept requires major reorganisation of the facility. The specialised technology concept should be done in conjunction with the smaller factory concept, where within the smaller facility all technology should be specialised toward the prime function of that area. All three methods promise savings both in materials and labour.

Plenert (1985) also contends that product sequencing in production planning systems offers many benefits to the West, especially with the potential of the U-line concept. By sequencing products in the U-line formation and within the smaller facility, in-line quality control has been successfully implemented in the United States by additional training being given to the employees. In this case, some drastic changes in the factories are required not only in the reorganisation of the facility but also in the management’s evaluation of priorities. Split shifts have already been implemented in some factories in the United States. But the concept of lifetime vendors is difficult to accomplish due to the requirement for the vendors’ close proximity to the factory. American vendors would be hesitant to build new facilities near the factory unless there is the assurance of being permanent vendors. Without this commitment, the lifetime vendor concept will not work.

All three concepts in management style techniques (QCC, SQC and long-term planning) have enormous potential benefits for the West. QCC are an entrenched practice in Japanese plants, but have only appeared in the United States in the last decade. Even though the initial installation of QCC does not seem to produce a satisfactory outcome (Hill, 1991), many Western companies
are now performing QCC in their plants. Modifications suited to Western culture, such as Self Directed Work Teams (SWDTs), can be seen in some companies and appear to enjoy some success in terms of achieving greater employee involvement. Statistical management, one of the four pillars of the Drucker's postmodern factory, has proved to be a considerable support in contributing to identifying and promoting quality and productivity. Finally, long term planning is required to implement the JIT system, since most JIT benefits can only be reaped at some future time after expending some substantial effort.

Among the five concepts of employee relation techniques, only three – no nepotism, profit bonuses, and morale programs – are being utilised to some extent in the United States (Plenert, 1985). Hence, expanding the usage of these techniques will enhance their potential benefits. Lifetime employment needs to be tested for its effectiveness in a Western business climate, but employee rotation and multi-skills training seems promising. The combination of these techniques with management style concepts will bring about positive increases in quality and productivity.

In this study, Plenert (1985) asserts that many American production and inventory control techniques cannot continue to prosper the way they are currently operating. Modification and improvement are required, and Western manufacturers should consider the better alternatives proposed by the Japanese manufacturing techniques mentioned in Table 11. The table shows that all sixteen methods offer some savings for the West, although in some areas the cost is excessive. It is worth considering that none of these techniques will work without adequate attention being paid to the personnel relationships, since the key to success in the control of production is in the treatment of the work-force who do the job.
4.7.1.2. *The Effect of Culture on JIT Implementation*

Other clear explanations on the cultural differences between the Japanese and the West and their impact on the resultant management techniques are given by Cooper (1984) and Kim and Takeda (1996). The first writer argues that bottom-up management in the form of quality circles is supported by the existence of longer working hours by the Japanese. The standard work week in America is forty hours, compared to fifty hours in Japan. Japanese workers, he adds, are fond of staying at the workplace having conversations with their peers after working hours because they have limited communication with their spouses. The possible reason for this lack of domestic communication is that the workers have less exciting news to share at the end of a typical day due to a less mobile occupation and seniority based promotion (Kim and Takeda, 1996).

Deeply rooted Japanese traditions and culture appear to contribute to some major differences in management style. These include company employees, bottom-up decision making, and continuous and mandatory training for employees (Cooper, 1984). In Japan, an employee 'enters a company,' hence, security and productivity are emphasised. The management style is participative from the lowest level to the top and all decisions are made by consensus. Hence, training is mandated and continuous. In the West, on the contrary, the workers 'take a job,' and the management style is an instruction from the top down to the bottom. Consequently, training is not mandatory and discontinuous.

An interesting empirical study investigating whether JIT is truly based on Japanese culture and tradition and whether there is any statistical relationship between competitiveness and the degree of JIT implementation has been recently carried out by Kim and Takeda (1996). Company unions can be regarded as a unique traditional attribute of Japanese industrial relations.
Of 68 unionised firms cited, 41 are JIT and 27 are non-JIT firms. Contrary to a common held belief that the presence of unions is an obstacle for successful JIT implementation, Japanese firms have successfully implemented JIT despite the presence of unions. Different characteristics between unions in Japan and in America might be the answer to this finding. The unions in Japan are “in-house” unions which do not have as much negotiating power as general Western “trade” unions. While Western employers are free to fire employees and employees are free to seek better position elsewhere, Japanese workers who belong to the “in-house” unions approach their firm on a personal basis and consider it as their own firm (Cooper, 1984).

Kim and Takeda (1996) provide more explanation about the paternalistic management approach originating from Japanese tradition and culture. Joint responsibility between management and workers is commonly called a “rentai” relationship. For the compensation of workers’ obedience ‘to follow orders without mistake, cooperate with co-workers, generate ideas and creativity to improve the competitiveness of the organisation, and respect upper levels of management as the leaders of the organisation,’ the management should ‘treat all workers (kobun) equally, allocate daily job responsibilities, evaluate their performance, and provide potential lifetime employment with the best personal care.’ The rentai relationship is usually extended to the suppliers in the form of “keiretsu,” where manufacturers guarantee a long term contract and mutual cooperation with suppliers and, in return, the suppliers guarantee the quality of products and deliveries.

Another Japanese culture which permeates most of the Japanese firms is “wa” culture. Under this culture, ‘everyone in an organisation tries to maintain the best possible human relationship.’ The combination of “rentai” relationship
and "wa" culture plays an important but invisible role in an organisation and is mutually beneficial to the employee and the employer.

Examining ten critical elements of JIT, the study of Kim and Takeda (1996) reveals significant differences in performance in seven elements, but no significant differences in the other three elements, between JIT and non-JIT firms. These findings partly support the observations of numerous authors who believe in the effectiveness of JIT manufacturing techniques in improving quality and productivity. However, as this research proves, the effectiveness of JIT techniques will only be fully realised when it is blended with the rentai culture. The application of only JIT techniques or rentai culture will not guarantee success. Lastly, an implementation of several JIT techniques alone, without the rentai culture, will create "islands of JIT," and will impede the total implementation (Kim and Takeda, 1996).

4.7.1.3. Management Control System for JIT

There has been much criticism of the unsuitability of Western accounting practices to meet the needs of modern-innovative manufacturing (Lubben, 1988; Drucker, 1990; and O'Guin, 1991). In contrast, Japanese management control systems have been modified to accommodate its innovative manufacturing strategies such as the JIT production system (Hiromoto, 1988). Therefore, this section will address an empirical study of management control systems for JIT between Japan and the United States as conducted by Daniel and Reitsperger (1991). According to the authors, this comparison has made an enormous contribution to the understanding and successful implementation of Japanese manufacturing strategies by the West.

The inventory reduction requires adequate information to facilitate coordination between various functions. The large-scale study by Daniel and
Reitsperger (1991) claims convincing evidence supporting the hypothesis that inventory and flexibility feedback information will be more widely disseminated in Japan than in the U.S. This finding is in accordance with Daley, et al. (1985), who maintain more favourable attitudes among Japanese than U.S. managers in regard to expressing budgets in monetary rather than in unit terms. This study also indicates that inventory and flexibility feedback is provided more frequently to Japanese than to U.S. managers. This action is extremely important in the JIT plant to avoid production interruptions in the absence of safety inventories.

In the JIT system, goal setting with the aim of decreasing slack resources and enhancing flexibility should be given, along with sufficient information to reinforce a focus on inventory reduction. The finding of this study also supports the hypothesis that a larger proportion of Japanese than U.S. managers receive specific performance goals related to inventory reductions and flexibility. Lastly, this study has also proved the existence of a stronger correlation between the provision of JIT-related performance goals and feedback in Japan than in the U.S., reflecting the dynamics of working for perfection in production. Therefore, it can be concluded that Japanese manufacturers have designed management accounting and control systems that reflect the requirements of JIT.

4.7.2. Initial Thoughts on The Applicability of JIT Implementation in Developing Countries

One objective of this study is to develop some suggestions in implementing the JIT production system in DCs. Therefore, this section highlights some initial issues. Detailed explanation about implementing JIT in DCs will be provided in the next chapter.

The first paper deliberating on the possibility of implementing JIT in DCs was written by Ebrahimpour and Schonberger (1984). This speculation was
based on the belief of the important role of technology in the process of development. The transfer of technology from industrialised countries to DCs, therefore, can be considered as important as the transfer of capital.

Also, these authors cited others’ arguments explaining how the Japanese were coping with imitating Western’s production technologies through adaptation and making them function in the Japanese environment. In this case, the Japanese government had a great influence in encouraging the flow of technology and borrowing and adapting it to Japan’s needs (Poates, 1972). Finally, the transferability of technology coupled with Schonberger’s belief that culture is not an obstacle have emphasised that DCs should learn JIT and TQC in order to close the productivity gap with industrialised countries.

A further question regarding this issue is how should JIT/TQC be implemented in DCs considering some typical problems faced by these nations?. Utilising studies by Lopez (1981) and Skinner (1968), several common problems of manufacturing firms in DCs can be identified. Furthermore, Ebrahimpour and Schonberger (1984) propose some actions that might be performed by JIT and TQC in diminishing all these problems as in Table 12.

Table 12 is self explanatory. This table suggests that the JIT system can be successfully implemented in DCs with some appropriate guidelines. The major challenge faced by manufacturing firms in DCs in pursuing the JIT philosophy is the requirement for multi-skilling employees rather than a single, narrow expertise as demanded by the old system. As explained previously, the role of training in JIT is not only for developing skills but also for building awareness and commitment to continuous improvement of quality through a waste reduction. Finally, when training commences, the JIT fundamental principles of simplicity, frugality, and worker-centred responsibility can be applied to develop a vigorous foundation for future productivity, quality, and growth.
<table>
<thead>
<tr>
<th>Industrial problems in developing countries</th>
<th>Improvements by JIT</th>
<th>Improvements by TQC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Underutilisation of both workers and equipment</td>
<td>Multifunction workers run several machines and go where the work is. Self developed equipment can be tailored to the production plan so that utilisation is high</td>
<td>Workers have quality responsibilities and projects to keep them busy when production quotas are met</td>
</tr>
<tr>
<td>2. Inferior quality</td>
<td>With low inventories parts are used soon; defects are thus revealed and corrected early</td>
<td>All aspects of TQC serve to improve quality</td>
</tr>
<tr>
<td>3. Unreliable and long lead time</td>
<td>Multifunction workers, GT, and quick setups cut lead time and improve productivity</td>
<td>Less frequency of stoppages from bad quality improve lead time and reliability</td>
</tr>
<tr>
<td>4. High rate of scrap</td>
<td>Small lots prevent occurrence of long runs high in defectives (potential scraps)</td>
<td>All aspects of TQC serve to reduce scrap</td>
</tr>
<tr>
<td>5. Poor &amp; inadequate maintenance</td>
<td>Multifunction workers keep workplaces clean and also do some repairs and preventive maintenance</td>
<td>Less-than-full-capacity scheduling permits stops for preventive maintenance</td>
</tr>
<tr>
<td>6. Shortage of raw material</td>
<td>Scrap avoidance helps conserve materials</td>
<td>Scrap avoidance helps conserve materials</td>
</tr>
<tr>
<td>7. Shortage of skilled workers</td>
<td>Simple machines decrease need for skilled workers; worker involvement in multiple functions improves receptivity to training; simpler production systems cuts needs for production &amp; inventory control staff</td>
<td>Less need for quality control staff since workers have quality responsibility</td>
</tr>
<tr>
<td>8. Lack of appropriate supervision</td>
<td>With little inventory to hide problems, workers become on-the-spot trouble shooters, thus assuming some of the supervisory role</td>
<td>Workers check their own quality thus avoiding some problems calling for supervision</td>
</tr>
<tr>
<td>9. Informal and casual quality control</td>
<td>Buffer stocks are cut to deliberately expose causes of poor quality – Which increases awareness of need for QC</td>
<td>All personnel are trained in QC and involved in QC improvement projects</td>
</tr>
<tr>
<td>10. Low productivity</td>
<td>Less material, labour, space, and indirect inputs with higher output equals greater productivity</td>
<td>Less quality control staff, scrap, rework, and customer returns cuts costs of inputs, which raises productivity</td>
</tr>
</tbody>
</table>

Table 12: Improvements by JIT and TQC to Manufacturing Problems in Developing Countries

Source: Ebrahimpour and Schonberger (1984)
4.8. Conclusion

The JIT manufacturing has continuously experienced modifications and refinement to accommodate the needs of the implementing companies. Because of its global recognition, more and more authors are attempting to interpret it in different ways and propose their own strategies for implementation. As a result, several labels have been coined to provide an appropriate name to such an excellent system.

The historical review on the development of the JIT system reveals that Japanese firms are one step ahead of companies outside Japan. Hence, the question of whether the JIT system is a collection of techniques or a philosophy, or whether the JIT system is better than or compatible with other systems is not relevant at this time. More crucial than this debate is to develop guidelines for its successful implementation in other industries and other environments. Fortunately, empirical studies on JIT implementation in Japan and the West provide some lessons for implementing the JIT system in DCs. In accordance with one of the objectives of this research, the following chapter will present some suggestions for the implementation of the JIT production system in manufacturing firms in developing countries.
5.1. Introduction

This chapter discusses the author's suggestions for implementing the JIT system in the environments of DCs. As explained in the previous chapter, the basic simplicity, low requirements for staff expertise and capital investment are JIT features that would appeal to DCs (Ebrahimpour and Schonberger, 1984). However, most JIT tools and techniques demand high commitment and coordination among employees within a company and mutual understanding between manufacturers and their suppliers. It is in these capacities that Japanese firms surpass their competitors from any other country. Manufacturing firms in DCs wishing to implement the JIT system, therefore, should learn from the Japanese experiences.

The suggestions are divided into four aspects: productivity improvement, management of quality, management of production and inventory, and building supplier relationships. These have general application across all economic activities, to specific application related to the JIT system. The author chooses these aspects to be included in the models, because the success of JIT implementation is mostly determined by the success of the four aspects as a whole. Others might add other aspects to be incorporated in the models. Furthermore, the overlapping between aspects cannot be completely avoided because some techniques can be applied in two or more aspects. For example, the training of employees are required in all the four aspects.
5.2. Productivity Improvement

Productivity improvement is included as one aspect in implementing the JIT system, because this concept can be applied in all economic activities. In fact, it has a significant contribution for the achievement of the JIT system. Productivity is a general term which economists define as the ratio of output to input (Conti, R. in IEBM, 1996: 4144). Maximising the ratio, and hence, productivity, can be achieved in various ways. Early methods for productivity improvement stressed the automation of machines and equipment. These, however, demand a large amount of capital, which not every country can afford. The Japanese productivity movement, after the second world war, demonstrated that the key points for improving productivity are related with how companies manage their human resources. Takeuchi (1981) summarised them into five idiosyncrasies of the Japanese productivity system: product quality control, grassroots involvement, quality control circles, non-financial rewards, and maternalistic management.

Firms in DCs wishing to lessen their productivity gap with industrialised countries should pay attention to the Japanese ways of managing productivity improvement. Similarities in culture and tradition, especially for those DCs located in Asia, will make it easier for them to imitate Japanese rather than Western ways. The following paragraphs will explain the five unique features of the Japanese system.

- Product Quality Control

The concept of Japanese Total Quality Control (TQC) is similar to TQM in the West in that it pervades all aspects of business and puts the emphasis on total people involvement in achieving quality awareness. This idea is accepted without question by the Japanese. In fact, TQC is not only
perceived as desirable, rather it is considered as essential for continued survival. A large number of Japanese companies have persistently implemented TQC principles and are totally committed to sustaining a process of continuous improvement (Dale, 1994).

Dale (1994) also mentions several things that can be learnt from Japanese companies in utilising TQC in every aspect of their business. Firms in the West as well as in DCs can reap the benefits from the Japanese experience through adopting the following approaches:

1. TQC must be consistently applied throughout the entire organisation in a systematic way by involving all employees to take personal responsibility in quality assurance activities within his/her area of control, and by integrating every process and every function in the organisation to assure product quality.

2. There is no quick success in TQC implementation. Quality improvement is a slow and incremental process. Companies should not expect rapid and major benefits from the application of any single method, system, procedure, and/or tool and technique. The seven original tools of TQC must be used together in order to reap the full advantage.

3. Management has to perform a permanent process to examine products, processes and procedures on a continuous basis. Self-assessment against criteria of a Quality Award is an invaluable effort for assessing an organisation's progress in satisfying customers.

4. There must be a fanatical obsession to pursuing perfection, challenging targets and seeking what went wrong and putting into place corrective actions

5. The concept of TQM is simple, a common sense approach. Putting TQM into practice, however, require total commitment from all employees.
• Grassroots Involvement

The major driving force behind Japan's productivity miracle in the last three decades has actually come from millions of rank-and-file dedicated workers who have taken initiatives and used creativity to suggest changes to their superiors. In addition to its effect towards quality and productivity improvement, the suggestion system results in a heavy promotional effort being directed at new employees to the company. Slogans such as "Make Every Worker a Manager" or "Make Every Worker an Engineer," can be used to encourage initiatives from even the lowest ranked workers.

Firms in DCs may learnt from this experience and develop programs for involving shopfloor employees in productivity and quality improvement. The programs have to be suitable to local tradition and culture. Any discussion about the programs is excluded from this work.

• Quality Control Circles

QC circles have been discussed several times in this thesis. This section will not address any further development of QCC in Japan and their diffusion to Western companies. Again, firms in DCs should install QCC suitable to local tradition and culture, but this is not part of this thesis.

• Non-financial Rewards

Rewards are meant to reflect someone's contribution and provide that person with something that will reinforce this contribution in the future. Most Japanese companies prefer non-financial to financial rewards. Non-financial rewards can take many forms. At a Honda Motor Company plant,
for example, small rectangular cards are hung from the ceiling directly above some of its workers. To encourage workers to provide suggestions for improvement, firms in DCs can imitate this system with some adjustment suited to local cultures.

- **Maternalistic Management**

Japanese companies play an important role and are closely involved with productivity and workers' well being. Maternalistic management or rentai relationship is characterised by the close caring and nurturing type of relationship that companies develop in an attempt to motivate, guide, and develop their workers' capabilities.

In relation to productivity improvement, maternalistic management is reflected in the following practices:

1. Top managers are always present at those events where their attendance means conveying something that they care about, such as QCC meetings.
2. Middle managers (immediate supervisors) provide guidance and support in QC circles.
3. The company assigns one or more full-time administrative staff to serve as facilitators between the company and QC circles members.
4. The company provides support to QCC in the form of supplying materials and equipment necessary for their activities.

The bottom-up nature of the Japanese productivity system does not come automatically as result of positive thinking of the workers. Companies have to spend a considerable effort to realise this condition. In fact, attempts to motivate and nurture the workers have started as soon as workers join the company. Also, the seeds for an active suggestion program have already
been planted during the first few days of training in the form of workers' encouragement to extend their creative thinking (Takeuchi, 1984).

Another excellent feature of Japanese management is putting together pieces of work into a meaningful outcome. In planning and organising programs of productivity improvement, Japanese companies rely on almost a fanatic dedication to details. Also, they are excellent in mobilising managers from different levels and staff members from different departments in achieving an integrated effort. These conditions are created as a result of maternalistic management, and can be deemed as the Japanese secret of multiplying productivity improvement in the rate faster than any other countries in the world (Takeuchi, 1984).

Many lessons can be learnt by firms in DCs from the way Japanese companies pursuing productivity improvement. Some originate from Japanese tradition and culture, and these are difficult to imitate. But there are also some other lessons to be learnt from the way they manage better than other countries. Finally, while this section deals with the general efforts of improving productivity and quality, the following section will concentrate on managing for quality.

5.3. Management of Quality

The relationship between TQM and JIT has been discussed in Chapter 2. There can be no JIT production without total quality (TQ) management, since TQ is the second basic element of JIT philosophy. Here, the importance of TQ in the JIT system is to involve everyone and every process in the provision of quality goods and services for meeting customer requirements. The realisation of quality products is mandatory for JIT plants, since the reduction of a WIP inventory requires that every part conforms to the specification in order to maintain the flow of production. Firms in DCs should learn about managing for quality from the experience of Japanese and Western companies.
The author’s suggestions for this are to follow the ideas in the *Universal Approach to Managing for Quality* developed by Juran and Blackiston (1995), and to learn from the reasons of failure in implementing TQM. The following sections will outline these matters.

### 5.3.1. Universal Approach to Managing for Quality

There are no simple guidelines to managing for quality. Every company follows a different path. In coping with this problem, Juran and Blackiston (1995) propose a new and universal training course to managing for quality. Underlying this training course is the quality trilogy: quality planning, quality control, and quality improvement. The new course encompasses the following principles:

- **Training**
  
  Training for quality should not be limited only to managers and engineers in the quality department, but must be extended to all functions. The model of universal training course is presented in Table 13.

- **Strategic Quality Planning**
  
  In order for reducing the risk of internal resistances by workers, it is necessary that the quality trilogy be grafted onto the existing business planning structure. A quality planning council is instituted to formulate and coordinate the quality activity company wide.

- **Setting Goals**
  
  Goals for the parameters affecting external customers must be based on meeting competition in the market place instead of satisfying past performance. Goals for parameters affecting internal customers, however, must be based on getting rid of traditional waste. This waste appears when wasteful process are not challenged due to management’s complacency with satisfactory performance.
### The Quality Trilogy

<table>
<thead>
<tr>
<th><strong>Training Issues</strong></th>
<th><strong>Training Issues</strong></th>
</tr>
</thead>
</table>
| **Quality Planning** | • Identify customers, both internal and external  
• Determine customer needs  
• Develop product features that respond to customer needs  
• Set goals that meet needs of customers and suppliers  
• Develop process to produce the product features  
• Prove process quality goals during operation |
| **Quality Control** | • Choose what to control  
• Choose units of measurement  
• Establish measurement  
• Establish standards of performance  
• Measure actual performance  
• Interpret the difference  
Take action on the difference |
| **Quality Improvement** | • Prove the need for improvement  
• Identify specific projects for improvement  
• Organise to guide the projects  
• Diagnose to find the causes  
• Provide remedies  
• Prove remedies are effective under operating conditions  
• Provide for control to hold the gain |

**Table 13: A Universal Training Course**

Source: Juran and Blackiston (1995)

- **Infrastructure**

  In accommodating the shift of quality responsibility from the quality department to all functional divisions, the quality infrastructure must have been in place to accommodate the new structure. In this case, every department requires a corporate review of divisional quality goals, plans, and performance reports.

- **Resources**

  Resources are required in several areas to carry out plans and satisfy goals, such as: undertaking training programs; measuring the competitive position of the markets; and diagnosing the cause of the problem and to provide the remedy.
With a limitation of skilled employees and capital, firms in DCs will face enormous obstacles in closing the quality gap with their Japanese and Western counterparts. The universal approach for managing for quality can be utilised as the starting point in pursuing for quality improvement. To initiate the programs for quality improvement, firms in DCs have to spend large amounts of resources on training their employees, in development of quality infrastructure, and in measurement of quality.

5.3.2. Reasons for TQM's Failure

Another point to be considered in the application of TQM in DCs is to investigate the reasons for past failures. By knowing beforehand the causes of the failure, preparation for their solutions can be anticipated. Based on previous studies on the implementation of TQM in a Western environment, Tatikonda and Tatikonda (1996) summarises the failure of TQM's efforts leading to improvement into ten major reasons:

1. Lack of Vision;
2. Lack of Customer Focus;
3. Lack of Management Commitment;
4. Training with No Purpose;
5. Lack of Cost and Benefit Analysis;
6. Organisational Structure;
7. TQM Creating its Own Bureaucracy;
8. Lack of Measurement or Erroneous Measurement
9. Rewards and Recognition;
10. Accounting System.
Companies implementing TQM require a clear vision to provide the organisations’ direction to progress. Lack of vision will lead to failure to make quality a part of their strategic plan. Accordingly, organisations’ goals and priorities are not clear and the role of quality in the organisation is often misunderstood. Also, the companies should understand precisely what customers want in order to be able to design the appropriate goods and services demanded. In realising quality improvement, however, the biggest single obstacle is the lack of commitment from top management. Again, the universal training course for managing quality developed by Juran can be applied by firms in DCs to enhance the commitment of their top managers.

Companies moving into JIT should also pay attention to the provision of training to their employees. Irrelevant training will only spend money without results. Hence, the universal approach for managing for quality can provide guidance to make use of training for enhancing capability in quality planning, quality control, and quality improvement. Measuring costs and potential benefits of quality improvement programs is another crucial action to be performed by companies commencing JIT. This activity is important to know whether companies can obtain the advantages from performing such programs. Moreover, one of the significant changes brought about by the TQM movement is radical transformation in organisational structure. TQM structure achieves the total picture through cross-disciplinary and cross-departmental efforts, flat organisational structure, and empowerment of people who are involved in value creation.

Another problem that has to be cautioned against when implementing TQM is the creation of a 'quality empire.’ In this structure, quality administration becomes a parallel process, creating layers of new bureaucracy with its own rules, standards, and reporting staff. As the empire grows
unnecessarily larger, irrelevant quality reports soon become the norm, the new layers become diffused and enormously complex with huge costs but no measurable results. Companies wishing to implement TQM should also consider the three basics that support quality improvements: strategic goals, performance measurements, and rewards and recognition. Changing the mind-set towards TQM requires significant alteration in behaviour which, in turn, is greatly influenced by rewards and recognition systems. Lastly, as explained earlier, traditional accounting systems have contributed to the failure of TQM.

DCs differ from Japan and the West mainly in that they are in the early stages of commencing the transformation into industrialised nations. Consequently, firms in DCs wishing to implement JIT will not only face the ten problems as described by Ebrahimpour and Schonberger (1984) in the previous chapter, but also problems dealing with lack of industrial infrastructure, lack of capital, lack of educational and research and development facilities, as well as attitudes and behaviour of their people that are disadvantageous to those demanded by the industrial environment. By paying attention to the ten reasons for failure in TQM implementation, firms in DCs can maximise their efforts in managing for quality.

5.4. Management of Production and Inventory

The discussion about the development of guidelines for managing production and inventory, in the framework of implementing JIT by firms in DCs, is divided into three parts. The first is to analyse the drive behind the development of JIT by Toyota Motor Company in order to understand what should be done by firms in DCs in initiating the JIT system. This is followed by addressing the implications of the JIT system to manufacturing activities. Finally, the importance of training in applying JIT production techniques is explained.
5.4.1. Lessons for Developing Countries in the Development of the JIT System

The first article about JIT manufacturing appeared in 1977 by Sugimori et al. (1977). In that paper, the authors explained the starting point of the concept of the Toyota Production System. According to Sugimori et al. (1977), TPS or JIT was created in recognition of two Japanese distinguishing features. The first was concerned with this country's lack of natural resources. Almost all raw materials were imported, and so the cost of production was certainly higher compared to Western manufacturers. For this reason, it was essential for them to strive to produce quality goods with lower production cost, as well as with lower raw material input, than those of other countries.

The second unique Japanese feature is their attitudes towards work, that is, group consciousness, a sense of equality, desire to improve, and diligence born from a long history of a homogenous culture; a high degree of ability resulting from higher education brought about by their desire to improve; centering their daily living around work. As described in the previous chapter, these Japanese traits are those required for full implementation of JIT, and are reflected in both JIT and non-JIT firms (Kim and Takeda, 1996).

Thus, the JIT system is based upon recognition of the two seemingly contradictory but complementary forces. First, the production system has to accommodate the need for low cost production, otherwise Japanese industries can not compete with overseas industries, and hence, their survival is in danger. Second, the production system has to provide chances for workers to contribute their full capabilities for the realisation of low cost production by treating the workers as human beings and with consideration (Sugimori et al., 1977).
The creation of JIT originated as an effort to materialise an efficient production system in the automotive industry or "the industry of industries," a phrase attributed to Womack, et al. (1990). So many processes are involved that a problem in any one of the processes can have a large overall effect. In order to satisfy customers, the automotive manufacturers have to be able to produce many different models with numerous variations, and sometimes with large fluctuation in demand for each variation. The manufacturer should also develop a new model every few years for each vehicle type launched into the market.

In coping with fluctuating markets, the traditional methods fulfil demands by holding a high WIP inventory over all the processes as a means of absorbing problems in the processes and changes in demand. This is certainly not the answer by the Japanese manufacturers. Alternatively, the Japanese have an obsession to invent a production system that can solve their problems and at the same time challenges their workers to realise it.

Firms in DCs need to take the notice from the above phenomenon. Firstly, this can be achieved by creating a condition that forces industries to implement the most efficient production system, for example, by banning monopoly, free trade, incentives for companies performing employee training as well as research and development, or by establishing a National Quality Award as an effort to encourage manufacturers to improve quality and productivity continuously. Secondly, the industries themselves have to realise that the only way to compete successfully is to implement a production system utilising the minimum amount of equipment, materials, parts, and workers which are absolutely essential to production. This is essential to maintain reasonable prices and, hence, to be able to compete in the world market. Thirdly, the production system has to provide opportunities for workers to contribute their full capabilities by respecting them as human beings.
5.4.2. The Implications of the JIT System on Manufacturing Activities

As stated in Chapter 2, JIT manufacturing is the most promising production system for firms in DCs and fulfils the three requirements mentioned above, namely to be efficient, to struggle for eliminating waste all the times, and to provide opportunities for workers to contribute their full capabilities. In realising JIT production, firms in DCs have to implement the JIT system as a whole as illustrated in Figure 2. This approach not only embodies a series of techniques, but also encompass two sets of beliefs, and the three basic elements of JIT.

There are four major JIT techniques concerned with the management of production and inventory which are significantly different from the traditional system: pull system, one piece production, levelling of production, and waste elimination. These techniques have already been detailed in Chapter 2. However, this section will discuss the implications of these techniques to manufacturing activities in DCs.

There is no great hindrance for manufacturing firms in DCs to implement the four techniques. The concept of ‘withdrawal by subsequent processes’ is not hard to imitate, except that it requires a close coordination among the involved work stations and production operators. While Toyota, the originator of JIT, performs the pull system by utilising Kanban, other companies, Nissan, for example, have incorporated it with a computerised MRP II system for planning its production for many years (Maskell, 1989: 19). The author suggests manufacturing firms in DCs adopt the Kanban system, because this system demands less capital and requires less skills than the MRP system.

One-piece-production requires factory reorganisation and multi-process operations. In turn, this requires re-engineering the process into U-shape layout and to train employees to be capable of doing multiple processes. Potential
employee resistance might happen when a worker is asking to perform several processes in a cell by him or herself. The worker feels hesitant to perform several processes alone because he/she does not now have sufficient time, or workers in surplus-labour developing countries feel pressured into doing several jobs at once while letting others remain unemployed. Therefore, it is important to remember that the role of training in JIT manufacturing is not only for supplying employees with new skills, but also for informing and preparing them against some changes in the production system.

The concepts of production levelling and waste elimination have already been explained in Chapter 2. The implications of the application of these techniques to manufacturing firms in DCs is similar with other JIT techniques, that is, it demands more training and employee participation.

5.4.3. The Importance of Employee Participation and Training in the JIT System

In order for the JIT system to be effective, employee participation in problem solving, decision making, and continuous improvement is compulsory (Schonberger, 1982). Involving employees in the Kanban system and one-piece-production, for example, requires them to possess many more skills than would be necessary in a non-JIT environment. In this case, Ahmed, Tunc, and Montagno (1991) discovered that manufacturing firms in the United States using JIT demand significantly a higher requirement of skills for their jobs than firms not using JIT. Consequently, firms in DCs wishing to implement JIT will encounter problems because of the low entry-level skills of blue-collar workers, as experienced by Mexico (Lawrence and Lewis, 1993). Hence, the desired level of employee participation for JIT implementing companies in DCs will not be as high as in industrialised countries. Managers and policy makers in DCs should consider this experience a challenge that has to be solved in the future.
Culture may also provide a problem in achieving employee participation in firms in DCs. Relationships between employer and employees, between management and workers, and among social classes are usually very hierarchical. The colonial impact, agricultural environment, and the legacy of mass production have created the condition of hierarchical relationships in DCs. This condition results in employees being hesitant in approaching their superior to propose new ideas for improvement and problem solving. Lawrence and Lewis (1993) have reported that the existence of hierarchical relationship in Mexico has resulted in a lack of effective employee participation in that country. Therefore, many Japanese corporations operating overseas still maintain their egalitarian relationship (the same colour uniform and the same canteen) for management and all their employees.

Furthermore, achieving employee participation requires manufacturing firms in DCs to make a higher commitment to the training of employees. Ebrahimpour and Schonberger (1984) warned that even though JIT and TQC are appropriate tools for manufacturing firms in DCs, the major obstacle for their full implementation is employee training. Imai (1986) also requires mass training for shopfloor workers on Kaizen problem-solving tools for companies commencing JIT production. The importance of training as a prerequisite for successful implementation of quality management has also been asserted by several quality exponents (Ishikawa, 1985; Deming, 1986; Juran, 1989; Peters 1989; Kim, 1990; and Oakland, 1993). Thus, education and training offer promising results to every organisation, whatever they are.

An example of a comprehensive training model in Practical Industrial Quality Systems (PIQS) is available at The University of Wollongong (see Figure 5). The PIQS training model was developed by Arndt (1989a, b, c, and d); and is very helpful in enhancing quality awareness of manufacturing
employees. This requirement is one part of the JIT basic elements, that is, preparing the people. Particular training on JIT production techniques can be designed for a specific industry, but this matter is not pursued in this thesis.

Figure 5: A Training Model in Practical Industrial Quality Systems
Source: Arndt (1990)

While firms in DCs are confronted with a limitation of resources, there is no alternative other than performing more intensive training as a prerequisite of the JIT system if they wish to close the gap with those of the Japanese and the West. To alleviate this problem, their governments should offer some incentives, for example, in the form of tax reduction for the firms carrying out training. Lastly, when training starts, the JIT principles of simplicity, frugality, and worker-centred responsibility can be applied to lay a sound basis for improving productivity and quality in the future (Ebrahimpour and Schonberger, 1984).
5.5. Building Supplier Relationships

5.5.1. Trade off Between Domestic and International Suppliers

Suppliers in a JIT environment are required to deliver frequently and reliably small lots of quality parts in order for the Original Equipment Manufacturers (OEMs) to actualise their just-in-time production. Consequently, reliability, quality and proximity are the main criteria for evaluating suppliers.

In DCs, there are usually very few big OEMs, some of them are Multi-National Companies (MNCs). There are also thousands of small companies which can not perform as suppliers, and a very few middle sized companies which have potential to be suppliers, but do not have the tools and expertises necessary to meet the needs of those big OEMs. Therefore, OEMs in DCs commonly encounter two difficult alternatives of selecting between domestic and international suppliers.

The local suppliers in Mexico, for example, generally do not have the ability to maintain quality and delivery (Lawrence and Lewis, 1993). This condition is very dangerous for companies implementing JIT production, particularly for ‘industry of industries’. A temporary solution is to utilise multiple suppliers in order to prevent interruptions to supply. Again, multiple-sourcing is contrary to JIT philosophy since it tends to exert force towards selecting the lowest bidder. While JIT companies in the US are tending to shift towards single-sourcing (Freeland, 1989), firms in DCs still face difficulties to realise this.

The reliance on international suppliers, on the other hand, may bring many obstacles to JIT implementation in DCs. Apart from the other advantages, some studies have proved that distant suppliers will restrict the full benefits of JIT manufacturing (Vickery, 1989). In this case, the problems of transportation cover not only transportation between ports of entry but also local port entry to
the location of the factory. In addition to distance and transportation problems, reliance on foreign sourcing may lead to problems of communication between OEMs and the suppliers. Consequently, OEMs have difficulties in involving suppliers in quality assurance, product development, material specifications, and manufacturing processes. In addition, it is also very hard for OEMs to provide performance measurement and feedback to suppliers, set delivery schedules together, and maintain close cooperation.

Certainly, at least in the long term, the best solution between the two disadvantageous alternatives of selecting suppliers by JIT firms in DCs is to develop local suppliers. However, the process of developing suppliers to meet the JIT requirement for quality, delivery, and price, is expensive to both OEMs and the suppliers in terms of time and expense. It is this condition that discourages firms in DCs to commence the JIT system. The full-scale implementation of the JIT system in the electronics industry in Hong Kong, for example, encounters some impeding factors such as lack of coordination among electronic manufacturers to develop JIT, and a lack of channels for communication of proven local successful JIT implementation. If Hong Kong, a new industrialised country, experiences problems in shifting to JIT, the other developing countries will encounter even greater difficulties. In this case, Government's assistance is required to foster a cooperative program on exchanges of ideas between OEMs and suppliers, and among suppliers in order to enhance the effectiveness of JIT implementation.

5.5.2. Some Lessons for Developing Countries

In discussing some lessons for developing supplier relationships in DCs, this section emphasises two things: these are requirements necessary to enhance the ability of suppliers; and the results of an illuminating study concerned with
foreign sourcing. Thomas Melohn, in Lubben (1988: 149-54), mentions four requirements that affect the supplier’s ability to perform:

1. **Mutual Trust**

Since businesses are operated by people, and people operate on the level of trust, trust demands personal involvement and commitment. In the JIT system, suppliers basically require the trust of customers (OEMs) to be fair and open in their business relationship, and vice versa. The supplier must be able to trust the customer to provide a degree of stability if the supplier meets their obligations. The customer must also be confident that the supplier will give support to them.

2. **Communications**

Communication between customers and suppliers is critical in the operation of the JIT system, since the customers’ expectation of shorter lead times and quicker response to problems will not be achieved unless communication lines are well established and operate at all times. To develop better understanding between customers and suppliers, there are two kinds of programs commonly performed: supplier contacts and supplier programs.

In supplier contacts, some companies assign a team of buyer quality-engineer to be the primary contacts for the suppliers. A member of this team is required to be present during every conversation held between the supplier and the company. The aim of supplier programs is to keep suppliers informed on the topics of mutual interest and ensure that they have access to information that will have an impact on the supplier’s production. There are usually three supplier programs for developing customer-supplier relations: supplier conferences, supplier symposium, and supplier workshops.
3. **Linearity of Production**

In addition to communications, linear or levelised production for internal schedules contribute greatly to improving manufacturing performance. The supplier is very concerned to keep a close watch on the customer’s needs by attempting to reduce the lead time to a minimum. On the other hand, the customer can utilise purchasing to influence the supplier’s production schedules through the use of long term commitment. Purchasing can also flatten the supplier’s workload by requiring frequent deliveries. Hence, to take full advantage of this, suppliers must produce in smaller lot sizes. This can be achieved if the supplier reduces the internal set-up times.

4. **Time and Visibility to Make Changes**

It is essential that suppliers be given enough time and clear guidance to make the necessary changes in the production schedule. These changes include purchasing materials, adding equipment, establishing work shifts, and hiring and training labour. By requiring the company to supply true information about schedules and production forecast, suppliers will be able to react more quickly and appropriately in the event of a sudden change in production requirement.

In the absence of capable local suppliers and given the urgent need of suppliers, the selection of foreign suppliers is unavoidable. International sourcing, along with its long supply pipelines, seems to be contradictory with the JIT system and its requirements for frequent deliveries of small quantities of items on several issues. Frequent shipments of small quantities is almost in impossible for foreign sourcing due to distance and the economics of transportation. Sole sourcing as advocated by the JIT system is also difficult to realise because it has the increased risk of supply disruption. Again, for similar
reasons, it is almost impossible to develop a close relationship between quality and engineering personnel in supplier and buyer plants as required by JIT.

Vickery (1993) investigates the implications of international sourcing for JIT manufacturing. In this study, he examines three U.S. firms: the first two are JIT facilities engaged in substantial offshore sourcing, and the third has been foreign sourcing for years and has recently implemented selected JIT principles in several of its plants. The results of the Vickery’s study are quite astonishing in the sense that the above contradictories can, in fact, be reconciled.

The Vickery (1993) study concludes that the benefits of foreign sourcing, for example, in terms of superior quality and technology, often outweigh its disadvantages, even in a JIT environment. As illustrated in his article, all the three companies still maintain international sourcing and JIT principles even with some adjustments to accommodate the restriction of distance and transportation economics. In realising frequent shipments of small quantities, for instance, the foreign suppliers approach the request by shipping large quantities of items to be warehoused by the buyer company and subsequently withdrawn from storage on a consignment basis. In terms of quality assurance, foreign sourcing often increases the length of time required for the new supplier to reach the desired level of quality. In general, suppliers in developed countries can get up to speed faster than suppliers in DCs. However, once up to speed, a foreign supplier is as quality effective as a domestic supplier. Finally, sole sourcing is in fact favoured by all the three rather than multiple sourcing. One company believes foreign sourcing encourages sole sourcing due to the volumes required for efficient sea transportation.

Furthermore, the Vickery (1993) study suggests several strategies for facilitating foreign sourcing in a JIT environment, as follows:
- Improved logistical planning and scheduling by the buyer to increase the feasibility of more frequent deliveries from foreign supplier.

- Improved planning and scheduling of production aiming at stable production schedule, since the minimisation of schedule changes precludes the need for costly 'special’ deliveries.

- Improved communications between buyers and suppliers.

- Developing a sole source, partnership relationship with foreign suppliers.

- The use of foreign trade zone to expedite customs clearance, thus reducing transportation lead time and the savings in duties.

Thus, manufacturing firms in DCs wishing to shift to JIT should consider developing domestic suppliers as far as possible. The four suggestions addressed above are worth considering. However, in the absence of local and capable suppliers, international sourcing can, in fact, offer some advantages. This has been experienced by firms in the US, an industrialised country with adequate industrial infrastructure. Finally, before choosing foreign sourcing, firms in DCs should think about the suggested strategies resulting from the above study.

5.6. Conclusion

Firms in DCs wishing to implement JIT can learn much from the experiences of firms in Japan and the West. This careful consideration may accelerate the process of industrialisation of these emerging nations. However, some requirements of JIT need time to be improved, such as the level of education of the work-force, and building sufficient infrastructure. Therefore, while DCs are developing their infrastructure, movement into JIT should be commenced immediately.
In parallel with its evolution and diffusion from the automobile industry to other industries and environments, the JIT system has undergone various interpretations and a transformation of principles, techniques and tools to adjust to the needs of individual industries and environments. A number of accepted JIT definitions, tools and techniques, exist. The definition by Harrison (1992) is applied throughout this thesis. According to him, the JIT system is defined as a combination of two sets of beliefs, supported by three basic elements of JIT/TQ, and furnished with a series of tools and techniques (see Figure 2).

The JIT system has proven to be an excellent method for enhancing quality and productivity. The differences between the JIT and traditional system can be viewed in terms of Kaizen and Innovation (see Table 1); or can be classified into three aspects: people preparation, quality consideration and supplier relationship (see Table 2). Moreover, examination of problems in DCs shows that most can be reduced by the implementation of JIT and TQC (see Table 12). The main obstacle to their rapid adoption is training.

Companies wishing to implement JIT need to pursue the appropriate strategies in order to reap success. The implementing companies have to accommodate their strategies corresponding to each stage of JIT development (see Table 9). Furthermore, JIT implementation can be divided into six steps: planning the projects, preparing the people, production process, procurement and suppliers, quality, and software support. Each step is equipped with strategies for implementation.
There are at least four factors needed to be considered in doing business in DCs: economic, political, cultural, and demographic. These factors are, in turn, influenced by the development level in terms of income per capita (see Table 4).

Since firms in DCs are confronted with different environments, they do not have to follow the same route in implementing JIT as Japanese and Western companies, but there are many lessons that can be learnt from the experiences of industrialised countries in adopting or implementing JIT. These lessons are summarised in Table 14.

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Methods Applied</th>
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<tbody>
<tr>
<td>Productivity Improvement</td>
<td>The Japanese Productivity System</td>
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<tr>
<td></td>
<td>• Product Quality Control</td>
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<td></td>
<td>• Grassroots Involvement</td>
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<td>• Quality Control Circles</td>
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<td></td>
<td>• Non-financial Rewards</td>
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<td></td>
<td>• Maternalistic Management</td>
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<tr>
<td>Management of Quality</td>
<td>1. Universal Approach to Managing for Quality:</td>
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<td></td>
<td>• Training (The Quality Trilogy)</td>
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<td></td>
<td>• Strategic Quality Planning</td>
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<td></td>
<td>• Setting Goals</td>
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<td>• Infrastructure</td>
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<td>• Resources</td>
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<tr>
<td>Management of Production and Inventory</td>
<td>2. Reasons for TQM’s failure</td>
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<tr>
<td>Building Supplier Relationships</td>
<td>1. In the long term, consider to develop local suppliers as far as possible</td>
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<td></td>
<td>2. Develop supplier relationships through mutual trust, communication, levelised</td>
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<tr>
<td></td>
<td>production, and the provision of enough time and visibility to change</td>
</tr>
<tr>
<td></td>
<td>3. If foreign sourcing is applied, develop strategies based on industrialised</td>
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<td></td>
<td>countries’ experiences with some adjustments to local condition.</td>
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Table 14: Guidelines for JIT Implementation in Developing Countries
Sources: Adopted from various sources
The following remarks elaborate some of the key points in the Table 14 of summary lessons learnt for implementing JIT in DCs:

Firms in DCs may copy Japanese experiences in improving productivity by inviting employee participation in control quality through the application of QCC, non financial rewards, and maternalistic management. In this case, although Japanese culture and traditions play dominant roles in actualising JIT production, firms in DCs can benefit through understanding the way the Japanese manipulate their cultural strengths into winning practices. Firms in DCs can also identify their cultural strengths to be converted into winning behaviour.

In managing for quality, firms in DCs can pursue the universal approach as proposed by Juran and Blackiston (1995) and learn from the failure of TQM implementation by Western firms. Also, companies in DCs should learn from the Japanese experience on how to create a suitable production system based on the recognition of their strengths and weaknesses. However, they do not have to develop their production systems from scratch. Instead, they can take lessons from industrialised countries through imitating their successes and avoiding their failures. Finally, the effectiveness of JIT techniques for managing production and inventory requires employee participation and training. In turn, employee participation needs maternalistic management and training. Thus, firms in DCs do not have any other alternative than performing more intensive training as a prerequisite of the JIT system.

In building supplier relationships, firms in DCs are confronted with the difficult choice of selecting between domestic and foreign suppliers. However, there are many lessons that can be learnt from the experiences of industrialised countries in developing supplier relationships. In the long term, firms in DCs have to take into consideration as a priority the building up of local suppliers through developing mutual trust, communication, levelised production, and
providing suppliers with enough time and visibility. If international sourcing is unavoidable, the several strategies mentioned in Chapter 5 can be considered.

There is no reason for companies in DCs wishing to improve productivity and quality not to implement the JIT system. If they do not, they cannot hope to compete in the global market. However, due to the limitation of resources, lack of infrastructure, and the low level of education of their employees, firms in DCs should adopt the following strategies to ensure effective implementation:

1. The JIT system should be manipulated and adjusted to accommodate local strengths while still maintaining JIT principles. For example, the application of JIT techniques should avoid complicated automation, but put more emphasis towards working as a team.

2. Since training in the JIT system is mandatory, the Government should provide incentives for the encouragement of training. Training through ‘cascading’ should also be considered, since this kind of training demands a small budget and will result in increased worker commitment and motivation; and plays crucial roles in communicating organisation's philosophy about JIT and the requirement of employee participation in realising JIT objectives.

3. The cultural issues should be considered wisely to avoid conflicts between the application of the techniques and the local culture as well as making the techniques more applicable and beneficial.

4. A campaign of quality improvement should be a National Movement, not only a company concern. In this case, the Government should consider establishing a National Quality Award to foster society’s awareness of the need for quality.
5. As far as possible, building relationships with local suppliers should be given priority and should be commenced in the early development stage of the projects.

Finally, this thesis is concluded by addressing several recommendations for further study:

1. Studies in a specific industry in several countries, or broad industries in a specific country are required to obtain a better understanding of JIT implementation in the targeted population.

2. Developing a comprehensive mechanism for measuring performance of JIT implementing companies is another important research agenda in the context of general implementation of new manufacturing techniques. Concentration on the environment of DCs would be more appropriate for the continuation of this study.

3. It is necessary to design an appropriate supplier system for a certain industry in a specific country in order to maximise the performance of industrial development in that nation. Developing an efficient supplier chain in a certain country will require not only knowledge of manufacturing management but also broader and interdisciplinary approaches including industrial management, total quality management, the role of government, and international business. Both empirical and mathematical models are required for better understanding of the reality and translating this into a more concise setting.
References


52. International Yearbook of Industrial Statistics (1996), UNIDO.


Appendix:
A Sample Questionnaire for
JIT Implementation in Developing Countries

1. Products and Firm's Characteristics:

♦ Job title (the person who fills this questionnaire):

........................................................................................................
........................................................................................................
........................................................................................................

♦ Major products (please, mention three major products):

a) ............................................................................................... SIC code, 3 digits: ........

b) ............................................................................................... SIC code, 3 digits: ........

c) ............................................................................................... SIC code, 3 digits: ........

SIC - Standard Industry Classification

♦ Type of company:

a) Independent

b) Subsidiary

c) Multi National Company

d) Others (please, mention): .................................................................

♦ Size of firm (number of employees):

a) Small (Between 1 - 99 employees)

b) Medium (Between 100 - 499 employees)

C) Large (Between 500 - 999 employees)

d) Very large (Between 1000 - 1999 employees)

e) Giant (2000 employees or larger)
Type of manufacture:

a) Job shop
b) Batch manufacture
c) Line manufacture (assembly line)
d) Process manufacture
e) Others (please, mention): .................................................................

Mode of production:

a) Make-to-order only
b) Make-to-stock only
c) Both make-to-order and make-to-stock

Customers:

a) Another manufacturers
b) General market
c) Others (please, mention): .................................................................

2. Material, parts, and subassemblies:

Forecasting accuracy (short term – less than 3 months) for:

Product 1: ...... Product 2: ...... Product 3: ......

a) Always inaccurate
b) Mostly inaccurate
c) Sometimes accurate
d) Mostly accurate
e) Always accurate

Percentage of raw materials and purchased parts and sub-assemblies:

a) Percentage of in-plant processed materials in the final product : .......
b) Percentage of purchased individual parts in the final product : .......
c) Percentage of purchased sub-assemblies in the final product : .......

Select one of the ranges below:
(1 = 0 - 20%; 2 = 21 - 40%; 3 = 41 - 60%; 4 = 61 - 80%; 5 = 81 - 100%)
♦ Location of suppliers for:

<table>
<thead>
<tr>
<th></th>
<th>Raw materials</th>
<th>Parts</th>
<th>Sub-assemblies</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Within industrial zone</td>
<td>...... suppliers</td>
<td>...... suppliers</td>
<td>...... suppliers</td>
</tr>
<tr>
<td>b) Within city</td>
<td>...... suppliers</td>
<td>...... suppliers</td>
<td>...... suppliers</td>
</tr>
<tr>
<td>c) Within state/province</td>
<td>...... suppliers</td>
<td>...... suppliers</td>
<td>...... suppliers</td>
</tr>
<tr>
<td>d) International</td>
<td>...... suppliers</td>
<td>...... suppliers</td>
<td>...... suppliers</td>
</tr>
</tbody>
</table>

♦ Average lead time of purchased parts and raw materials:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Raw materials</td>
<td>....... days</td>
</tr>
<tr>
<td>b) Individual parts</td>
<td>....... days</td>
</tr>
<tr>
<td>c) Sub-assemblies</td>
<td>....... days</td>
</tr>
</tbody>
</table>

3. Production management:

♦ Cost relating to significant reduction in set-up time:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Not very costly</td>
<td>d) Very costly</td>
</tr>
<tr>
<td>b) Somewhat costly</td>
<td>e) Cost prohibitive</td>
</tr>
<tr>
<td>c) Costly</td>
<td></td>
</tr>
</tbody>
</table>

♦ Frequency of major machine breakdowns:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Very easy</td>
<td>d) Difficult</td>
</tr>
<tr>
<td>b) Easy</td>
<td>e) Very difficult</td>
</tr>
<tr>
<td>c) Somewhat difficult</td>
<td></td>
</tr>
</tbody>
</table>

♦ Percentage of equipment on which preventive maintenance is done:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 0 - 20%</td>
<td>d) 61 - 80%</td>
</tr>
<tr>
<td>b) 21 - 40%</td>
<td>e) 81 - 100%</td>
</tr>
<tr>
<td>c) 41 - 60%</td>
<td></td>
</tr>
</tbody>
</table>
4. Suppliers

- Number of suppliers:
  - Product 1
  - Product 2
  - Product 3
  a) Within industrial zone: ..... suppliers
  b) Within city: ..... suppliers
  c) Within state/province: ..... suppliers
  d) International: ..... suppliers

- Quality of suppliers in relation to:
  a) Maintaining product quality:
  b) Maintaining delivery schedule:
  c) Flexibility to schedule and production changes:

- Relationship with suppliers:
  a) Extent of ongoing program with suppliers to improve product quality:
  b) Extent of ongoing program with suppliers on product development:
  c) Extent of ongoing program with suppliers on material specifications:
  d) Extent of ongoing program with suppliers to improve manufacturing process:

- Criteria for suppliers’ selection (provide ranking):
  a) Proximity: ........
  b) Quality: ........
  c) Delivery Performance: ........
  d) Flexibility: ........
The application of sole sourcing for purchased materials or components:

e) 0 - 20%
f) 21 - 40%
g) 41 - 60%
h) 61 - 80%
i) 81 - 100%

5. Human resources

Annual employee turnover rate:

a) 0 - 4.9% d) 15.0 - 19.9%
b) 5.0 - 9.9% e) Larger than 20.0%
c) 10.0 - 14.9%

Cost of employee training to be flexible:

a) Very low d) High
b) Low e) Very high
c) Moderate

Benefits from flexible employees:

a) None d) High
b) Little e) Very high
c) Not sure

Union’s attitudes towards employee programs (e.g. flexibility):

a) Negative d) Very cooperative
b) Indifferent e) No union
c) Cooperative

Skill requirements for manufacturing jobs:

a) Very low d) High
b) Low e) Very high
c) Moderate
6. Management commitment

♦ Resource allocation for planning the changes:
  a) Very little
  b) Little
  c) Moderate
  d) Substantial
  e) Very substantial

♦ Resource allocation for implementation of the changes:
  a) Very little
  b) Little
  c) Moderate
  d) Substantial
  e) Very substantial

♦ Resource allocation for follow-up of the changes:
  a) Very little
  b) Little
  c) Moderate
  d) Substantial
  e) Very substantial

7. JIT implementation

♦ Stages of JIT implementation:
  a) JIT not considered
  b) JIT considered but found not feasible
  c) Learning process
  d) Pilot program
  e) Partial implementation
  f) Full implementation

♦ Reasons for implementing JIT production:
  a) Meshed with business strategy
  b) Required by customers
  c) Driven by competition
  d) Endorsed as corporate policy
Major benefits of JIT implementation (provide ranking):

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>e) WIP reduction</td>
<td></td>
</tr>
<tr>
<td>b) Increased flexibility</td>
<td></td>
</tr>
<tr>
<td>c) Raw materials/parts reduction</td>
<td></td>
</tr>
<tr>
<td>d) Increased quality</td>
<td></td>
</tr>
<tr>
<td>e) Increased productivity</td>
<td></td>
</tr>
<tr>
<td>f) Reduced space requirements</td>
<td></td>
</tr>
<tr>
<td>g) Lower overheads</td>
<td></td>
</tr>
<tr>
<td>h) Others (please, mention &amp; rank)</td>
<td></td>
</tr>
</tbody>
</table>

Techniques applied in JIT implementation:

<table>
<thead>
<tr>
<th>Technique</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Lot size reduction</td>
<td></td>
</tr>
<tr>
<td>b) Set-up time reduction</td>
<td></td>
</tr>
<tr>
<td>c) Buffer stock removal</td>
<td></td>
</tr>
<tr>
<td>d) Group technology</td>
<td></td>
</tr>
<tr>
<td>e) Leveling production</td>
<td></td>
</tr>
<tr>
<td>f) Small machines, multiple copies</td>
<td></td>
</tr>
<tr>
<td>g) Flexible work force</td>
<td></td>
</tr>
<tr>
<td>h) Product simplification</td>
<td></td>
</tr>
<tr>
<td>i) Preventive maintenance</td>
<td></td>
</tr>
<tr>
<td>j) Statistical process control</td>
<td></td>
</tr>
<tr>
<td>k) Continuous improvement</td>
<td></td>
</tr>
<tr>
<td>l) JIT purchasing</td>
<td></td>
</tr>
<tr>
<td>m) U-shape lines</td>
<td></td>
</tr>
<tr>
<td>n) Manufacturing cells</td>
<td></td>
</tr>
<tr>
<td>o) JIT team</td>
<td></td>
</tr>
<tr>
<td>p) Standardisation</td>
<td></td>
</tr>
<tr>
<td>q) Poka yoke or fail saving</td>
<td></td>
</tr>
<tr>
<td>r) Kanban</td>
<td></td>
</tr>
<tr>
<td>s) Computer integrated manufacturing</td>
<td></td>
</tr>
<tr>
<td>t) Others (please, mention)</td>
<td></td>
</tr>
</tbody>
</table>

(1 = Well developed; 2 = Just starting; 3 = Learning; 4 = Heard but not learning; 5 = Never heard)
Explanations for the questionnaire:

This questionnaire is a suggested method for assessing the effectiveness of JIT implementation by manufacturing firms in DCs. This should be very helpful for performing further research as recommended in this study. In the absence of adequate information in empirical studies for JIT implementation in developing countries, this questionnaire was the result of collecting empirical researches for JIT implementation in developed countries. Fortunately, several studies by Ahmed et al. (1990), White (1993), Voss and Robinson (1984), Gilbert (1990), and Fawcett and Birou (1993) fulfil the requirements for developing the questionnaire.

The assessment of the effectiveness of JIT implementation in DCs can be accomplished through distributing the questionnaire to those companies which have fully or partially implemented JIT production, or are still testing by using a pilot program, or are undecided about it. The questionnaire attempts to examine whether some untested principles, suggested by the literature, are really executed in the practice of implementing JIT, or whether some of the JIT principles are valid only for a certain stage of implementation, or only after some requirements are fulfilled. Therefore, cross-checking among the critical elements affecting the successful of JIT implementation is embodied in the questionnaire. Finally, the questionnaire is required to be validated and redesigned further before it is actually distributed to the companies. Reviews on recent studies on JIT implementation are also beneficial for gaining some confirmation on some controversial issues. The questionnaire deals with seven broad issues as follows:

*Question 1 (product and firm’s characteristics)* is intended as a control variable to cross-check JIT implementation against types of products, types and sizes of companies, mode of production and targeted customers.
Question 2 (materials, parts, and subassemblies) is intended to examine the behaviour of the product in terms of forecasting accuracy, percentage of raw materials and parts purchased, locations of suppliers, and averages of lead time required.

Question 3 (production management) is intended to evaluate performance in the management of production, in terms of costs expended for set-up time reduction, frequency for machine breakdowns, and percentage of preventive maintenance on the equipment.

Question 4 (suppliers) is intended to examine the specific characteristics of suppliers, such as criteria for choosing and maintaining suppliers, joint activities with suppliers, the application of sole sourcing, etc.

Question 5 (human resources) is intended to examine the characteristics and performance of human resources in the company.

Question 6 (management commitment) is intended to evaluate management commitment towards JIT implementation in terms of resources allocated for planning, implementation and follow-up of changes.

Question 7 (JIT implementation) is intended to evaluate JIT implementation in the company. They include stages, reasons, major benefits, and techniques applied in JIT implementation. In turn, they can also be utilised to cross-check against other characteristics of JIT implementation.