JÖNKÖPING INTERNATIONAL BUSINESS SCHOOL
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# Managing Production Ramp-Up in Manufacturing Networks

Master of Science Thesis

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**Abstract**

Production and manufacturing companies today, in a bid to achieve time to market and time to volume, makes use of production ramp-up. To achieve effective and rapid returns in investing in newly manufactured products it is necessary to maintain appropriate cost and volume as well as considerable manufacturing quality.

This research is aimed at how to achieve cost effectiveness and market potentials, accomplished due to early market domination, by implementing ramp-up production process in manufacturing industries.

Through production performance, speedy time to market and time to volume could be achieved if there is an effective collaboration between production development performance and production ramp-up. This relationship promotes a fast achievement of time-to-volume compared with the silent leading hypothesis of time-to-market.

The study shows that the level of learning is very important as well as the sources of learning like engineering time, experiments as well as normal experience.

Supply chain capabilities are used to promote and encourage meaningful growth and development so as to achieve time to market and time to volume. These supply chain capabilities are integrating customers and manufacturers as well as supply and demand in the market.

**Recognitions**

My sister Yara: You have helped me so much with everything! Proud to be your brother!

My mother Maud: Because you are my source for inspiration and at the same time my best friend! You are an inspiration for life itself since you have leaded me through it!

My wife Claudia: I love you since you have always supported me when my faith was weak!

My children Vale, Livf, Idun, Svea, and Freja: Thanks for existing. You lead me, even that you do not know this! I would not have been here if it was not for you, you are my everything, all of you!

I also want to give great thanks to my tutor Dr. Jensen and my friend Dr.Hilletofth for helping and encouraging me.

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# CHAPTER ONE

# INTRODUCTION

## 1.1 Background

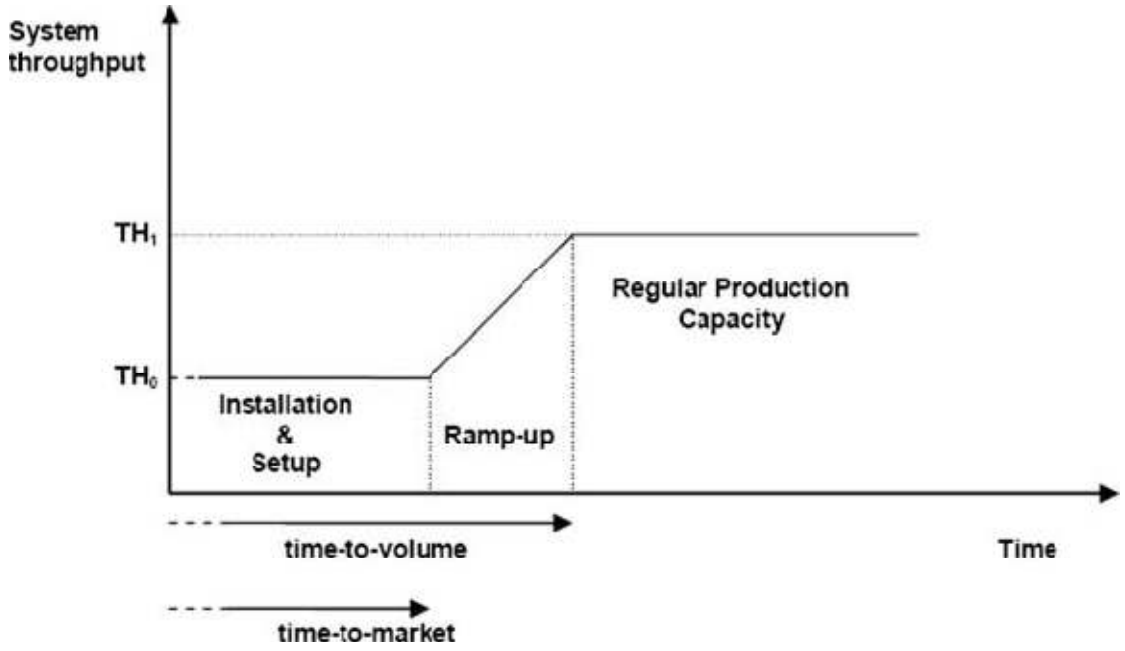
Ramp-up in business and economics is a term that is used in describing the increase in an organisation's production ahead of planned or anticipated increase in the demand of the product. Also, ramp-up describes the time interval between developing or manufacturing a particular product and the complete utility offered by the product, which is characterised by a process and by product improvements and experimentation.

Ramp up process begins when an organisation initiates a deal with a major producer, retailer as well as distributor and significantly increases the demand of a particular product. A ramp-up is normally in the early stage of an organisation or market development. It also involves and deals with venture capital and speedily increases return rates on investment.

For example, the manufacturer Honda has had great success, since they focus on ramp-up, in rapid development of platform projects. With its three to three and a half years development time, it is among the fastest in the automobile industry today. Their focus on fast ramp-up has enabled them to create supply chain as well as completion of factory changeovers in only a single weekend for the production of a new car model (Wheelwright and Clark, 1992).

In organisations today, developing a new product is a very great challenge due to a number of unmanageable forces that have come into play in the early 21st century. According to Barnett and Clark (1996), these have really put companies that manufacture and launch new products in the high-technology area under serious pressure. Some of the most significant forces in the market include shrinking production life cycle, technological changes, and alternative materials as well as increased global competition. Today, competition in the international market has constantly been very severe as new players are constantly coming into the market with various styles.

Fig. 1 Time-to-market, Time-to-volume and the Ramp-up phenomenon




Taken from Matta et al (2007).

For example in the late 20th century, only a few mobile device suppliers existed, but today there are spread all over the globe. The fast diminishing brand preference is rapidly becoming a major difficulty for the world's top ten mobile device producers (Nokia, Samsung, LG, Research in Motion, Sony Eriksson, Motorola, Apple, HTC, ZTE and G´five). The small players are often more automatic to changes in market trends and also very competitive in price.

Divided markets as well as refined customers are the effects of accumulated experience and individualism (Van der Merwe, 2004). This has put customers on the edge and sensitized them to select products for causes that do not in any way have to be related to technical performance but to the accomplishment of their needs. Consequently, organizations and manufacturing companies develop strategies that make available products for various customer segments in different markets.

Technological changes might be the most important driving force for high-technology companies; this could evolve from the possible effect of new technologies on existing business models (Barnett and Clark, 2001). New innovations like short range communication services like the WLAN (Wireless Local Area Network), the VOIP internet services (voice over internet protocol) as well as the GPS (global positioning systems) has greatly affected the value chain of telecommunication companies and the possibility for other players to achieve a pledge in it (Pufall et al, 2007).

Falling product lifecycles are another face up for high-technology industries, due to the fact that product lifecycles and market windows are diminishing in length and on the other hand technology investments are rising. Also, competitor product gaining has broad significance and therefore, companies must reduce their development time. That means reduced time to market and at the same time they have to concentrate on the time it takes to arrive at complete production volume, which is also referred to as time to volume, so as to maintain high productivity and business efficiency (Carillo and Franza, 2004).

Early competitor to the market will take pleasure in higher profit margins as well as longer product life cycles and can as a result set up a leading position in the market place. Christopher (2008) explained that, a product that is on the financial plan, but was introduced late into the market couldcreate great losses of the prospective life cycle turnover. With this backdrop the economic accomplishment of manufacturing industries is greatly dependent on their capacity to discover the requirements of customers and to speedily develop products that will meet these needs and that can be manufactured at low cost.

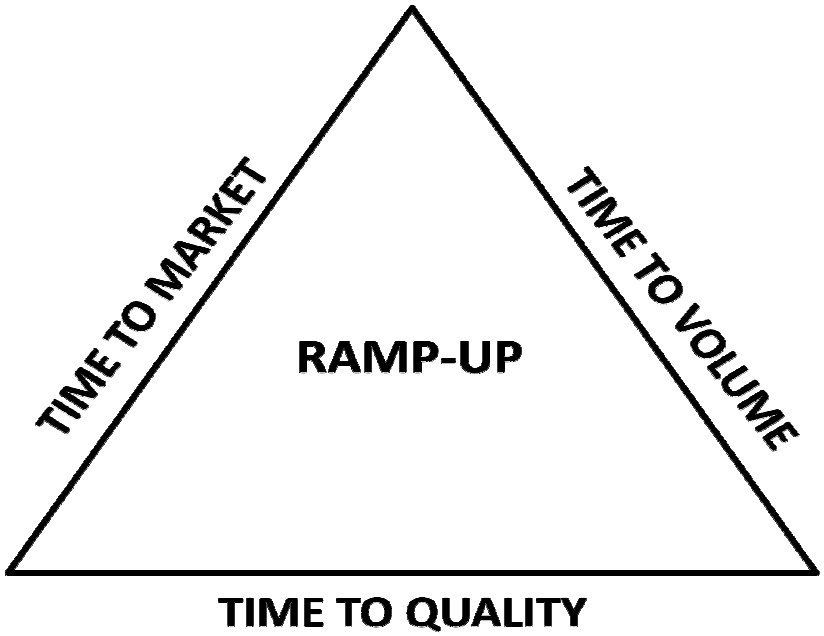
Despite the considerable progress in new product development methods like the synchronized engineering or design for manufacturing, the ramp-up period remains the most important challenge and provides a considerable opportunity for achieving competitive benefits in high-technology organizations.

To elaborate on the role of rapid production ramp-up in manufacturing industries towards achieving time to market, Wheelwright and Clark (1992) developed a practical and more functional definition of the term ramp-up as “a stage where

an organization or an industry begins commercial manufacture or production at a comparatively low level volume". As an organization develops confidence in its manufacture and production process to implement constant production as well as develop its marketing abilities to market the product, the manufacturing volume increases. Therefore, at the end of the ramp-up stage, the manufacture or production system must have achieved its planned or anticipated goals together with the targeted levels of quality, cost as well as volume.

Volume alone has no impact on ramp-up unless it reaches the market (time to market) and has acceptable quality (time to quality). Because of this reaching one of these factors without fulfilling of the others has no impact on the ramp-up effect.

Fig. 2 The triangle of Ramp-up




In the triangle the base is quality, since without quality the volume is only a waste, since end consumers will not accept a product without the essential quality that is demanded by the customer.

## 1.2 Aim of study

The major aim and purpose of this study is to investigate and assess the role and function of rapid production ramp-up of manufacturing industries towards achieving fast fulfilment of customer demand. However, to achieve rapid returns in investment in newly manufactured products, production and manufacturing companies must reduce their time to market and also, the time it takes them to achieve reasonable as well as considerable manufacturing quality, cost and volume, which is also known as ramp-up. As described in the background chapter the traditional research has, for the most part, been focusing on time to market, time to volume or time to quality. Because of this there is a lack in research of how they are combined as well as to why they interact. The few exceptions are the research of Terwiesch and of course Clark and Fujimoto. Nevertheless Ramp-up is still a quite virgin area of study and still holds great potentials for firms in maximizing their efforts in getting payback as well as achieving fast market penetration.

## 1.3 Research Questions

This research paper will answer questions that relate to the effective management of speedy production ramp-up in the manufacturing and production industries. It also try to explain how these manufacturing industries will achieve ramp-up in the production and manufacturing process so as to achieve time to market as well as time to volume. These questions include:

- **What kind of capabilities is necessary for rapid supply chain operations ramp-up?**

- **What kind of aspects influences the performance of rapid supply chain operations ramp-up?**

## 1.4 Significance of the Study

This study will research on how companies can through ramp-up, easily achieve time to market and time to volume of products to meet up competitive challenges in the emerging markets. It will state the differences that exist between time to market and time to volume in the commercial manufacture and production process. It will also demonstrate how ramp-up is very necessary for full-scale production and the assessment of the functions played by ramp-up in manufacturing industries.

## 1.5 Methodology of the study

Since earlier research has mostly been done in the three areas of TTV (time to volume), TTM (time to market) and TTQ (time to quality/total quality management) these where the search criteria in order to find material for the thesis, as well as ramp-up itself (although very limited amount available). The articles and books had to be published as well as recognised in order to be of relevance. Another criterion was that the articles and books had to have a relevant conclusion in the subject at study. Since the three areas (described above) are quite complex the material had to be extensive in order to create valid and reliable conclusions (Easterby-Smith et al, 1991). In comparison to a qualitative method there was no case study or any other gathering of primary information; instead the entire thesis is built on already existing studies, thus secondary information (Bell, 2008). The sources of information had to pass criteria's as if they where relevant for the thesis as well as if they were credible (Ejvegård, 2009).

Since the thesis is a meta-analysis(Cooper and Hedges, 1994) it is based on secondary findings in order to detect the divergent ways of efficient ramp-up. Since the thesis is not aimed at finding ways to optimise the entire product life cycle the research takes the three factors (TTM, TTQ and TTV) into consideration as it analyses the production from the very beginning (design) until it reaches the final customer. Because of this the thesis will not analyse areas such as product afterlife (recycling as an example).The research analyses how the supply of innovative new products to the market increases rapidly with cost-effective prices. It also analyses how manufacturing companies that are not

market leaders create their own supply chain or numerous supply chains, so as to balance the uncertainty in the market to meet customer demands of their products. The research critically analyses the ramp-up time or production time interval between one cycle of producing a particular product and producing another product. This research was performed to compare how ramp-up production time to market and time to volume could be achieved in the production process. The research also greatly elaborated on the role of rapid production ramp-up in manufacturing industries towards achieving time to market. The various capabilities required for supply chain operation ramp-up as well as the various aspects that influence performance of rapid supply chain operations ramp-up were analysed. The research was performed to analyze how ramp-up production process is achieved through a product developmental process that includes design, procurement, pilot production, production as well as distribution with information and management. The whole process of production from design down to distribution with proper and effective management and information was analysed to see how effective and efficient production or manufacture process is undergone in manufacturing companies. All the processes constituting the production process are discretely defined and to show and demonstrate a well and elaborate production process of goods so as to achieve time to market.

To facilitate for the reader several models (Ejvegård, 2009) are also included in the work, some taken from named authors and others made by the writer himself. The references are made according to the Harvard system (Bell, 2008) of referencing with the name of the author and the year of publishing cited in the text.

### 1.6 Content of the chapters

**Chapter one** gives an oversight of the study. It explains why and how the study is done.

**Chapter two** will establish the main purpose of the study. It is dedicated to review the literature and study significant interfaces between new product development as regards time to market as well as time to volume. The chapter will

also compare and contrast different ideas and existing theories on ramp-up management. The fundamental and critical factors that control the product ramp-up will be put forward including the role of product development, capabilities for a rapid ramp-up of the supply chain operations and it will also take culture and partner integration into concern.

**Chapter three** is focused on the proper ways of ramp-up performance measurements as well as indicators that can show whether the performance is increasing or decreasing. It compares different models and shows the difficulties to create a ramp-up performance measurement system that is reliable. The chapter takes up weaknesses and strengths in different systems.

Chapter four is concerning the supply chain ramp-up performance capabilities and how these can be enhanced by using technology as well as by the simple uses of collaboration and profit sharing. It also emphasises on the significance of observing the complete process, from design to distribution, as a part of the ramp-up process.

Chapter five displays empirical findings that supports or interacts with the theories displayed by earlier chapters and tries to give answers to questions asked in Chapter one. It also gives examples of how important ramp-up can be in order for an organisation to survive in today's severe business climate.

In Chapter six, the final chapter, the conclusions are presented, as well as discussion and further research**.**

# CHAPTER TWO

# TEORETICAL FRAMEWORK

## 2.1 Introduction

This section will establish the main purpose of the study and answer research problems relating to the study. Through existing body of knowledge as well as previous research made on the topic, the study will compare and contrast various ideas and existing theories on ramp-up management in the manufacturing environment. The literature will review significant interfaces between new product developments as regards time to market as well as time to volume.

## 2.2 Product Development Analysis

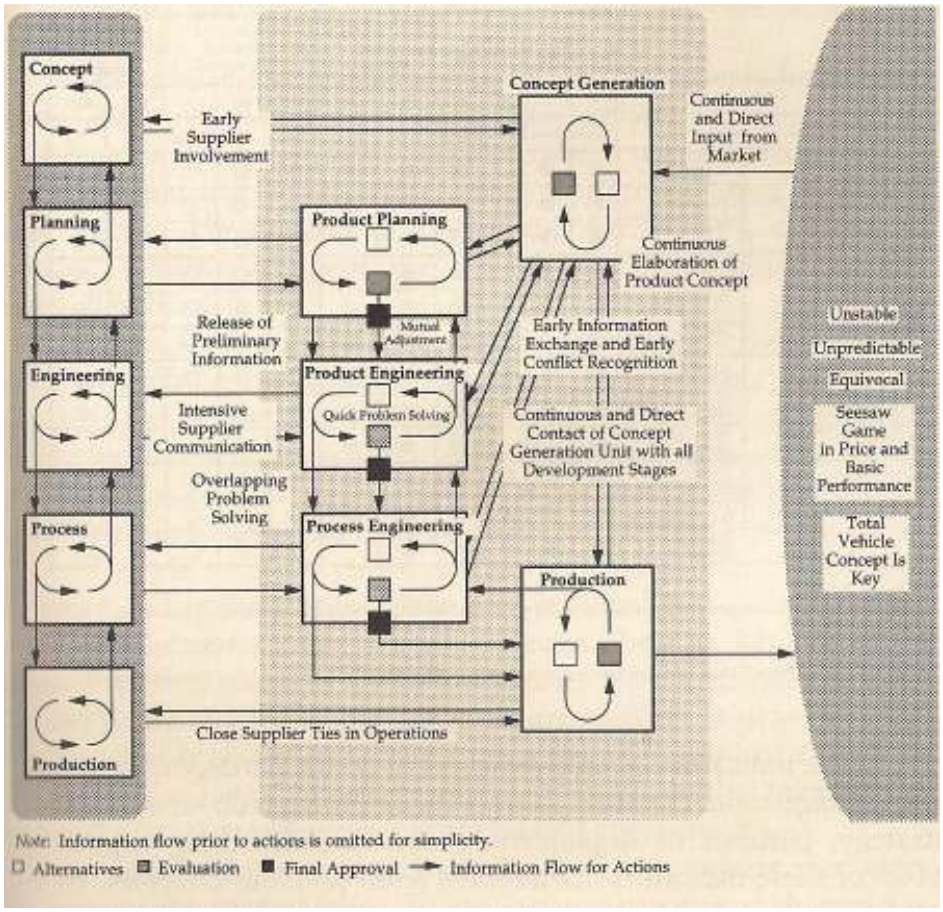
A lot of cost and time to market potentials can be achieved if major factors of successful ramp-up management are employed in production processes in the manufacturing industries. Though, several researches have been done in lots of other industry sectors abound, but the most common research has been performed in industries to investigate the ramp-up of time to market and time to volume in manufacturing industries together with its effective management. Clark and Fujimoto (1991) performed research to analyse and understand how new product development is done in the automobile industry. Their field research combined surveys and case studies of several manufacturing companies. The main focus of the research was impact of effective management, organization and strategy on product development. In their research, they discovered four fundamental and critical factors that control the product ramp-up:

1. Integrated product process linkage: Integrating problem solving cycles in product as well as process engineering enables producers to reduce time without having to reengineer or compromising the quality. The capacity to make production rapid and efficient; a high manufacturing capacity results in rapid model cycles, high-speed tool development times as well as efficient ramp-up volume production.
2. Integrated customer/concept/product linkage: A product management system as well as broad engineering tasks tightens the information link-

age among engineers, concepts, development as well as the crucial link to the customer. Also, Brown et al (1997) explained that if new production techniques are introduced (with the new product) they should be monitored by new performance measurement systems, since suitable performance measures must be designed to measure the impact of the new manufacturing techniques. They also point out that the old measurement techniques must be abandoned in favour of the new ones, because if this is not done, people will tend to use the old ones in favour of the new, since they are more familiar with these.

3. Integrated supplier linkage: Close and early or on-going communications with selected first tier suppliers can reduce late reengineering as well as it can increase the speed of prototype parts procurement and improving component integration. This mostly affects the ramp-up as a result of its impact on general operation time per day, the complexity of products in the line as well as the assembly speed.
4. Flexible, short cycle manufacturing capability: JIT (just in time) as well as TQM (total quality management) emphasises short throughput times, adaptability, fast problem detection and continuous improvement (kaizen) and applies to prototyping, tooling, production start up and engineering changes. Since the short cycle times will create unevenness in the manufacturing environment this will demand for various policies to bring into line the work force and balance it with the production rate. A particular manufacturing industry can either try to maintain a steady work force over a period of time, discharge and recruit during transition or enhance the work force provisionally during the changeover phase. Therefore, the learning and performance rate tends to be elevated if the working circumstances and job assignments are also steady.

Fig. 3 Product Development System of High-Performing Volume Producers




Taken from Clark and Fujimoto (1991)

## 2.3 Product Development Performance

However, product development performance is closely related to successful ramp-up development. Clawson (1985) explained that, product development performance help manufacturing companies achieve timely manufacture and launch of products in order to achieve time to market and time to volume under real time production. However, these findings are based on established concepts in the automobile industry in the late 20$^{th}$ century, therefore cannot be made comprehensive without allowing for the specific characteristics in other manufacturing industries today. Pufall et al (2007) explained that the mobile device industry is an example of an industry that is characterized by very short development times and life cycles, various sales means as well as diverse manufacturing/logistic models that are the product of the volume, time, price as well

as size differences. Also, one major aspect of the ramp-up management research performed by Perks et al (2005) is to achieve a position analysis so as to properly categorise research demands that leads to quantum increase in the aspect of ramp-up management and performance. This study takes more direct steps and addresses the area of ramp-up management and performance compared to the study performed by Clark and Fujimoto (1991) that was mostly focused on product development performance in general. With on-site researches, public discussions and workshops in three business areas like the engineering industry, electronics and automobile industries, Gevers (2004) identified the various factors that influence ramp-up performance and categorized them into six different classes that include:

1. Product development: Which is the level of innovation as compared to already existing products
2. Production processes: This involves the measure of process strength, suppleness and newness
3. Organization and personnel: It is the measure of qualification and responsibility transparency
4. Logistics: Which is considered as the general term for the accessibility and quality of the various parts and subassemblies
5. Networks and cooperation: Is characterized by the information flow and information clearness
6. Methods and tools: Involves project management as well as transformation management practices

Based on these features, five achievement areas for additional research like holistic knowledge management, improved cooperation models, changed management procedures, robust manufacturing systems as well as the development of advanced methods to control ramp-up complexities are to be integrated in the production process. Also, similar research conducted by Ghiani et al (2004) in their standard project in the automobile industry refer to the theory of complexity management and performance as an effect of the dynamics and multitude of mutually dependent objects and their communication with diverse work functions. However, these features are in consonant with the ones recognized by

Gupta et al (2007) when they researched on the work function and classified them based on their logistics and sourcing, production level as well as developmental process. Yet, none of these two researches included a more comprehensive analysis of the difficult relations of the recognized factors in connection to ramp-up development and performance. Rather, their most important goal was to classify additional improvement prospects ignoring the need to appreciate the fundamental occurrences during the changeover from the development phase to volume production for a particular industry. This is quite similar to the works of Clark and Fujimoto (1991) as they developed learning curves that illustrate ramp-up as through the communication between numerous basic processes whose excellence and capability curves are recognized. The existing types of drivers for learning in ramp-up were further grouped based on their sources such as:

- Workers skills: Broad skills created by different task assignments in assembly as well as a diverse product mix are a major factor for ramp-up advantage.
- Rapid organisational learning: Fast learning in ramp-up depends on effective real-time communication, continuity of the production system, exposure of the product during pilot as well as working on the skills at working level of problem solving. It is also essential for the supervisors to circulate around the company while discussing problems and solutions with the workers.
- Continues improvement (kaizen) is, although effective in increasing the output of the production, not enough for the radical increase that a serious ramp-up in production may demand. Here more radical changes are demanded (kaikaku) and as an example in an American company the problem solving of ramp-up was accomplished by a team of engineers consisting of totally 250 employees assigned to the task on a project basis.
- Rapid prototype cycles as well as fast die manufacturing cycles can create great advantages in overall lead-time as well as quality of design.

Also efficient process control creates lower die costs, ability to run mixed model assembly creating conditions for a quick ramp-up.

Most importantly, it is observed that the most widespread type of interruption is the failure of the suppliers to distribute materials of the right position in the right quantity on time. There is an express communication between categories and the various features identified apart from some higher-level models that demonstrate the difference of the ideas among the various studies. Also, Terwiesch and Xu (2003); states that a proper and effective integration of strategies is a way of promoting a developmental process. This theory explained that production systems should always be controlled and managed at full speed so as to improve learning rate as well as providing the right quantity and quality of information necessary for effective disturbance control and management. Furthermore, a soft transition from pilot to volume production progressively contributes to the improvement of performance. Also, clear managerial responsibilities including a high dedication and cross practical interaction promotes a smoother transition. The introduction of product policies allows organisations to influence and control preceding ramp-up understanding for the ramp-up of new products with the same proposal. Haller et al (2003) explained that, some reasonable variables that completely affect the ultimate verification process and these factors include the development of a provisional organisation to continue the ramp-up process and the theory of full speed. The study only takes into cognisance, the last periods of the development phase therefore ignoring the aspects of product development and conceptualization. Also they emphasize the need for short cycle times and constant yield improvements during the ramp-up. Studies related to ramp-up production normally promote and support this theory, but due to the result of the explorative nature of the research, it does not present a systematic analysis of the association between product development and production ramp-up.

## 2.4 Relationship between Ramp-up Product Development and Performance

In manufacturing and production industries today, the speedy time to market and time to volume is achieved through an effective collaboration between production development and performance. Gerwin and Barrowman (2002) analysed the impact of the relationship between ramp-up performance and product development and described this collaboration or relationship as positive towards effective yield and utilization. The effect of their relationship is based on the results of their simulation underlining the significance of the relationship that binds both product development as well as product performance. This relationship promotes the fast achievement of time-to-volume compared with the silent leading hypothesis of time-to-market. The level of learning is very important as well as the sources of learning like engineering time, experiments as well as normal experience. Though the study has made well developed simplifications of genuine world ramp-up circumstances that it makes use of in providing positive and functional insight into the impact of the speed first or the yield first policies.

As a corresponding study on the relationship between the ramp-up product development process and problems throughout the first commercial manufacturing of a new product, Griffin (1997) developed and analysed a theoretical framework to investigate the effect of the development process, the product design and the manufacturing capability on the original commercial manufacturing period. However, the study was carried out in the late 20$^{th}$ century when the mobile device manufacturing industry was still in its early life and the business environment was partially different from the one that exist today. According to Lee (2004), in determining the level or the nature of the relationship that exist between product development and performance, it is however important to know how the development and performance process is managed. It is also important to create an atmosphere of effective communication and cross-functional relations within the supply chain that breeds improved and better results. Emphasis should also be placed particularly in extremely technical and motivated product development and performance in the design and manufacturing industries.

The capacity and capability of manufacturing is discussed here and also stressed by Wheelwright and Clark (1992) with a case study in the pharmaceutical industry, with a finding that validates the significance of process development at an untimely stage of the development cycle as a way of building sustainable and unique competitive position. In their study, they also revealed that manufacturing process innovation is more effective in faster and more productive environments as a way of launching various products with improved product functionalities. In another study by Rogers et al (2003), was employed a conceptual framework that integrated the idea of knowledge harnessed from training as a driver of ramp-up performance with the theory of innovation, signifying that ideas for new products can come from seven different sources that are: marketing and sales personnel, research and technology development teams, product development and commercialization teams, manufacturing and operations organisations, customer and potential customers, suppliers and third parties and finally from competitors as well as from potential competitors. Rogers et al. (2003) also points out that 75 per cent of new product development programs fail to succeed commercially. They claim that the reason for this would include lack of market information, ignorance to the voice of the customer, lack in pre-development homework, unclear product description, poor execution of development tasks and poorly structured project teams. This study provides a well-built practical support for the relationship between the various levels of novelty and ramp-up performance. In the process of trying to find a quantitative relationship between the novelty proportions and ramp-up disturbances, Zirger and Maidique (1990) used a mixture of various case study methods like the pilot framework to develop a product plan and also two different case studies that evaluate a new policy introduction and a new product line that were used to develop the pilot framework. Even though this study made resolute the elements of innovation that greatly affect the production ramp-up period, certain factors were not integrated into the model.

## 2.5 Capabilities for Rapid Supply Chain Operations Ramp-up

Contemporary manufacturing industries make adequate use of supply chain capabilities to facilitate gainful growth and development towards achieving time to market and time to volume. To be effective in business performance and to quickly and speedily achieve production ramp-up in organisations today, manufacturing industries consider and adopt a number of supply chain capabilities that assist them to develop and maintain a growth-enabling supply chain.

### 2.5.1 Timeliness and Visibility of Data

Visibility in the manufacturing and production context means the capacity to effectively collect data on every aspect of an organisation's operations as well as customers and at the same time develop influential insights from the available data. McIvor et al (2006) put forward that, even though they observed great benefits for companies by early supplier involvement (ESI), they also found obstacles to this approach in the case company. The first obstacle was the senior management's failure to communicate a clear business strategy as well as unwillingness to allocate enough resources in areas as the joint buyer-supplier cost analysis. The second was lack of cooperation with functions, within the company as well as with other companies in order to "defend" their territory. The third obstacle was the simple fact that the buyer and supplier always had been working at "an arm´s length" basis, making it cultural hard to brake this habit. Harrison and van Hoek emphasised the need for dividing the products/items into four categories before involving suppliers.

These are:

1. Strategic items; here the suppliers should be involved in the development process.
2. Bottleneck items; either the company should involve the supplier to create a greater predictability/availability or they should redesign the product in order to eliminate the need for this items.

3. Non-critical items; here there is no need for any cooperation whatever since these items are standard and plentiful on the market.
4. Leverage items; here there is no real need to involve the suppliers, unless the company want to transform this item/product into another one of the categories above.

Visibility also make available ample insight into the framework and type of supply chain or network required to serve particular customers or the various segments of the industry and at the same time, improve market share and revenue. True vision into an organisation's operations includes knowing the various positions where goods are in the supply chain at a particular time, ascertaining customer and supplier relationships as well as the total landed costs of goods (Liao et al 2009). Such information and facts allows the manufacturing industry to economically meet customer expectations like having sufficient inventory in stock and adequate product delivery when and where required. Also, to meet particular policy of the nation in areas where its suppliers transact business, as well as guarantee the safety and security of its properties and resources together with deliveries and create the opportunity to categorize possible cost-reduction prospects.

### 2.5.2 Effective Integration with Customers and Suppliers

Most manufacturing and production companies have performed a good job of incorporating operations within their immediate environment. Christopher (2005) asserts that, most contemporary organizations have taken integration to their business partners beyond just simple teamwork, with leaders accomplishing process and information incorporation throughout the supply chain. This really makes it possible for organisations and their business partners to link sales with available raw-material suppliers in real time, even though those suppliers are in the most remote part and cannot easily access available resources. Also it creates a win-win situation since these relationships creates mutually beneficial long term advantages for both, as well as it at the same time increases the mutual dependencies transforming independent companies into interdependent partners. Smith and Reinerstein (1998) explained that, Zara and Liz Claiborne

are two obvious illustrations of a well incorporated supply chain of information streaming from consumers back to suppliers who supply and provide materials and services; Zara (as an example) can find out the latest trends on a regional market and within two to three weeks supply that particular market with new goods.

### 2.5.3 Deploying Innovative Supply Chain Technologies that Act as Foundation for Achieving Partner Integration and Supply Chain Visibility

Today, most organizations and manufacturing companies concentrate their investments and positioned technology through a well thought out plan that profits themselves and their partners. Christopher (2005) explained using historical perspectives that, most organizations have concentrated the use of technology towards making effective and efficient supply chain processes. As lots of manufacturing companies prepare for growth, management of the organisations seek to know how supply chain technologies such like predictive monitoring, dynamic pricing systems, product life cycle management software, smart cards as well as radio frequency identification (RFID) can help accomplish growth. Harrison and van Hoek (2005)divided the advantages of RFID into four areas of application:

1. Tracking products throughout the distribution pipeline, also called asset tracking, in order to provide continuousquantities and position in the supply chain.
2. Tracking products back to the store or even to the shelf.
3. Giving shelf “intelligence”, whereby thieves stealing products from them automatically raises alarm signals.
4. Registering sales without involving any real life person as a cashier, a scenario where the customer simply passes a reader at the exit of the store and the system automatically reads witch products that are included in the basket and also bills the customer by her credit card.

Due to the quantity of information accessible and necessary to effectively run a global company’s supply chain, the perceptive application of technology, such as EDI/Middleware, is a must for corporations to obtain data visibility and deci-

sion support essential to link with customers, manage difficulty and loosen up the supply chain as required to meet strategic and operational objectives.

### 2.5.4 Promoting Cultural and Organizational Supports towards Growth Oriented Supply Chain

Management of production and manufacturing companies recognize that the best and most effective supply chain technologies and processes in the world mean nothing without any standard organizational skills and structure in place to support its intuitive growth. However, Kaski(2002) explained how CEOs of organizations try to figure out the best practices and strategies to grow their businesses and how a lot of them are beginning to realize that integrating the best business strategies and business practices is bound to fail except the company has:

1. A supportive as well as a relevant organizational structure.
2. A well skilled, adaptive and dynamic workforce that identifies itself with the business strategy and understands how their various actions and behaviour contribute positively to the organization's achievement of its planned goals.

From the perspective of a supply chain, Kaski (2002) also revealed that leaders have been able to break up the walls that traditionally have separated the various demand functions like sales and marketing from supply. This is particularly critical in planning, as sales and marketing really identify with the customer base and can make available for the supply chain organization a broader understanding of what is in reality the driving demand. Management of manufacturing organisations also perform extremely well in creating and developing a culture that promotes innovation as well as growth. Kaplan and Norton(1996)report that, it is imperative to create a supply chain in organisations that predict and drive change, rather than respond to it and at the same time they should champion the supply chain at the maximum level of the company to guarantee that supply chain capabilities are measured in the development of business strategy.

### 2.5.5 Metrics that Reward Integration

Top organizational management expect to achieve the ultimate goal of profitable growth. Consequently, they make use of metrics that do not just aid them estimate the performance of supply chain activities and functions that are significant to growth, but also discourage the optimization of individual activities or functions in favour of the general organizational performance (McIvor et al, 1997). Kaski (2002) has revealed that, leading manufacturing companies normally employ four significant metrics to estimate their performance in relation to their growth and developmental goals. The various matrices include:

1. The total cost of the supply chain with materials, inventory carrying as well as manufacturing costs.
2. Very critical customer service like the cycle time and fill rate.
3. The value of the organisations´ inventory that go beyond days of accessible finished products inventory to include the value of finished goods being delivered to customers, work-in-progress and also the value of the raw materials on hand at that time.
4. Period to cash and it includes gauging the time period between acquiring materials for an order and when the customer really pays for the finished product in cash.

## 2.6 Ramping up Quickly

The major value of outsourcing mastering as well as developing supply chain capabilities is not quite easy, especially as a lot of companies continue to increase their area of operations and take it to more isolated locations around the world and collaborate with partners of different levels of technology and process sophistication. Consequently, Cui et al (2009) revealed that a growing amount of manufacturing or producing companies are entering into different kind of outsourcing arrangements some of which involve conventional uses of third-party logistics (3PL) suppliers to implement particular activities. But in some cases, some suppliers involve in more inventive deals in which a third party takes responsibility for a supply chain process or even the whole supply chain itself, also called fourth-party logistics. They will care for the supply network in its

whole as to manage such activities as system architecture and integration, control of the supply chain, utilisation of information and knowledge across the network and accessing the best of breed asset providers (Christopher, 2005).

According to Yan et al (2009), ramp-up productions in most manufacturing industries today really achieve a great extent of time to market and time to volume with effective supply chain capabilities. The pathway to high performance growth is a part of the agendas of most CEOs of manufacturing and producing companies. To this end, companies employ the concept that is capable of optimizing their supply chain to be more than just a cost centre. Instead, the major insight is that high-performance businesses have developed a way of using their supply chains to stimulate growth. They understand that this core potential has played a major role in effectively separating themselves from their immediate competitors.

It is observed that, the gap between high-performance businesses between organizations continues to grow wider as some organisations make use of their supply chains to help them enter new markets taking supply to meet up demand so as to better serve existing customers. They supply innovative new products to the market more rapidly with cost-effective prices so as to avoid being left behind. Companies that are not market leaders must develop their own supply chain or numerous supply chains (networks), to balance the uncertainty in the market to meet customer demands of their products (Brooks and Schofield, 1995). They must also adjust their supply directly to customer demand to create optimal levels of service and efficiency, and make sure that their operations are flexible enough to meet the unavoidable shifts and uncertainties of their industries. It is by doing this, that these companies can balance the uncertainties in the market and join market leaders on the course to high performance. Two kinds of strategies that improve supply chain performance in an organization include the demand uncertainty reduction as well as the supply uncertainty reduction. Both these strategies are connected to visibility and information sharing along the supply chain as well as common investments in soft- and hardware enabling such features as focused forecasting.

# CHAPTER THREE
# RAMP-UP PERFORMANCE

## 3.1 Ramp-up Performance

An evaluation of ramp-up performance can only be performed based on a suitable capacity system. According to Beamon (1999), a performance measure or a set of performance measures is normally used to determine the effectiveness as well as efficiency of an active system and to evaluate competing substitute systems. The addition of four characteristics is very important for the establishment of such a system. These characteristics are:

1. Inclusiveness: Which is a measure of every relevant
2. Universality: Which allows for assessment under different operating conditions
3. Measurability: The necessary data is measurable
4. Consistency: The measures are regular with the organisational goals

To achieve these goals, most of the established performance measurement systems consist of a set of performance measures and indicators. Browne et al (1997) defined performance measure as “a description of something that can be openly and directly measured”. However, a performance indicator could be defined as a description of something that is premeditated from performance measures. A performance measurement system is a full set of performance measures and indicators to achieve completeness. Only efficient and management process can assure production ramp-up through sustaining productivity as well as efficiency and quality in the production or manufacturing process (Schmidt et al, 2009). The model asserts that the performance of an organisational system is a complex interrelationship between seven performance standards that include profitability, innovation, quality of work life, productivity, quality, efficiency as well as effectiveness. However, the most accepted model has been the balanced scorecard planned by Kaplan and Norton (1996), a concept that integrates and identifies four various groups of performance such as inno-

vative and learning perspectives, internal business, customer as well as finance.

One major weakness is that the model does not integrate a competitive measure and a human resource viewpoint. Another framework developed involves the working functions of an organisation, which measures the satisfaction of the stakeholder in a combination of determinant factors such as stakeholders' contribution, capabilities, processes as well as strategy. De Toni and Tonchia (2002) developed their own model to improve this list and created the frustum model, which disconnects customary cost performance measures like productivity and cost production from the non-cost method such as flexibility, time and quality.

These models help to differentiate between internal cost and non-cost as well as external performance. However, this provides a valuable classification of the most universal measures on a planned level that are required to explore ramp-up performance on a more effective level. One major problem is creating a ramp-up performance measurement system that is reliable with the general business goals and does not result to disagreements between the different functions that constitute the model. Also, another issue with the performance measurement is based on the fact that it is so diverse and the various aspects of performance measurement system design are independent of the other.

One very important aspect of production ramp up is proper understanding of the various requirements of the distinct customer segments that are used to make an efficient supply chain (Petersen et al 2005). On the other hand, operational performance is regarded as a high percentage of sold products with the supposition of a very effective capability utilisation rate of the mechanised system. The time period immediately after the ramp-up begins is very critical due to the promotion and sales activities that are already started while lots of configuration and improvement activities are still in progress. Particularly in projects with a well-built intention on time to market, the various project teams constituting the system strive for accelerated product growth, often opposing the time achieved in earlier stages of the development cycle throughout an unproductive ramp-up

that come as result of heavy ramp-up problems. Karlsson and Ahlström (1996) puts forwards that efficient ramp-ups are categorised by a greater operational performance, where efficiency is made to measure how an organisation's resources are economically utilised.

To measure the operational performance throughout this phase, it is only advisable to measure the real invoiced quantity over a given time period and estimate the ratio with the established quantity for that period. This presents a closer relation to profitability than those measures that are entirely based on manufacturing output. For instance, any mechanised output that is achieved based on plan but manufactured to stock or without established account would definitely demonstrate a strong manufacturing performance which does not in any way contribute to profitability. More so, manufacturing output that contributes greatly to profitability has to be achieved with a high rate of capacity utilisation.

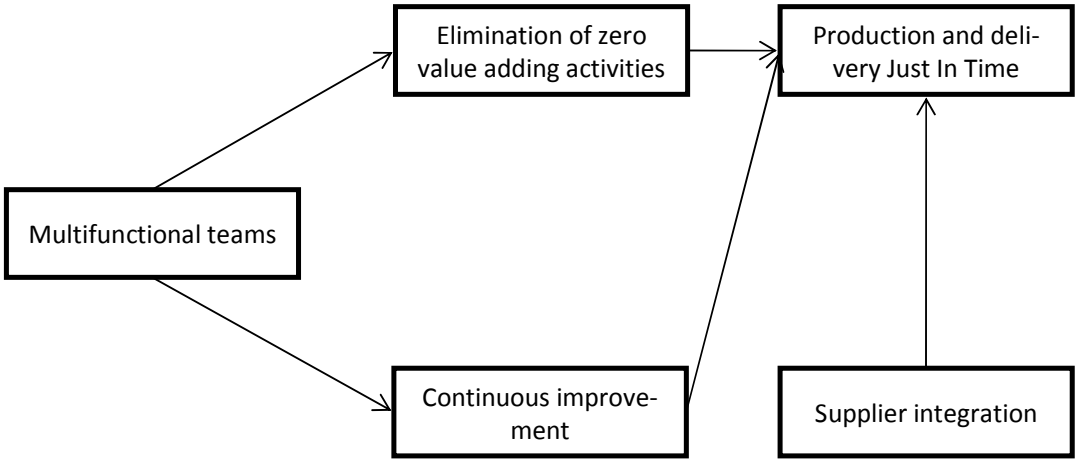
Sánches and Peréz (2001) established other measures to indicate production performance and divided these into five different groups:

1. Elimination of zero-value activities; this is measured by six different indicators: The percentage of common parts in company products should increase, the value of work in progress in relation to sales should decrease, the inventory rotation should increase, the number of times and distance parts are transported should decrease, the amount of time needed for die changeovers should decrease and finally the percentage of proactive maintenance should increase.
2. Continuous improvement; this is measured by eight different indicators: The number of suggestions per employee and year should increase, the percentage of implemented suggestions should increase, savings and benefits from the above should increase, the percentage of inspections carried out by autonomous defect control should increase, the percentage of defective parts adjusted by production line workers should increase, the percentage of time machines are standing still due to malfunction should decrease, value of scrap and rework in relation to sales

should decrease as well as the number of people primarily dedicated to quality control.

3. Multifunctional teams; this is measured by five different indicators: The percentage of employees working in teams should increase, the number and percentage of tasks performed by this teams should also increase, the percentage of employees rotating within the company should increase, the average frequency of task rotation should increase and finally the percentage of team leaders that have been elected by their own co-workers should increase.
4. Just In Time (JIT) production and delivery; this is measured by five different indicators: The lead time to customer should decrease, the parts delivered by suppliers JIT should increase, the level of integration between suppliers and the customer company should increase, the percentage of parts delivered JIT between sections within the company should increase and at last the production and delivery lot sizes should decrease.
5. Suppliers integration; this is measured by seven indicators: The percentage of parts designed in cooperation with suppliers should increase, the number of suggestions made to suppliers should increase, the frequency of visits by the suppliers technicians should increase, the frequency of visits to the suppliers by the customer companies technicians should increase, the percentage of documents interchanged with suppliers should increase, the average length contract with strategic suppliers should increase and finally the average numbers of strategic suppliers should decrease.

Fig. 4 Flexible Information System




Taken from Sánchez andPéres (2001)

A considerable amount of an organisation's business is made up of business to business transactions which require that every participant plays a major function. Under these circumstances the violation of approved dates of delivery could result in punishment clauses or lost sales with a negative effect on the product business in general, the concentration on pure ramp-up speed is economically not wise since lack in quality and other cost drivers can build up to a level that can sustainably affect the general company competitiveness (Twigg 1998). Also, meeting up customer requirement of this nature requires excellence in flexibility and dependability. These dimensions are measured using the ratio between the real production result over a specified time period and the established sales quantities that have been decided within that time before the ramp-up begins. This ratio provides an idea of the general planning exactness of new products that is also reproduced in the financial reporting of the corporation (Kaski 2002).

Twigg (1998) claims that it is crucial to determine the type of relationship the suppliers are in with the customer company before ramp-up begins as well as deciding upon location of authority and responsibility in order to maximize coordination. Also a timeframe within a specified time period has to be chosen as a result of the launch procedure and ordering of long lead-time mechanisms that has to be put into use before the ramp-up begins. Pufall et al (2007) explained

that, in an environment that is characterized by steady volume estimates this procedure would be adequate. Though, due to environmental effects activated by competitor performances, portfolio changes as well as new technology openings and ramp-down decisions for other projects, the volume estimate is highly unbalanced. Integrating this feature in the calculation alters the reliability ratio of the change in market demand. For instance, a product ramp-up could perform very well if it is calculated based on the earlier agreed numbers and at the same time, could still lose a significant opportunity if the market demand would increase (Sharifi and Pawar, 2002).

A prospective weakness of this system of measurement is that, it assumes the ramp-up speed will be synchronized and made to achieve maximum profitability. This is basically guaranteed by normal reassessment of the product business case established by the product program manager but ramp-ups in fast manufacturing or producing industries with corresponding short lifecycles will always face the predicament that they have to make steady asset investments rates, material risk orders as well as the obtainable ramp-up speed. Hilletofth et al (2010) mentioned that companies should focus their efforts on developing customer oriented business models by organising themselves in such a way that they understand the customers' needs and identifies customer value as well as understanding how this value can be delivered to the customer. Also the companies must obtain the knowledge of how the processes within the supply chain effects one another and how these can be coordinated.

Conventionally, quality has been defined based on conformance to measurement provided. Therefore, quality-based measures of performance have concentrated on issues like the cost of quality. With the introduction of total quality management (TQM) the importance has shifted away from order qualifiers to requirement towards order winners that delivers consumer satisfaction or quality that exceeds customer's expectations. Brooks and Schofield (1995) explained that, this is still considered as one of the most significant performance indicators in the high-technology and manufacturing industries as it emphasis on the concept of customer retention and lost sales, even though it is one of the most complicated indicators to measure. Several factors like service, price, design

and functionality together with device reliability have effect on customer perceived value, considering greatly the general performance of an organisations manufacturing and delivery performance. In order to fulfil this, the company must understand the market and deliver the factors that are essential for the customers at focus.

Consequently, the focus is more on the issues that results in providing an ideal order to customers than on the observation of the customer towards the new product and effective service. The proportions that are associated with a perfect order are complex and comprise issues like non-damaged delivery, accessibility and functionality of all items and also accurately picked orders. Higher manufacturing equipment, tools investments as well as resources for early risk orders using possible undeveloped material would tolerate for more improved ramp-ups, but only at the expense of risk and cost involved (Terwiesch et al 2001). To calculate these dimensions in excess of the ramp-up period, the return rate of the initial delivery batches, as a proportion of the total deliveries would include two measures such as time to market as well as pure cost measures. However, time to market and pure cost measures are significant performance measures, even though they constitute a negative effect relying on them during new product ramp-ups. In the short term, the effects of cost on the general profitability are small, but evidently constitute changes in the mid as well as long term.

Any lost sales and apparent lost profits in a fast clock speed industry will offset all the other potential efficiencies in the value chain by a clear margin. Manufacturing companies are faced with increased global competition and are operating in markets that pursue more frequent innovation as well as higher quality. This results in that companies can only outperform competition by offering superior value, either by lower cost or by providing superior benefits for the customers (Hilletofth, 2008). Regarding time to market, Clark and Fujimoto (1991) considers this as a significant dimension of product development performance, even though time to market is not integrated in their model due to the fact that, time to market is often calculated as the time involving sales start as well as concept generation. And also, it is more an assessment of product development performance than of ramp-up performance.

Fig. 5 Correlations between Consistency and Performance

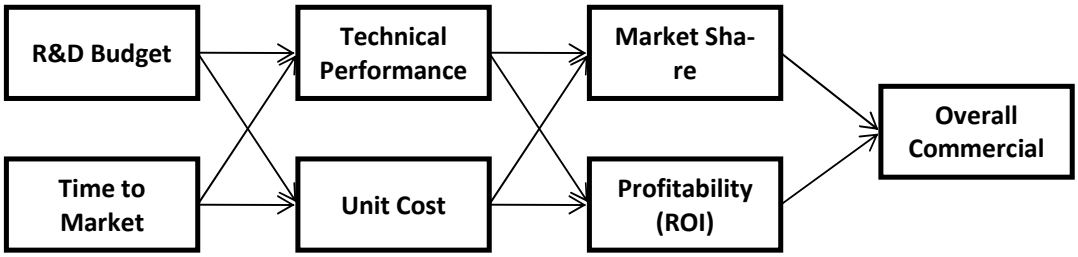
| Performance Concistency | Development Productivity | Lead Time | Total Product Quality |
|---|---|---|---|
| | | | |
| | | | |
| **Overall Consistency** | **x** | **xxx** | **xxx** |
| | | | |
| **Strength of External Integrator** | **no** | **x** | **xxx** |
| | | | |
| **Strenght of Internal Integrator** | **x** | **xx** | **Xx** |
| | | | |
| **Integrated Engineering** | **xxx** | **xxx** | **xx** |
| | | | |
| **Other Internal Integration Mechanisms** | **no** | **no** | **xx** |

Taken from Clark and Fujimoto (1991)

Secondly, the model follows the hypothesis taken by Mallick and Schroeder (2005) who argue that time can rather be considered as a valuable resource. Integrating the concept of time to market as a significant variable of the new product development procedure as a dependable factor within the product development area into a single conceptual model. There is experimental evidence that amplified pressure on time to market during new product development pro-

jects could greatly reduce development time but at the cost of other performance measures such as ramp-up quantity, quality as well as effort.

Fig. 6 Proposed Framework for Measuring Product Development Performance




Taken from Mallick and Schroeder (2005)

### 3.2 Conceptual Model and Propositions

Conceptual models as well as propositions are normally defined and quantify well known characteristics into more elaborate and detailed relationships between the various characteristics so as to generate a comprehensive conceptual model (Brown et al 1997). Initially, a regroup function will be performed on the seven identified characteristics (related to the manufacturing strategy, non financial measures, similar measurement systems at different locations, change over time if needed, simple and easy to use, provides fast feedback and finally intended to foster improvement) into major categories that make available the headers for the subsequent sub-sections that include the external environment, logistics system, the product development process, the manufacturing capability as well as the product architecture. This grouping supports the identified features with experience and observations from an organization's specific environment. Also, it is observed that the outstanding elements, which involve the human resource group or the practice and usage of tools, are either suitable to all of the features or just part of the main characteristics. The product architecture is made up of all the physical as well as functional items that are required to fulfil the customer needs. The product architecture is also the planning of the functional elements of a product into the various physical blocks (Clark and Fu-

jimoto, 1991). The product architecture generally starts to appear during the concept formation phase and becomes more complicated during the development phase by choosing major design suppliers, technologies, components as well as variables.

# CHAPTER FOUR

# THE SUPPLY CHAIN RAMP-UP PERFORMANCE CAPABILITIES

The supply chain performance capabilities include the functions that help manufacturing companies achieve ramp-up through time to market as well as volume to market when effectively integrated. They include:

## 4.1 Front End

The front end of supply chain will become as significant as the back end in making the most of total economic yield. Also, cost data is often only obtainable too late or based on the wrong functions and as a result, it is often irrelevant to the decision-making or performance assessment during supply chain (Chen et al 2005). However, due to the growing demand that has now made itself in several ways through the web, through online marketplaces, or in combination with partnerships, smart companies will be concentrating their prominence on the front end of the supply chain. Therefore, front-end supply chain management is a capability of responding to and understanding customer needs that will become a major aspect of supply chain strategy. Song and Swink (2009) explained that, in the past, supply chain management deals greatly with vendors, which mean that manufacturing companies concentrate mostly on making better logistics, which referred to as the back end of supply chain. Also, deploying new yield-management methods to assist in building collaborative design processes and prioritize customers. To effectively measure the significance of front-end performance, what is greatly considered is the company's investment capital rather than profit potential. For giving an example it could be a smart move to equip store managers with handheld devices using GSM/WLAN to communicate customer response directly to the designers who then can change the design accordingly or to the production, if the product is a total failure, telling them to switch off production. This would lead to products that where more adapted to the real customer need as well as lower total cost due to overproduction is avoid. Also the organisation can benefit from short mechanised runs and access to instant demand data since this also will help to avoid over production or

stock outs. By organising the supply chain management and the information tools the organisation can operate in a more cost efficient way. Wheelwright and Clark (1992) add that the use of platforms also can facilitate for the supply chain ramp-up abilities. But to create a platform, three essential characteristics must be present:

1. Core performance capabilities that matches the primary needs. The solution that the project develops must be highlighted in order to create system solutions to the needs of the customers.
2. Support of an entire product/process generation. Platform projects generates products and processes that posterior development can expand and intensify through the addition of incremental additions; creating a product and process family. Also the platform must be flexible enough to be adaptable to the changing needs of the customer.
3. A link to the previous and subsequent generations. Platforms act as a migration path facilitating movement from one product generation to the next. This creates stability for customers as well as to the distribution channels, enabling the firm to supplement more fully its position and resources.

### 4.2 Collaboration

In the past, several companies controlled and administered their businesses the old-fashioned way that involved shipping from the warehouse, building product, connecting suppliers as well as taking orders. With this method, they may lose out to businesses that centre their energies on outsourcing the rest product, sales and marketing, brand management and also design. This is due to the fact that, supply chains are growing into being too composite and difficult for just a single organization to effectively managing it in a competitively dominant manner. Another way to be competitive without outsourcing is to collaborate with other companies, sometimes even your own competitors.

The real challenge is to be able to create a nurture relationship as well as managing complex groups cross the national and regional boarders and cultures. Companies that want to explore this potential for increased profitability as well

as cross functional learning must start with a learning process that makes the staff fully understand the counterpart in the form of national/regional as well as company culture. Also it is important with a win-win scenario; creating trust and mutual interest in common success. The four themes in order to obtain this are responsiveness, reliability, resilience and relationship, creating the basis for successful logistics and supply chain management (Christopher, 2005).

### 4.3 Value Delivery

Activities as well as functions that don't centre to value liberation will be diversified to specialists that can make more money on them. Before, companies normally outsourced noncore task based on cost and by selecting the least bidder. However, this is fast becoming a very risky strategy, since vendors that operate on thin margins will be less and less capable of matching the types or various levels of service obtainable by other operators. In addition, less viable will be vendors that persist in absorbing low-margin mechanised plants or storehouses, hoping to make income on volume (Harrison and van Hoek, 2005). Alternatively, clever companies will identify that they must figure out new ways to do business, conceivably through shared-profit activities in which suppliers profit from their success.

Profit-sharing activities and schedules that goes beyond the conventional outsourcing deal allows companies to adapt supply chain costs from fixed cost and transform them into variable cost, thereby cutting down expenses and making it feasible to serve customers more openly. Sun and Wing (1999) said that, ramp up production is even more effective in proper and efficient brand management. For instance, under profit-sharing activities, an outsourcer could also obtain performance dividends for meeting or surpassing cost and customer service objectives, particularly when the performance creates higher profits for the customer company.

According to Cui et al (2009) companies can gain great advantages by outsourcing, such as global transportation networks, knowledge, faster services as

well as the fact that companies can replace innovative, variable cost outsourcing conventions with self owned fixed assets that include trucks and warehouses, therefore reducing capital on the books and making use of the capability required rather than owning the excess.

### 4.4 Support

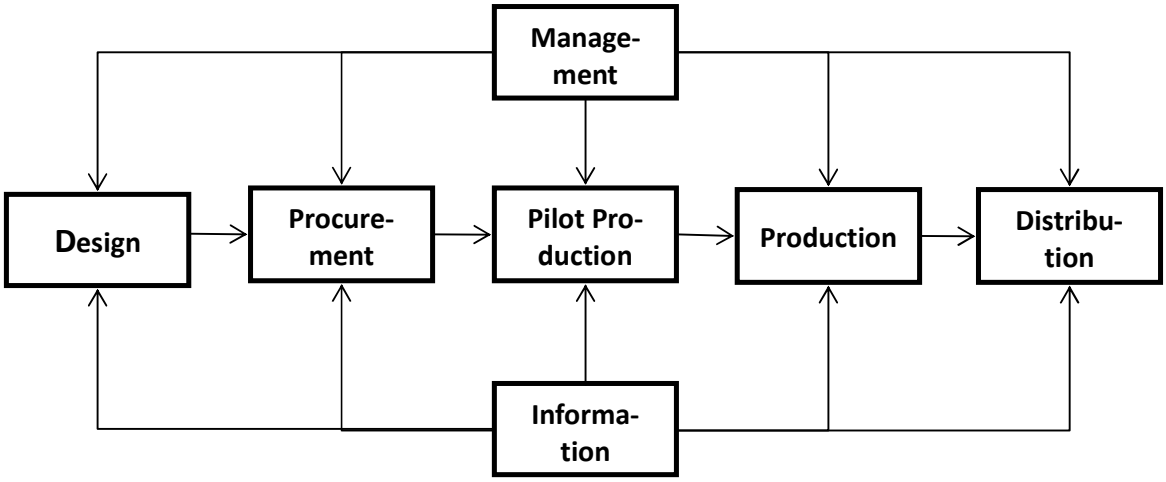
The utmost margin potential occurs immediately after products have been shipped, as service and support become as valuable and significant as the product itself since it also can generate long term income for the company providing the service. Manufacturing companies are supposed to realise that, supply collaboration as well as product development is a very complex and multifaceted process (Xu et al, 2007). In responds to this trend, supply chain winners will need to work harder to package great products with strong service contributions, thus make the most of long-term customer profitability and taking care of customers' increased emphasis on ownership cost. Hilletofth et al (2010) asserts that, with more companies in search of solutions rather than seek for particular products or brands, an increasing number of goods will then become commodities. Customers are gradually acquiring products with a channel for content, services, or other assessment that go beyond the fundamental value of the product itself. Moreover, business customers will transform their focus from obtaining the product based on its characteristics alone to highlight the total service supplied, including maintenance and operational consistency. Therefore, involving product sales with the service network will become a major value driver for several companies. This implies that supply chain management must deliver not just the original product but also a complete stream of products and services to the customer normally through diverse channels and even different locations. However, these changes will add to the company's difficulties in the supply chain operations, but they also will turn out to be a major source of income and profit growth.

### 4.5 Adaptability

A company's ability to adapt to changes in the near future will become even more important. Hilletofth (2008) explained that, this is due to the fact that,

companies that are located to work economically and resourcefully with multiple partners will acquire most of the accomplishment, while those that are hard to work with will mostly be ignored. Rapid and practical partnering also will be significant to new supply chain management strategies, as the best players will be made to work collaboratively to attain the major prises. Also, creating a flexible as well as an adaptive supply chain strategy while administering a business is just as simple as changing the wheels on a car while it is in motion.

Fig. 7 Matrix of Product Development Process




### 4.6 Product Development Process

A product development process is the chain of procedural and step by step activities that a venture employs to commercialise a product, design as well as conceive. According to Gevers (2004), a lot of these steps and activities involve logical, rational and organisational steps rather than physical. However, some organisations define and track a specific and more detailed development process, while some of them cannot even explain their processes. In addition, every organisation makes use of a process that is at least different from that of every other organisation in one way or the other. Also, similar activities may follow different processes for each of a number of different types of development projects. However, this study will consider processes involved in the manufacture

and production of products matrix such as design, procurement, pilot production, production as well as distribution with information and management.

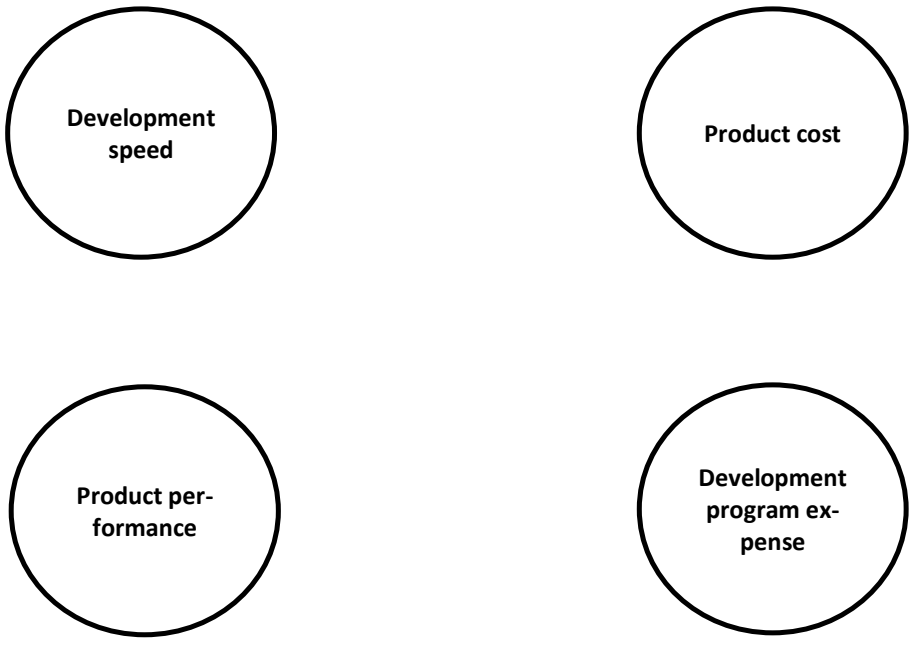
### 4.6.1 Design

In the production process, a detail design phase includes the absolute requirement of tolerance, materials as well as the geometry of all of the distinctive parts in the product and the detection of all the measured parts that have to be purchased directly from the suppliers. Kaski (2002) in his research explained that, a process plan is recognised and tooling is calculated for each part to be designed within the entire production system. The output of this phase is the control records for the product together with the drawings or computer records describing the geometry of each part and its construction tools, the stipulation of the purchased parts as well as the process plans for the manufacture and assembly of the product. Vigorous and efficient performance as well as production cost is the two basic problems of the design phase. Wheelwright and Clark (1992) highlight three forces that drive development:

1. Intense international competition. The globalisation has created an atmosphere of greater competition as natural geographic boarders are disappearing. This has lead to (as an example) USA based companies having to compete with Asian as well as European companies on the home market.
2. Fragmented, demanding markets. What used to be order winners have today become order qualifiers; as what are the order winners of today will be the qualifiers of tomorrow. Consumers do not want, or expect, to have to posses special knowledge in order to operate their goods and are also more sensitive to differences in products, which attracts them to the products that most appear to fulfil their particular need.
3. Diverse and rapidly changing technologies. Technology has, as well as it is, changed the conditions for designing and therefore creating new forms of meeting customer expectations. Uprising technologies in materials can also change the very fundamental character of products or competition.

Further on Smith and Reinertsen (1998) identified four factors that can assist in developing a new product, which they named The Four Key Objectives. The first one is development speed, which starts as soon as the company or its competitors actually starts to develop a product. If the company has not begun its design and the competitor has, then the clock has started ticking. The second one is product cost that simply is the cost developing the product. If the cost is too large it will handicap the final product since, as a result, the price can very well exceed what the final customer is willing to pay. On the contrary efficient design can keep the cost down resulting in taking market shares from competitors as well as possibilities to create new markets. The third one is product performance, which indicated how well a product meets the expectations from the customers. If the design meets what the market place calls for, it has achieved a good product performance, while on the other hand if it does not meet the demands it will have failed to create a good product performance. The last one is development program expense and displays how much resources that are invested in new products and is to be taken in comparison to what the new products generates in income

Fig. 8 Four key Product Development Objectives




Taken from Smith and Reinertsen (1998)

### 4.6.2 Procurement

The procurement phase precedes the design phase, where after the design, planned procurement or purchases are made to mark the beginning of the actual production process. Materials required to initiate the production will be bought so that production of the product or services to be delivered is commenced. This phase adopts commercial strategy and involves the market objectives as well evaluation of technology developments. The output of the procurement phase is what creates room for commencement and initiation of the production process. Oskarsson et al (2009) explains that in order to supply the production with materials at an efficient rate, the company must have suppliers that they can depend on, both in aspects of quality as well as ability to deliver. The supplies can be directed through a storage (insuring availability but also creating additional costs) or directly from the supplier either in the form of JIT (Just In Time) or SIL (Sequence in Line). A middle way can be to incorporate the information systems of the customer and the supplier and by doing so creating conditions for VMI (Vendor Managed Inventory) so that the supplier supervises the storage and automatically refills it if so is required.

### 4.6.3 Pilot Production

In the production process, pilot production involves both testing and refinement of the projected product to be produced. Wheelwright and Clark (1992) said that, this phase involves the evaluation and construction of multiple preproduction versions of the product. Early models are typically built with production-intent parts-parts with similar geometry as well as material properties as planned for the production edition of the product but not automatically fabricated with the real processes to be employed in the actual production phase. Alpha models are tested to determine the nature of the product, whether the product is feasible or not and also, whether the designed product convince the major customer requirements. After that, (beta) models are typically created with parts supplied by the proposed production processes, which may not be assembled by means of the projected final assembly process(Pressman, 2009). Beta models are broadly evaluated on the inside and are also normally tested by custom-

ers in their own use atmosphere. The main purpose of the beta models is typically to answer questions about performance and consistency so to identify essential engineering adjustment for the final product.

Fig. 9 Timeline of an Alpha Model

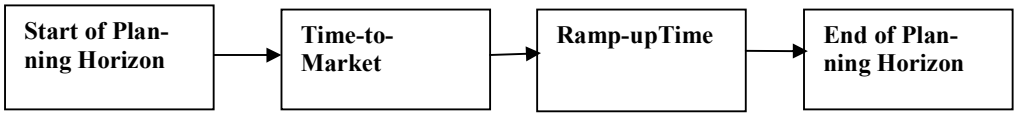
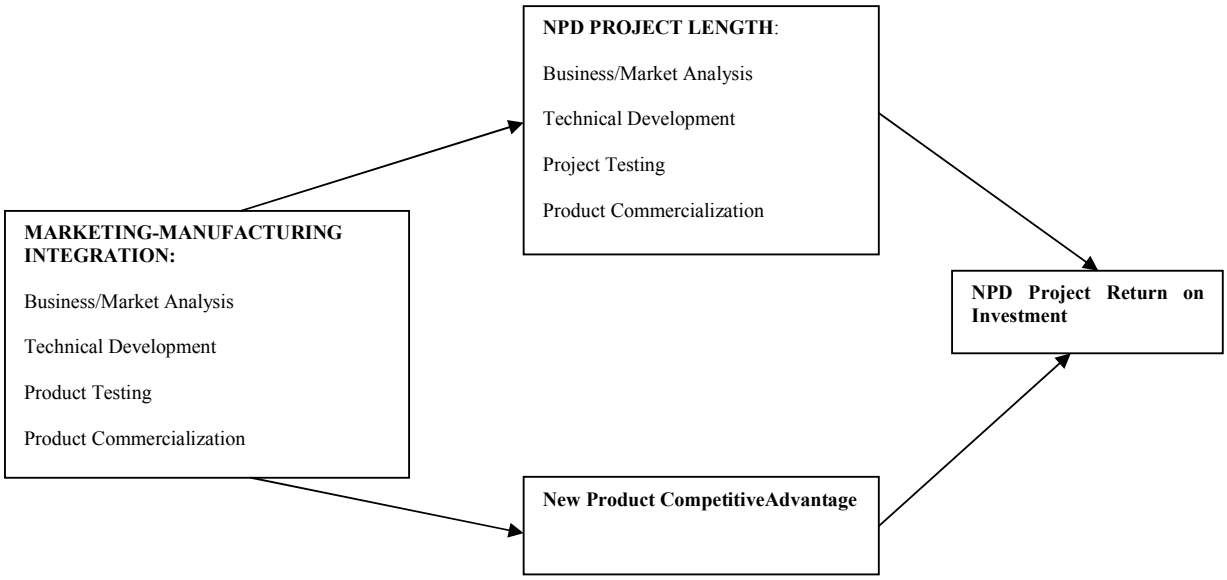



Fig. 10 Framework of the Beta Model




In the production process, after pilot production, which involves testing of the real product to be manufactured, the production phase comes up next in ramp-up production process. In this phase, the production or manufacture of the real product is commenced with the use of proposed production system (Koren et al, 1999). The function of the ramp-up is to educate, properly instruct as well as guide the work force on how to go about the production as well as work out any outstanding problems in the manufacturing processes. Products produced throughout the production ramp-up are occasionally supplied to chosen or preferred customers and are carefully assessed to recognise any existing flaws. The changeover from the production ramp-up to procedural production is typi-

cally gradual. At some point in this changeover, the product is initiated and becomes obtainable for extensive distribution.

### 4.6.5 Distribution with Management and Information

After completing the production process, distribution of the goods is the remaining aspect of the production process. For the production process to be complete, the produced goods must get to the hands of the final consumers for whom the goods were produced. This phase involves a detailed and properly managed concept development that aids distribution of the manufactured products. However, this can be effectively achieved with adequate management as well as information. Proper distribution of manufactured products is directly proportional to effective management and adequate information in the distribution channel (Meier, 2001). Cui et al (2009) explains that in order to obtain high service level without the burden of heavy investments, companies can take the advantage of forming relationships with Third Party Logistic Firms (3PL). This way they can outsource the distribution, as well as other aspects, and achieve superior service levels at the same time as it generates opportunities for the company to focus its efforts on the core activities. 3PL firms can also provide access to new markets, since the 3PL firm can have a larger distribution network and more customers that will, by merger of goods, implying lower transportation rates as well as resulting in wider distribution. Also this is a way for the outsourcing company to transform fixed costs into variable costs.

### 4.6.6 Management

For effective management of the manufactured products, the target markets are clearly identified, substitute product models are generated and assessed, together with one or more theories that are selected for additional development and testing. In this context, Karlsson and Ahlström (1996) explained that, a concept is a depiction of the features, functions as well as forms a product assumes and is typically accomplished by a set of conditions like performing an analysis of other competitive products as well as an economic explanation of the project. Mattsson and Jonsson (2003) divided the strategic management into six main decisions:

1. Goals for the logistics, such as lead times for delivery and levels of service. Usually the service level should be at 95 %, since lower will create loss of customers and higher to large costs in relation to benefits for the customer (Oskarsson et al, 2009).
2. Decide on product mixture and width of variation of the products.
3. Centralised production for the entire market or decentralised; each decentralized production supplying its own regional market.
4. Policy for dimensioning of the capacity.
5. Either produce and deliver to order or to make to stock. The problem with the latter is that the company will be forced to produce towards prognoses, which only are estimations of the real consumption (Oskarsson et al, 2009).
6. Decision on the structure of suppliers; that is if to use single sourcing, double sourcing or even multiple sourcing. Advantages of using single sourcing are that the company can create deeper cooperation with the supplier than when using several. At the same time single sourcing makes the company vulnerable to fluctuations in the suppliers' ability to deliver (Harrison and van Hoek, 2005).

### 4.6.7 Information

Also, Koren et al (1999) explained that, adequate information about a product in the production phase includes the proper definition of product architecture as well as the decomposition of the product into subsystems and mechanism. This will provide adequate information about the nature of the goods produced, the amount, where and when it should be distributed so as to achieve time to market of that particular goods produced as well as time to volume.

However, deployment of multi disciplinary teams does not really mean that a holistic approach is put in place to check the production process. Also, when a production process tends to be stable, the supply chain tends to be prolonged. The production process itself requires a lot of fine-tuning and it is always subjected to uncertainty yields, even though the supply chain may not reliable as suppliers themselves go through process innovation. Therefore, to reduce sup-

ply uncertainties in the production process, the production process must follow the designed framework that directs production down to distribution. Supply chains can only be effective if processes in the production process will be followed in proper order.

Labahn and Krapfel (2000) explained that, the capabilities of ramp-up production is achieved with adequate time to market as well as time to volume when the production capabilities of a production process is balanced with equal supply chain capabilities. In the manufacturing and production companies, the supply chain capability can be achieved if supply risks are reduced. Perks et al (2005) explained that, achieving effective chain capabilities means utilising design strategies that are directed towards creating the highest cost efficiencies in the supply chain. Therefore, non-value added functions should be eliminated and optimisation techniques should be adopted and deployed in the production process so as to achieve the best capacity utilisation in the design-distribution ramp-up production process.

# CHAPTER FIVE

# EMPERICAL FINDINGS

Two important research questions were raised in chapter one:

- What kind of capabilities is necessary for rapid supply chain operations ramp-up?
- What kind of aspects influences the performance of rapid supply chain operation ramp-up?

Throughout the study different capabilities and influential aspects have been analysed and in this chapter empirical findings that support the theories are presented.

## 5.1 Effective Integration with Customers and Suppliers

As discussed in chapter two one important way to speedily achieve time to market, time to volume and production ramp-up in organizations today is through an effective integration with customers and suppliers. This kind of integration is also known to create benefits such as improved quality, higher level of innovation as well as reductions in expenses.

### 5.1.1 Finding

A good example of how customer and supplier incorporation can be created is the example of General Motors (GM) whose suppliers have to submit highly advanced technical concepts to GM´s purchasing. After this GM reviews the samples and finally chooses the suppliers to participate in the ESI (early supplier involvement) program. The chosen suppliers are then given some level of involvement such as attending design meetings and working with the focal customer in the early stages of the new product development (Labahn and Krapfel, 2000). Brooks and Schofield (1995) go as far as to claim that by using Concurrent Engineering (which includes sharing of information, people and processes) the companies can gain such benefits as:

- Reduced time from concept to delivery by 30-50 percent
- Improved quality, responsiveness and compliance to customer requirements
- Lower costs of product development as from 15 up to 30 percent

- Less rework and non-value adding activities
- Higher profits

## 5.2 Ramping up Quickly by the use of Outsourcing

Outsourcing is another way of that is an up going trend that can have great impact on time to market, time to volume and time to quality.

### 5.2.1 Findings

Nike Inc. Is a good example on successful outsourcing since it outsources 100% of its shoe production, only left to produce indoor the key components of the Nike “Air-system”. By focusing its own efforts on development and research as well as marketing, distribution and sales Nike manages to create maximum value for its customers as well as its shareholders. Nike even went as far as to outsource its advertising part of the marketing to Wieden and Kennedy, which took Nike to the very top of the product recognition scale, creating growth at a compounded 20 percent and earning a 31 percent return on equity for its investors (Quinn and Hilmer, 1994).

One other company that has made use of outsourcing to speedily create supply chain capabilities required to maximise growth is the Apple Computer, which outsourced 70 percent of its manufacturing and components costs, instead of investing in in-house production, since Apple lacked unique skills in these fields. The Apple computer company outsourced critical design, printers and even the key element of marketing to companies like Frogdesign, Tokyo Electric and Regis McKenna. The internal resources of Apple was instead focused at developing the own Apple DOS and the supporting software in order to give Apple products their exclusive look and feel. The open software architecture inspired independent developers to write the software that gave the Apple users a uniquely high functionality. Since Apple was able to work as a flat organisation as well as avoiding making unnecessary investments in research and development, Apple was able to achieve three times the capital turnover and also creat-

ing the highest market value in relation to its fixed investments among the major computer producers (Quinn and Hilmer, 1994).

## 5.3 Effects of failure or success in Ramp-up

Without short throughputs in the industry of today companies can fail to meet the customers demand in time and at the same time increasing capital that is locked in to work in progress.

### 5.3.1 Findings

A example of what can happen when companies fail to succeed in their ramp-up process is the Nintendo DS: The Nintendo Company announced that the 3D version of the DS was to be launched before the ramp-up process for this product was implemented in their production, resulting in the customers stopping to buy the regular DS in anticipation for the 3D. Since Nintendo was unable to create volumes in their production at an efficient time rate they made losses of 2 billions of Yen (over 24 millions USD) in lost sales (Svenska Dagbladet, 2010-10-28).

An example of when ramp-up actually can counter disaster for a company is the one displayed by Reuters (20 of April, 2011). When the earthquake and tsunami hit Japan; Nissan lost most of its supply of auto parts, fast decreasing from a buffer of 70 cars down to 25. Nissan is now relying on its suppliers to rapidly ramp-up their production in order to be back at full production by May or June. In this case the vulnerability of single sourcing of suppliers, which is becoming more and more custom in the auto-industry, is effectively counteracted by the supplier's ability to quickly ramp-up, even after a disaster as severe as the recent.

## 5.4 Collaboration and value delivery

External, as well as internal collaboration is still another way to create significant improvements by streamlining the process of supply as well as to decreasing the demand uncertainty and hopefully creating synergy effects.

### 5.4.1 Findings

Clark and Fujimoto (1991) explained that: “Among the examples of effective development coalitions was “Project Four,” in which four European producers – Fiat, Lancia, Alfa Romeo and Saab – jointly developed mid-size models that shared floor panels and other components yet retained distinctive identities and were received in the market as differentiated products”. Other successful examples of development coalitions are the one between Ford and Mazda concerning the Mazda 626 model and the Ford Probe, where the latter “borrowed” the chassis and body structure in order to create a car with Mazda´s superior handling and functionality combined with Ford´s more sporty design.

Although all coalitions have not been successful; General Motors, to give an example, have had several disasters in this area. First they failed to collaborate with Toyota (the NUMMI venture), followed by failures to work with Isuzu, Suzuki and Opel. Resulting in the brand of GM eroding and lost sales followed as the customers did not relate to the brand as unique anymore.

Womack and Jones (2003) illustrated an example of supply chain partnership in their study of the Tesco collaboration with its suppliers. The Tesco Company used to have great lead times in their procurement of the supplies, this because lower lead times would either demand that orders have to be totally uniform over time so that the producers all along the stream could operate stable schedules with a low level of inventory or the upstream producers would have to have large inventories in order to handle shifts in demand. Since none of this solutions was desirable (large inventory) or even possible (uniform orders) Tesco installed a point of sales system that permitted each store to know exactly how much inventory they had at any point of day given. This also enabled Tesco to introduce automatically generated orders to its suppliers, and with time some of the replenishments were directed by the suppliers themselves. Although this approach gave very précis information to both the suppliers and Tesco the new strategy also involved every day resupply of the stores, this on other hand demanded that the suppliers would leave the old production system (with high-speed machines and long changeovers and large batches) and in-

stead turn to produce against real volatile demand. By introducing the above the Tesco Company has increased its service level in the retail stores from 92 to 98.5 percent and reduced its stock changeover from 21 to 12.8 days.

## 5.5 Evolution

One aspect that influences the performance of an organizations rapid supply chain operation ramp-up, is the flexibility to be able to evolve and adapt to the changes in the customer behaviour as well as to changes in suppliers and competitors behaviour. This can ~~be~~ either be done proactive or reactive, where the latter is responding to what already has happened in the organisations surroundings and the first one is reactions on changes that the company foresees.

### 5.5.1 Finding

Harrison and van Hoek (2005) reports that, during the 1980´s Tesco developed a supermarket theory coming to goods transaction. They partnered with equipment partners, logistics as well as software and it responded by entirely rebuilding its store and supply chain functions and businesses. Since then, Tesco became the only key supermarket operator with a three-tier distribution system. This permits it to secure favourable terms on more slowly moving items by purchasing in full truckloads without destroying other channels.

The first tier facilities comprise of a property of distribution facilities that hold up each Tesco functioning division that takes care of traditional quick-turning commodities. The second tier is made up of facilities for slower turning items that are principally and generally merchandise and health as well as beauty care items. The third tier promotes the easy movement of slow-turning migratory merchandise and store provisions. Harrison and van Hoek (2005) also explained that, Tesco's new business model was planned to contain leading-edge distribution systems by providing company's warehouse information network (WIN), online inventory information as well as real time information that helps in organising and at the same time managing service across Kroger's provincial distribution centres and functioning divisions. An example of this is the electronic point of sale system that enables the supplier to get updated every four

hour about the sales, registered by the hand scanners the customers use. Strongly integrated distribution is also a valuable function as Tesco has out-sourced the administration of numerous distribution centres' to involve third parties. By influencing its market governance, a federal procurement system and an efficient logistics network, Tesco has productively kept down costs while maximising profit margins. Additionally, in an attempt to merging its distribution centres, Tesco expects to lessen working capital and product-acquisition costs while reducing the amount of capital required furthering modifying the network.

# CHAPTER SIX

# CONCLUSIONS AND DISCUSSIONS

## 6.1 Conclusion

However, the kind of rapid supply chain operations ramp-up used as well as the various aspects of ramp-up that influences the performance of rapid supply chain operation, time to market greatly determine general ramp-up performance in a manufacturing company. The major purpose of this paper is the classification of the most favourable policies for ramp-up time decisions, concerning TTM, TTQ and TTV. Particularly, the best possible time-to-market takes place when the sum of the insignificant marginal value of the collected design knowledge and the value of the sales of the new product balance the marginal value of the sales of the big invention of product. Consequently, the strategic profit derived from design information allows an organisation to obtain higher net benefits after time-to-market or at the end of the planning sphere, making the organization to convey the new product to market. Also, the most favourable ramp-up time takes place when the accumulated production capability reaches the peak level of demand predictable for the new product. However, ramp-up is more relevant to production process in manufacturing industries than other concepts like time to market and time to volume due to the fact that effective and efficient ramp-up process could be used to reach, not only, time to market and time to volume but also time to quality. Ramp-up helps to manage organisations production process with enormous capital as well as effectively speed up production.

Demand and supply uncertainties could be used as a structure to develop the appropriate supply chain strategy that will enhance the effective balancing of production ramp-up capabilities. Innovative products with an equal unpredictable demand as well as an evolving supply process experience a major challenge. This is due to very short product life cycles with an emergent pressure for dynamically changing and adapting manufacturing process in a company's supply chain strategy. Organisations can encourage and promote integration or incorporation with other manufacturing companies by operating with particular

rules or standards that clearly define responsibility and authority within the concerned parts. They supply innovative new products to the market more rapidly with cost-effective prices so as to avoid being left behind. Companies that are new to the market must develop their own supply chain or numerous supply chains, so as to also balance the uncertainty in the market to meet customer demands of their products.

The supply chain framework supports decision making through data assessment and adequate availability, time horizon and restrictions of active products or supply chains that explains the selection of modelling techniques. The resultant effect is expected to be predominantly useful for new product improvement where most of the products life-cycle costs are determined. The literature addresses an important aspect of investments in more advanced process capabilities for production ramp-up to meet up time to market and time to quality aspects as well as time to volume. The bulk of the ramp up process is based on the manufacturing cost and most traditional capabilities addresses the importance of the process change implemented towards increasing manufacturing capabilities. Several of the reviewed literature researches addressed the benefits of process capabilities to help an organisation's effort of minimising it’s time to market with a major focus on investments that promotes an organisation's transition flexibility. For instance, an organisation may invest in process change to reduce transition or changeover costs or time just to promote the changeover manufacture of generations of new products. It is crucial that feedback between the consumer market, production, suppliers and design are iterative in order to create an agile production that further improves the ability to ramp-up in a proper and flexible way.

In a manufacturing company, the major players that constitute the production process are implemented effectively so as to achieve time to market of a particular product. With this however, organisations today adopt systematic approaches to integrated, concurrent product design and their related processes that is comprised of manufacturing and effective distribution to final consumers. The difference between high performance organisations continues to grow wider as some organisations make use of their supply chains to help them to

enter new markets taking supply to meet up demand so as to better serve existing customers. This approach is targeted at developing a comprehensive and well-planned framework of the process development life cycle from design to effective and efficient distribution. The main aim of production is to meet customers´ demands of particular products and the supply has to be effective so as to balance the demand at any point in time. Apart from manufacturing a product, what constitutes the chain is the demand and supply capabilities that makes ensure the manufactured product gets to the final consumer. Also, the essence of manufacturing and production companies is to organise and manage its resources to meet up production process. In creating a team philosophy that will be integrated between product design and distribution, factors like commitment, teamwork, multi-functionality, experience as well as proficiency would be required to achieve a quick and easy production time.

In terms of research question 1, we can say it is crucial for organisations to leave the old, one dimensional, tradition of either focusing on time to volume, quality or market since one of these factors cannot create a positive impact on ramp-up without including the others. Instead there has to be three dimensional views where all three factors are regarded equally important. Further on the ramp-up process must leap all the way from the very beginning of the product development until it reaches the final customer in order for a maximum productivity rate. Out of a supply chain perspective it is important that the capabilities includes timeliness and visibility of data, achieving partner as well as customer integration, promoting cultural, metric and reward integration as is illustrated by the GM case as well as the case of the “Project Four”. Outsourcing can also be a very efficient way of ramping up production, with the above taken into consideration, as the Nike and Apple cases illustrated, creating great return on equity while still remaining unique as a brand identity. The cases of Nintendo and Nissan illustrated the risks for a company to fail in the ramp-up process, but also the asset that a well functional ramp-up is capable of becoming.

In terms of research question 2, we can say that effective relationship between ramp-up product development and performance that is based on the results of their simulation underlining the significance of the relationship that binds both

product development as well as product performance, really help to influence the performance of rapid supply chain operation ramp-up in a manufacturing network. The conceptual model of the alpha model begins with proper and effective planning to get in time to market and from there it moves to ramp-up volume at the end of the planning horizon. However, it is important that a planning timeline is being implemented for effective and easy management of ramp-up production. The beta model integrates and analyses the production commercialization as well as the market analysis and the competitive advantage of the new product competition. Since supply chain ramp-up often demands single sourcing with a close relationship to the supplier the variations in efficiency as well as other supply factors can affect the entire chain. But we have observed that it can also be the very solution of such disruptions, as in the Nissan case described in chapter five. This is of interests since this would challenge the old philosophy who claims that multiple sourcing is the best way to ensure the incoming flow of goods.

## 6.2 Discussion

However, while placing much emphasis on the time to market and process improvement and developmental issues in isolation, both the production as well as design decisions that encourage new product development into the market are left unexplored. It is also observed that, the concept of production ramp-up is very similar and related to time to market. Analysing a model of production ramp-up together with the interactions between the various experimental productions and also learning yields indicates a viable time to market production process as well as ramp-up. Today, it is no doubt that managers of organisations have recognised the significance of enhanced production capabilities to support a fast growing strategy. For instance, the implementation of computer aided design/computer aided manufacturing (CAD/CAM) software promotes the initial design, testing as well as transfer of complicated designs to manufacturing processes that reduces time to market. Also the various aspects of manufacturing and production have recognised the significance of investments in the processes of improving new product development and time to market. The use of aggregate planning approach is another approach adopted by manufacturing

industries to adequately check or reduce time to market and also control improved manufacturing costs.

The whole process of production from design down to distribution with proper and effective management and information is to ensure an effective and efficient process. All the processes constituting the production process are discretely defined and to show and demonstrate a well and elaborate production process of goods so as to achieve time to market. However the procedural nature of the production process demonstrates or signifies a great deal of the various activities and functions of the production process. The mere fact that the production process takes into consideration customer requirements demonstrates that the production outcome of those processes involved is incorporated in the complete production process. More so, the function of the production process is very critical to the framework that has its success in effective distribution with effective management and proper information at the required place and time. Parallelism of various activities as well as the early involvement of all the relevant functions constitutes the production of a well planned and distributed product.

Effective and proper ramp-up production in manufacturing networks were analysed and also the supply of innovative new products to the market that increases rapidly with cost-effective prices. It is also analysed how manufacturing companies that are not market leaders create their own supply chain or numerous supply chains, so as to balance the uncertainty in the market to meet customer demands of their products. The research critically analysed the ramp-up time or production time interval between one cycle of producing a particular product and producing another product. This research was performed to compare how ramp-up production time to market and time to volume could be achieved in the production process. The research also greatly elaborated on the role of rapid production ramp-up in manufacturing industries towards achieving time to market.

The various capabilities required for supply chain operation ramp-up as well as the various aspects that influence performance of rapid supply chain operations

ramp-up were analysed. The research was performed to analyse how ramp-up production process is achieved through a product developmental process that includes design, procurement, pilot production, production as well as distribution with information and management. The whole process of production from design down to distribution with proper and effective management and information was analysed to see how effective and efficient production or manufacture process is undergone in manufacturing companies. All the processes constituting the production process are discretely defined and to show and demonstrate a well and elaborate production process of goods so as to achieve time to market. However, production and manufacturing using ramp-up production process could be achieved with effective supply chain performance that influences capabilities within a manufacturing network.

### 6.3 Further research

A study should be conducted where the principals of ramp-up is applied in order to verify the conclusions of the thesis. Also the connection between ramp-up and lean production should be further researched in order to get deeper knowledge about its effects on the ramp-up capabilities as well as to investigate any synergies that may occur. Another relevant area of research would be the effects of efficient ramp-up in order to suppress fluctuations in the supply chain process.

Future research could focus on case studies rather than Meta in order to evaluate the Meta conclusions. They would have to include several companies in different areas of business in order to obtain relevant data and conclusions about the three base pillars of ramp-up; TTM, TTV and TTQ. Also, in order to eliminate any potential outliers, the companies would have to be organisations of sufficient size so that the research could be performed in the different stages of production and preferably in large quantities of products. With this said an extensive Meta study with deeper analysis of the connection between ramp-up and lean production has to be conducted before any case study concerning possible synergies as well as capabilities.

## CHAPTER SEVEN

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