DOCTOR OF PHILOSOPHY

Effective integration of operations strategy for manufacturing SMEs

integrating decisions and decisions and actions with time tactics to improve the strategic role of operations

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Award date:
2019

Awarding institution:
Coventry University

Effective Integration of Operations Strategy for Manufacturing SMEs: Integrating Decisions and Actions with Time Tactics to Improve the Strategic Role of Operations

By

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May 2018

A thesis submitted in partial fulfilment of the University's requirements for the Degree of Doctor of Philosophy

Content removed on data protection grounds

Certificate of Ethical Approval

Applicant:

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Project Title:

Manufacturing strategy alignment: Continuous Improvement and Balanced Performance Measures Framework

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

Date of approval:

13 April 2016

Project Reference Number:

P31932

DECLARATION

I declare that the work in this dissertation was carried out in accordance with regulation of the Coventry University. The work is original, except where indicated by special reference in the text, and no part of the dissertation has been submitted for any other academic award. Any views expressed in the dissertation are those of the author.

Adam Shukry Bin Ali

May 2018

To Hazwani, Maryam, Mum, Dad, Ayah and Mama
Thank you for the love and encouragement

ACKNOWLEDGEMENT

I would like to gratefully acknowledge contributions made by a number of people, who supported me throughout the development of this work.

First of all I would like to express my heartfelt gratitude to my Director of Studies, Dr. Ivan Arokiam for his professional guidance, unwavering support and patience through adversity during development of this study. I am honored to get his trust and confidence in my ability.

I would also like to extend my appreciation to Dr. Richard Anderson, Prof. Keith Popplewell, Jean-Marc Vasnier, Dr. Owen Richards and Dr. Mark Hooper for their expertise, guidance and constructive ideas. My acknowledgement also goes to PhD students in the Faculty of Engineering and Computing (EC) for their kind cooperation and support.

A special appreciation goes to Majlis Amanah Rakyat and Kolej Universiti Poly-Tech MARA for the sponsorship that made this study possible.

Sincerest thanks to my friends Boq, Syaf, Shimi, Amy, Ijhar, Aid and others for their kindness and assistance during my time in Coventry. To those directly and indirectly involved in this study, your support means a lot to me.

Finally, earnest gratitude to all my family members for the continuous encouragement, sacrifice and support throughout the process of completing this work.

ABSTRACT

Challenges and uncertainties resulting from the volatile global market environment require organisations to operate efficiently, hold on to their market share and increase product value to stay competitive. Achievement of these goals depends on a number of factors. One of the routes that are pivotal to a positive contribution is the effective development of operations strategy. This requires visibility of the current level of the organisation that will help direct the strategy in the appropriate direction to achieve maximum benefit. Additionally, if the organisations can get a good understanding of their current positioning and level, they can proactively pursue to move to the next level.

While the above mentioned may seem straight forward, it is not due to various reasons. There is also the absence of effective routes to facilitate organisations to take this step with confidence. The lack of some form of guidance and informal nature of operations can be an issue especially for Small and Medium Enterprises (SMEs). Understanding the key problem and gaps will establish suitable guidance in this area that organisations can use. The core of the thesis concerns these developments.

The thesis aims to investigate the process of improving manufacturing SME operations. This is by exploring actions taken by 'competitive SMEs' to discover decisions, actions, practices and tools which contribute towards improved operations and competitiveness. The research adapted mixed-methods qualitative and quantitative enquiry by combining the use of questionnaire, interviews and Delphi.

The findings reveal that to be competitive, the role of operations should be shifted towards attaining quality and dependability capabilities. The process can be initiated by starting improvement activities, consisting of making decisions and carrying out actions which contribute towards improvement in quality and dependability. To get an effective result, improvement activities are suggested to be implemented within 3 years and included within short to medium term strategic planning.

There are four original contributions made by the research. First, it provides the tools and actions required to improve manufacturing SMEs operations. Second, a timeline is provided to show when the tools and actions should be carried out. The tools, actions and timeline are integrated by creating the Action-Time Framework (ATF). Fourth, it contributes by designing a research method which can be used to examine taxonomy-type framework and increase data validity. Finally, the data used for the development of the framework was derived by experiences from real SMEs managers, owners and expert panel which have a vast knowledge regarding operations in manufacturing and improvement programs.

In general, the thesis addresses the need to establish a framework by creating the ATF, which provide support to organisations by not only giving directions on where it should be and how to improve but also providing guidance when actions should be initiated. In the end, it will benefit a new start-up and also organisations which is still unclear about the strategic operations direction that should be pursued.

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LIST OF ABBREVIATIONS

ATF	Action-Time Framework
BP	Best Practice
CEO	Chief Executive Officer
CI	Continuous Improvement
CIS	Competition Intelligence System
CNC	Computer Numerical Control
ERP	Enterprise Resource Planning
FMEA	Failure Mode and Effect Analysis
FMS	Flexible Manufacturing Systems
FSM	Four Stage Model
JIT	Just in time
MRP	Materials Requirement Planning
MS	Manufacturing Strategy
OEM	Original Equipment Manufacturer
PDCA	Plan-Do-Check-Act
PM	Performance Measures
R&D	Research and Development
SDCA	Standardise-Do-Check-Act
SMEs	Small and Medium Enterprises
TQM	Total Quality Management
WIP	Work In Progress

PUBLICATIONS

Ali, A., Arokiam, I., Anderson, R., Popplewell, K. and Vasnier, J., M.,. (2017) ‘Effective Integration of Manufacturing Strategy’. 7Th *International Conference on Industrial Engineering and Operations Management*, April 11-13, Rabat, Morocco.

Effective Integration of Operations Strategy for Manufacturing SMEs: Integrating Decisions and Actions with Time Tactics to Improve the Strategic Role of Operations

"Surviving in this new business world is totally dependent on the company's ability to create its own competitive capabilities to face local and international competition." (Shaaban & Awni 2014: 393)

Chapter 1: Introduction, Research Background and Overview

1.1 An Overview of Manufacturing SMEs in The UK

The manufacturing industry in the UK accounts for 10 per cent of the economy, employing 2.6 million people and contributing to £148 billion UK gross value added (GVA) in 2013. The increase in industry competitiveness could boost the UK economy around £30 billion by 2025 (HM Government Department of Business, Innovation and Skills 2015). The sector is not only consisting of large manufacturers but also supported by suppliers who are largely small and medium-sized enterprises (SME) which remain an integral component to the sectors. The sector faced challenge provided by globalisation and economic liberalisation, where strong competition emerges from low-cost economies in addition to other industrialised nation such as Japan, South Korea and Germany (Global Manufacturing Competitiveness Index Rankings 2016). To keep up with the changes in the competitive environment faced by the manufacturing SME, the UK government (Department of Business, Innovation and Skills 2015) had suggested support to be directed in several areas namely:

1. Strategic management and leadership capability,
2. Development of training strategies to meet future skills need.
3. Access to the right finance.
4. Brand improvement.
5. Making the right connection with buyers.
6. Meet standards of (Original Equipment Manufacturer) OEM demands.
7. Finding the right innovation support.

It is important for the SMEs to get the right support for them to remain competitive. With the current trends of outsourcing, the role of SMEs has become more prominent as they contribute to the growth of many national economies and act as an ancillary industry for large companies (Dangayach and Deshmukh 2001). Therefore, it needs the right support provided by the government, large multinationals as well as research and academic institutions. In light of this, the research is intended to provide a contribution from an academic point of view on the process of becoming a competitive enterprise.

1.2 Motivation

The research is motivated to understand how decisions are made within manufacturing SMEs, which enable them to compete with their rivals. It is driven by the belief that every organization has the potential

to grow if the right decisions are made. On the contrary, many SMEs were content with maintaining their 'status quo' and as a result, holding them back. This best summed up by the following authors:

"Their strategy is to continue with their current product and customers regardless of changes in market or environmental situations. They considered it to be a low risk strategy, but clearly in a rapidly changing market this is a high risk option, and many were seen to decline in the face of market shifts or legislative changes."

(Mosey et al. 2002: 176)

"A typical SMEs characteristics can be summed up as being reactive, having fire-fighting mentality, resource limitation, informal strategies and flexible structures. As a consequence, they tend to have a failure rate higher than the larger organisations."

(Terziovski 2010: 892)

In contrast, the compact size and informal characteristics SMEs should not be viewed as limitations, rather an advantage allowing faster adaptation to change, quicker response to customer requirements and better communication due to flat organisational structure. These are highlighted by the following authors:

"SMEs have more flexible structures, less bureaucratic procedures, a more responsive climate to go ahead with new and ambitious projects – flatter hierarchies making them more able to accept and implement change."

(Arbussa et al. 2017: 277)

"Majority of SMEs have simple system and procedures, which allows flexibility, immediate feedback, short decision making chain, better understanding and quicker response to customer needs than larger organisations."

(Kumar and Singh 2017: 635)

The above statements provide some indication that SMEs limitations should work to their benefit if it can be positively exploited. Therefore, the research intends to investigate the transformation process of becoming competitive SMEs, in the end providing guidance on how this process can be replicated.

The work is important as SMEs need to be adaptable to changing market environment and also competitive in ensuring their survival, as their presence provides significant contributions by creating jobs, skilled worker as well as products and services. Consequently, it is imperative to understand how they can become competitive and the way it can be achieved, particularly for manufacturing SMEs.

1.3 The Strategic Role of Operations

The dynamic nature of today's competition requires companies to respond quickly to changes within their external environment. There are many forces that shape how companies are going to operate: influence of suppliers which look for better value, changing government legislation, demanding customer and shareholders that requires a better return on investment. As a result, companies are under great pressure to respond to change set by the external forces.

In order to respond to the above changes, the role of operations should be guided by strategic goals and choices, depending on market and capabilities a company have. To achieve this, the evaluation of market and capabilities has to be conducted to determine competitive priorities for the company and tuning the operations in accordance with priorities that have been set. Failure to address this will result in a set up of operations which no strategic direction and eventually leading to negative outcomes.

In manufacturing, for example, a general assumption by top-level management that cost should be the key to successful operations will lead them to set up manufacturing operations which are low in operation costs, but at the expense of delayed order and a high number of defects. In addition, the tendency to adopt expert views, best practice or sudden technological upgrade without consulting the operations function will lead to the wrong adoption of strategies and in the long run would cost a lot of effort and time to rectify. Solving these problems is a daunting task for manufacturing SMEs, which face a higher risk of failure due to their size and resource restrictions.

1.4 Research Aim

To address the above problems, the aim for the research is constructed to explore key evidence in the form of actions and motives that leads to the improvement of operations. It considers investigating strategic operational decision that contributed to manufacturing SMEs competitiveness. Specifically, the research aims *to investigate the actions, the reasons they are carried out and how they are integrated in order to improve the strategic role of operations and competitiveness within manufacturing SMEs*. Findings gathered from the research can be used by manufacturing SMEs to set their operations strategy configuration. Similarly, it can be a reference for policy-makers in channelling funds and drafting regulations to help and protect SMEs that operates in the manufacturing industry.

1.5 Research Objectives

Six objectives are created in line with the above aim. They are listed as follows:

- Conducting a literature review on manufacturing strategy taxonomies.
- Creating appropriate instruments for data collection.
- Investigating areas of improvements within manufacturing SMEs operations
- Investigating the drivers of improvement in manufacturing SMEs and;
- How those improvements are pursued, obtained and in the end;

- Developing a framework integrating the above findings by including time and action plan.

A research question is established to support the aim and objectives. The next section will justify the formation of the research question.

1.6 Research Question Identification

World class manufacturing has been the term used in projecting the pinnacle of operational excellence. Achieving the status demands continuous commitment to improve, by doing things better, faster, cheaper and being more agile (Digalwar *et al.* 2013). SMEs may find this difficult to achieve because unlike larger organisations, they are difficult to 'benchmark' (Abdullah 2010). This due to their diverse nature and forms. They operate in different sizes and involve in traditional business, leading to the use of non-standard tools and techniques. Nevertheless, research conducted by Kathuria (2000), Sum *et al.* (2004), O'Regan and Ghobadian (2006) and Andersen (2012) shows that with an effective strategy, SMEs can achieve a similar status by becoming trendsetters and competing in multiple capabilities.

This notion has led to a question of *how can manufacturing SMEs improve its strategic role of operations and competitiveness?* Despite the fact that it can be answered by referring to fundamental work by analysing competitive forces (Porter 1996), emergent strategy (Mintzberg 1994: 23) and diversification (Ansoff 1984: 155) there is little work that investigates this process specifically in manufacturing SMEs, which is the subject of this research. To understand this scenario, an investigation is needed to evaluate decisions, actions and the way it is integrated by manufacturing SMEs in improving their operations and subsequently, competitiveness. The research intends to explore how companies can improve their position by using manufacturing strategy taxonomy as a reference.

Manufacturing strategy taxonomy is used because it classifies organisations according to its strategic configurations such as competitive priorities, market segmentation and investment decision (Frohlich 2001). Additionally, it reveals insights into the underlying structures of competition from the viewpoints of operations (Zhao *et al.* 2006). Therefore, an investigation can be conducted to discover the process as well as the organisation's motivation for choosing a particular strategic and operations configuration. Importantly it will lead to the discovery of operation areas that can be improved and the way improvement can be carried out. In order to achieve this, the study will provide answers to the identified research question of:

How can manufacturing SMEs improve its strategic role of operations and competitiveness?

Answering the research question requires an investigation to cover areas that are related to performance improvement in SMEs, drivers of improvement as well as evaluating related frameworks. In the end, the investigation outcome can be used to create a practical framework and give a contribution in the form of

new knowledge. The initial step in finding the answer to the research question is by establishing the research area. The steps involved in establishing the area are explained in the following section.

1.7 Establishment of Research Area

The study started by conducting an exploratory visit to a local manufacturing plant to gain insights on the way strategies is being implemented. The manufacturing plant, operational since the middle of World War II has been involved in multiple strategic transformational programmes. This has enabled them to keep their presence in the industry for over 70 years. General ideas obtained from the visit were used as a guide in searching for related literature. A further understanding is developed by attending a subject-specific module focusing on manufacturing strategy development.

This understanding is further advanced by reviewing related literature on manufacturing strategy framework. Works surrounding the frameworks are reviewed before a research gap is established. Finally, feasibility studies on the identified gaps are conducted. This is to assess the research viability in terms of gaining access, cost, support and most importantly can be completed within an allocated time. *Figure 1.1* shows the process of identifying and establishing the research area.

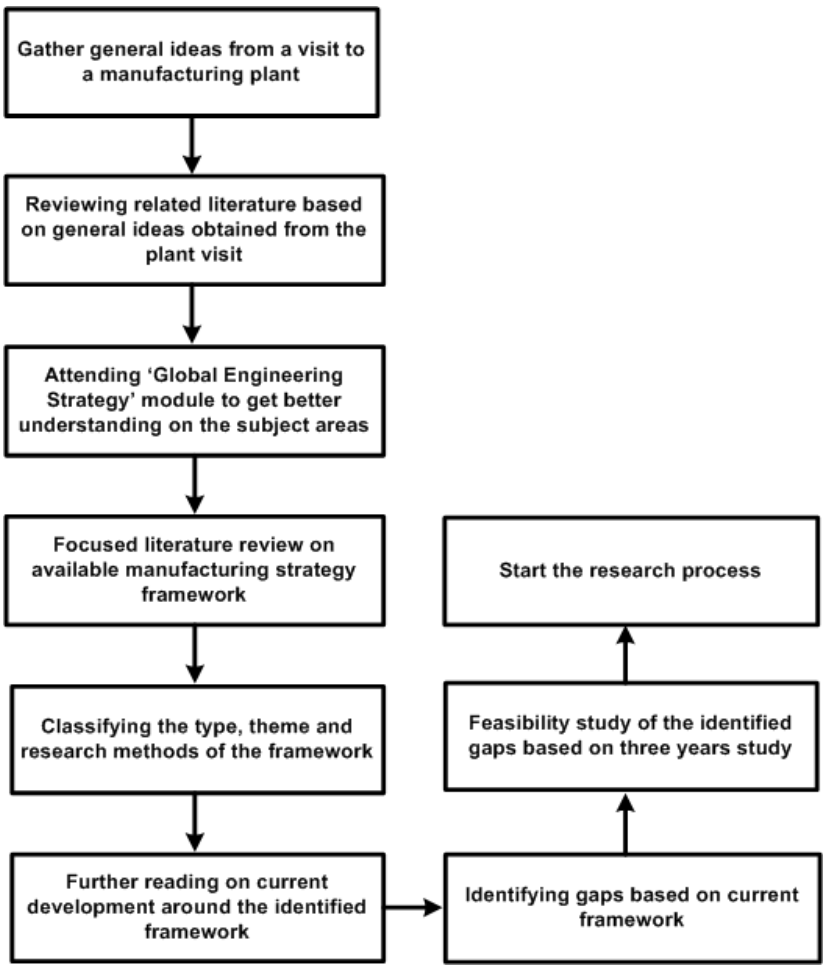


Figure 1.1: Research area identification process

The feasibility study allows for a plan to be established in conducting the research. Plan will include the identification of possible organisation, data collection methods and potential outcomes. Once this is in place, the research process can be initiated. In the end, a thesis is produced as a report and for future reference. The following section will describe the way this thesis is structured.

1.8 Thesis Structure

Each chapter will start with an introduction, setting a scene and giving readers a brief overview of the chapter. There will be a conclusion at the end of a chapter, summarising its contents. The thesis is structured in the following way:

Chapter 2: Literature Review and Initial Investigation

Chapter 2 presents a discussion on works of literature covering manufacturing strategy and its related areas such as competitive priorities, best practices and actions to support strategy implementation. The chapter discusses and evaluates available framework, types, current work and the gap in knowledge. In addition, the chapter presents a literature review based on the findings from initial investigation conducted at the beginning of this research. Results from the evaluation and discussion from this chapter will be used to justify a framework that will be selected as a guide in answering the research question.

Chapter 3: Methodology, Research Design and Data Collection

This chapter aims to explain the stance of philosophical understanding, its selection and strategy of conducting the research. There will be evaluation and justification for the selected research methods. Also, there are discussions on the underlying research design which includes the process of designing data collection techniques and selection of respondent.

Chapter 4: The Proposed Framework and The Development Process

The chapter presents the process undertaken to create the framework. It is presented to link chapters in this thesis with the process of developing a framework. The proposed framework is introduced together with a description of the way it should work. The practical implications and framework contribution completed the discussion in this chapter.

Chapter 5: Phase 1 Questionnaire and Phase 2 Interview Results and Analysis

The result and analysis are divided into two chapters due to the data collection process which is conducted in four phases. The first chapter will explain the result and analysis from the phase 1 questionnaire and phase 2 interviews.

Chapter 6: Phase 3 Delphi, Phase 4 Questionnaire and Validation Results and Analysis

The second chapter will discuss results obtained from phase 3 and 4 data collection which are Delphi and questionnaire. The proposed framework will be validated to test its applicability with actual manufacturing SME. Validation results are presented at the end of this chapter.

Chapter 7: Discussion and Evaluation

The chapter comprises the research summary and analysis of the findings. Evaluation will be conducted to assess the research quality, validity and outcome. The summary of the objective accomplishment is included in this chapter. Further, the chapter explains the contribution of the work to the body of knowledge and the research limitations.

Chapter 8: The Research Conclusions

Chapter 8 will provide overall research conclusion. Highlights on the overall findings and the original contribution to knowledge are presented in this chapter. Additionally, opportunities for future research, concluding remarks and personal reflections of the author are also included.

1.9 Conclusions

This chapter provides a general view of the research by describing its importance and the motivation behind its undertaking. It also provides the aim, objectives and the process of identifying the research areas. In this chapter, the research question is developed to set the scene for the investigation. In the end, an overview of the thesis structure is provided to summarise the thesis contents. Chapter 2 will review the related literature, leading to the identification of the research gap and related areas to be investigated.

Chapter 2: Literature Review and Initial Investigation

2.1 Introduction

Most companies share access to the same process, technology and practices (Sharma and Talwar 2007; Singla *et al.* 2017). In the same way, structures, systems and other infrastructure elements are equally universal (Harrington 1997). What makes a company different is the way they aligned operations with process and infrastructure to create competitive advantage (Hill and Hill 2009: 17). In the past, organisations compete based on past success factors such as assets, pricing, location and products. The knowledge-based economy has transformed the way business conduct their operations, and managers realised the key to compete lies with their employees to innovate and generate new ideas (Pangakar and Kirkwood 2008).

According to Morden (1999: 113), business planning and strategic management are the most important responsibilities of managers whether in the SMEs, private, public, profit or non-profit companies. He further explained that business strategies determine how the enterprise intends to carry out its business during the time horizons to which it is working. There are various interpretations of business strategy and sometimes it is difficult to distinguish it with the competitive strategy. However, these two terms are not different but they are linked together. Sohrab *et al.* (2013) best described the link between the two, by explaining business strategy is a way of companies to achieve competitive advantage, and it is used as an instrument of competition in a competitive market.

Hill (2005: 33) explains large firms might have many business units contributing to a total business, the business units will have their own strategy, for example, a car manufacturer might have more than one product and this product have their own strategic direction. Porter (1996) argues that operational efficiency is not a strategy and benchmarking will eventually lead to companies having the same capabilities. As a result, Porter identifies three distinctive strategies a firm could pursue. They are differentiation by offering unique product or services, cost by competing based on price and focus by offering specialised products and services in a niche market.

Wickham Skinner highlights the ‘strategy’ issues on the US industrial organisations where the flaw of strategies formed by top managers failed to connect to the manufacturing function, even when they are using the best systems (Skinner 1969, 2007). This has led to the generation of new term ‘manufacturing strategy’ which was introduced by Skinner in *Harvard Business Review* (1969).

The past 30 years, research on manufacturing strategy has seen growth since the original idea was introduced. However, most of these work focused primarily on parts of the idea, simplifying and elaborating rather than expanding (Voss 2005). Information on terminologies which will be used throughout the thesis can be referred to *Appendix 1*.

2.2 Manufacturing Strategy

Strategic discussion on manufacturing are often neglected by managers due to the assumption of manufacturing are merely a collection of resources, constrain and was expected to fulfil efficiently the target that has been set by the other higher profile functions, such as marketing and finance (Dangayach and Deshmukh 2000). The idea by Skinner (1969) on 'the missing link' has created interests and since then, firms have realised exploiting a certain manufacturing function can be a powerful weapon to obtain a competitive advantage.

The manufacturing strategy (MS) has been interpreted by various researchers. Hayes and Wheelwright (1984: 32) define it as consisting a sequence of decision that, over time will enable business unit to achieve the desired manufacturing structure, infrastructure and a set of capabilities. Hill (1987: 23) stated MS represents a coordinated approach from manufacturing to create a distinct advantage in the market place, while Amoako and Acquaah (2008) suggested that MS add details to competitive strategy. Manufacturing competitive priorities are the most important components which guide a MS setup. They define strategic preferences or the dimensions along which a company chooses to compete in the targeted market (Russell and Millar 2014). It is widely accepted that academics agree on the generic components of manufacturing competitive priorities. *Table 2.1* shows its interpretations from several authors.

Table 2.1 Manufacturing competitive priorities

Authors	**Manufacturing competitive priorities**
Hayes and Wheelwright (1984)	Cost, quality, dependability, flexibility
Hill (2000)	Price, delivery reliability, delivery speed, demand increases, product range, design, distribution
Dangayach and Deshmukh (2006)	Cost, quality, delivery dependability, delivery speed, flexibility, innovation
Martin-Pena and Garrido (2008b)	Cost, flexibility, quality, delivery, after-sales service, environment protection
Slack and Lewis (2011)	Quality, dependability, speed, flexibility, cost

There are various methods used by firm and academic to develop manufacturing configurations, which in the end created a MS. Dangayach and Deshkmukh (2001) discover 260 papers relating to the MS literature from its inception from the year 1969 up to 1998. It demonstrates that there is a vast study which had looked into the same area and the work is still evolving to this day. Bozarth and McDermott (1998) bring up the issue of difficulties in categorising those frameworks as a result of having a large amount of them in the literature. He came out with a description which categorises the MS framework into two groups namely: typology and taxonomy. This is later adapted by Martin-Pena and Garrido (2008a) see *Table 2.2*.

Table 2.2: Difference between MS typology and taxonomy

	Typology	Taxonomy
Definition	Ideal types.	Classification of real organisations in representative and mutually exclusive groups.
Objective	To match one of the ideal types theoretically proposed to obtain better results.	To obtain stable groups by using several techniques and data samples.
Approach basis	Mostly conceptual.	Mostly empirical.
Key features	Generic theories for all type and theories for each type. Can be empirically tested.	Right choice of classification variables. Not influenced by techniques of samples. Can be used to generate knowledge.
Result of procedure	It is formed before classifying organisation into class. Previous theories are used rather than using empirical data.	Emerges from empirical process to describe groups of companies on the degree of similarities between variables or characteristics.

Table 2.2 shows the key differences possessed by the two types of MS framework. Of the two, the research is interested in looking in-depth into the MS taxonomy. This is due to three reasons: first, the methods used to classify the group are the representation of a real organisation. Second, it allows generation of knowledge that can further the understanding of a phenomenon thus generating new theories. Third, it overcomes the limitation of typology, which trying to match ideal companies which could fit in with the framework. Taxonomy allows the variations of manufacturing organisations to be grouped into the right choice of classification variables (Martin-Pena and Garrido 2008a).

The above discussion highlights the main areas the research intended to explore. However, it is also important to review examples of MS typology framework, before going in-depth to look at the work related to MS taxonomy. The following discussion will review three main MS typology framework.

2.3 The Manufacturing Strategy Typology

In principle, the MS typology describes the ideal process to develop MS. There are different perspectives on how this approach should be taken and external forces such as customer, market and the competitive environment has a big influence in directing a company MS. Amoako and Acquaah (2008) and Lowson (2001) suggested the type of MS that companies implement is dependent on their chosen competitive strategy: namely cost, differentiation and focus. This is as were advocate by Porter (1996). In other words, the manufacturing competitive priorities are determined by the adoption of competitive strategy.

For example, business units that choose a higher level of differentiation would tend to focus more on manufacturing processes, product quality and variety of product offerings. The process of formulating MS can be explained by referring to the three MS framework in the following paragraph.

2.3.1 Hill (2000: 32) Manufacturing Strategy Framework

Hill (2000: 36) suggests identifying the market requirement by analysing current firm position separating them into two categories: order qualifiers and order winners. In order to become order qualifiers, a company must have the criteria for a customer to even consider it as a possible supplier. Order winners won the order from customers and have unique elements that distinguish them from order-qualifiers. Hill (2000: 31) state there are five steps to help link manufacturing to marketing with the corporate strategy development (a detailed framework *Figure 2.1*):

Step 1: Define corporate objectives.
Step 2: Determine marketing strategies and meet these objectives.
Step 3: Assess how different product qualify in their respective markets and win orders against competitors.
Step 4: Establish the appropriate process to manufacture these products (process choice).
Step 5: Provide manufacturing infrastructure to support production.

Corporate objectives	**Marketing Strategy**	**How do products qualify and win orders in the market place?**	**Manufacturing strategy**	
			Process choice	**Infrastructure**
Growth Survival Profit Return on investment Other financial measures	Product markets and segments Range Mix Volumes Standardisation versus customisation Level of innovation Leader versus follower alternatives	Price Quality conformance Delivery speed reliability Demand increases Colour range Product range Design Brand image Technical support After-sales support	Choice of alternatives processes Trade-offs embodied in the process choice Role of inventory in the process configuration Make or buy Capacity size timing location	Function support Manufacturing planning and control systems Quality assurance and control Manufacturing systems engineering Clerical procedures Compensation agreements Work structuring Organisational structure

Figure 2.1: Hill's Manufacturing Strategy Framework (Hill 2000: 32)

First of all, the framework emphasis on marketing – manufacturing link, this shows that the approach is top-down, where MS is determined by much the input from the marketing strategy. Next, the competitive criteria are represented by order winners and qualifiers. The order winning criteria are market and time specific.

Dangayach and Deshmukh (2006) argued that order qualifiers are dynamic in nature. For example, criteria for order winners today might change to order qualifiers in the future due to the competitive squeeze. As a result, reviews on the market requirement need to be conducted consistently. However, a sole focus on the market forces to create MS will delay the development of capabilities. This is due to the frequent changes in the market environment which may as well shift the pursuance of competitive priorities before any capabilities can be achieved. Therefore, companies needed to strike a balance between responding to their market and also gradually increasing manufacturing capabilities.

2.3.2 Voss (1995) Manufacturing Strategy Paradigm

The work by Voss (1995) explains further the idea of using competitive environment as the main tool to formulate the MS. The paradigm of manufacturing strategy is based on previous research and firm practice, where the firm's strategy adoption is according to how they want to compete.

<table>
<tr><th></th><th>Competing through manufacturing</th><th>Strategic choices in manufacturing</th><th>Best practice</th></tr>
<tr><td rowspan="3">Key concepts</td><td>Order winners

Key success factors

Capability

Generic manufacturing strategies

Shared vision</td><td>Contingency approach

Internal and external consistency

Choice of process

Process and infrastructure

Focus</td><td>World Class Manufacturing

Benchmarking

Process re-engineering

Total Quality Management

The Japanese way

Continuous improvements</td></tr>
<tr><td colspan="3">Process</td></tr>
<tr><td colspan="3">Measurement</td></tr>
</table>

Figure 2.2: Manufacturing Strategy Paradigm (Voss 1995)

Voss (1995) further elaborate, that the key concept should not be seen as a stand-alone approach, but should be seen as a system as a whole. For example, once a firm has decided what the order-winners

criteria are, they would assess their focus on the strategic choices, then they would adopt what is the best practice and align them by using process and measurement.

The MS paradigm, however, is being criticised by Spina (1998) citing that the framework put limitations to innovation and narrowing the scope of what firms can achieve by putting best practice as the final outcome. This is because, best practices tend to be copied quickly and in the end, it would lead competing firms becoming similar to each other (Brown *et al.* 2007; Lowson 2001; Porter 1996). He argued firms should design their own MS by evaluating their own resources and capabilities.

2.3.3 Slack and Lewis (2011: 21) Operations Strategy Matrix

Slack and Lewis (2011: 2) changed the term manufacturing strategy to 'operations strategy' to show the inclusiveness of their framework to organisations that have some mix of product and services. They agree the most commonly used process to create fit or alignment started with a market requirement and then align resources to match them. However, they conclude there is no universal argument about how operations strategy should be described (Grant *et al.* 2013). Based on the conclusion, four perspectives emerge:

- Top down - MS should interpret higher level strategy.
- Bottom up – MS should learn from day-to-day experience.
- Operations resources – MS should build operations capabilities.
- Market requirement – MS should satisfy the firm market.

Slack and Lewis (2011: 11) identifies one of the creations of manufacturing strategy is based on day-to-day experiences. In their opinion, not all business is good at identifying their market and some of them are having a hard time identifying their capabilities let alone the distinctive capabilities. Therefore, in creating a higher level strategy, top management needs to have input from the individual function of the firm based on their experience over-time.

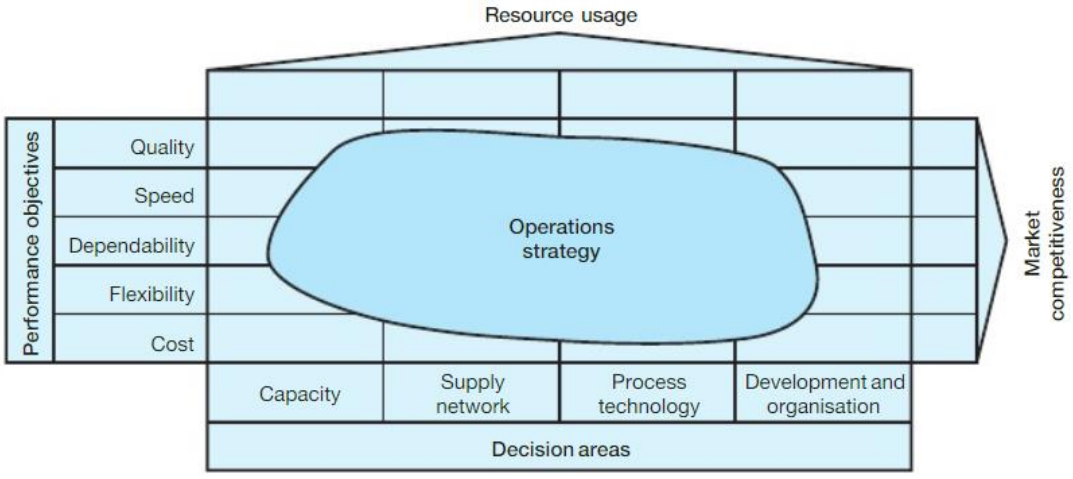


Figure 2.3: Operations Strategy Matrix (Slack and Lewis 2011: 21)

The term can be known as ‘emergent strategy’ as a strategy can become clearer overtime after firm realise their way of operations on a daily basis are the right thing to do (Kim *et al.* 2014; Mintzberg 1994: 23). It can be easily related to the Japanese principles of Kaizen or Continuous Improvement (CI), which promotes gradual improvement over time. This is useful when most of the market that the firm is in, usually are dynamic and unpredictable. Therefore, it is believed it would be suitable for a company that has a hard time trying to figure out how they can perform best. There is a caution to this approach as it would take a substantial time to realise the strategy that fit the firm due to the long process of learning. It is, however, a journey worth to take. Bessant and Francis (1999) agree on the time-consuming process of building up capabilities in CI initiatives, but they pointed out competitive advantage created out from CI are unique and are hard to copy or transfer.

In order to address the problem of identifying market requirements and capabilities, Slack and Lewis (2011: 21) come out with the Operations Strategy Matrix (*Figure 2.3*). One of the distinctive features of the framework is that it tries to reconcile performance objective, resource usage, decision areas and market competitiveness. Although it is conceptually simple, the application on the framework and the analysis are limited in the literature. Slack *et al.* (2004) further elaborate on the dynamic nature of the market, capabilities and constraints of operation resources; it is hard for companies to maintain the fit between the two.

2.3.4 Conclusion on Manufacturing Strategy Typology

The idea of ‘step-by-step’ or ‘universal’ MS formulation is still left unanswered. Golec (2014), Grobler (2006) and Swamidass *et al.* (2001b) agreed that there no such ‘systematic’ approach to create MS. As organisations are unique in their own way, trying to fit their operations according to the typologies may not be the best approach to create MS. This may be the biggest factor that hinders researcher from furthering the work by Slack and Lewis (2011: 21), Voss (1995) and Hill (2000: 31). In this case, it is found that there is no related work that tests these typologies, apart from validating order winners and qualifiers from Hill (2000: 36). This instance supported this research argument of looking at MS taxonomy which is empirically tested and to find gaps to further generating knowledge. The following section will review framework categorised under MS taxonomy.

2.4 The Manufacturing Strategy Taxonomy

The main approach of developing taxonomy-type framework is by setting the classification rules. The enquiry is based on the set rules before grouping is done as the findings or conclusion. The discussion in the following sections revolves around the rules that are set during the enquiry, the geographical location and the size of the data. Also, particular attention is given to the type of companies involved to make sure the samples are related to manufacturing organisation, especially SMEs.

2.4.1 Miles and Snow (1978: 29)

The framework is from the interpretation of existing literature and continuous studies on four industries in the US, namely college textbook publishing (16 firms), health care (19 hospitals), electronics, food processing and health care (49 companies). The framework informed the alternative strategies companies adopted and the structure as well as the process involved, mainly describing their behaviour towards competitors (Miller and Roth 1994). They identified three problems of organisation adaptation cycle: acceptance to a particular product-market domain, the creation of systems to accept the particular product-market domain and reducing uncertainty within the previous two adaptations cycles. They went to create a classification showing how organisations move within the cycle by classifying it into four phases:

- Defenders – Organisation which relies on a certain market niche. Managers in these organisations are expert in their organisation limited area of operations and look to maintain their position in an established market. The objective of their decision is improving efficiency in their current operations.
- Analyser – Operate in stable and changing of product market-domain. In a stable market, they have a formalised structure and process. In the other market, they always look for opportunities particularly within their competitors and try to adopt those they deemed promising.
- Prospectors - Continually looking for market opportunities. They regularly adapt to changing environmental trends. Usually innovators, their competitors are likely to respond to change introduced by them. More emphasis is put on innovation compared to capability.
- Reactor – No consistent patterns of decisions. Therefore, they did not have a long term goal. They seldom make an adjustment on strategy until forced to do so by environmental pressures.

The taxonomy shows a different approach taken by companies towards its market environment by looking at specific strategies and the way decisions are made. O'Regan and Ghobadian (2006) tested the model on 194 UK small and medium engineering firms. They found high proportions of the SMEs surveyed are classified 'prospectors' followed by 'defenders'. They come to the conclusion that 'analyser' and 'reactors' are not appropriate to the SMEs surveyed. This shows an indication of companies which tend to ignore the new opportunities and market and put more focused on defending their existing markets once they have established their presence. On the other hand, 'prospectors' type firms emphasize external orientation and staff creativity to drive innovation and customer satisfaction, while 'defenders' emphasize internal orientation and control strategy mainly to avoid problem areas.

2.4.2 Hayes and Wheelwright Four Stage Model (1984: 396)

Hayes and Wheelwright (1984: 33) suggest two criteria for evaluating MS. First, is consistency between internal and external forces where firms need to find the right balance between resources available, competitive behaviour, government restrains and other functional strategies. Next is a contribution, where manufacturing should be given more attention when setting competitive priorities. This will result in

manufacturing capabilities which are relevant to competitive priorities. In order to evaluate the strategic role of the manufacturing function of a company, Hayes and Wheelwright (1984: 396) developed a four-stage model. In their opinion, there are four ways of how a company view the role of its manufacturing function. See *Figure 2.4*.

Stage 1 - Minimise Manufacturing's negative potential (Internally neutral)
Manufacturing is viewed as a function that needs to be operated without a major problem. Most of the time, experts are used in solving strategic management issues. Top management believes investing in new technologies and equipment, but lack emphasis on improving planning and measurement system.
Stage 2 - Achieve parity with competitors (Externally neutral)
Industry practice in equipment, process and employee policies are adopted, with the aim of achieving parity with competitors. Operations planning include units outside manufacturing and capital investment is favoured means to achieve a comparative advantage.
Stage 3 - Provide credible support to the business strategy (Internally supportive)
Firms expect manufacturing functions to provide credible and significant support to its overall business strategy. A decision is screened to make sure that they are aligned with the business strategy.
Stage 4 – Pursue a manufacturing – based competitive advantage (Externally supportive)
Manufacturing capabilities are expected to play a major role in achieving business strategies. Investment in an in-house process and product improvement are on-going with the aim of becoming a leader in the industry. To some extent, manufacturing strategy is actively involved in making major decisions for the company.

Figure 2.4: The Four Stage Model (Adapted from Hayes and Wheelwright 1984: 396)

The Four-Stage model is a taxonomy of an evolutionary approach on transformation production went through until being considered a functional area of strategic importance and essential competitive edge in any organisation (Martin-Pena and Garrido 2008a). The model provides a reference in determining manufacturing strength and hence possible direction to pursue, thus becoming a diagnostic tool that can be used to appraise manufacturing role within a firm (Gilgeous 2001; Jain *et al.* 2013).

It must be noted that the position of the company along the stage can ascend or descend from one stage or the other. The taxonomy can be useful to managers in providing the strategic direction on where they are currently at and where they should be. Even though the work is widely accepted by academicians, Hayes and Wheelwright did not describe how a firm should go from one stage to the other. Swamidass *et al.* (2001b) tried to bridge this gap by conducting further work on the model. However, their work is only limited to identifying the type of strategic decision approach that took place in each of the stages.

2.4.3 Miller and Roth (1994)

Three distinct clusters of manufacturing strategy groups were observed by using a sample of 164 large American manufacturing business units from 1987 Manufacturing Futures Project Survey. The instrument that was used in the study includes the competitive capabilities, performance measures employed and key action program the business unit intended to invest in over two years. The result shows that there are three main clusters that represent manufacturing strategic groups. See *Figure 2.5* followed by descriptions of each group.

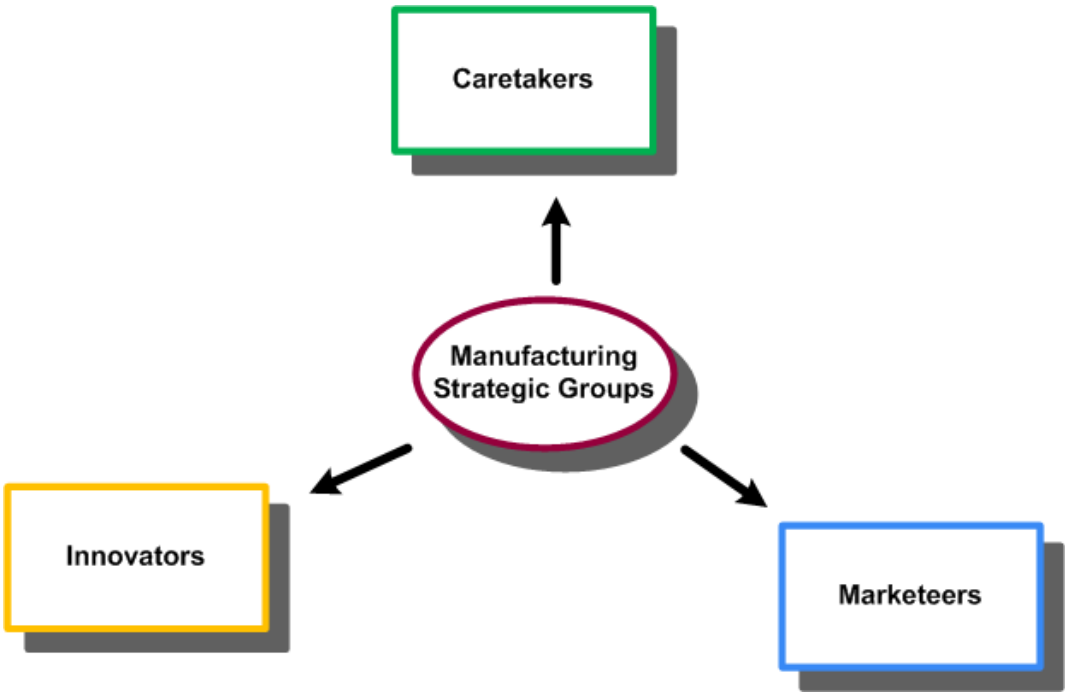


Figure 2.5: Manufacturing Strategic Groups (Miller and Roth 1994)

1. Caretakers – Emphasize on competitive capabilities development to stay at the minimum level of competition. Cost is the most important capability pursued by these firms followed by dependability, quality, after sales service.
2. Marketeers – The group seeks to gain broad distribution and product lines as well as flexibility in their operations. The top priorities pursued are quality, dependability, product performance and cost.
3. Innovators – Put more emphasis on the ability to make changes in design and introduced new product quickly – without any compromise on quality. This is followed by dependability and price.

Zhao *et al.* (2006) influenced by Miller and Roth (1994) created a new taxonomy based on 175 Chinese companies. They identified the need to replicate the study in China as most available taxonomies uncover

the experience of American and European companies. Four clusters were identified from the study: (*quality customizers*) emphasis quality conformance and ability to change and modify products, (*low emphasizers*) low emphasise on competitive capabilities due to not having operations included as part of strategy, (*mass servers*) focused on conformance quality, broad product line, cost and speed. Finally, is the (*specialized contractors*) which emphasise on speed, cost and performance quality, whilst flexibility was the least emphasise attribute.

The geographical study of MS taxonomy was further expanded by Grant *et al.* (2013). They replicate the study by Miller and Roth (1994) by applying the taxonomy on a small newly industrialised country, namely Ireland. Analysing the sample of 199 manufacturing companies, they named them into three clusters: (*best value*) high-performance product at a low price, (*budget*) low price broad product range and (*multi-focus*) where they compete on all capabilities, showing support towards the cumulative model rather than trade-offs. All the three clusters describe capability priorities used by companies in competing in their respective markets. They also found that most companies view quality and delivery as perquisite capabilities to allow them to enter the market, thus supporting the notion of order-qualifier suggested by Hill (2000: 36).

2.4.4 Kathuria (2000)

The manufacturing strategy taxonomy by Kathuria (2000) is the first approach that exclusively used small manufacturer as their sample. The taxonomy was developed by classifying manufacturing units according to four competitive priorities which are quality, delivery, flexibility and cost. In addition, he also looked at whether the competitive priorities are associated with industry membership. The sample size of 99 manufacturers from six industries is used in the study. As a result, he comes out with four clusters which are: (*starters*) emphasising on quality to qualify in the market, (*efficient conformers*) emphasis on quality and cost, (*speedy conformers*) emphasis on quality and delivery and (*do all*) put emphasis on all four priorities.

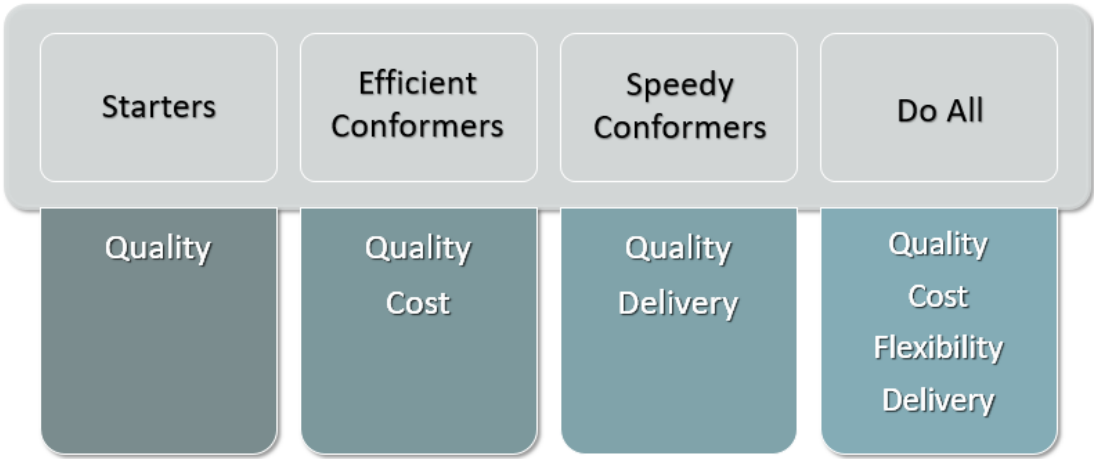


Figure 2.6: Manufacturing Strategy Taxonomy (Kathuria 2000)

The study shows no evidence that suggests companies in the same industry are pursuing the same selection of competitive priorities. Nevertheless, quality is found to be the main priorities emphasis by the four clusters. Therefore, demonstrating quality as the basic criteria established before gaining other priorities. There is also proof of small manufacturers who are simultaneously pursuing all four competitive priorities, thus reinforce the views of obtaining cumulative capabilities rather than trade-offs.

2.4.5 Other MS Taxonomy

In addition to the previous discussion, there are other works which similarly established MS taxonomy in different perspectives and settings. Sum *et al.* (2004) develop a taxonomy of operations strategies based on operational performance of high performing SMEs in Singapore. Using a sample of 43 companies, they classified them according to competitive priorities (quality, delivery, flexibility and cost). Using cluster analysis, they come out with three different groups: (*efficient innovators*) outstanding performance in cost, delivery and flexibility without any compromise on quality, (*differentiators*) differentiated itself on flexibility, delivery and quality but at the expense of high cost. Finally, is the (*all-rounders*) which similarly related to *efficient innovators,* but have superior quality, thus contributing to sustaining all the other priorities.

Ward *et al.* (2007) in their investigation on linkages between business strategies and structural and infrastructural decision create a taxonomy based on 101 US manufacturing firms. They come out with three classifications which are (*broad-based competitors*) compete on the dimension of low cost and differentiation, (*differentiators)* pursue some combination competency in dimension (quality, design, support and image) other than price and (*price leaders*) which put more effort in reducing the cost to compete on price.

Focusing on Spanish medium and large manufacturing organisations, Martin-Pena and Garrido (2008b) using a sample of 358 companies found two types of cluster with each emphasising on pursuing excellence while the other prioritising quality and delivery. They also come to the conclusion that their studies support the views of cumulative capabilities which contradicts the theory of trade-offs.

Andersen (2012) developed a resource-based view taxonomy by using samples from 186 micro and SMEs manufacturers in Sweden. They create a link between resource configuration/capabilities and performance. As a result, they come out with six different groups namely: (*Ikeas*) low cost and highly innovative, (*Craftsmen*) highly skilled for product that do not require complex technological facilities, (*Marketeers*) market-oriented with complex product capability using advanced technological resources, (*Conservatives*) product simple products, below average in marketing and unwillingness to respond to changing environment, (*Technocrats*) has technological production capabilities, produces complex and innovative products but do not market their product to a great extent and (*Nomads*) relational resources and do not have any apparent competitive advantages.

The work around the MS taxonomy mentioned in literature shows that they are applicable in the real settings and can be used to generate more insights. Based on the evidence provided, the published taxonomy usually is further validated to confirm its application towards different settings or to provide an extension to the theory. It is also identified that the main theme on the taxonomy is evolving around strategic choices pursued by companies. Further, there is a large influence of competitive priorities in determining the clusters. This research managed to identify the four-stage model (Hayes and Wheelwright 1984: 396) as the one it intended to explore further. This is contributed by the following reasons:

1. Most of the framework currently asking questions such as "where are we now?" and "what we are doing?", while the four-stage model put an additional perspective to it by asking "where should we be?" and "what should we do to get there?".
2. The framework depicts a journey or progress rather than merely focus on how companies positioned itself in the marketplace or capabilities they are pursuing. Thus giving a sense of direction on the way companies evolve or regress. In turns, opening an opportunity for the process to be studied further.
3. Excluding the Miles and Snow (1978) taxonomies, it is found that the work by Hayes and Wheelwright are more in-depth, taking from constructionism point of view rather than objectivism. The classification of firms is based on the author's years of experience in conducting research and consultancy among US companies. As a result, it uncovers some elements of competitive priorities, decision making and the role of manufacturing as were viewed by the management.

2.5 The Hayes and Wheelwright Four Stage Model (1984: 396)

Among the manufacturing strategy research framework which has been reviewed above, the Hayes and Wheelwright Four Stage Model (FSM from now on) are being actively tested since its inception in 1984 until 2013 according to the latest search. The concept of the FSM is expanded by Chase and Hayes (1991) to include service firms. Their article classified service firms into Available for Service (Stage 1), Journeyman (Stage 2), Distinctive Competence Achieved (Stage 3) and World Class Service Delivery (Stage 4).

2.5.1 Operationalisation of the FSM

At this point, subsequent works were published to test and operationalise the model. Bates *et al.* (1995) examined relationships between organisational culture and manufacturing strategy. They operationalise the model by using a Likert scale and classified 41 US and Japanese- owned plants located in the US according to the FSM. They managed to demonstrate links between stage 3 and 4 with organisational culture. However, they found questions relating to stage 1 and stage 2 unreliable. Newman and Hanna (1996) complemented the four FSM by integrating the model with environmental awareness. Using a sample size of 22 companies, they classified stage 1 (environmental reactor), stage 2 (environmental benchmarker), stage 3 (environmental integrator) and stage 4 (environmental innovator).

Hum and Leow (1996) operationalise the FSM as a strategic manufacturing audit tool using questionnaires from 55 electronic manufacturing plants in Singapore. The study is however limited to examining stage 2 and stage 4 using decision categories. Their research finds most companies are positioned between stage 2 and 3 and moving towards stage 3 within the FSM. Hum (2000) apply the FSM in a third party logistics company using a single case study. The study is exclusively intended to probe stage 4 companies by applying the 'litmus test' guidance provided in the original book.

Swamidass *et al.* (2001a) using three companies case studies explore the participation of manufacturing managers in the strategy development process in the FSM. They found out that in stage 1 (manufacturing managers have very little control), stage 2 (allowed to form plans, independent business strategy), stage 3 (manufacturing plans screened against business strategy) and stage 4 (manufacturing plans are key to business strategy). The study limits the coverage to only stage 2 and 3+ on the FSM. In a different paper, Swamidass *et al.* (2001b) using three case studies, they identify the alternative patterns of manufacturing strategy development according to the FSM. They found there is evidence of informal manufacturing strategy development such as following patterns of incremental actions (stage 1), adopting improvement program (stage 2) and going for core competencies development (stage 4). However, there is no evidence on the testing of stage 3 companies.

Gilgeous (2001) identified five factors that affect manufacturing effectiveness based on the FSM. They are the attitude of top management towards manufacturing, the involvement of manufacturing managers in setting the strategic direction of the firm, the emphasis on formulating manufacturing strategy, proactiveness and coordination between manufacturing and other functions. They created a model based on these 5 elements and linked them with manufacturing competence. Using questionnaires send to 295 British companies, they validated the model and found there are only stage 2 and 3 companies in their sample. Further, they found evidence of JIT implementation in stage 3 companies.

Dangayach and Deshmukh (2003) used a Likert type questionnaire to 100 Indian automobiles, machinery and process companies. They managed to yield results showing companies at stage 2, 3 and 4 with the majority being at stage 4. Dangayach and Deshmukh (2006) again conduct the same application of the model, this time using case studies in three companies by looking at 5 areas namely (order-winners, top three improvement activities, top three competitive priorities, the person who formulated manufacturing strategy and focus of manufacturing strategy). *Table 2.3* shows the result in two key areas in stage 2 companies. They are top 3 improvement activities and competitive priorities. Quality can be seen as the main concern for the two companies as it is mentioned in both areas (Top 3 improvement activities - TQM and Top 3 competitive priorities - Quality).

Table 2.3: Key findings from Dangayach and Deshmukh (2006)

Company	**Top 3 improvement activities**	**Top 3 competitive priorities**
Company Alpha	1. Management training 2. ERP 3. TQM	1.Dependability 2. Quality 3. After sales service
Company Gamma	1. Management training 2. Benchmarking 3. TQM	1. Dependability 2. Quality 3. After sales service

Barnes and Rowbotham (2004) operationalise the FSM in a variety of UK organisations including manufacturing and service, profit-seeking and non-profit. Using a three-point Likert scale, they found just under half of the answers received can be categorised into a single dominant stage of the FSM, and some companies even positioned themselves to more than a single stage. They identified a few issues that contributed to the results such as respondents which did not fully understand some or all of the questionnaire, respondent which not have an adequate level of knowledge regarding their organisations and respondent which wanted to represent their organisation in best possible light.

Rowbotham and Barnes (2004) again use the questionnaire in testing the FSM. This time they use the questionnaire in conjunction with three case studies conducted in UK manufacturing SMEs. The use of the case studies helped them in validating findings from the questionnaire by confirming the position of the companies along the FSM. They found studied SMEs are categorised into stage 1, 2 and 4 of the FSM. Further, they identified what drives the need to conduct a strategic review and having a manufacturing strategy for the three companies. The summary of the findings are as follows:

- Stage 1 company as having a strategic review in getting out of crisis management and have no formal manufacturing strategy.
- Stage 2 company conducted a strategic review expecting to secure the future and having no manufacturing strategy.
- Stage 4 company conducted a strategic review to challenge internal thinking and they have a formal manufacturing strategy.

The study by Rowbotham and Barnes (2004) are the first which specifically mention SMEs as the target group. Their study validated the characteristics of stage 1, 2 and 3 of the FSM while generating additional findings as mentioned above. Nevertheless, they stopped short of giving an indication of how achievement on each stage, particularly stage 2 and 3 are conducted.

Jain *et al.* (2013) develop a questionnaire by identifying four factors that affect the strategic role of manufacturing according to FSM. They interpret FSM according to two sources (Chase and Hayes 1991;

Hayes and Wheelwright 1984: 396) into four categories which are: catalyst of manufacturing initiatives, proactiveness of manufacturing function, the attitude of top management towards manufacturing and nature of manufacturing initiatives. They managed to come out with 14 items but their work is mainly conceptual and they did not validate the findings.

Table 2.4 summarises the previous work around the model. Also, it shows the method used, stage involved, sample size and geographical description of the studies. Based on the geographical description, the model has been applied in the US, UK, Singapore and India. The most used method applied in testing the FSM is questionnaires (7 studies) followed by a combination of questionnaires and case studies (3 studies) and case studies (2 studies). Out of the 12 papers, 7 are found to be using a questionnaire to classify companies according to the FSM. Interestingly, none of these papers attempts to investigate movement between one stage to another, hence opening up the opportunity for further investigation.

Table 2.4: Studies incorporating the FSM

Author	**Region of studies**	**Methods**	**Sample size**	**Stage involved**	**Summary**
Bates *et al.* (1995)	US	Questionnaire	41 plants (822 respondent)	3 and 4	Investigating relationship between organisational culture and manufacturing strategy by using the FSM.
Newman and Hanna (1996)	US	Survey/Questionnaire	22	1, 2, 3 and 4	Develop a framework to integrate environmental management into the FSM.
Hum and Leow (1996)	Singapore	Questionnaire	55	2 and 4	Testing the 10 decision categories of the FSM.
Hum (2000)	Singapore	Single case study	1	4	Apply the stage 4 litmus test to evaluate whether a

					company truly a stage 4 level.
Swamidass (2001a)	US and the UK	Case studies/questionnaire	1 US & 3 UK (4)	2 and 3	Identifying manufacturing manager level of participation in FSM stage 2 and 3.
Swamidass (2001b)	US	Case studies	3	1, 2 and 4	Identifying patterns of the strategic development process by stage 1, 2 and 4 companies on the FSM.
Gilgeous (2001)	UK	Questionnaire	295	2 and 3	Validating stage 2 and 3 on the FSM.
Dangayach and Deshmukh (2003)	India	Questionnaire	100	1, 2, 3 and 4	Testing FSM on three industries in India.
Barnes and Rowbotham (2004)	UK	Questionnaire	460	1, 2, 3 and 4	Testing the FSM in manufacturing, service, profit and non-profit organisations in the UK.
Rowbotham and Barnes (2004)	UK	Questionnaire and case studies	3	1, 2 and 3	Formulate and validate questionnaires to classify companies according to FSM in UK SMEs.

Dangayach and Deshmukh (2006)	India	Questionnaire + Case studies	23 questionnaire and 3 case studies	1, 2, 3 and 4	Testing FSM in Indian machinery manufacturing companies and identifying 5 important strategic issues on three stage 2 and 3 companies.
Jain *et al*. (2013)	Not mentioned	Questionnaire	28	1, 2, 3 and 4	Develop a questionnaire to measure companies according to the FSM.

2.5.2 Stage Transition on the FSM and Relation to Research Question

It was mentioned in Chapter 1 that the research intends to find out *how can manufacturing SMEs improve its strategic role of operations and competitiveness?* by using MS taxonomy as a reference. After a thorough review of MS taxonomies, it is found FSM would be the most appropriate. This due to its dynamic nature by showing the progression of operational effectiveness. As a consequence, it provides an opportunity to investigate actions and decisions which contribute to improved operations and competitiveness. Importantly by examining the FSM in the context of SMEs, answers can be provided to the research question.

The applicability of the FSM can be referred to its ability to answer questions that are related to strategy formulation. This is because strategy sets the general directions in which the firms' positioned will grow and develop. Sequentially, asking the question of "Where are we now?", "Where do we want to be?" and "How shall we get there?" (Ansoff 1984: 31-32; Barnes and Rowbotham 2004; Bordum 2010).

The majority of 12 works of literature around the application of the FSM are found to answer the first question and partially addressing the other two. Therefore, there is a need to further look into addressing the second and third questions. This is by providing answers in accordance with the research question on "Where do we want to be?" (to be competitive) and "How should we get there?" (by improving the strategic role of operations).

During the inception of the FSM, Hayes and Wheelwright (1984: 403-408) described the journey of transition from stage 3 to stage 4 by providing case studies on how General Electric and IBM achieved them. However, the majority of subsequent studies in operationalising the FSM did not extend this work but focusing classifying their samples according to the stages. Thus not addressing how a firm should move along the FSM. Hence there is a need for this research to address this gap by identifying the process of moving from one stage to another.

At least two studies indicate the process. First is Swamidass (2001b), but their findings are limited to identify the type of strategy development in every stage of the FSM. Second is Dangayach and Deshmukh (2006), presenting the top three improvement activities of stage 2 and 3 companies in India. It shows evidence that both papers provide highlights on the improvement process. However, they are still short from giving evidence on 'enablers' that allows progression within the FSM.

The identification of enablers in moving to a higher stage of FSM is the gap identified from work by Swamidass (2001b) and Dangayach and Deshmukh (2006). Also, most of the reviewed works apply the model without specifying the categories of the companies (small, medium or large enterprises). Therefore, this research is intended to add findings to the body of knowledge by:

- Expand the work in the context of small and medium enterprises (SMEs) as they represent the vast majority of business (Roy *et al.* 2013).
- To geographically look at the UK and Malaysian companies.
- Identifying other key enablers to move to stage 2 of the FSM.
- Comparing the research findings with similar related work.

There is evidence from the literature showing the FSM are tested partially either by selecting one, two or three combinations of the stages (*Table 2.3*). It is found studies that intended to identify the process in each of the stages put more focus on probing companies in stage 2 (Dangayach and Deshmukh 2006; Swamidass 2001a). To extend the findings, this research will probe the process of moving between stage 1 and stage 2 on the FSM.

The research decided to investigate the movement from stage 1 to stage 2 because it can directly answer the research question. This is due to increasing the role of operations from stage 1 (viewing manufacturing is viewed as a function that needs to be operated without major problems) to stage 2 (achieving parity with competitors) is a sign of improvement in competitiveness, as it enables companies to compete with competitors. This is in addition to four other important reasons:

- Stage 1 companies need to build a good foundation in improving their operations performance so that they will have a clear direction and continually improve to move up the stages.

- There is only one significant work (Swamidass *et al.* 2001b) that discover process undertaken by stage 1 companies in developing their strategy. This is limited to examine the type of approach taken towards the formulation of strategy. Investigating decision areas and actions that may that contribute to strategy realisation will provide additional findings that complement previous work.
- It is important to have a good start as stage 1 company that goes backwards might not have a chance to correct them and might face closure. As with stage 3 or 4 companies, they have at least a stage down to look at or before they can correct things.
- To limit the scope and to make sure the amount of work is appropriate to a 3 years PhD study.

The above explanation shows the importance of this study to look at the movement to stage 2 of the FSM to answer the research question. The following discussion will begin with identifying the characteristics of stage 1 and stage 2 according to previous research. It will then continue to discuss elements that will be identified as the major point in directing the research, starting with a discussion on competitive priorities.

2.5.3 Identifying Stage 1 and Stage 2 Company Characteristics

In order to differentiate and identify stage 1 and stage 2 characteristics, interpretations from 5 different papers are provided in *Table 2.5*. The 5 papers are chosen because aside from characteristics, they indicate competitive priorities for the two different stages on the FSM. Evaluation of the competitive priorities based on *Table 2.5* can be referred to section *2.5.4*.

Table 2.5: Description of stage 1 and stage 2 according to previous research

Author	**Stage 1**	**Stage 2**
Hayes and Wheelwright (1984:396)	1. External experts are used in making decisions about strategic manufacturing issues. 2. Internal management control systems are the primary means of monitoring manufacturing performance. 3. Manufacturing is kept flexible and reactive.	1. Industry practice is followed. 2. The planning horizon for investment decision is extended to incorporate a single business cycle. 3. Capital investment is the primary means for catching up to competition or achieving a competitive edge.
Chase and Hayes (1991)	1. Customer stays with the firm for reasons other than performance. 2. Operations are reactive, at best. 3. Quality is highly variable. 4. Customer is unspecified, to be satisfied at a minimum cost.	1. Customer neither seeks out nor avoids the firm. 2. Operations functions in a mediocre, uninspired fashion. 3. Quality meets some customer expectations, consistent in one or

	5. Technology is introduced for survival. 6. First line manager's job is to control the workforce.	two dimensions. 4. Market segment whose basic needs is understood. 5. New technology justified by cost savings. 6. Workforce follows a set of procedures. 7. First line managers control the process.
Dangayach and Deshmukh (2006)	1. Minimise manufacturing negative potential. 2. Internal control system is used to control manufacturing. 3. Firefighting is common at the plant. 4. Short term performance is emphasised. 5. Outside experts are called in to make decision about strategic manufacturing issues. 6. Manufacturing is kept reactive and unfocused.	1. Industry practice is followed. 2. Capital investment is the primary mean for catching up with the competition. 3. Aim is to achieve parity with competitors. 4. Dependable delivery. 5. High-performance product. 6. Product reliability.
Barnes and Rowbotham (2004)	1. The need of customer is not widely understood. 2. Quality is highly variable. 3. New technology is introduced for survival. 4. Workforce is tightly controlled. 5. Top management only gets involved in operations if controls show that operating performance is off standard.	1. Basic need of customer is commonly understood. 2. Quality consistently meets the expectations of customer one or two key dimensions. 3. New technology is introduced when it justifies cost savings. 4. Workforce maintains efficiency by following procedures.
Martin-Pena and Garrido (2008b)	1. Strategies aimed at minimising cost and improving delivery speed. 2. Offering product in the time agreed with the customer.	1. Focusing on the highest quality of a product. 2. Adapt quickly to consumer's need by giving them the product rapidly and on-time. 3. Adapt numerous after-sales services.

According to *Table 2.5*, several areas are mentioned to describe the current state of operations in a company. Therefore, a further investigation in the main areas will be looked at in the following section. They are:

1. Competitive priorities.
2. Industry best practice.
3. Comparison with competitors in achieving parity.
4. Establishment of work procedures.
5. Performance measures.

Together with the five areas mentioned above, there will be additional areas the research will investigate. It will be elaborated and finalised towards the end of the chapter.

2.5.4 The Competitive Priorities According to the FSM

The term competitive priorities are used to describe manufacturers' choice of manufacturing tasks or key competitive capabilities, which are usually expressed in terms of quality, delivery, flexibility and cost (Kathuria 2000). In the book 'Restoring Our Competitive Advantage', Hayes and Wheelwright (1984: 403) mentioned flexibility, dependability, cost and quality as the competitive priorities pursued by firms in the model. However, the discussions are exclusively describing stage 4 firms. In addition, they explicitly describe low cost as the priorities pursued by stage 4 firms.

"*The traditional approaches that are used to improve manufacturing performance such as providing flexibility through excess capacity, improving delivery dependability through holding finished goods inventories, and reducing cost through labour productivity improvements often are conceptualized in creative ways in stage 4 firms.*"

"*One of the types of firms that pursue a stage 4 manufacturing strategy is those firms whose business strategy places primary emphasis on a manufacturing-based competitive advantage. The advantage is usually low cost.*"

"*Flexibility may also be achieved through changes in the design of products and/or processes, faster delivery through shorter production cycle times and low cost through improved product quality and reliability.*"

Hayes and Wheelwright (1984: 399-401)

When Chase and Hayes (1991) expand the FSM in the service sector, 'service quality' was mentioned as one of the indicators in showing progress to the higher stage of the FSM. According to them, emphasis on

quality beginning to take place when a firm is in stage 2 of the FSM. This is when companies beginning to meet some customer expectations and producing consistent quality in one or two key dimensions.

The indication of quality as stage 2 competitive priorities was adopted by Barnes and Rowbotham (2004). In their questionnaire, stage 2 is depicted as having the quality that is consistently meeting customer expectation. Dependability, in addition to quality, was described by Dangayach and Deshmukh (2006) as the main priorities pursued by Indian stage 2 manufacturers.

Martin-Pena and Garrido (2008b) reviewed 10 taxonomies and 6 typologies in manufacturing strategy literature to identify the strategic theme. They identified the strategy pursued by stage 1 companies are aiming at minimising costs, improving delivery speed and offering product in the time agreed with the customer, while stage 2 companies are focusing on highest quality of a product, respond to customers need rapidly and on-time as well as adding numerous after-sales service. On the other hand, stage 4 implement new technologies, new process to introduce new designs and product rapidly.

The analysis by Martin-Pena and Garrido (2008b) is limited to briefly describe strategies for stage 1, 2 and 4. It is found they did not mention what is the strategy pursued by stage 3 companies and there are no references made in showing what are the competitive priorities adopted by those companies. As a result, the strategy they described for stage 2 companies can be viewed as consisting of some elements of those stage 3 companies. Therefore, further work could point what are the competitive priorities that should differentiate between the firm at stage 2 and stage 3.

Based on the description provided from *Table 2.5*, it is found competitive priorities or manufacturing competitive advantage in the FSM is mentioned in five works of literature. First is from the book by Hayes and Wheelwright (1984: 399) mentioning low cost as strategy pursued by stage 4 firms. Second is from Chase and Hayes (1991), explaining the progress on quality on each of every stage. Third, Barnes and Rowbotham (2004) pointing out quality as the priorities pursued by stage 2 firms. Dangayach and Deshmukh (2006) mentioned dependability and quality as a strategy adopted by stage 2 firms in India. Finally, Martin-Pena and Garrido (2008b) described quality and dependability as stage 2 company strategy. After sales service is not considered to be on stage 2 due to the explanation in the previous paragraph.

The statement indicating competitive priorities on FSM by the five sources highlights their importance as guidance to progress towards higher classification within the model. More importantly to show the way operations should be viewed by the management. It provides a purpose, by directing where the resource and decision regarding operations should be focused. Based on the indication given by the five papers, there are two competitive priorities that are closely related to a description of stage 2 companies which are: quality and dependability. In the next section, topics around the competitive priorities will be discussed by reviewing related literature.

2.6 The Manufacturing Competitive Priorities

Competitive priorities consist of objectives pursued by a manufacturing function and must be designed according to competitive strategy (Martin-Pena and Garrido 2008b). The demand that is placed by competitive strategy indicates the direction of manufacturing, ignoring it will lead to failure in achieving high reliability, economies of scale or an ability to introduce product quickly (Skinner 1969). The establishment of a competitive strategy for a business unit in industry allows it to find a position in the industry where the company can best defend itself against competitive force or can influence it in its favour (Porter 2004: 4). The statement from these authors highlights the importance of setting competitive priorities so that resources and decision can be concentrated towards them. In the end, allowing companies to obtain capabilities that would enable them to achieve organisational goals.

There are two main foundations in choosing competitive priorities. First is according to trade-offs, where one competitive priority is compromised in order to achieve other priorities. Achieving capability in cost might come at the expense of quality as low-cost raw materials are being preferred to more durable and premium materials. On the contrary, the second foundation advocates priorities which can be achieved cumulatively. It is believed capabilities need to be built up, along the way achieving multiple competitive capabilities. This is started by building quality capability up to reaching the ultimate goal of cost efficiency. The focus put on quality will lead to fewer rejects, rework and time needs to correct related errors. It eventually leads to quicker delivery times and reduces operating expenses.

Based on the discussion in *2.5.4*, FSM implied that competitive priorities are obtained gradually starting from quality and progressing to obtain cost efficiencies. In addition, the cumulative model makes very important assumptions that all companies compete on the same set of competitive capabilities and they must excel in all four areas to be considered successful (Hallgren *et al.* 2011). Due to this, the cumulative capability model is the most suitable theoretical foundations to be assessed in this research. It can be supported by two underlying reasons, first is because it has a general set of competitive priorities which applies to multiple industry background (Kathuria 2000). Second, it is found the FSM indicates progress in obtaining competitive capabilities. It shows how companies started from not having any focused competitive capabilities (stage 1) to become cost-efficient organisations (stage 4). The gradual capability improvement demonstrated by the FSM makes a case for cumulative capabilities to be investigated further within this research.

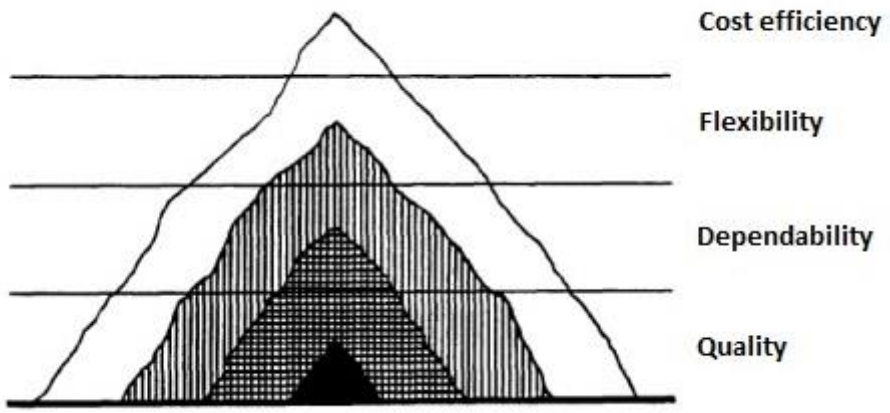


Figure 2.7 The Sand Cone Model (Ferdows and Meyer 1990)

The sand cone model by Ferdows and Meyer (1990) (*Figure 2.7*) is the earliest work to explore the applicability of building cumulative capabilities. They believed the concept of trade-offs should be used the other way around or it can be avoided altogether. Rather than sacrificing a capability to accommodate another, they suggest it is instead used in enhancing it. In order to build lasting capability, management attention and resource should start with improving quality which enables them to improve on dependability, flexibility and finally cost efficiency.

While the seminal paper did not validate the model, it raises interests for subsequent work to conduct the validation. Leung and Lee (2004) validate the model by using two case studies. They found that the model does not apply to firms that have different business statuses. Firms in survival-struggling status might want to pursue different capabilities compared to those in business domination situation. There are two shortcomings identified in this paper. First, their validation did not include newly established companies and second, the sample is limited to large firms (1,000 workers and a public listed company) and failed to cover smaller firms.

It is important the above issues are addressed. This due to the limitation on time, resources and flexibility, most small and newly established firms depend on an informal process to establish the need of choosing the right capabilities (Lofving *et al.* 2014). Consecutively delaying the process of developing a strategy as time was used to experiment decision rather than developing an action plan. Further, the majority of smaller firms are supporting those big businesses; literally they have a major influence in deciding whether bigger firms are in survival-struggling or business domination status.

Grobler and Grubner (2006) examine the relationship between strategic manufacturing capabilities to find out whether they are cumulative or trade-off in nature. Using questionnaires from 465 plants they found quality directly lead to the improvement of delivery and provide indirect support for a plant's flexibility and cost efficiency. The work is supported by the findings from Hallgren *et al.* (2011), using a sample of

211 small and large companies they managed to confirm that the development of the high level of quality significantly supports the development of delivery capabilities. Results from both studies showed that competitive capability is cumulatively achieved and dependent on each other. Importantly they proved description of competitive priorities made on FSM (stage 2 – quality and delivery, stage 4 – cost efficiency) are actually based on the cumulative capability model.

2.6.1 Manufacturing Competitive Priorities Selection and Justification

The discussion on competitive priorities will be based on quality, dependability, flexibility and cost, by giving more focus on quality and dependability. The reason why these four capabilities are given consideration is by referring to previous work on the FSM, taking quality as the starting point of movement to stage 2 (Barnes and Rowbotham 2004) and low cost as an indicator in achieving the ultimate aim of stage 4 status (Hayes and Wheelwright 1984: 399). Further, it is known that environmental concern, after sales service and innovativeness has made way to the discussion in the competitive priorities. However, it is the four capabilities of quality, dependability, flexibility and cost which are seen as the most important and generally accepted (Christiansen *et al.* 2003; Krajewski and Ritzman 1999: 33; Kathuria 2000; Roth 1996; Sum *et al.* 2004).

Supporting the stance of cumulative capabilities; the research did not intend to go in detail examining the process of obtaining all the four priorities. This is due to the scope which intended to cover the movement from stage 1 to stage 2 of the FSM. As was discussed in *2.5.4*, particular attention will be given in identifying the process of pursuing quality and dependability. In short the research intended to:

- Explore the process on how companies in stage 1 (internally neutral) move to stage 2 (externally neutral) from the FSM by;
- Re-validating the competitive priorities and;
- Exploring the course of action taken by stage 2 companies to address its competitive priorities.

Silveira and Sousa (2010) suggested other than developing manufacturing capabilities, adopting best practices are the core requirement of producing manufacturing performance. They went further by suggesting companies to adopt total quality management (TQM) as they believed the practice is the main driver in getting the broader impact of manufacturing performance. Next section will discuss further on manufacturing best practices, issues and its relation to the FSM.

2.7 Industry Best Practices

Following industry practice is one of the descriptions of stage 2 company mentioned by Hayes and Wheelwright (1984: 396) and Dangaych and Deshmukh (2006). As a result, it forms an integral role in achieving parity within the competitors. The information can be obtained by conducting an external evaluation of the company's operating environment. In addition to best practices (BP), the evaluation could provide analysis on competitors, market requirements, suppliers and availability of raw materials.

These analyses are intended to compare the operations between rivals and to discover the trends of customer demands. Regarding BP, it can provide a resource to companies in identifying their weak areas and how other company response and improve in similar situation or systems (Ungan 2005).

According to McLoughlin (2013) companies that adopted BP perform better than those who are not. He further noted that in the UK, BP is evident in the automotive and aerospace sector and it is more prevalent in foreign-owned UK sites than in domestic companies. The adoption of BP, however, is dependent on the extent to which firms could obtain specific capabilities (Benito and Lannelongue 2014). According to Ungan (2005), several factors that encourage companies to adopt BP includes resource availability, operational benefits, satisfaction with the existing practice, external pressures, and compatibility.

Apart from the positives that can be obtained by implementing BP, there are arguments on BP which will eventually become standard practice over time. Kuula *et al.* (2012) in a longitudinal study that examines manufacturing BP adopted by manufacturing organisations in 1993, 2004 and 2010 concluded that there is a lifecycle on the adaption of BP in manufacturing. They found the best-practice lifecycle is quite short because once they have served the purpose, they might be eliminated. Moreover, BP may become an industry standard over time. In turns, it requires organisations to look for a new practice to achieve competitive advantage. This is supported by Alceu *et al.* (2015) where in interviews conducted in 6 automobile engine manufacturers show companies which belong to the same production have the tendencies of adopting similar practice to each other in the long term.

The difference organisational settings, however, tend to make it difficult for companies to adopt BP. (Benito and Lannelongue 2014) argued that since companies are operating in different types of environment and are unique in their own way, universally good practice may not even exist. In addition, Ungan (2007) and Laugen *et al.* (2005) cited the view of BP which is often considered as generic, without considering the type of industry, size, product and process. They went on to suggest in order for companies to identify BP, an investigation must be done according to the environment that the company operate.

Voss (1992) argued that BP comes in small isolated pieces such as just-in-time (JIT), total quality management (TQM), flexible manufacturing systems (FMS) and materials requirement planning (MRP). These are often treated by isolated manner by companies, assuming that if they can put the system in place, they will become more competitive. He further stressed that perspective such as appropriateness and whether it will support key competitive needs are often failed to be examined. It can give a bad implication for companies if the adoption of BP is not in line with the strategic vision of the company. First, implementing BP could be costly. Next, it involved every strategic level in the company. If the investments turn out to be a failure, it will be a great task for management to turn it around and total failure might loom sooner rather than later.

There is evidence on a piecemeal approach of BP adoption, to demonstrate that companies only adopt BP which they feel suited to their way of work. A two company case study by Bamford *et al.* (2015) examines the process of lean implementation on UK companies. They found that it is possible to have a partial implementation of lean rather than having full lean implementation citing examples where companies decided to implement lean if they believe there is an operational benefit in terms of efficiency and performance. Demonstrating decision to adopt lean techniques are based on practical trial period, rather than a theoretical prescription from the literature.

It can be concluded there is no generic template on BP that are available; in other words, 'one size fits all' best practices. As a result, the adoption is dependent on the type of organisations, culture and the uniqueness of the manufacturing company. However, a study from Tiwari *et al.* (2007) combined with the BenchmarkIndex 2002 identified eight most popular BP initiatives which are:

1. 5S Housekeeping
2. Total productive maintenance (TPM)
3. Total quality management (TQM)
4. Six sigma
5. Just-In-Time (Kanban)
6. Kaizen
7. Business process re-engineering (BPR)
8. Benchmarking

Striving to implement all the 8 initiatives should be the ultimate aim. However, there is evidence that it could be adopted as a piecemeal approach (Bamford *et al.* 2015), which can be appropriate to stage 2 companies. Accordingly, the research will look into investigating BP which can suit the needs of SMEs. In the end, making suggestions on suitable BP as were adopted by FSM's stage 2 companies. The source of investigation may also include suggestions from the community of practice. This in turns will give valuable information on stage 1 or newly established SMEs on the BP they should look to implement.

2.8 Comparison with Competitors

The basic approach in analysing competitive strategy is by conducting comparison across rivals (Lampel *et al*. 2014: 77). As a first step in improving manufacturing operations from stage 1, the FSM highlight the importance of companies to be at the same playing field with their competitors. According to Fahey (2003) there are several reasons why competitors can be a good point of reference. First, it provides critical means of learning on the current and potential competitive environment. Second, intense emotions and feeling about rival bring heightened energy and commitment from managers to analyse and learn from competitor scenarios. Third, the tendency of customers to switch between rivals makes it important to understand the underlying reasons for their switch.

The need for conducting market analysis is widely emphasis in the MS literature. Suggestions include the use of order winners and qualifiers (Hill 2000: 36), market competitiveness (Slack and Lewis 2011), understanding market requirements (Maslen and Platts 1997) and analysis of the market situation (Tan and Platts 2005). Apart from suggesting the process of conducting market analysis, these authors do not explicitly point out where the information should come from and where companies should seek the information. Assuming most of them should come from marketing function, it is not necessarily applied to SMEs which operate on a much smaller scale and has flatter structure from larger organisations, rarely with formal marketing units. Hence it is important for SMEs to look for 'intelligence' from their competitors.

The use of intelligence from competitors' helps companies inform and support their business strategies as well as supporting the daily operations of a company, by knowing leading practices and tactical plans (Culver 2006). Traditionally, it is the task of the marketing function to provide intelligence. However, the task is not exclusively dependant on the marketing functions as intelligence can also be gathered by managers and engineers from visits to customer, conferences and the literature (Sorensen 2009). This is true according to Porter (2004: 72), underlining the fact that there is no correct way to collect competitor data. He proposed the competition intelligence is gathered from two sources: field and published data. See *Table 2.6.*

Table 2.6: Source of competitor intelligence

Sources of intelligence	
Field data	**Published data**
Sales force	Articles
Engineering staff	Newspaper in competitors location
Distribution channels	Want ads
Suppliers	Government document
Advertising agencies	Speeches by management
Personnel hired from competitors	Analyst report
Professional meeting	Filings to government and regulatory agencies
Trade associations	Patent record
Market research firms	Court record
Reverse engineering	
Security analysts	

The data sources provided by (Porter 2004: 72) are not limited and can be very exhaustive, considering a large number of available sources. Wright *et al.* (2002) studied the sources of intelligence in UK companies, and they found there are various ways which include sending bogus customers into contact with competitors, watching competitor's premises, hiring competitor's staff, talking to customers and

using materials from the public domain. Both authors show there are variable resources can be used to retrieve information on competitors formally or informally.

The limited resources possessed by an SME would restrict them to a minimal effort in conducting competitor analysis. One of the first steps that can be done is by looking at the competitors which are operating in a similar environment (Porter 2004: 3). The information can be obtained informally and as were pointed out earlier, there are many sources which may provide them. Therefore, it is important for the research to address the sources relied by manufacturing SME in gathering information about their competitors.

2.9 Work Procedures

The second article by Chase and Hayes (1991) described how service organisations in stage 2 of the FSM operate by following a set of work procedures. It is then included by Barnes and Rowbotham (2004) questionnaire in evaluating the FSM in the UK. Both papers pointed out work procedures as a starting point to establish consistency in operations. Considering its importance, this section will explain the need for stage 1 companies to establish them.

The establishment of work procedures will help an organisation to describe, standardised and improve a process. Ungan (2006) explained that work procedures created consistency and allow companies to get a positive perception of service or product quality. Recording step-by-step tasks should be a way of internal knowledge transfer and also can reduce the learning time for a worker to understand a process, tasks or even becoming a skilled worker. In addition, the work procedure will provide traceability and visibility in operations. In lean philosophy, it is related to the use of visual management tools which includes value stream mapping, flowcharts, name boards and process map (Eaidgah *et al.* 2016).

The visual work practice has a positive impact on the business process. Visual work practice can be manifested in many forms such as work instructions, signs, labels, colours, lighting and presentation of tools through shadow boxing; all the application is a building block in implementing other lean tools (Kattman *et al.* 2012).

While there is an argument that some are too technical or too simple, a work procedure is not a static document as it can be improved when new products or technology becomes available (Ungan 2006). In addition, it facilitates the process of continuous improvement by identification of deviation from the standards through increased process transparency, further opening the opportunities to implement appropriate problem solving techniques (Tezel *et al.* 2016). In order to understand the philosophy of continuously making an improvement, the following section will look into implementing it as a strategic approach and how it relates to the research presented in this thesis.

2.10 Continuous Improvement (CI) as a Strategic Approach

Hayes and Wheelwright (1984: 386) mentioned two highly contrasting strategies: "strategic leap" approach which is favourable among U.S firms at that time and "incremental improvements" adopted by German and Japanese manufacturing companies. Although they did not specify which one is better than the other, they did assert the need to put organisational resources and talent doing the basic thing a little better, every day over a long period of time.

Although Japanese auto manufacturers such as Honda and Toyota are considered as world class manufacturer, Leong and Ward (1995) argue that they achieved this status with little regards to formal planning. Rather, they built their capabilities incrementally, which has yielded a robust and sustainable advantage. Similarly, Swamidass *et al.* (2001b) identified the MS development in stage 1 companies are based on patterns of incremental actions, which may reveal actual MS over time, due to the absence of a formal plan. They further indicate in stage 2 adoption of techniques, philosophies and practice at improving operations are considered as a substitute to a formal MS. Based on these findings, the research will highlight the philosophy of CI and at the end provide a summary on initial investigation conducted at a single plant in the U.K.

Liker (2013) emphasise that every strategic leap or big changes are disruptive in nature as people might take time to understand and it is impossible to think through all the changes in much detail before implementation. He suggested drawing a plan for breakthrough changes and break it into small pieces. As a consequence, people who involved in them could feel more comfortable adapting to the changes. In other words, big changes will require a small improvement to succeed. Hence, stressing the importance of having an incremental improvement. The following paragraph will elaborate more on improvement based on CI philosophy, their difference with breakthrough improvement and its drawbacks.

In CI, there are two major functions of management which is maintenance and improvement. According to Imai (2012: 3) maintenance involves maintaining current technological, managerial and operating standards while upholding the standards through training and discipline. Improvement, on the other hand, refers to activities uplifting the current standards. In other words, the Japanese philosophy of management is focused on maintaining and improving standards.

Improvement in context can be translated into two widely accepted approaches: CI and innovation. CI suggests small improvement as a result of a progressive approach, while innovation allows radical improvement as a result of the large investment of resources in new technology, personnel or equipment. Slack *et al.* (2004: 655) defines innovation as a breakthrough improvement, where free thinking and individualism is encouraged. He further adds the principles of breakthrough improvement includes actions such as 'starting with a clean sheet of paper', 'going back to first principles' and 'completely rethinking the system'.

Table 2.7: Features of CI and Breakthrough Improvement (Slack *et al.* 2004: 655)

	Breakthrough improvement/Innovation	**Continuous Improvement/Kaizen**
Effect	Short-term but dramatic	Long term and long lasting but undramatic
Pace	Big steps	Small steps
Time-frame	Intermittent and non-incremental	Continuous and incremental
Change	Abrupt and volatile	Gradual and constant
Involvement	Select a few 'champions'	Everybody
Approach	Individualism, individual ideas and effort	Collectivism, group efforts, systems approach
Stimulus	Technological breakthrough, new invention, new theories	Conventional know-how and state of art.
Risks	Concentrated – 'all eggs in one basket'	Spread – many project simultaneously
Practical requirement	Requires large investment and little effort to maintain	Requires little investment but great effort to maintain
Effort orientation	Technology	People
Evaluation criteria	Results for profit	Process and efforts for better results

Companies require a quick fix and have the financial capability can choose to invest in new resources. The underlying risk is the amount of money involved must be justified with the output produced by the new resources, or else it will turn into a wrong investment. It is because there is a big adjustment made to process, people and organisation when new technologies are put in place. If the investments prove to be a failure, there is a lot of effort required for corrective actions. Hence, careful planning need to be in place before any new investment in technology is undertaken. The discussion above doesn't mean to pit innovation against CI, but it rather elaborates on the philosophy that they promote. While both of the approaches has its own merits, less effort is required when it comes to the continuous approach. This is suited to manufacturing SMEs, which operates within a limited budget. The next paragraph will explain the justification of this notion.

CI doesn't necessarily involve a big financial investment. It emphasizes on human efforts, morale, communication, training, teamwork, involvement and self-discipline. This demonstrates an approach using common-sense and low cost to improvement (Imai 2012: 4). In addition, it adopts process-oriented thinking as a process must be improved for results to improve. There are two main strategies of CI when it comes to improvement and this is based on the proper use of standards. Based on Imai (2012: 52), standards need to be maintained and improved over time. As such CI introduces two terminologies:

- Plan-do-check-act (PDCA).
- Standardise-do-check-act (SDCA).

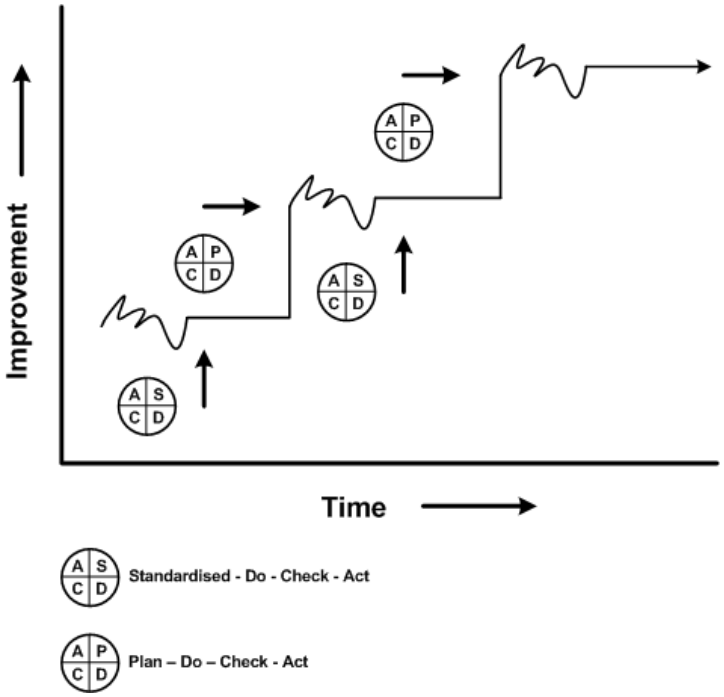


Figure 2.8: How improvement is achieved from SDCA cycles to PDCA cycles
(Sources: Imai 2012: 53)

In explaining CI as a strategic approach, Bessant and Francis (1999) considered CI as a dynamic capability. They believed strategic advantage is built-up overtime in a highly firm-specific fashion, which attributed to maintaining a competitive advantage in uncertain and changing market requirement. They further classify three elements of dynamic capability:

- Paths – The amount of competencies organisation accumulated based on firm-specific behavioural routine.
- Position – Adoption of product/market condition based on competencies they have built over time.
- Process – The way organisation approach issues of innovation, learning and renewal.

In order to explain how CI is adopted and the direction, Bessant and Francis (1999) and Bessant *et al.* (2001) created a revolutionary framework which introduces staged development available for adoption.

They believed CI is used in pursuing the resource-based advantage by exploiting 'own ways of working'. The model consists of five stages which are illustrated in *Table 2.8*.

Table 2.8: Bessant Five Stage CI Evolutionary Model

CI Level	Characteristic behaviour patterns
Level 1 - Pre-CI Interest in the concept has been triggered - by a crisis, by attendance at a seminar, by a visit to another organisation, etc. - but implementation is on an ad hoc basis	Problems are solved randomly; No formal efforts or structure for improving the organisation; Occasional bursts of improvement punctuated by inactivity and non-participation; Solutions tend to realise short-term benefits; No strategic impact on human resources, finance or other measurable targets; Staff and management are unaware of CI as a process
Level 2 - Structured CI There is formal commitment to building a system which will develop CI across the organisation	CI or an equivalent organisation improvement initiative has been introduced; Staff use structured problem solving processes; A high proportion of staff participate in CI activities; Staff has been trained in basic CI tools; Structured idea-management system is in place; Recognition system has been introduced; CI activities have not been integrated into day-to- day operations
Level 3 - Goal Oriented CI There is a commitment to linking CI behaviour, established at 'local' level to the wider strategic concerns of the organisation	All the above plus: Formal deployment of Strategic Goals; Monitoring and measuring of CI against these goals; CI activities are part of main business activities; Focus includes cross-boundary and even cross-enterprise problem-solving
Level 4 - Proactive CI There is an attempt to devolve autonomy and to empower individuals and groups to manage and direct their own processes	All the above plus: CI responsibilities devolved to problem solving unit; High levels of experimentation
Level 5 - Full CI Capability Approximates to a model 'learning organisation'	All the above plus: Extensive and widely distributed learning behaviour Systematic finding and solving problems and capture and sharing of learning; Widespread, autonomous but controlled experimentation

The model suggests there are different levels of CI development activities. As an indication, level 1 started when CI is implemented as an ad hoc basis, while level 5 indicates full CI capability (learning organisation). The movement between the one level to another represents the process of learning, practising and mastering the behaviours which make up the ability (Bessant *et al.* 2001). The classification of the ability based on the 5 levels will give indications of where the organisation stands compared to their competitor and work as a guide which level of CI they should aim for.

Further testing of the Bessant's model was conducted by Bertus *et al.* (2004) when they conduct a single case study in an ore mining in South Africa. They come out with Four CI Improvement Model which assesses basic conditions necessary to ensure a culture of CI for employees:

1. Understanding – Know/agree on improvement.
2. Competence/Skills – Know how to improve.
3. Support/enable – Assess process and systems in place that make it possible to improve.
4. Commitment – Desire to improve.

In addition, they introduce 'The CI Wheel', which guide the CI process and the steps need to be taken in order to monitor and implement changes. It requires continuous effort by the management to communicate on the changes needed to 'buy-in' the idea from personnel and further creating visibility. It

is also noted that they include measurement to check on the progress. The model can be useful in sustaining the CI process and ensure the movement between different stages of Bessant's model. *Figure 2.9* shows the process of the CI wheel.

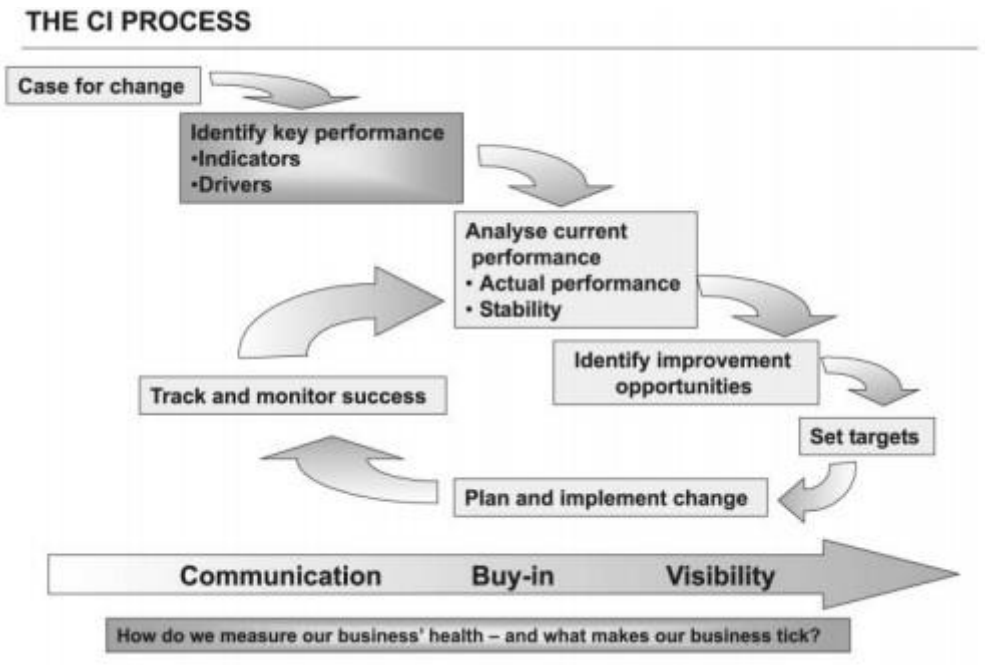


Figure 2.9: The CI Wheel

Fryer *et al.* (2013) argued that Bessant's model did not show how an organisation can progress from one stage to another. Therefore, in their opinion, the model can be used as an indicator, not as an audit tool to check CI implementation. To fill this gap, they conducted 16 semi-structured interviews with public sector manager. From the result of the interviews, they grouped the 21 statements from Bessant's model under three stages theme which are "Going through the motions- transforming- embedded". However, they did not test the model and they suggested it be tested by using a case study approach.

Evidence presented by Bertus *et al.* (2004) and Fryer *et al.* (2013) shows that CI is applied in achieving better operations capability. The ability to create an improvement over time will be a great source of competitive advantage. Besides, this process stimulated continual learning in organisations and contributed to competitive advantage. This is because learning can assist CI initiatives by helping to avoid repeating mistakes and improving operations by understanding past weaknesses and ways to correct the problem (Oliver 2009). Towards the end, the knowledge generated from the continuous learning process enables an organisation to create a more sustainable competitive advantage in the form of innovation (Chatha *et al.* 2015).

Based on the CI five stages evolutionary model and the subsequent work by Bertus *et al.* (2004) and Fryer *et al.* (2013), there is evidence CI has been used to obtain competitive position in the real settings. Even

though there is criticism towards time taken to achieve the desired results, it is a good option as it requires fewer investments, involved everyone and makes the success harder to be copied by a competitor. It is also worth to make note that the work by both papers are limited to the non-manufacturing sector and their model can be further tested in manufacturing settings. To look at the role of CI in manufacturing, an investigation to a manufacturing plant is carried out to get general ideas on what are its role and tools that can help companies to start CI initiatives. The following section summarises and provides literature review on the findings.

2.10.1 Review of Literature Related to Findings from Initial Investigation

During the initial stage of the research, a three-hour visit was conducted to a manufacturing plant in the UK. The visit intended to gain some idea on the development of MS by having interviews with the quality and operations manager as well as doing an observation during the plant tour. The following is the conclusion that was made from the visit:

- A matured 5S application should be the foundation in applying other best practice tools.
- The performance measures are the main indication of aligning the corporate strategy and manufacturing strategy.
- Ishikawa diagram is the main tools used in the shop floor to solve any problems in operations.

The above statements indicate the areas that will be examined further by the research and will be divided into three subsections namely (5S, problem solving and performance measures). The research further adds skills and training to look into actions taken by companies in ensuring the availability of the workforce.

One of the contributions of this research towards the FSM is to identify actions, consisting of tools and techniques enabling companies to be classified as stage 2. This is by suggesting the most appropriate tools which can aid SME to consistently attain quality and for them continuously improve. On the other hand, the research will also look at skill and training initiatives. This is intended to add details to the FSM as well as giving appropriate information that could be useful in developing a framework. The following section will provide a literature review on the tools used in supporting quality implementation obtained from the initial investigation.

2.10.2 5S

A common definition of 5S is housekeeping. The early version was based on 3S and later 4S (Gapp *et al.* 2008). In line with the principal of CI, the implementation of 5S must be done gradually starting from the first 3S: sort (seiri), set in order (seiton) and shine (seiso). Once the best practice on the shop floor is identified, the practice needs to be standardised (seiketsu) and sustained (shitsuke). Bayo-Moriones *et al.* (2010) explain that the hardest part of practising 5S is to sustain (shitsuke) due to difficulties in getting a commitment to maintaining a new way of work. Gupta and Jain (2015) highlight the importance of self-discipline in achieving long term success of 5S implementation.

The implementation of 5S has been described as having several benefits. It creates a quality environment by promoting cleanliness (Gupta and Jain 2015). In addition, it organises the work environment, assigns clear ownership of process to employees and reducing idle time (Bayo-Moriones *et al.* 2010). Chen and Lu (1998) acknowledge 5S as a building block to quality transformation programme by creating a clean and well-organised environment. This, in turn, will encourage employee commitment towards quality CI. This was supported by Bamber *et al.* (2000) stating 5S is the foundation of obtaining ISO 9000 and ISO 14001 quality certification. Srivinasan *et al.* (2016) mentioned 5S could provide instant and tangible benefit by reducing the risk of accident and providing a safe working environment.

Quality environment needs to be created in order to effectively implement BP such as JIT, TQM or Six Sigma to enhance products and process. The previous paragraph shows that 5S can be a starting point to create a quality environment. The tool is chosen due to its cost-effective way of introducing the quality system and its simplicity. While its success is largely contributed to a prolonged commitment, the advantage is evident and it can provide an impetus for organisations to continually improve. Thus, adopting other tools in the future. The next step is to look at problem solving technique to complement 5S implementation.

2.10.3 Problem Solving Techniques

Problem solving techniques allows identification of problems, its root causes and leads to preventing recurrence. According to Tezel *et al.* (2016) and Rusjan (2005), once work procedures have been established, the next step is to find the suitable problem solving techniques that could improve the process further. In addition, achieving a structured CI status according to Bessant (1999) model requires a structured problem solving process in place. Also, it could minimise 'firefighting', which is the norm in stage 1 companies (Dangayach and Deshmukh 2006). Therefore, in this section, the research will discuss the available problem solving techniques and how they can contribute to improved operations.

A problem that is not solved systematically by investigating the root cause often involves actions that produce waste (motion and waiting) (Worley and Doolen 2015). It is particularly important to address this by having a tool in place to make sure corrective action is taken. Solving problem as it emerges will likely make the problem re-appear in the future. Use of systematic tool would reduce operating costs and increase worker creativity and can be beneficial to SMEs which operates with limited budget and manpower.

One of the tools developed to solve quality in a systematic manner is the 'Ishikawa' or 'fishbone' diagram. It indicates the relationship of the incident or work process being analysed and the various parameters which influence this process (Kruger 2001). Smith *et al.* (1994) advocate the introduction and training in problem solving techniques such as Ishikawa diagrams to revive competitiveness and correct quality problems.

Types of suitable problem solving techniques for SMEs can be investigated by collecting information from people who have been involved in introducing and also from companies which have successfully use them. This way, important information regarding the timing of implementation can be obtained. As a result, the research intends to find out the problem solving techniques currently being used in stage 2 manufacturing SMEs and to put them in the developed framework.

As an introduction to implementing problem solving tools, companies may point the main benefits such as creating a safe working environment, improved quality and also increased salary. This is to make sure that there are motivations which could drive the implementation process. Piercy and Rich (2015) examined the relationship between lean and sustainable operations by conducting a longitudinal case study in 5 companies. They found out improvement tools introduction is initiated by frontline worker engagement followed by training. To expand the discussion further, the following section will elaborate on worker skills and training.

2.10.4 Workers Skills and Training

The role of worker skills and training has a big influence on company competitiveness. In the philosophy of CI, Imai (2012: 3) explains that training is part of actions required to uphold standards and consistency in improvement. In the report by the UK Department of Business, Innovation and Skills (2015) suggested support to be channelled to the 'development of training strategies to meet future skills need', thus highlighting the importance of having plans for training.

Manufacturing plants that have proficient skilled worker tend to have a better performance. It often contributed to reduced scrap rate, raised direct and indirect productivity and at the end leads to higher cost efficiencies (Woodcock 1996). The drivers to conduct training in SME have been highlighted in three studies. Jones (2015) using secondary data found manufacturing SMEs in Australia conduct training as a response to organisational change, new production technology, introduction to improvement program and quality initiative. Similarly, Bayo-Moriones *et al.* (2003) identify technological change, advanced work organisation practice, quality assurance and presence in the international market as key factors that determine the training investment in 6601 Spanish small manufacturing plants.

In examining the reason why some manufacturing SME in Spain outperform the others, Rubio and Aragon (2009) explore the role of strategic resources and found a positive relationship between manager training and SMEs performance. The evidences shows that there is a need to be a strategic direction in the training of workers. From a worker's perspective, training allows them to increase skills, be more flexible and innovative. Therefore, the research will go into detail in at the underlying reasons for training and mechanism used by manufacturing SMEs in undertaking training exercises.

While there is a proof of strategic consideration in conduction training, interviews with 10 manufacturing SME in the UK by Achanga *et al.* (2006) made a conclusion that most of them employ people with low

skill level and they do not foster the idea of skill enhancement. This is attributed to lack of strategies in determining improvement path that a firm should take and also operations that merely targeting to attain a status quo. It outlines the importance of the research to look into available actions related to worker skill and training which may allow for progression to stage 2 of the FSM.

2.10.5 Performance Measures

Dangayach and Deskhmukh (2003) describe stage 1 companies as emphasizing on short term performance, while Barnes and Rowbotham (2004) cited stage 1 company deployed a detailed measurement so that operations do not go off track. Evidence provided by these authors' shows in stage 1, performance measures (PM) is mainly used to ensure trouble-free operations. It demonstrates less importance given in improving operations in a longer term, let alone attaining capabilities over time.

In the case of SME, PM may not be systematically documented. Barnes (2002) mentioned the strategy realisation in SMEs which are emergent and incremental in nature. This contributed to the adoption of a formal measurement system at a later stage of operations, once a formal strategy is identified. The issue with this action is the time taken until a strategy is realised will expose companies to suffer significant losses. This is due to the chain reaction effects of not determining appropriate PM at an earlier stage of operations. This reverts to the importance of identifying competitive priorities at the beginning of operations, as it will guide the areas where monitoring and control are necessary.

In addition to monitoring and control, PM is used to communicate company's strategy throughout the organisation and also aligning strategic organisational goals with operations (Elg 2007; Leong and Ward 1995; Mathur *et al.* 2011; Najmi 2005). Voss (1992) created the performance paradigm framework and identified measurement and process as a theme to a different manufacturing strategy paradigm. He pointed out measurement as a link in his iterative model and it must match the company strategic needs. This is based on the 'plan-do-check-action' cycle and measurement works by keeping aims and goals in check. Neely *et al.* (1994) recognised PM is used to influence behaviour and affect the implementation of a strategy. It can be a tool to identify the timing of intervention when the business performance is deteriorating. Mills *et al.* (2002: 129) explained the use of PM in the resource-based view context by suggesting PM need to be aligned with the resource-based view strategy elements, where it could facilitate the process of improvement rather than focusing on the target that has been set.

Kaplan and Norton (1996: 25) realised the use of financial performance as the main measurement indicator are not the best way to remain competitive, thus prompting them to introduce the 'balanced' scorecard. They advocate the use of performance indicator in at least four areas (financial, customer, business process and learning). Neely *et al.* (2001) expanded the idea by stating manufacturing excellence is the result of consistency in decision making and action. Thus, adding further elements such as employee, partners, regulators and pressure groups in their performance 'prism'.

Even though PM could contribute to the positive outcome of company performance, there are still a few flaws as a result of poor planning in designing PM. A common mistake is to view PM to satisfy the need of auditors and assessors as part of a compliance system and as a means of controlling standards, this failed to realise the main intention of PM, which is to improve performance (Bourne *et al.* 2004; Nenadal 2008). The view is shared by Walsh (2005) and Mills *et al.* (2002) citing it is important to show progress rather than seeing PM as something need to be reported.

In the current industrial practice, there are tendencies of companies to over-emphasis on PM. As a result, it put unnecessary pressure in resources and likely defocus critical issues that need consistent monitoring (Hon 2005). The view is shared by Walsh (2005) as creating too many measuring parameters at the beginning of the PM implementation is not the best way to start. He suggested starting with less than perfect measures because when the strategy is agreed, it would likely remain the same and the PM will evolve over time with experience and new data sources. Therefore, PM needs adjustment from time to time to realign or altering strategies, to ensure continuous improvement and respond to the changing competitive environment (Bhasin 2008; Perkins *et al*. 2014).

The previous paragraph has described the importance of having performance measures, the usage as well as issues around its implementation. The status of PM in the FSM however, is not specifically clear as it was never explicitly mentioned in subsequent work around the model. Therefore, the research intends to discover PM being used by stage 2 companies.

2.11 Conclusions

The chapter started the discussion on the importance of having a MS. Next, it identifies two themes of MS framework, typologies and taxonomies. Due to the fact that MS taxonomies are deduced from the organisation's real settings, this study interested to look more in-depth in work around the MS taxonomies. It is found that the work around the various taxonomies is static in nature and revolves around identifying the competitive priorities and how the companies portray itself in its environment.

The Hayes and Wheelwright (1984: 396) FSM has been singled out as the main framework to be explored in detail, due to its evolutionary approach of showing the proactiveness of operations function. A further investigation found there are evolving works around the FSM in the past 10 years and they are mainly trying to identify companies and classify them according to the stages, while there are two papers that investigate types of actions and activities of improvement of companies in some of the stages. Based on these findings, the study identifies that FSM is the best framework that can be used to answer the question of *"how can manufacturing SMEs improve its strategic role of operations and competitiveness?"* This is by choosing to investigate how progress is made at the start of the journey from stage 1 to stage 2 of the FSM.

The areas intended to be discovered mainly related to the improvement of operations competitiveness by achieving parity with competitors. This is by focusing at seven areas namely competitor analysis, competitive priorities, best practice, work procedures, problem solving, performance measures and worker skills and training.

The purpose of the research is to look for progress that being made by stage 1 companies towards becoming stage 2 by discovering the journey of the progression. The above paragraph pointed out to several areas of investigation which has been identified from this chapter. The investigation may not be limited to only discussed areas, but it may well go beyond that, as it is believed more information will emerge once the data collection phase is completed.

Chapter 3: Methodology, Research Design and Data Collection

3.1 Introduction

Before further discussion on methodology, it is important to assert this research is taking on a pragmatic approach, putting more emphasis with getting on with the research rather than putting more emphasis on philosophising (Robson 2011: 30). In other words, the research design is emerging, and the final design can only be described towards the end, considering uncontrolled events such as low response rate and denial of access to carry out data collection. As a result, it leans towards practical matters or simply defined as 'what works'. Therefore, the research philosophy is identified as the research is progressing and towards the end, rather than identifying it before the process started. As were explained in Chapter 1 (refer *Figure 1.1*), the research started through exploratory studies, a plant visit, literature review and attending three months' subject-specific modules.

The exploratory studies enable manufacturing strategy (MS) to be explored in three different perspectives, current practice by companies, issues discussed by academics in the literature and what are being taught in the university. Hence, heeding the suggestion by Slack *et al.* (2004) to reconcile the world of theory and practice. As a result, it raises two interesting questions: Why there are companies which are better than others? And how those 'better' companies improve themselves? The two questions lead to the development of the research question, subsequently leading to FSM which address the evolution of MS. The literature around the FSM and its limitations have been discussed in Chapter 2 as well as its relation to the research question. In addition, preliminary investigation managed to discover additional key decision areas that will act as enablers in moving from stage 1 to stage 2 (see section *2.10.1*). The strategy to answer the research question can be addressed by understanding the use of methodology before formulating on the research design.

This chapter is divided into two main sections. The first section elaborates on methodology covering philosophical stance, choice, strategies, methods and techniques. The second section discusses the way the research instrument is designed and implemented (see *Figure 3.1*).

To start the process, the philosophical nature of the research needs to be understood and selected. The way a researcher view, understand and interpret the reality of the world will give an impact on how the research process is going to take place. This is to help to choose the right strategies to carry out the research. In the end, it guides the main aim of research which is to develop knowledge in a particular field. The following section will provide an introductory discussion before continuing with the process of identifying methodological stances related to the research.

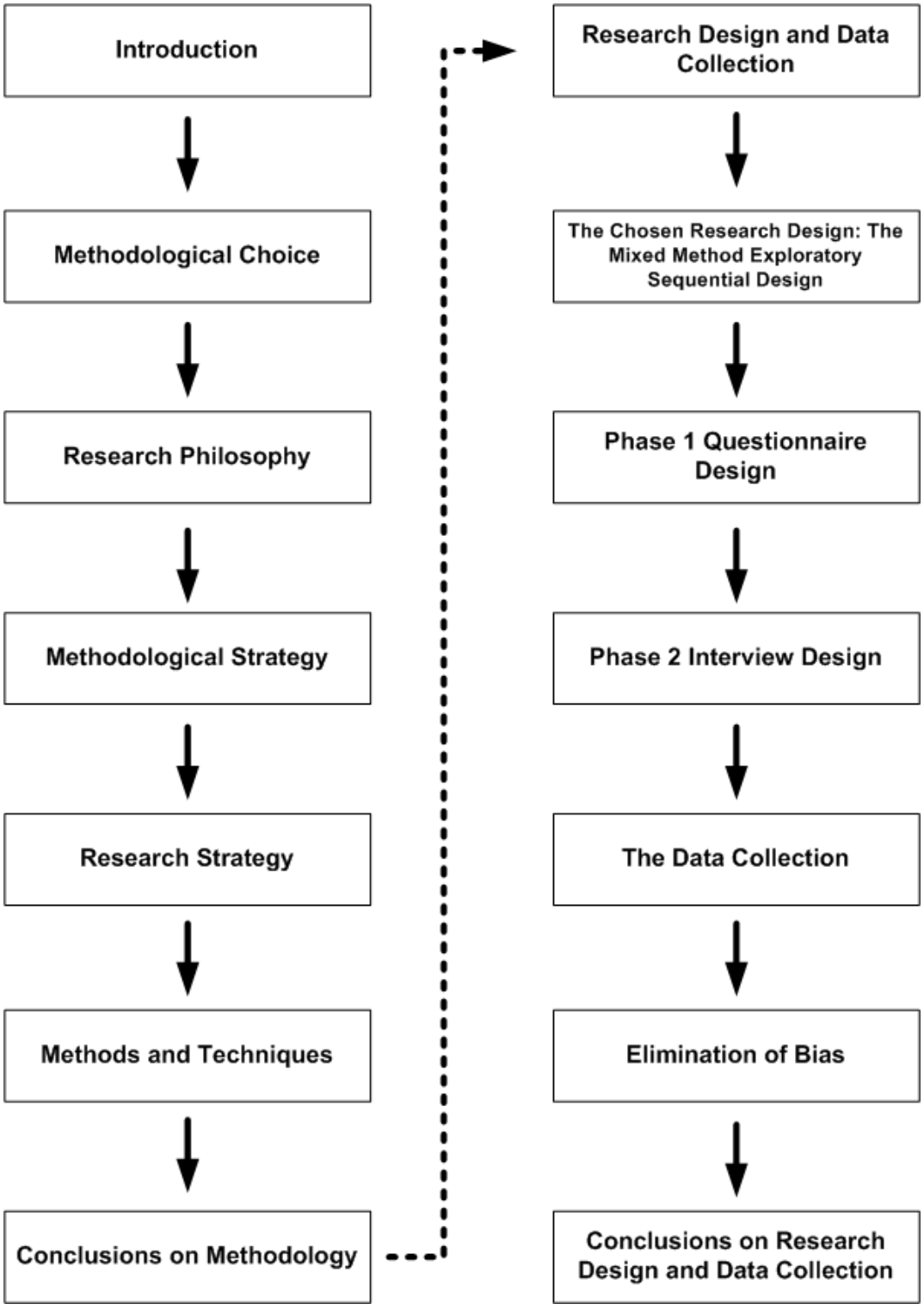


Figure 3.1: Chapter 3 structure

(Adapted from Saunders *et al.* 2009: 138 and Easterby-Smith *et al.* 2012: 18)

The structure of this chapter is according to *Figure 3.1*. The following paragraph explains the nature of studies in general, before relating it with the area of the research.

Studies in research may be exploratory, descriptive, explanatory and causal (Sekaran and Bougie 2013: 96). The nature of the studies depends on the stage which knowledge about the research topic has advanced. Descriptions of the classification of research are as follows:

i. *Exploratory* - conducted when there are no earlier studies which generate the information that is related to the problem or the issue. The main goal of this study is to look for patterns or ideas to develop rather than testing hypothesis (Collis and Hussey 2014: 4).
ii. *Descriptive* - is to describe phenomena as they exist. It often involves a collection of data on the characteristics of a problem. It helps the researcher to understand an event or situation.
iii. *Explanatory* – is a continuation of descriptive research, where the study will go further by discovering and measuring the causal relation of a phenomenon.
iv. *Causal* – The objective of the study is to test whether or not one variable causes another to change. Experimental design is the most used method in establishing the causal relationship (Sekaran and Bougie 2013: 98).

Based on the above classification, this study can be defined as '*exploratory*'. This due to several reasons. First, the mixed method nature of the research allows data to be collected and analysed at a different point of time. Thus allowing one method to inform another, which is *exploratory* in nature. Secondly, in the beginning, the research itself is heavily influenced by an exploratory study by conducting a plant visit, attending classes and literature review.

Thirdly, is related to the use of the exploratory questionnaire in phase 1 data collection to identify SMEs that match the description of stage 1 and stage 2 on the FSM. Fourth, is the use of interviews conducted to explore steps taken in becoming a stage 2 company and to discover additional decision areas involved, which later on to be validated during Delphi sessions. Finally, is the goal of the research throughout which looks for patterns and developing it into action timeline. Next paragraph will discuss the research position according to MS literature and associated themes.

Chatha and Butt (2015) identified two main themes of MS publications. The first theme is *process*, which includes the aspect of design, development and implementation of MS. The second theme is *content*. It consists of subthemes such as strategic types, strategic choices and performance. With performance being subject to coverage of different topics such as competitive priorities, process design and infrastructure.

In terms of the research theme, *process* is considered more appropriate compared to *content*. It can be argued that *content* may be suitable as in the previous chapter, there are seven areas identified in relation to the process of achieving stage 2 status. However, the difference of this work lies in investigating actions and decisions by SMEs to address the need of those areas rather than exploring how they are being developed. Therefore, it probes more on the aspect of planning, development and implementation

of MS. The next paragraph explains more about the methodological choice of this research and the justification behind its selection.

3.2 Methodological Choice

An explanation on methodology will show how the research process is undertaken and how it would help to produce research outcome. Similarly to theories, the chosen methodology cannot be perceived as true or false only to be described as more or less useful (Silverman 2000: 79). There are two general terms for research inquiry which is qualitative and quantitative (Saunders *et al.* 2009: 151).

Dangayach and Deshmukh (2001) emphasised the importance of research on the relevance of MS to SMEs either using quantitative or qualitative enquiries, demonstrating the applicability of both approaches in MS research. Both enquiries have their role in advancing knowledge in research. The use of quantitative methods could verify findings in a larger context and assess it generalisability. On the other hand, qualitative may uncover process and phenomenon which may not be captured quantitatively.

Nonetheless, it can be argued that every organisation is unique and they have their way of doing things, which makes qualitative enquiries more suitable option in finding answers to the research question. Moreover, research has to be carried out in a field-setting because it requires information on process, task and strategy development. This is qualitative in nature and might limit the findings and leaving out rich interactions and organisational process if it is conducted in a quantitatively (Kiridena *et al.* 2009).

The conceptual ideas generated from qualitative studies practically very useful because it verified what is actually done in practice and may uncover other variables that may contribute to the development of MS. Therefore, reducing the problem of separation between research and practice, which can contribute to model or solution which are not influenced by practitioners or managers (MacCarthy *et al.* 2013).

However, the research in this thesis did not intend to discard the use of quantitative enquiry. It may have advantages like rapid turnaround in data collection and economically effective instrument (Creswell 2003: 154). Further, it may be useful in research that intends to discover prevalence, average and patterns in data. In regard to this research, the approach was used during the final round of data collection.

3.3 Research Philosophy

Before establishing the research methodology, it is important to understand philosophical positions that influence the outcome of the research. Understanding the philosophical issues will help to clarify and recognise the best research design. The selection of the methods and techniques are dependent on the decision and assumptions which is based on ontology, epistemology and methodology. This will lead to the appropriate methods and techniques, time horizon and data validation. The following paragraph will describe the terminology of the research philosophy and how it influences the selection of methods and techniques for a research project.

3.3.1 Ontological Selection

Ontology is about the nature of reality and existence. It is a question of what constitutes reality and how existence can be understood. On the ontology assumptions, the researcher must decide whether the reality is objective and singular apart from the researcher. To put in another way, it interprets how the researcher views his research. This can be objective (objectivism/realism) and external to the researcher or socially constructed (constructionism/relativism) and can be understood by examining human factors (Easterby-Smith *et al.* 2012: 19; Hussey and Hussey 1997: 48)

Objectivism implies social phenomena and their meaning have an existence that is independent of social actors. For instance, the researcher can discuss organisations as a tangible object. It has a view where everything should have a set of rules and regulations, in addition to standard procedures that are used in getting things done (Bryman and Bell 2011: 21). Also, it asserts pressure on individuals to conform to the requirement of the organisations. Constructionism implies that social phenomena are in a constant state of revision. That is an emergent reality in a continuous state of construction and re-construction (Bryman and Bell 2011: 21).

It has been explained that this thesis is taking a pragmatic approach, which justifying bringing together qualitative and quantitative approach (Robson 2013: 30). As a result, the research is taking a middle stand by accepting that everything should have rules and regulations, while not discarding the fact they are emergent and continuously constructed. There are three underlying reasons that contributed to this stance. First, the constructionism ideology of challenging pre-set rules and regulations can be used to study how manufacturing SMEs develop their MS in field settings. Constructionism captures critical treatment of basic research assumptions by acknowledging different meaning, interaction process and describing complexity (Lindgren and Packendorff 2009). This allows for empirical evidence to be obtained in investigating the process of operations improvement. The approach enables the investigation to understand the growing frequency and magnitude of changes in technology and managerial methods (Voss *et al.* 2002). This is important as organisations are largely defined by the process that they undertook Silva *et al.* (2012).

Secondly, the multi-disciplinary elements of operations strategy make it difficult to categorise them into a single theme (Slack *et al.* 2004). Hence adopting constructionism at the beginning intended to uncover important decision areas and actions contributed to operations improvement according to the FSM. Thus, letting the data from the field emerge rather than pre-setting the rules. Once the boundaries and rules from the emerging data are set, validation in the form of Delphi technique is used to enhance data validity. Subsequently, objectivism approach is applied to get a further validation from the community of practice, ensuring its generalisability on a wider audience. In the context of this thesis, manufacturing SMEs. Towards the end, developing a research outcome which is representative of a 'real' organisation.

Thirdly, is to address validity concerns. The above paragraph mentioned the importance of constructionism in obtaining critical events on decisions and actions that lead to operations improvement. On the same wavelength, it is also important to validate those findings to ensure that it is relevant and applicable so that the result can be a point of reference for manufacturing SMEs and future research work. As a consequence, objectivism is used to obtain further validation from a different perspective, which can generalise the findings and get a number of participants from the community of concerns.

3.3.2 Epistemological Selection

Epistemology is about the best approach of enquiring into the nature of the world. It is a study on what constitutes a valid knowledge and the way it can be obtained. The epistemological issue concerns the question of what is regarded as an acceptable knowledge in a discipline. The central issue is whether or not the social world should be studied by the same principles and procedures of natural sciences (Bryman and Bell 2011: 15). The approach can be divided into two: positivism and social constructivism (Easterby-Smith *et al.* 2012: 23). In line with pragmatism, this study tends to avoid the debate between truth and reality. Therefore, accepting the existence of those two views and believing there can be variations in addressing a research question (Easterby-Smith 2012: 61; Saunders *et al.* 2009: 109).

This understanding is best summed up by Tashakkori and Teddlie (1998: 30), stating pragmatism allows a paradigm that philosophically embraces mixed method and mixed model design, most important it present practical and applied research philosophy: 'study what interest and is of value to you, study it in the different ways that you deemed appropriate and use the results in ways that can bring about positive consequences within the value system'. Consequently, the following paragraph justifies reasons for the adoption of pragmatism stance.

The social constructivism philosophy may capture the rich interactions and organisation process that form a MS (Kidirena *et al.* 2009). This can be in the form of underlying reasons for decisions and actions taken to improve operations performance. However, it cannot be denied that organisations, in general, may share access to the same process, technology and practices which best be captured using positivist stance. It can be in the form of procedures, problem solving techniques and performance measures. Appropriately, pragmatism stance, using a mixed method design can be used to capture both types of information.

The research question that has been generated can provide acceptable knowledge by using both observable phenomena and subjective meaning. The question of *"how can manufacturing SMEs improve its strategic role of operations and competitiveness?"* will enable the discovery of answers, including data which is observable and subjective. Additionally, the multiple types of samples also contributed to the selection of pragmatism. The focus is in a single community of practice where data used for framework development will come from individuals with different operations and manufacturing background: SMEs owners, operations managers, academics and consultant. Different philosophies are required to capture

information from them. For example, social constructivism is useful in capturing key decision areas made those individuals while positivism can be used to identify trends and validate the findings from the point of view of academics and consultant. In the end, producing a research outcome which represents views from academics and industry stakeholders.

3.4 Methodological Strategy

The decision to choose either qualitative or quantitative is dependent on the nature of the research which drives the study, similar works, research design and the final output and contribution the researchers tend to achieve (Johnston 2014). To start the research journey, there two methodological strategies that can be used which is inductive and deductive.

3.4.1 Inductive

Inductive research is a study in which theory is developed from observation to empirical reality (Collies and Hussey 2014: 7). Deductive research works from more general to a more specific. It is a study where the conceptual and theoretical structure is developed and tested by empirical investigation (Collies and Hussey 2014: 7). The chosen methodological strategy for the research is *inductive*. The reason behind the selection is based on the process of identifying research direction which begins with the initial enquiry to the real environment of a manufacturing organisation. The inductive process started at the beginning of the research, can be shown in *Figure 3.2*.

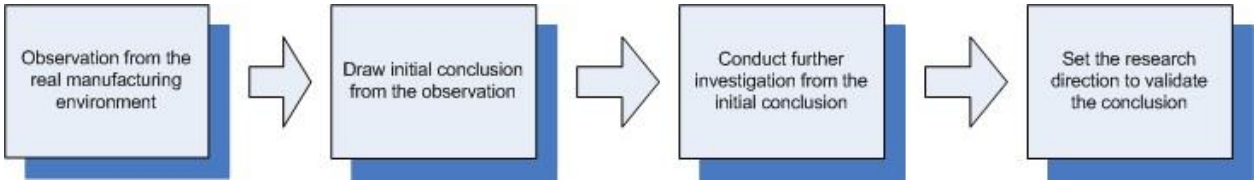


Figure 3.2: The inductive research process of the research (Investigative phase)

Creswell (2003: 136) asserts the use of theory may be directed by the emphasis on either quantitative or qualitative approaches in the mixed methods research. In the case of FSM, this study decided to test and add more detail to the theory, rather than merely testing it, thus examining the research gap inductively rather than deductive. In addition, the inductive approach is justified by three main points.

First is to explore additional details which describe a stage 2 company according to the FSM. The aim is to complement FSM by adding new descriptions that could provide more detail and understanding regarding stage 2 state of operations. Second is to obtain field data in addition to the ones described in the literature. This is to make sure that the outcomes presented in this research are relevant to current development in manufacturing SMEs operations. Finally, it is to capture processes and underlying reasons made on key decision area within operations. Tools and techniques that come out from the investigation can be complemented by understanding the motivation behind every decision that leads to operations improvement.

Use of inductive may be a higher risk strategy as it may well be protracted (Saunders *et al.* 2008: 127). This is due to the nature data and ideas which will emerge gradually during the research process and may take longer to arrive at a conclusion. In order to reduce this risk, mixed methods research is used after the initial investigation is completed. The following paragraph will explain the strategy that can be used to conduct the research.

3.5 Research Strategy

The research strategy is associated with obtaining two forms of data: quantitative, usually linked with the use of experiments and surveys, and qualitative, often related to the use of ethnography, grounded theory and case studies (Creswell 2003: 14). Three options were assessed before a selection of research strategy is made. They are case studies, ethnography and action research. These strategies are assessed based on the suitability to answer the research question and the possibility of gaining access to obtain data.

3.5.1 Case Study

A case study is an in-depth inquiry conducted in the field within a single stance, event or setting with the purpose of explaining the processes of a phenomenon. A case can be analysed by examining an organisation, individual or as big as a country. Case studies can be considered suitable for this research as it is the relevant method to explain some present circumstance, by answering the question of 'how' and 'why' some social phenomenon works (Yin 2009: 4).

The case study can provide a major source of theory development and allows the researcher to have a close look at the real problems and issues in organisation (MacCarthy *et al.* 2013). An analysis by Chatcha *et al.* (2015) pointed out to the majority of qualitative MS research which is conducted by using a case study approach. The reason the method is chosen is because of its ability to unfold the aspects of theory and practice of MS which cannot be obtained by using numbers.

For the case study to yield a good finding, access to an organisation is required (McCartthy *et al.* 2013). However, the process is not straight forward as obtaining access requires the researcher to have a good contact within the industry and justification on the benefit it will give to the organisation. Besides, case studies have a limitation in terms of generalisation based on the result of a limited number of cases (MacCartthy *et al.* 2013). To improve this, Tharenou *et al.* (2007:18) suggest that improvement can be done by using more than one case.

3.5.2 Ethnography

Ethnography allows researchers to immerse themselves in a specific social setting for a long period of time (Maanen 2006). During this time, the researcher obtains experience from participation in the research settings. The experience is then used to generate a narrative-based interpretation that took place (Dey 2002).

Johnson *et al.* (1999) encourage for field role to be negotiated to conduct an ethnographic study in a manufacturing organisation. There is two field role that was suggested. They are complete observer role and participatory role. In a complete observer role, the researcher will have a little or indirect interaction with members or process in the organisation. On the other hand, the researcher will have more active involvement in a participatory role, where they can act as a consultant or a full team member.

By using either role, a participant will be able to witness the first-hand experience and obtain an in-depth understanding of an organisation. As an outcome, it will yield a valuable perspective. For example, a researcher can understand a management approach that is practised in a Japanese company in contrast to a UK company. However, gaining prolonged access to organisations may be a challenge. It will take time to negotiate as granting them will be based on trust and relationship the researcher has with the organisation (Green *et al.* 2017). Additionally, the sample size involved in ethnography may be limited due to the extended time required to collect and analyse the data.

3.5.3 Action Research

Action research can address the problem of division between differentiation of theory and practice. It worked in reverse, rather having a specific object to study, the researcher will be a part of an object. It worked like an iteration with the continual process of diagnosis (research) and intervention (action) until there is a conclusion can be made from the object of study (e.g. organisations) (Somekh and Lewin 2006: 90). Action research aims to investigate specific issues or problem in organisations and try to address them (Lancaster 2005: 124).

Coughlan and Coghlan (2002) highlight the benefit of action research in operations management fields due to the different interpretation of how operations work: either it is done according to its own accord, or it is unique depending on its environment. They believed that action research main aim is to create knowledge from direct involvement in operations and process rather than viewing it from outside by using detached observation or archival study. The main issue of action research is the willingness of an organisation to accept rigorous inquiry during the analysis and implementation of action (Coughlan and Coghlan 2002).

3.5.4 Research Strategy Selection

The selection research strategy is made based on several considerations. The first consideration is regarding gaining access to an organisation to carry out the data collection. Secondly is the type of data that are required and methods that may be suitable to obtain them. Investigating the process of movement from stage 1 to stage 2 on the FSM can be best conducted by using either case study, ethnography or action research. This is due to these strategies which enable the researcher to have a closer look and participate in an organisation to examine how operations work.

However, there are difficulties of obtaining permission for full access to an organisation to implement the above research strategy as was mentioned by Green *et al.* (2017), McCartthy *et al.* (2013), Coughlan and Coghlan (2002) and Johnson *et al.* (1999). Additionally, organisations may not be willing to accept the researcher as a facilitator due to the secrecy of operations, especially for high-performance organisations. Further, the presence of a researcher can be perceived as a disruption to the daily operations.

Nevertheless, answers to the research question can be provided from experience by selected people within the organisation. Managers or SMEs owners are the best individuals to provide this information due to their experience in handling day to day operations and making strategic decisions. As a result, it opened up the possibility of using alternative methods such as interviews or document analysis to obtain the required data. Subsequently, it can eliminate the need to have full access to conduct investigation.

As was mentioned in the opening paragraph, this work considers answering the research question to be more important than either the method or the philosophical position. Thus, preferring to answer the research questions with any methodological tools available believing on pragmatist stance of 'what works' (Tashakkori and Teddlie 1998: 21). Based on this assumption, the study believes that there is an alternative way of getting the required data without the need to negotiate for full access. This stance has been influential in the selection of mixed methods strategy in this study. This will be elaborated further in the next section.

3.5.5 The Mixed Method Exploratory Sequential Design

The process of conducting mixed methods design can be fixed or emergent (Creswell and Clark 2011: 54). The fixed design is pre-determined, planned at the beginning of a research process and completed as planned. On the other hand, emergent design occurs when one method is deemed inadequate. Therefore, qualitative or quantitative element needs to be added to enhance the findings. The research can be described as the latter, due to the need for enhancing data validity obtained in the earlier phase of the study, in addition to the need for obtaining a comprehensive set of data.

However, the mixed methods will have its shortcomings. It needs greater time investment (Bazeley 2016 and Gobo 2016). This is due to the extended time of data collection, which may be influenced by time for the participant to respond to a request of access, checking the validity of response and researcher ability to gather skills required to conduct different types of data collection techniques. To reduce this risk, several steps are taken: sending invitations to a larger pool of SMEs, asking a manufacturing research centre to sponsor the survey to get a more informed sample and conducting a frequent discussion on research methods with faculty staff. Further, the use of mixed methods also is one of the contributing factors of reducing those risks as it provides additional data collection options if requirement emerges during the research process.

Creswell and Clark (2011: 69) listed 6 major mixed methods research design. This research can be categorised into the exploratory sequential design as depicted in *Figure 3.3*.

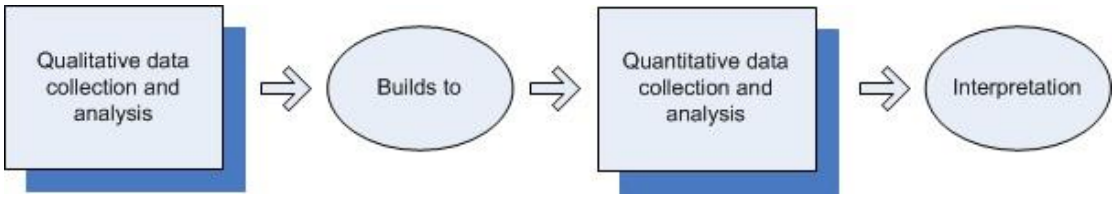


Figure 3.3: Sequential exploratory design (Adapted from Creswell and Clark 2011:69)

It is important to highlight that the research started with multiple qualitative investigations before applying the quantitative data collection. Therefore, it put more emphasis on qualitative data and analysis compared quantitative (QUAL+quan) (Gobo 2016; Robson 2011: 165). The research is also aware of concern by Bryman (2008) regarding the tendency of using a mixed method which is driven by 'trends' rather than 'needs'. Resulting in researchers employing it when it is not appropriate. This concern can be answered by referring to several justifications, where the selected research design can:

i. Reduce the bias provided by a single data collection method, by informing findings of one method to the other. For example, results from the initial questionnaire can be improved using interviews by asking for justification of answers provided from the questionnaire.
ii. Complementary role. Qualitative to facilitate quantitative research (Bryman 1988: 134). The use of a qualitative method to inform construct to be used in the quantitative data collection. Data obtained from interviews and Delphi is validated by using a survey to capture more information.
iii. Act as an audit tool to ensure rigour in the data used in making research conclusion. For example, Delphi session can examine and add to the result obtained from the questionnaire and interview. Therefore, experts participation in Delphi will act as an internal auditor to review and provide feedback on the findings.
iv. Enable data to be collected from the community of concern. In this case, the research can get information from SME business owners, CEOs, plant manager, operations manager, academics and consultant. Hence, increasing the validity of findings and getting a diversity of views to enhance the completeness of the source of data.
v. Be an alternative strategy to ethnography, action research and case studies which require lengthy access to a manufacturing plant, and may be difficult to obtain (Voss *et al*. 2002). Thus not compromising the richness and reliability of data, while requiring reasonable access time and can be easier to negotiate.

The first stage of the study is conducted to explore the areas of MS by investigative studies which are mainly qualitative. The research question is created once the theory has been identified. Evaluation of the best approach to answering the research question is conducted before another qualitative enquiry is

adapted. In the end, results from the qualitative data collection are used quantitatively to construct a framework. The evaluation of methods which can be applied in obtaining data for the study is explained in the following section.

3.6 Methods and Techniques

In the previous section, the philosophical understanding and strategy to address the research question have been discussed. For the strategy to work, tactics need to be adopted in investigating answers for the question. Several methods and techniques have been identified as an option. In the following section, these options will be discussed and towards the end, the most appropriate techniques will be selected and justified. In section *3.5.5*, qualitative and quantitative enquiries are selected as the research design. There are several techniques that can be used in the research. They are observation, focus groups, questionnaire, interviews and Delphi.

3.6.1 Observation

Observation allows the researcher to systematically observe and look at behavioural, action and interaction. The method enables a researcher to gather information based on the original setting of an object being researched. During the process of observation, the researcher needs to record, take note and understand the object that they are observing. The location and focus of observation are usually determined by the research question and aim of the observation (Hennik *et al.* 2011: 170).

Within this research, observation is used as a complementary technique rather than the main one. In other words, it is used informally along interviews during a visit to a manufacturing plant. This is due to the opportunity to use observation in parallel with plant tour, which often done during interview visits to manufacturing plants. The technique can contribute to supporting the findings from interviews to enhance the quality of data. Moreover, it can reveal unexpected findings which might not be available from the interviews.

In MS literature, Rytter *et al.* (2007) conducted 9 months' study, which includes the use of observation in a single company to explore the operations strategy formulation in practice. They concluded the process of operations strategy is mainly developed by continuous dialogue and action. Similarly, Adamides (2015) conducted two months' observation by taking notes and regular informal discussion with the manufacturing manager in a food processing SME to describe the process of linking corporate strategy and operations strategy. There is a similarity between both works with this research, which is investigating the strategy formulation process. It demonstrates that observation can be used to document a similar scenario; in this case, the process of operations improvement in manufacturing SMEs.

3.6.2 Focus Group

Focus group is the next option for data collection. According to Bader and Rossi (2002: 2) focus group allows participants to elaborate, revealing the nature and origin of their thinking on a particular issue.

Additionally, it can produce a valuable outcome by involving key stakeholders who can contribute to an in-depth understanding of an issue. Another advantage is the ability of the focus group to generate more ideas than interviewing a single individual (Asquith 1997).

In relation to this research, the drawback could come from the requirement of the focus group which need a different level of manager to sit in a single session. The challenge is to get the SMEs managers and supervisors to attend a focus group session and simultaneously maintaining the operations without any distraction. The nature of SMEs which is using the multi-tasking approach in their operations makes it more difficult to gather everyone at the same time. Nevertheless, it is adequate to use interviews to obtain information from SME managers or owners as their knowledge of operations can be considered sufficient. This is due to the flatter organisational structure of an SME enabling them to plan, oversee and evaluate results of improvement programs.

3.6.3 Unstructured Interviews

Interviews can be either structured or unstructured. The structured interview may be appropriate when the aim is to provide an overview of the research population with regards to values, behaviour, attitudes or perceptions (Ruane 2005: 151). On the other hand, the unstructured interview can be useful when there is an inquiry to detail. The researcher can attempt to achieve an overall understanding of the interviewee's point of view or situation (Dawson 2007: 28). Alternatively, there is a semi-structured interview that provides a balance between the two, with some flexibility to probe additional details so that other information can arise.

Unstructured interviews may be the best option as it can obtain detailed information about an event or process (Dawson 2007: 29). However, large data that come out from the unstructured interview may take an extended time to analyse. Also, an interview session will require more time allocation, and it is usually difficult to obtain particularly from SMEs managers and owners. Due to this restriction, the semi-structured interview can be the most appropriate as it put the researcher more in control of the situation. This can be in the form of using a question guide, which will reduce the time to complete an interview session and make the answers easier to analyse. Additionally, the interviewer can provide an estimated time for the interview session to complete, allowing the interviewee to allocate reasonable time. This is useful when negotiating access to an interview with prospective companies.

3.6.4 Selection of Methods and Techniques

The above evaluation explains observation, focus groups and unstructured interview as the viable alternatives in providing answers to the research question. For this study, three methods and techniques will be used. They are questionnaire, semi-structured interviews and Delphi. Their relevance and justification will be explained in the following section.

3.6.5 Questionnaire

Survey or also known as non-experimental design is usually related to the usage of questionnaire in collecting data. It allows the researcher to gather critical information by posing a set of questions. According to Tharenou *et al.* (2007: 46), questionnaire is useful when studying real-life setting and use people, testing hypothesis on a large population and generalising the findings based on a large sample.

The questionnaire can be an efficient form of data collection as it will not require the researcher to have personal contact with the respondent. Usually, a mail survey is used to collect a large sample of data. Therefore, it can break barriers of time and space, where the researcher is not required to travel or spend their time in collecting the sample (Ruane 2005: 123). The literature review in Chapter 2 found a majority of works around the FSM is using questionnaires, with some of them combining it with the use of case studies (see *Table 2.4* in Chapter 2). Most of the work (Barnes and Rowbotham 2004; Dangayach and Deshmukh 2003; Dangayach and Deshmukh 2006; Gilgeous 2001; Jain *et al.* 2013; Rowbotham and Barnes 2004) identify and classify their samples along the stage of FSM. This is done by using questionnaires as their primary data collection method.

Referring to the work described above, the research aims to use the questionnaire with the same intention. This is to identify manufacturing SMEs along the stage of FSM, specifically the position of stage 1 and stage 2. Additionally, the questionnaire is also used to serve three other important reasons. First, is to obtain a perceptual opinion on the competitive priorities that manufacturing SMEs pursued, particularly by stage 2 companies. The purpose is to investigate the top competitive priorities and subsequently to use interviews to probe steps that were taken to address those priorities.

The second reason is to get contacts from companies identified at stage 2, so that an interview can be conducted during the second phase of the data collection. To facilitate the interview process, it is imperative to get contacts from stage 2 companies as it will make sure that interview data are valid and represent characteristics of that stage 2 companies. The final reason is to use questionnaire to add details. This is done during the last phase of the mixed method data collection to obtain a time dimension. It is intended to investigate the typical time to implement improvement initiatives obtained from interviews and Delphi. The data will subsequently analysed to build a framework.

The suitability of a questionnaire can be challenged as it requires self-completion, where the respondents need to complete the questionnaire based on their perception of the questions. As a result, some respondents may not understand or partially understand the true meaning of question that is being asked. Hence, it will influence the validity of result analysed from the questionnaire and it might not produce the intended outcome. The example can be referred to studies by Barnes and Rowbotham (2004) when only half of the questionnaire can be used due to the inability of respondents to understand some of the terminologies described in the questionnaire.

Taking the problem from the above scenario, the interview is used in the research with the aim to reduce bias and to validate the answer from the questionnaire. An interview could be useful because the direct conversation between the researcher and interviewee can address any misunderstanding and at the same time, allowing an in-depth probe to complement findings from the questionnaire.

Getting a big sample from the interview is difficult and a time-consuming process as a researcher needs to gain access to the interviewer and the interview session which may require an extended time to complete. In terms of access, the interview may be a better option compared to the other methods, such as focus group and observation. This is because it only requires participation from selected individuals representing SMEs and did not require prolonged or extensive access to a manufacturing plant, which may be difficult to obtain. Further, it is not necessarily required a visit and can be done through phone or even email. To complement the result of the questionnaire, the phase 2 data collection will use the semi-structured interview. The explanation is presented in the following paragraph.

3.6.6 Semi-Structured Interview

The use of the questionnaire is aimed at indicating the position of companies along the FSM. This is the first step in answering the research question, by identifying companies that fit with the description of stage 2 on the FSM. Once companies have been identified, the next step is to explore the justification of answers provided in the questionnaire. This is to identify the key decision areas and actions, which facilitates the process of becoming a stage 2 company.

In addition, the research noted the concerns by Barnes and Rowbotham (2004) and Swamidass *et al*. (2001b) regarding the limitation of using questionnaire where the respondent may not understand the terms used and it may not unearth the evolvement of MS if the inquiry relies solely on a questionnaire. With this in mind, a semi-structured interview is identified as the second primary data collection technique to be used after obtaining data from the questionnaire.

The semi-structured interview is chosen due to five considerations. First, is to increase the data quality obtained from the questionnaire. This is by adding more depth by capturing reasons and investigating additional key decision areas in moving towards a stage 2 company. Secondly, is due to the flexibility of the semi-structured interview, allowing additional questions to be included in order to get satisfactory feedback. Thirdly, it gave the flexibility to ask questions in a varied order while staying in a controlled theme. Therefore, allowing feedback from an interview session to evolve while making sure the objective and scope are intact. Finally, answers obtained from the semi-structured interview are represented in a structured way and easier to analyse which will increase the data confidence. This is rather than using unstructured interview, which may be difficult to control, require more time to complete and the information obtained may be dramatically varied (Rowley 2012; Saunders *et al.* 2009: 321). Further adding to the above considerations, the selection of semi-structured interview is based on the need to have a consistent question directed at few interviewees. This is to look for a particular theme or patterns.

There is a potential source of errors and bias while the interview is being conducted. Questions misunderstood by interviewee will yield answers that is not related and makes investigation objective harder to achieve. Interviewee bias will lead answers which aim to please the interviewer and answers which are not representative of the real situation (Adams 2007: 148). This will jeopardise the validity of the answers. According to Adams (2007: 149) to minimise the risk, responses from interviews can be verified with data from other sources. Echoing this stance, Delphi is being chosen to increase the validity of data. The following section will explain in detail the justification for its selection.

3.6.7 Delphi

A Delphi study is a systematic, iterative process to elicit a consensus view from a panel of expert. It can be conducted by holding two or more discussion sessions with an expert. The method is different from brainstorming or focus group approach in that it avoids group interaction between an individual (MacCharty and Atthirawong 2003). Therefore, Delphi reduces the influence of dominant individuals and develop a consensus of expert opinion on subjective issues.

Delphi has two advantages that will directly benefit this research. First is the careful selection of relatively small panel according to a set of relevant criteria for a particular study can yield valuable data (Loo 2002). Valuable data can be in the form of information that has been missing or overlooked during interviews. Second, data confidence can be achieved by Delphi outcome. This is by getting a recommendation based on the complexity of an issue and the inability to satisfy the conflicting demands of different stakeholders (Jung-Erceg *et al*. 2007). Because the interview is being used and there is a risk of getting a limited number of respondent, Delphi could be used as an offset, by providing an in-depth probe on the findings and provide a recommendation to increase the data validity.

In the operations management fields, there are three most current papers that were identified using Delphi in their data collection. MacCharty and Atthirawong (2003) used two rounds of questionnaires in getting feedback from 38 experts to obtain knowledge and opinion on manufacturing location decision. Tri Putri *et al.* (2014) used three rounds mail survey from 10 industrial and academic experts to critically evaluate the critical factors for successful quality engineering implementation in automotive related companies in Malaysia and Indonesia. Finally, is by Forster *et al.* (2014), developing a strategy for consumer goods supply chain using a two-phase Delphi involving 8 experts for data collection and 81 for data validation.

The examples above show that Delphi has been previously used in the operations management field. It indicates its applicability to this research where there are similarities with the objectives to extract information from a panel of experts and the purpose of gaining opinion and evaluating decisions on operations improvement. Additionally, it shows that there are variations on the number of Delphi samples that are being used. This is in line with notion by Loo (2002) stating that there is no advocated one sample size for Delphi and it can be determined according to the research needs. This makes the case for this study to use a limited number of samples for the purpose of validating answers from interviews.

In this research, Delphi is not being used to illicit statistical sampling or to generate a final conclusion. Rather, it is used to conducted validity test to make sure the content, decision areas and actions are in line with the current trends of strategy. As a result, making it relevant to be used in the next phase of data collection. In detail, this work intends to use Delphi to serve four purposes. First, is to obtain additional or missing information that may have been overlooked during the earlier data collection process. Second, is to determine the level of agreement from experts based on findings from preceding data collection methods. Third, is to maximise the diversity of viewpoints by getting opinions from a wider community of practice which consisting of consultant and academics. Finally, it is to examine the content validity, to make sure it can be understandable and applied by manufacturing SMEs in general.

It is essential for the data to be verified as they are to be used in a questionnaire during the phase 4 data collection. Instead of using multiple rounds of questionnaire as an end to drawing the conclusion, the research use discussions in the Delphi session as a means to arrive at a conclusion. It allows an interactive and constructive conversation to take place where questions and answers can be conducted at the same time. Therefore, more information can be discovered and recorded in a single session.

Mullen (2003) highlighted the issue of expert panels in Delphi, stating that there is no consensus on the true meaning of an 'expert', which may deteriorate the quality of findings. As a result, generating views which are not a representative to a targeted population. To overcome this, panels will be selected by using more than one criterion to satisfy the need of having qualified individuals as an expert. Again it is important to take note the Delphi is not intended to obtain a view of a targeted population, but to enhance findings from earlier data collection method to do a check and balance procedure. Also, obtaining the diversity of views from the community of concern by getting opinions from operations management academics and practitioners.

3.6.8 Secondary Data Collection

In addition to primary data collection mentioned in the previous section, secondary data is used to support the findings from the primary data collection. It can be used as supporting evidence in the form of document review. For example, it can be a substitute for activity records which could not be observed directly. Further, it highlights shortcomings in previous user account or research so that future improvement can be made.

3.6.8.1 Review of Literature

Literature reviews on academic sources include academic journals, conference proceedings and doctoral thesis. Depends on the approach taken, it can be called 'secondary' when the sources may be purely conceptual, presenting, evaluating and formulating concepts and theories; as such they may contain little or no data, but they may provide comprehensive reports of what has already written (Gray 2014: 512).

In this research perspective, the literature review is used to position the research in the current body of knowledge. This is done by critically reviewing literature related to MS, identifying gaps and current work as well as selecting an appropriate framework that can be used as a main reference to the study. Further, it helps to understand the current policies and development surrounding MS and SMEs. From a methodological point of view, the literature review enhanced the process of selecting data collection methods and techniques. This is by providing an evaluation of how previous similar research have used them in conducting their studies and its limitations.

Additionally, a literature review can aid the process of creating an outcome for this research. It can be in the form of providing literature which allows comparison, supporting justification and criticising the research content. Finally, it can help the study to progress by allowing the researcher to identify areas for future investigation.

The result of the literature reviews has been extensively distributed throughout the thesis, with Chapter 2 focusing on a review in the areas of MS which lead to the need for conducting this research. The following section will explain how the data are merged at the end of the research, before providing a summary on the first section of this chapter.

3.7 Conclusions on Methodology

The adoption of a pragmatic approach is the main reason for the adoption of mixed methods design. This is due to focus that is directed of finding the best way to answer the research question rather than meddling with choosing either positivist or interpretivist stance. To ensure results are valid and reliable, mixed method approach is used to cross-check the results obtained from one method to another. In the end, rigour in the findings can be achieved.

Regarding the use of the data, authors such as (Robson 2011: 158) and (Bryman 1988: 131) suggested the use of triangulation in mixed methods design. In this research, merging is chosen over triangulation. This is by using the result of one analysis approach as a starting point to designing further steps or collecting new data using another approach (Tashakkori and Teddlie 1998: 127). Towards the end, all the data collected are merged to establish a framework (Gobo 2016). *Figure 3.4* provides a graphical representation of this process.

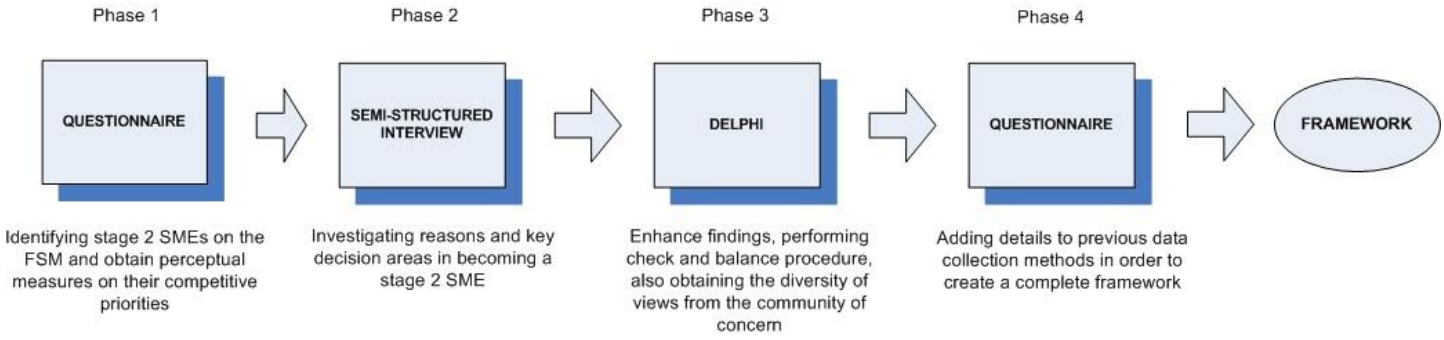


Figure 3.4: How data are merged to create a framework

The objective of the first section in Chapter 3 is to provide clarification on research methodology. The discussion about the underlying reasons and justification on the methodological stance has been conducted throughout the section. Based on the evaluation that has been conducted, three primary data collection methods have been selected. They are questionnaire, semi-structured interview and Delphi. They are complemented by the literature review as the secondary data collection method. The use of mixed methods in the study is driven by the need to validate and to supplement findings from different data collection methods. Importantly, they are used to address validity concerns and to reduce the risk of incomplete data. The next section will discuss how the methods are applied, the procedure, initial results and the way the study will arrive at a conclusion.

3.8 Research Design and Data Collection

In the previous section, the discussion revolves around the methodological stance which leads to the selection of appropriate data collection methods. The second section of Chapter 3 will continue the discussion on the process of designing data collection techniques, selection of respondent, issues arise with the chosen research design and the way it is addressed.

Again it is worth to note that the research adopts a pragmatic approach, which enables the use of multiple techniques in arriving towards a conclusion. This proves to be a significant uniqueness of this work. In addition, this is a first attempt at combining more than two data collection techniques in examining FSM, allowing results to be derived from the wider community of practice. The following paragraph will explain the chosen research design and the way it will be carried out in answering the research question.

3.9 The Chosen Research Design: The Mixed Method Exploratory Sequential Design

To start the discussion, it is important to highlight the research question that was discussed in Chapter 1 (see *1.6*) and Chapter 2 (see *2.5.2*):

Research Question: *"How can manufacturing SMEs improve its strategic role of operations and competitiveness?"*

As were discussed in *2.5.2*, movement from stage 1 to stage 2 on the FSM is used as a guide to answer the research question. There are four phases of data collection involved in answering the research question. *Table 3.1* shows a brief review of the approach made in each of the phases.

Table 3.1: Approach made on each research phase

Phase	Approach
1	Exploratory questionnaire to identify companies classified as Stage 2 on the FSM. In addition, it captures perceptual opinion on the most important competitive priorities pursued by SMEs.
2	Interview is conducted once stage 2 SMEs are identified. The purpose is to explore the reasons behind answers provided in the questionnaire, identifying the process of moving towards stage 2 and other key decision areas and actions that supported the transformation process.
3	Two experts from academics and industry are invited to participate in a Delphi session. The aim is to increase the validity of findings obtained in phase 1 and phase 2.
4	A questionnaire is built from results obtained from earlier data collection phases. The objective is to complete the framework development process. This is done by investigating improvement programmes identified within the key decision areas and the appropriate time to implement them.

The second section of Chapter 3 is structured according to the phases as mentioned above. It will start by designing the questionnaire and ends with initial findings from the data collection.

3.10 Phase 1 Questionnaire Design

The questionnaire is chosen based on three considerations. First, it would enable the research to obtain attributes of a population from a small group of individuals (Cresswell 1994: 119). For instance, the survey is aiming at identifying perceptual information on competitive priorities pursued by manufacturing SMEs in the West Midlands, UK and Malaysia. Also, the questionnaire is useful in providing hard evidence which is factual and descriptive information (de Vaus 2004: 5). Referring to the research, it is the best way to get evidence on companies positioned either on stage 1 or 2 by using the description from the original authors (Chase and Hayes 1991; Hayes and Wheelwright 1984: 396). The replication allows proven statements to be re-tested using new data sets in a different setting (Grant *et al.* 2013). In the case of this research, manufacturing SMEs. Regarding the types of survey, web-based surveys are selected as the main method of implementation and it has several advantages over the traditional mail surveys (see *Table 3.2*). This method is selected because it is relatively easy to administer. It can be delivered online, subsequently made it easier to manage and carry out analysis.

Table 3.2: The advantages and disadvantages of using a web-based survey (Rea and Parker 2005: 12; Wright 2005)

Web-based survey	
Advantages	**Disadvantages**
Convenience – The web-based questionnaire is easy to access. It can be accessed when there are an online connection and a compatible device.	*Limited respondent bases* – People with no computer, internet connection or have limited computer literacy might not be able to provide the answer through web-based surveys.
Fast data collection – It is not only easy for the respondent to complete the questionnaire, at the same time the analysis can rapidly being completed.	*Self-selection* – It contributes to lower response rate when those who did not use email and are not comfortable with using web-based technology exclude themselves from the sample.
Cost effective – Web-based surveys eliminate the need for postage and paper supplies as well as it is not labour intensive. Also, it is an environmentally friendly way to conduct a survey.	*Access issues* – Some research access potential participant by posting an invitation in bulletin boards, discussion groups or chat rooms. Some of the members of the group may find this rude and offensive or consider this posting as spam.

Phase 1 questionnaire is designed by constructing 15 questions with an extra question in the comments section. The answer is measured using the Likert scale. It is used because it works particularly well in elicit attitudinal information such as beliefs and opinion about one specific subject matter (Rea and Parker 2005: 68). Questions were developed mainly to find out information on the current state of company operations. This is according to the description of the FSM and how they view the importance of competitive priorities. Therefore, a Likert scale is the most suitable because it can be used in seeking an opinion from a managerial perspective on how operations are being carried out. However, the Likert scale has its own issue. Referring to Barnes and Rowbotham (2004), they found out that most of their respondent is answering according to the way that they are expected to answer. Thus, obscuring the real honesty on the answer. This can be attributed to the uni-dimensional of the scale as they provide limited answering choices and the tendency of a respondent to avoid 'negatives' in answering. The questionnaire is attached as *Appendix 4.*

Due to the issue highlighted above, phone survey is going to be used to re-validate the answer obtained from the questionnaire. It is to make sure the answer represents the current operational state of the company, to increase the validity and honesty of the answer. This is planned to be carried out when all the answers were returned.

3.10.1 Designing Phase 1 Questionnaire: Testing the Four Stage Model

The questionnaire consists of four constructs to capture competitive priorities. The aim is to generate actual constructs based on the results of interviews, which can be used in phase 4 questionnaire. As were

mentioned earlier, the questionnaire is intended to get an opinion from SME on their current state of operations. To do this, FSM will be tested. The construct being used in identifying the position of the company along the FSM is the same constructs which have been previously used in similar work and settings (Barnes and Rowbotham 2004; Dangayach and Deskmukh 2006). In addition, it is designed according to original work by Hayes and Wheelwright (1984: 396) and (Chase and Hayes 1991). This is to enhance content validity, as it was described in the original work and has been previously tested (Grant *et al*. 2013). *Appendix 5* shows the constructs to test the stage 1 and 2 of the FSM and the reasons leading to its selection.

It is anticipated that companies might answer questions that are not describing the true nature of their operations. The way this scenario is addressed is by putting a scoring system to select companies that fit with stage 2 criteria. Refer to *3.12.2* for further discussion on how the process is carried out. The following paragraph explains capturing competitive priorities in the questionnaire and issues regarding its usage.

3.10.2 Designing Phase 1 Questionnaire: Identifying the Competitive Priorities

The questionnaire second objective is to identify the most important competitive priorities pursued by these companies. As were mentioned in Chapter 2 (see section *2.5.4 and 2.6.1*), priorities must be given to the attainment of quality and dependability to become a stage 2 company. This is before achieving stage 3 or 4 by obtaining flexibility and cost efficiency.

In order to obtain perceptual information, respondents are required to state the level of importance placed on competitive priorities. This information will be useful during interviews to investigate the types of measures undertaken to obtain the priorities. An additional four questions related to quality, dependability, flexibility and cost were asked in the questionnaire. The type of questions used is similar to Chan (2005) work in identifying competitive strategies by using perceptual measures. It is believed this type of measures is useful in empirical research related to managerial evaluations.

It is also worth to note that there is a slight adjustment made to the questions. As a result, operational definitions from multiple elements are not being designed to achieve the objective. This is contributed to three reasons. First is due to the sequential approach to the research design. The phase 1 questionnaire is used to obtain a general perceptual opinion from managers towards the current state of their company. Therefore, the result is expected to provide some indication on the competitive priorities, which can be validated during interviews.

Secondly, the in-depth probe on competitive priorities selection is expected to take place during the interview sessions. As a result, once the first phase questionnaire is completed, interviews are used to uncover competitive priorities constructs obtained from stage 2 SMEs. It can be enhanced later by conducting Delphi and subsequently tested again in phase 4 questionnaire.

The final reason is to encourage complete response and attract as much as respondent as possible. As a consequence, the questionnaire is made simple and only consists of 16 short questions. It is understood that obtaining a response from the intended SME is quite difficult. Therefore, a short survey will be easier for them to answer and require less time to complete. It is aligned with Fan and Yan (2010), mentioning the time taken to answer a survey is closely related to the response rate.

Table 3.3 Competitive priorities definition from various authors

Competitive Priorities	**Authors**	**Definition**
Quality	Lin *et al.* (2012)	Producing and delivering products to the highest possible standards consistently.
	Dangayach and Deshmukh (2006)	Manufacture of products with high quality or performance standards.
	Grobler (2007)	Producing with high-quality conformance of products.
Dependability	Miller and Roth (1994)	Deliver on time (as promised).
	Phusavat and Kachana (2007)	Dependable promises are one of elements of customer focus.
	Sarmiento *et al.* (2007)	Level of quality need to be corrected first time to ensure deliveries can be made on time.
	Gyampah and Acquaah (2008)	Meeting delivery promises and providing faster delivery.
	Flynn and Flynn (2004)	On time and fast delivery of products.
Flexibility	Lin *et al.* (2012)	The ability to respond to changes in terms of product range, design and volume.
	Esturilho and Estorilio (2010)	The ability of a manufacturing system to deal with uncertainties and cope with supplier and customer fluctuations.
	Boyle (2006)	A system's capability to cope with a wide range of possible environmental changes.
	Flynn and Flynn (2004)	Ability to deal with difficult or non-standard orders.
Cost	Hussain *et al.* (2015)	Competing on the basis of cost efficiency requires striving for low-cost production.
	Grobler and Gubner (2006)	To produce with low cost.
	Hilmola *et al.* (2015)	The capability to compete on price.

Based on information provided in *Table 3.3*, a single sentence will be used to summarise the meaning of competitive priorities in the questionnaire. The constructs used are:

1. Quality - Quality is the most important objective.
   The sentence used in the survey is the reflection on the importance of quality as the first priorities need to be given attention before pursuing other priorities. It is aligned with works that promote cumulative capabilities (Ferdows and Meyer 1990; Grobler and Gubner 2006; Nan *et al.* 2011; Roth 1996) that emphasis on building up quality capabilities as the first step in improving manufacturing operations.
2. Dependability - Top priorities is to deliver the right product, right quantity and as promised.
   The question is a combination of dependability described by Sarmiento *et al.* (2007) where quality needs to be correct at the first time and description by Miller and Roth (1994) which describes it as delivering on time (as promised).
3. Flexibility – Customer has the flexibility to change an order once the order has been placed.
   Table 3.4 implied flexibility as 'change' or 'fluctuations' on manufacturing systems. Therefore, to make a simple statement in the question, 'a change of order' is being mentioned to represent flexibility.
4. Cost – The main aim of production is to keep the cost down.
   The statement is to test whether the cost is pursued as part of the competitive strategy (Bowman and Faulkner 1997: 3; Mintzberg and Quinn 1996: 83; Porter 1996). In addition, it is to compare the answers with other competitive priorities to look at whether it is the main aim of the production.

It can be noticed that the use of single construct variable might not be enough in getting a clearer picture on the competitive priorities that are pursued and respondent may tend to answer according to what they feel right about the company. With this issue in mind, the interview will do an in-depth probe on those priorities to come out with constructs that represent their selection. This is conducted after both analysis (phase 1 questionnaire and phase 2 interviews) has been completed. In the end, constructs on each variable, particularly quality and delivery will be established. These constructs include representation of actions taken by the company in pursuing those competitive priorities. This process can produce data from the real settings and action, rather than solely using construct available within the literature. This can be validated in the later phases of data collection. By carrying out this process, it can fill the gap in the literature by coming out with new or additional constructs which are yet to be published. The following paragraph will discuss the interview design and followed by the process of data collection.

3.11 Phase 2 Interview Design

According to Granot *et al.* (2012), the best way of understanding the meaning of participant's actions and decisions can be obtained by using interviews. In the context of this research, semi-structured interviews are being used to understand the process of becoming a stage 2 company on the FSM. As a result,

managers are being interviewed to obtain historical and current information on operations. The participants from the interviews are recruited based on the analysis that was made from phase 1 questionnaire. *Appendix 5* shows the constructs used in phase 1 questionnaire to identify stage 2 companies.

3.11.1 Phase 2 Interview Design: Identifying the Process of Becoming Stage 2 Companies

The interview main aim is to identify the process and reasons behind those progressions to stage 2. This is to identify key decision areas and their actions to create a framework that can be used to improve stage 1 company. Questions 7, 5, 11, 12, 13 and 17 are constructed by mainly referring to the original work by (Hayes and Wheelwright 1984: 396) and (Chase and Hayes 1991) (refer to *Appendix 7*). Additional questions are asked to identify other areas (problem solving techniques, skills and training and performance measures) which may contribute the progression to stage 2. Further, it is to understand the steps take to address the most important competitive priorities. Interview questions and its aims are shown in *Appendix 7.*

Due to the nature of the semi-structured interview which allows for some degree of flexibility, follow up questions may arise in the duration of the interview. This enables additional information to emerge as the interview progresses. The way data are being collected will be explained in the next section. The discussion on Delphi and the phase 4 questionnaire is included towards the end of the chapter.

3.12 The Data Collection

Time horizon, gaining contact and costs are taken into consideration when distributing the questionnaire. Online questionnaire is used as it will be easier for the data to be collected, managed and analysed. Distinction on firm size is being made according to micro, small manufacturing companies and medium-sized companies. Further, SMEs from the UK and Malaysia are selected based on available contacts in the UK and the access to company information in the *Federation of Malaysian Manufacturers* directory. The criteria for company selected are according to *Table 3.4*. This is in addition to respondent criteria that need to be at least in a managerial position that oversees the company manufacturing operations.

Table 3.4: SME definitions

Author	SME definition
Ward and Rhodes (2014)	Micro business - 0 to 9 employees. Small business – 10 to 49 employees. Medium business – 50 to 249 employees.
SME Corporation Malaysia (2013)	Micro enterprises across all sectors – Sales turnover of less than RM300, 000 (GBP 45,500) and full-time employee is less than 5. Small enterprises – Sales turnover from RM 300,000 (GBP 45,500) to RM 15 million (GBP 2.3 million) full-time employees from 5 to 75. Medium enterprises – Sales turnover from RM 15 million (GBP 2.3 million) to not exceeding RM 50 million (GBP 7.6 million) employees from 75 to not exceeding 200.
O'Regan and Ghobadian (2006)	Fewer than 250 employees.

For the phase 1 questionnaire, respondents are required to indicate the relative importance of questions that represent the characteristics of stage 1 and stage 2 companies on the FSM. Using a five-point Likert scale, their opinion can be rated based on 1, strongly disagree to 5, strongly agree. The questionnaire first section is related to the company characteristic which includes size, location, industry sectors, and years in operations. Also included is a requirement for respondent's information such as name, designation and e-mail address. These are included to make sure contact could be established once potential stage 2 companies are identified. The process of getting questionnaire samples is explained in the following section.

3.12.1 Phase 1 Questionnaire Distribution

Contact was established with a research centre that supports and collaborates with manufacturing SMEs within the UK. After an informal conversation, the contact agreed to put forward an invitation to participate once she received a formal email invitation and the survey link. It was informed that the questionnaires are forwarded to twelve manufacturing SMEs located in the West Midlands. Two additional companies, suggested by a member of staff agreed to participate at the last minute. Significantly, West Midlands is well known for its ties to the UK automotive industry. According to the West Midlands Report 2015:

i. The West Midlands has ten vehicle assembly plants and two engine plants.
ii. 10% of UK Automotive job is concentrated in Coventry and Warwickshire area.

iii. 29% of cars produced in the UK are made in the Midlands.
iv. All of the above are supported by SMEs who employs at least 120,000 workforces.

14 invitations to participate in the study were sent to UK based manufacturing SMEs and a total of 10 questionnaires were returned. The contacts of Malaysian manufacturing SME were obtained by using the online directory provided by *Federation of Malaysian Manufacturers*. The directory was referred because it has been previously used in studies concerning responses from Malaysian manufacturers (Anuar and Yusuff 2011; Jusoh *et al.* 2008; Singh and Mahmood 2014). In order to make sure questionnaire were mailed out to targeted recipients, which are SMEs, companies were selected based on the description in *Table 3.4*. A total of 200 companies were identified and invitations to participate in the survey were sent. After the first invitation, 4 companies responded. Reminders were sent after a week, gaining an additional 11 responses. In total, 15 responses were obtained. Out of 15 received, 4 were rejected as they are either impartially completed or the respondent answering with a single answer for all questions. In total 11 usable responses were obtained.

In total, 214 invitations to participate in the study were sent to UK and Malaysian manufacturing SMEs. 21 completed responses were returned, indicating a response rate of 9.8%. *Table 3.5* and *3.6* shows the company size and industrial sectors by countries.

In general, online surveys are proven to be less likely to garner high response rate compared to the ones administered on paper (Nulty 2008). However, according to Fan and Yan (2010), the sponsorship of a survey is found to affect both mail and web-based surveys. They mentioned that surveys which are sponsored by academic and government are likely to obtain higher response rates compared to commercial ones. The high response rate by UK SMEs is largely contributed to the help of the research centre in supporting the process of promoting the research project.

Table 3.5: Company size by countries

Company size (employees)	Malaysia	United Kingdom	**Total**
10 -49	4	8	12
50-75	2	1	3
76- 200	5	1	6

Table 3.6: Industrial sector by countries

Industry sector	Malaysia	United Kingdom
Iron, steel and metals	2	6
Automotive and transport		2
Machinery and equipment		1
Textile, footwear and clothing		1
Wood and paper	3	
Pharmaceutical	1	
Industrial waste recycling	1	
Electrical and electronics	1	
Rubber and plastics	2	
Food, beverages and tobacco	1	

3.12.2 Phase 2 Interview Invitation Selection Process

Invitation for interviews was sent to companies identified categorically belongs to stage 2 companies on the FSM. The decision to categorically classify the company is based on the positive answers (✓ under table headings A) on a Likert scale (4-Agree and 5-Strongly agree) to characteristics of a stage 2 companies (see *Appendix 5*). Specifically, the characteristics are:

1. Having a formalised problem solving process.
2. New technology is introduced when it can justify cost savings.
3. Some work procedures have been established in the company.
4. Equipment brought from the same as competitors or best suppliers.

In addition to the above characteristics, stage 2 companies are determined by negative and neutral answers (× under table headings B) on descriptions of stage 1 company on the Likert scale (1-Strongly Disagree, 2- Disagree and 3- Neutral). Specifically, the characteristics are:

1. Focusing on cost-cutting.
2. Occasional strategic issues which are solved by outside help.
3. New technology is introduced when it becomes necessary for survival.
4. Management intervention in manufacturing operations when there is a great need to do it.

Table 3.7 Identification of stage 2 companies

Company	A				B				
	Formalised problem solving	New technology for cost savings	Established work procedures	Equipment from best supplier	Focused on cost cutting	Occasional strategic issues solve by outside help	New technology for survival	Intervention by management when there is a great need	Number of stage 2 company characteristics
1	✓	✓	✓	✓	✓	✗	✗	✗	**7**
2	✓	✓	✓	✓	✗	✓	✓	✓	**5**
3	✓	✓	✗	✓	✗	✓	✗	✗	**6**
4	✗	✓	✓	✓	✗	✓	✓	✗	**5**
5	✓	✓	✓	✗	✓	✗	✗	✓	**5**
6	✓	✓	✓	✓	✓	✗	✓	✓	**5**
7	✓	✓	✓	✓	✗	✗	✓	✓	**6**
8	✗	✓	✓	✓	✗	✓	✗	✓	**5**
9	✓	✓	✓	✗	✓	✓	✓	✗	**4**
10	✓	✗	✓	✗	✗	✗	✗	✓	**5**
11	✗	✓	✓	✗	✓	✗	✗	✗	**5**
12	✓	✓	✓	✓	✗	✓	✓	✓	**4**
13	✓	✓	✓	✓	✗	✓	✓	✓	**5**
14	✗	✓	✓	✗	✓	✓	✓	✓	**2**
15	✓	✓	✓	✗	✓	✓	✗	✗	**5**
16	✓	✓	✓	✓	✓	✓	✓	✗	**5**
17	✓	✓	✓	✗	✓	✗	✗	✓	**5**
18	✓	✓	✓	✓	✗	✓	✓	✓	**5**
19	✗	✓	✓	✗	✓	✓	✓	✓	**2**
20	✓	✓	✓	✓	✓	✓	✓	✗	**5**
21	✓	✓	✓	✗	✓	✓	✓	✓	**3**

Table 3.7 shows how answers from the questionnaire are used to classify companies which belong to stage 2 in the FSM. Emails were sent to companies that achieve a value score of 4 and above to invite them to participate in interviews. A total of 18 emails were sent and 5 companies responded (company

numbers highlighted in *Table 3.7*), willing to take part in the interview. The interviews were conducted in the span of 4 months. It was carried out by using several techniques, namely phone, email and face-to-face interviews. *Table 3.8* shows the information in each interview session. In addition to conversations, all face-to-face interviews are complemented with a short tour of the facility, with the aim of observing elements that were not captured in the interviews.

Table 3.8: Interview session information

Company	**Industry sector**	**Person interviewed**	**Interview type**	**Duration**
2 (Company B)	Automotive and transport equipment	Managing Director	Face to face	2 hours
3	Automotive and transport equipment	Managing Director	Email	N/A
11 (Company A)	Wood and paper	Factory Manager	Telephone	1 hour
9 (Company C)	Iron, steel and metals	Manufacturing Engineer	Face to face	2 hours
10 (Company D)	Textile, footwear and clothing	Production manager	Face to face	1 hour

Apart from identifying the stages, it is also worth to note that questions on competitive priorities are asked again in the interview to validate the findings from the questionnaire. The interviewees were asked to provide rank on 7 competitive capabilities that they feel pursued by their company (Refer *Appendix 7*, item no. 7). Additional questions were asked regarding why their company decided to pursue the most important priorities that they have listed.

It is important to highlight the email interview send to company 3 is not being used in the analysis due to the answers provided by the managing director which is too brief and incomplete. Therefore, the analysis will be conducted based on the interview sessions with company 2, 11, 9 and 10. In the next chapter, the company will be renamed as 2 (Company B), 11 (Company A), 9 (Company C) and 10 (Company D). Once the interview results are obtained, Delphi sessions are organised to validate the answers.

3.12.3 Phase 3 Delphi Panel Selection Process

There are two Delphi sessions conducted in this research. Both sessions are conducted through face-to-face meeting to elicit opinion regarding the outcome of the questionnaire and interviews. Two experts were invited to participate in a Delphi meeting. The experts are selected based on three considerations which are: they must have experience working in a manufacturing plant, have knowledge or teaching experience in operations management and must include at least 7 years of experience in the said field. 7

years' experience in the field allows them to oversee a long term strategic realisation plan (Drago 1996; Harrison 1995; Kachaner *et al.* 2016). The following are the expert profile:

1. The first expert is a consultant who has experience advising over 15 manufacturing SMEs on lean manufacturing, problem solving, change management and continuous improvement. Also, he holds a Six Sigma Black Belt and has 15 years' experience working in the automotive industries in the UK, USA, South Africa and France as manufacturing engineer and lean director.
2. The second expert is a lecturer who has 10 years of working experience as a production engineer and production manager before moving on to an academic career. He has 17 years' research and teaching experience in operations management, business strategy and research methods subjects. In addition, being an external examiner on operations management courses in other four UK based universities.

The above individual is contacted through a recommendation from one of the academic staffs and also by direct approach. Below are the processes of conducting the Delphi sessions:

1. They are explained about the FSM, the use of the framework and the current work around the model.
2. They are explained about the research gap and how the research intends to address it.
3. They are briefed on research current progress and how the Delphi sessions are going to contribute to the research.
4. The result from interviews and questionnaires are presented.
5. All the discussion and feedback is recorded throughout the meeting.

Question and answers are conducted interchangeably during the above process. The meeting report is promised to be delivered to the experts involved within one week through email. This is to make sure their input and feedback are properly understood and the aim of the session can be achieved. Results from Delphi are presented in Chapter 6. See *6.2*.

3.12.4 Phase 4 Questionnaire

A further validation process will be carried out upon the completion of Delphi sessions. This is to make a conclusion on the typical timeline in implementing actions in the key strategic decision areas identified during phase 1, 2 and 3 data collection. To do this, another opinion from the industry and academics are required. Again, the questionnaire is used to get as much feedback as possible, as well more informed sample. Additionally, the use of perceptual measures such as action, time and impact on operations output can be best investigated using a questionnaire rather than interviews. This is contributed to four important reasons.

First, the constructs that were used in the questionnaire has been deduced from the interviews and Delphi sessions (refer to Chapter 6, *Figure 6.1*). Hence increasing the validity of its content through multiple rounds of validation. Second, answers to the number of questions (172) are best captured by using questionnaire. In addition, it can be sent to multiple respondents across locations and can be filled out quickly. Third, the use of interviews may be time-consuming and may not capture the required answers due to a large number of questions involved. Finally, requesting respondents to spend their time to complete a long interview is difficult and require extended time to get multiple interview session.

3.12.4.1 Phase 4 Questionnaire Constructs

A total of 43 actions are converted into statements. The second task is to add time to the questions. This is to obtain information on the typical time to implement actions within the decision areas. Five strategic planning literatures were reviewed to identify a suitable timescale. They were selected because there is a specific mention on time to set organisational objective. Details can be referred to *Table 3.9*.

Table 3.9: Strategic planning timeline

Authors	**Strategic planning time**
Kachaner *et al.* (2016)	Long term - More than five years Medium term – Three to five-year period Short term – A year to three year period
Oliver (2000)	Three to five years to look for long term global or macro trends
Drago (1996)	Short term objectives (1 year or less) Long term objectives (two or more year time span)
Harrison (1995)	Short range 1-3 years Mid-range 3-5 years Long range 5-10 years
Hay and Usunier (1993)	Distant future 5-10 (levels of strategy: vision) Future 3-7 (levels of strategy: mission/goals) Intermediate future 2-5 (level of strategy: plan/staircase) Near future 1-3 (level of strategy: step by step initiatives) Present/near future 1-2 (level of strategy: individual objective)

Table 3.9 shows there is varying timescale used to describe time for strategic planning. 1 year is the shortest, while 10 years is the longest timescale. Also, there is a varying range of time classification, which was generally described as short, medium and long term. To summarise they are categorised into three. First is short term planning with a time range from 1 to 3 years. Second is mid-term planning with a time range from 3 to 5 years. Third is long term planning with time starts from 5 years and above.

Based on the above, the scale used in the questionnaire will have a range from less than 1 year to 5 years, with an additional item indicating actions to be taken after year 6 and above. It represents short, medium

and long term planning timeline. This enables the questionnaire to capture information on when the action is included in the strategic planning timescale.

Apart from time, respondents are also required to rate the impact of actions on quality, delivery and cost. They are required to indicate on a Likert scale, whether these actions have a highly positive (++) or a highly negative (--) impact on quality, delivery and cost. The questions aim to rank the importance of each action towards pursuance of the first priority (quality), second priority (delivery) and third priority (cost). Due to the fact that quality was validated to be the first priority within this research, actions that give positive impact to the first priority (quality) could be positioned on earlier timescale within the developed framework.

Cronbach's alpha was used to measure the reliability of the scale. The result is depicted in *Table 3.10*

Table 3.10: Cronbach's Alpha

Cronbach's Alpha	N of Items
.948	172

The result which shows the value of 0.948, indicating the reliability of the scale is acceptable. This is considering 0.7 is the normal readings for a set of reliable set of items (de Vaus 2002: 20) and the threshold point of 0.6 (Prajogo and McDermott 2008).

3.12.4.2 Phase 4 Questionnaire Respondents

The five companies involved in the previous interview session are invited to participate in the questionnaire. In addition, respondent is selected by contacting individuals on a professional social network site, LinkedIn. The site was chosen based on three reasons:

1. Displaying information on job history, position and description – Showing employment history from past and present organisations with description regarding the position, job scope and the task performed. This information is valuable to ensure respondent has the required background to answer the questionnaire.
2. Information on featured skills and endorsement – Informing the skills an individual possesses and endorsement, which allows different persons to validate the ability of the individual to perform those skills. These features show respondent expertise which is specific and credible. This will increase the validity of response in the questionnaire.
3. Validity and reach – Information on LinkedIn allow questionnaires to be distributed to more informed individuals, as well as allowing more prospective respondent to be contacted.

The respondents are chosen based on several criteria, which can show they are the experts that have the skills and experience to answer the questionnaire. The criteria are as the following:

1. Years of experience – The minimum years of experience is 7 years. This is based on the projection of short term planning time (1 year) up to the long term planning time (5 years). Additional 2 years is considered the time when they could oversee results from plans made in year 1 to year 5.
2. Position – The minimum position required is a manager. Other positions such as lecturer and trainer are included as well.
3. Skills and endorsement – Respondent must possess a minimum of five skills namely (change management, problem solving, 5S, lean manufacturing and quality management). This must be endorsed by at least one person.
4. Industry - The person must currently or previously involve in the manufacturing industry.

The above selection is made based on three considerations. First is to increase the validity of answers and secondly to obtain views from multiples sources within the manufacturing industry. Finally, to make sure they have the knowledge and are familiar with the terminology used within the questionnaire. All these are taken into account to realise the objective of obtaining information on the typical time in implementing the actions within the key decision areas.

The survey is piloted to an operations management lecturer who has experience in working with 12 manufacturing SMEs. This is intended to get another opinion regarding the overall design of the questionnaire and its applicability to the targeted sample. Results from Delphi and phase 4 questionnaire will be elaborated further in Chapter 6.

3.13 Elimination of bias

The opportunity to conduct plant tour, phone follow-up and conduct interview give a considerable impact in reducing bias generated from the phase 1 questionnaire results. It is understandable that managers might answer them by thinking all the description represents their company operations. This is because some managers might complete the survey in either through of superficial manner (Collins and Cordon 1997). As a result, responses reflecting the desired state of operations rather than the reality. Therefore, interviews validate and provide more assurance on the results obtained from questionnaires. This is added with Delphi and piloted phase 4 questionnaire distribution to add more detail to the findings.

3.14 Conclusions on Research Design and Data Collection

The chapter objective is to discuss how the data collection will be used to answer the research question. The discussion includes the process of designing questionnaire, interview and selecting respondent, as well as issues regarding the selected techniques. In the end, four data collection techniques are combined to increase the validity of data, reducing bias in interpreting the findings and informing one to another.

To summarise, the phase 1 questionnaire is used to identify FSM stage 2 SMEs and the most important competitive priorities pursued by them. Phase 2, which is the semi-structured interviews are conducted to identify key decision areas in enabling SMEs to move to stage 2 on the FSM. Additionally, to find reasons for answers provided in the previous questionnaire and identifying how pursuance of competitive priorities are addressed.

Phase 3 deployed Delphi to get an expert opinion on the results from the interviews and questionnaire. Phase 4 is the distribution of another questionnaire, which is different from phase 1. It is different due to its purpose of investigating an ideal timeline in carrying out actions on key decision areas and actions obtained from interviews and Delphi sessions.

Detailed design on the phase 1 questionnaire and phase 2 semi-structured interviews, as well as the initial result, has been explained in the previous section. This is in addition with discussions around Delphi and phase 4 questionnaire. Chapter 5 will discuss further phase 1 questionnaire and interviews findings. The process of developing the proposed framework will be explained in the next chapter.

Chapter 4: The Proposed Framework and The Development Process

4.1 Introduction

The aim of this chapter is to link the proposed framework to the analysis. The discussion in this chapter will evolve around the data collection process and outcomes, as well as the process of designing the proposed framework. Also, this chapter will introduce the proposed framework, discussing its practical implications and contributions. To begin the discussion, it is important to reiterate that the research presented in this thesis adopts an emergent approach where interviews, Delphi and questionnaires are used to add findings on one another. As a result, the data analysis presented in this thesis will be explained according to the sequence of data collection.

The analysis is presented in two chapters. In Chapter 5, the analysis covers data obtained from phase 1 questionnaire and phase 2 semi-structured interviews. This is followed by Chapter 6, where the analysis is focused on data obtained during Delphi, phase 4 questionnaire and framework validation. This approach is taken to better record the data collection process. Importantly, it is to show how the data evolved and merged to create a framework.

For a detailed explanation of how this is going to be carried out, this section will clarify the step-by-step process that will take place during collecting and analysing data for this research. This is to establish a guide on the way data are interpreted, how it will be analysed and arrive at a conclusion. In the same way, this guide will be useful in explaining the way the thesis is written from this point onwards. *Figure 4.1* shows how the data collection is conducted and how each method generates a contribution to knowledge.

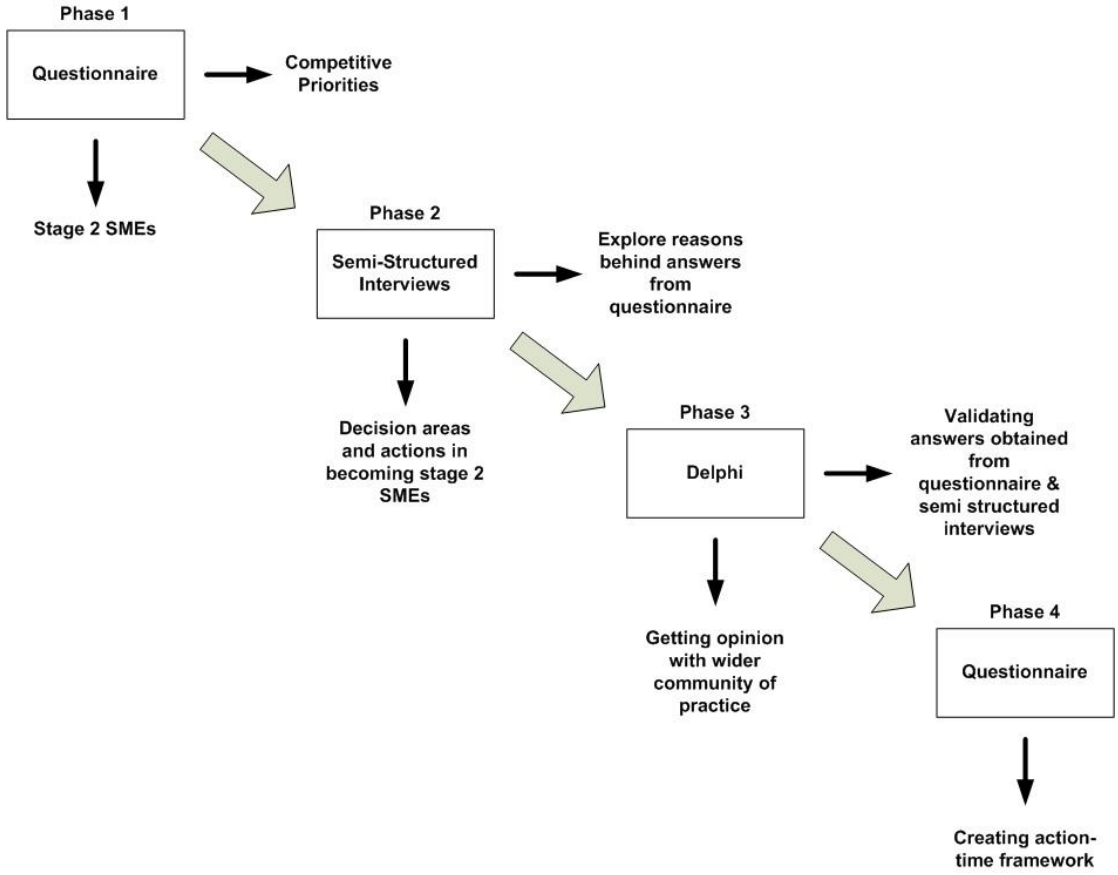


Figure 4.1: Data collection process and outcomes

Figure 4.1 displays a summary of the data collection process. The process involves four phases of data collection. Three data collection techniques are used. They are questionnaire, Delphi and semi-structured interview. Each of the techniques yields outcomes which complement each other and eventually creating the Action-Time Framework (ATF). Starting from phase 1, questionnaires are distributed to the UK and Malaysian manufacturing SMEs. This has contributed to the identification of stage 2 SMEs and their most important competitive priorities. Based on this information, semi-structured interviews are conducted in phase 2 to investigate decision areas and actions in becoming stage 2 companies.

Interview questions are guided by areas that were identified earlier in the literature reviews (see *Figure 4.2*). At the same time, interviews produced information relating to reasons for answers provided in the questionnaire, particularly regarding the competitive priorities. Next, Delphi technique is deployed in phase 3 to validate findings from the interviews. Finally, in phase 4, another questionnaire is distributed to complete the data gathering process. All this information is merged at the end to create a framework. The process is explained in the following section with reference linked throughout the thesis.

4.2 Designing the Proposed Framework

In phase 1 questionnaire, a set of 15 questions has been created with the aim of identifying stage 2 SMEs and obtaining perceptual measures on most important competitive priorities. The detailed explanation of designing and distributing the questionnaire can be referred to *3.10 and 3.12.1*. Contents included in the questionnaires was derived from the literature review and initial investigation conducted during a visit to a manufacturing plant. As a result, several areas were identified to be further investigated. They are comparison with competitors, competitive priorities, work procedures, best practices, problem solving techniques, performance measures and skills and training. *Figure 4.2* shows this in a graphic form.

Figure 4.2: Stage 1 to stage 2 research areas

Figure 4.2 shows areas intended to be investigated by the research. In addition, it refines the scope which will be covered in the investigation. In the end, it allows a framework to be based in these areas, which enables stage 1 company to adapt and improve their operations. These areas will be used as a foundation to guide the research direction. The adoption of mixed methods exploratory sequential design allows data to be expanded with the use of different data collection methods. Therefore, new areas will be identified as the research progress.

The identification of stage 2 manufacturing SMEs is conducted in phase 1 questionnaire. This lead to phase 2 data collection, semi-structured interview to commence. The interviewee selection process, based on the phase 1 questionnaire outcome is described in *3.12.2*. Also, perceptual measures on competitive priorities are captured in the same questionnaire. The results are presented in *5.2*.

The next step is Phase 2. Interviews are carried out with manufacturing SMEs identified from phase 1. The process of designing the interview is explained in *3.11*. The goal is to validate the competitive priorities, why and how they are pursed and also investigate decision and actions that contributed to becoming stage 2 companies. Four manufacturing SMEs are involved and the results are discussed in *5.5*.

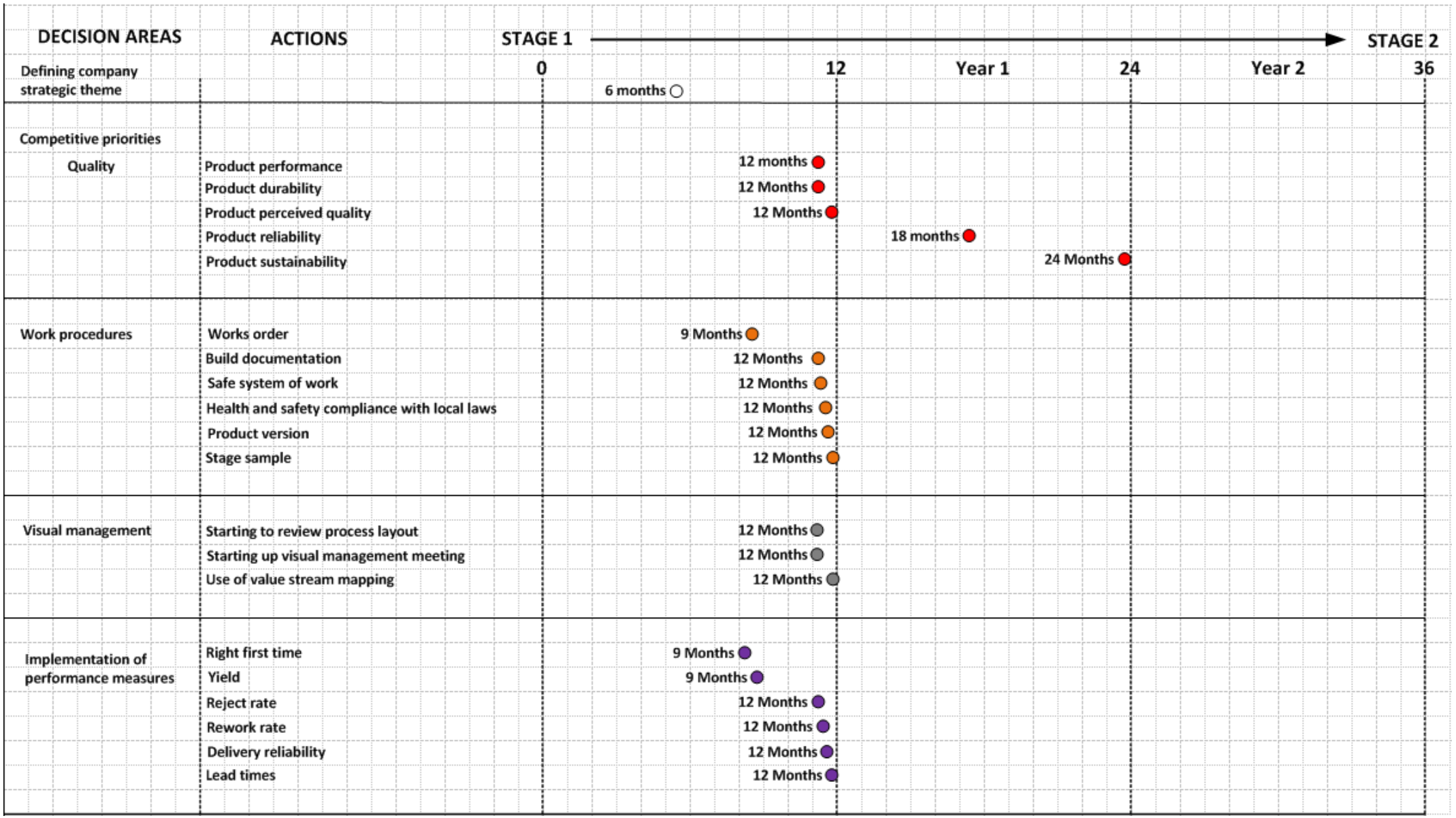
Phase 3 began once the interviews have been completed. Phase 3 is organised to validate data acquired from the questionnaire and interviews as well as getting opinions from a wider community of practice. In this phase, data is collected by using Delphi technique. The explanation and the way the Delphi panel is selected can be referred to *3.12.3*. One of the suggestions from the Delphi outcomes is to integrate timeline with actions and decisions obtained from interviews and Delphi itself. The reason is to provide a time plan on when identified actions and decisions can be implemented. This leads to the use of another questionnaire in phase 4. Detailed outcomes from Delphi is presented in *6.2*.

Phase 4 is the final iterations of data collection performed in this research. This is in response to the suggestion obtained from Delphi as explained in the above paragraph. Importantly, this phase completes the development of a framework that can be practically used by manufacturing SMEs in improving their operations towards stage 2. In this phase, a new set of questionnaire is created based on information gathered from interviews and Delphi. The objective is to collect information on typical time to start the process of becoming a stage 2 company. *3.12.4.1* and *3.12.4.2* explain the process of designing and distributing the questionnaire. Next section will introduce and describe the proposed framework.

4.3 The Proposed Framework: Action-Time Framework (ATF)

The Action-Time Framework (ATF) name was given because the framework integrates actions with time plan. It is created by using information obtained from investigating decision areas and actions that enables an organisation to move from stage 1 to stage 2 on the FSM. It is complemented by a timeline indicating the *latest start time* when the actions can be implemented. The position of action along the timeline is influenced by two factors which are the typical time the actions are initiated and its impact on quality, dependability and cost. A highly positive impact on quality means earlier *latest start time*. This is followed by dependability and cost. Detailed information on the calculation process is presented in *6.3*.

Companies can use the ATF by comparing decision areas and actions that they have undertaken with the one presented within ATF. Any actions that are found yet to be initiated, should be initiated at the soonest possible or within the *latest start time* indicated in ATF. The ATF will be presented on the next page. It will be followed by the framework description section, explaining in detail the way actions presented in the ATF can be implemented.


DECISION AREAS
ACTIONS
STAGE 1
STAGE 2
Defining company strategic theme
0
6 months
12
Year 1
24
Year 2
36
Competitive priorities
Quality
Product performance
12 months
Product durability
12 Months
Product perceived quality
12 Months
Product reliability
18 months
Product sustainability
24 Months
Work procedures
Works order
9 Months
Build documentation
12 Months
Safe system of work
12 Months
Health and safety compliance with local laws
12 Months
Product version
12 Months
Stage sample
12 Months
Visual management
Starting to review process layout
12 Months
Starting up visual management meeting
12 Months
Use of value stream mapping
12 Months
Implementation of performance measures
Right first time
9 Months
Yield
9 Months
Reject rate
12 Months
Rework rate
12 Months
Delivery reliability
12 Months
Lead times
12 Months

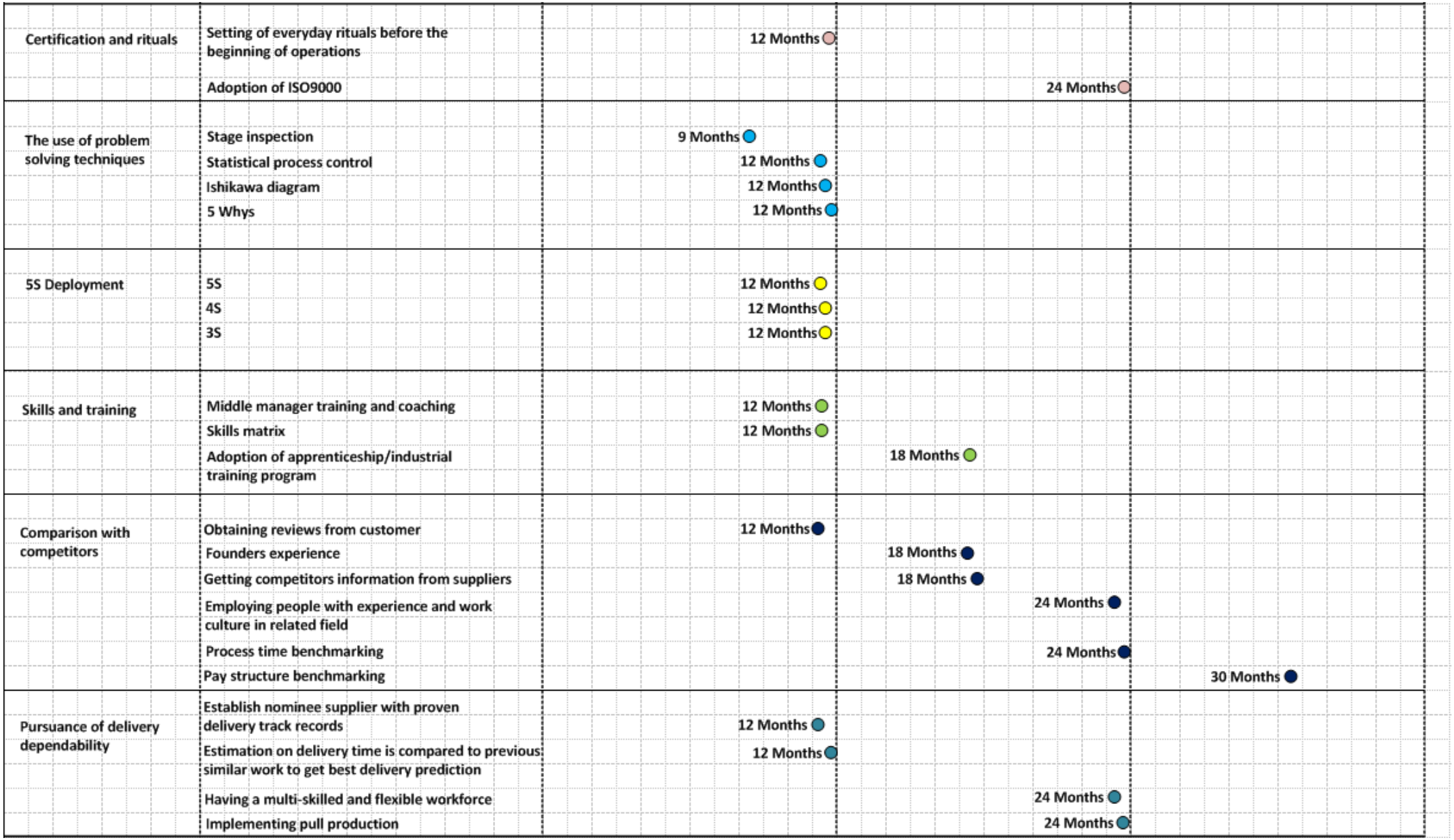


Figure 4.3: The Action-Time Framework (ATF)

4.4 Framework Description

The Action-Time framework (*Figure 4.3*) shows elements from 11 areas coded by different colour scheme (*Table 4.1*), to be addressed by stage 1 company. The sequence of actions is depicted according to its position along the monthly grid. It also can be referred to their vertical position within the actions column according to their decision areas. The framework can be used by new and established companies which require the first step of improvement in pursuing the right competitive priorities.

Table 4.1: Decision areas and colour code

Decision Areas	**Colour Code**
Defining company strategic theme	
Competitive priorities: quality	
Work procedures	
Visual management	
Implementation of performance measures	
Certification and rituals	
The use of problem solving techniques	
5S Deployment	
Skills and training	
Comparison with competitors	
Pursuance of delivery dependability	

The Action-Time Framework (ATF) provides clear priorities to pursue, allowing resources, energy and decisions to be concentrated on obtaining a set of focused capability. This is complemented with elements of CI, promoting small incremental improvement, enabling them to be monitored and allowing employee empowerment. It can be used as a guide in identifying actions which need to be implemented and plan for the next. The decision areas and actions included within the framework are:

1. Defining company strategic theme – Can be done within the first six months. The strategic theme may not necessarily be too optimistic. It can be simple as just '*Staying Alive', 'Always Quality'* or even '*The Best in Coventry'* for example. This can be continually revised and improved as the company is progressing. It can provide a sense of direction or goal to pursue. It is also must be shared and understand by every person in a company.

2. Competitive priorities (Quality) – The framework shows an SME should start addressing the need of obtaining product *performance* and *durability* at the same time, with *perceived quality* at a little bit later in the first year. *Reliability* follows at 18 months and *sustainability* at 24 months. There are two advantages on the way the quality dimension is presented in the framework: it shows which dimension needed more focus at the beginning, and it provides aim on when and what dimension should be pursued next. For example, it signals product *performance* and *durability* as dimensions of quality which should be the immediate focus. This is by referring to the timeline on the framework, indicating it should be initiated at the earliest *latest start time*.

3. Work procedures – There are six types of work procedures need to be established and created, with *works order* started at 9 months of operations. It started earliest as it is a document that records customer requirement detailing specifications of their order. Once arrived at the 12th month, *Build documentation* is established to record step by step process of assembly or production of a single product. Followed by safe *system of work* depending on a production process and later complemented by *local law health and safety requirement*.

   It then continues with *product version* to record any changes and improvements made to a single product as well as keeping track product development. This enables future reference to be made on a product as part of CI initiatives. Finally, documenting *stage sample* to record how good and bad product should look like. All the procedures will be a point of reference to ensure consistency of quality output, also allowing easier integration of new employees and allowing easier skill upgrade for current employees.

4. Visual management – Introduced to improve visibility, layout and safety of operations environment. Consistent practice will lead to better efficiency, improved delivery time and productivity. *Reviewing process layout* and *visual management meeting* should start at the same time in the 12th month. It can be enhanced further by using *Value stream mapping*, analysing more details such as time and participant in the value chain to increase efficiency and delivery predictability, resulting in improved production planning.

5. Implementation of performance measures – There are six performance measures used in pursuing quality and dependability capability. Within 9 months, two performance measures must be established. They are:

   a. Right first time, measured by:

$$\frac{(\text{Total units produced} - \text{quantity of rejected units})}{\text{Total unit produced}} \times 100$$

   Example: Total units produced = *1000*
   Quantity of rejected units = *30*

$\frac{(1000 - 30)}{1000} \times 100 = 97\%$

Right first time = *97%*

b. Yield, measured by:

$$\frac{\text{Total units produced}}{\text{Total units supplied}} \times 100$$

Example: Total units produced = *1000*

Total units supplied = *1300*

$\frac{1000}{1300} \times 100 = 76.9\%$

Yield = *76.9%*

Moving towards the 12th month, additional four performance measures should be used. They are:

c. Reject rate, measured by:

$$\frac{\text{Total units rejected}}{\text{Total units produced}} \times 100$$

Example: Total units rejected = *30*

Total units produced = *1000*

$\frac{30}{1000} \times 100 = 3\%$

Reject rate = *3%*

d. Rework rate, measured by:

$$\frac{\text{Total units required rework}}{\text{Total units produced}} \times 100$$

Example: Total units required rework = *10*

Total units produced = *1000*

$\frac{10}{1000}$ x *100 = 1%*

Rework rate = *1%*

e. Delivery reliability, measured by:

$$\frac{\textit{Number of planned deliveries} - \textit{(number of not on time deliveries + number of incorrect quantity deliveries}}{\textit{Number of planned deliveries}} \times 100$$

Example: Number of planned deliveries = *50*

Number of not on time deliveries = *2*

Number of incorrect quantity deliveries = *1*

$\frac{50 - (2+1)}{50}$ x *100 = 94%*

Delivery reliability = *94%*

f. Lead time, measured by:

Cycle time x work in progress (WIP)

Example: Cycle time = *15* hours

Work in progress = *6* units

15 hours x *6* units = *90* hours

Lead times = *90* hours

6. Certification and rituals – A routine on *rituals* should be conducted once operation arrived at 12 months. It is by organising a short meeting at the beginning of the day or shift. This is to allow a brief discussion between everyone in a manufacturing plant regarding previous day issue and objective of the day. The purpose is to keep everyone aware of operations aim and objectives. In addition, providing mitigation and solution which may hinder the aim and objectives.

   ISO 9000 is a basic quality management principle to help organisations to be more efficient and consistently meet customer's requirement. Understanding *ISO 9000* is the first step which can lead to the certification of ISO 9001. The framework suggests the process to start at 24 months.

This is after starting the process of documenting work procedures and systems within an organisation.

7. The use of problem solving techniques – Within 9 months, *stage inspection* procedures should be implemented. Inspection must be carried out before, during and after the production process. This is followed by the introduction of *statistical process control*, *ishikawa diagram* and *5Whys*, all at the 12 months mark.

8. 5S Deployment –*5S* Housekeeping can improve organisation of a workplace. A best practice for its deployment is to start with *3S*, *4S* and *5S*. However, in the framework, it's started with *5S* and followed by *3S* and *4S*. There are three reasons contributed to the results: first; due to higher impact on quality once the 5th S is obtained, second because of widespread acceptance of the *'5S'* term compared to *'3S'* and *'4S'* and finally because of there is evidence of full *5S* implementation which can be completed within 5 months (Gupta and Jain 2015).

9. Skills and training – There are three elements included in this section. The first two are the *middle manager training and coaching* and the establishment of a *skills matrix* which should be at the 12th month. The last element is the *adoption of apprenticeship/industrial training program* implemented within 18 months.

10. Comparison with competitors – At the 12th month, the first comparison with competitors can be conducted by obtaining *reviews from their customers*. This is by enquiring about products details and looking for gaps that can be improved. Once this information is gathered, improvement can be planned at 18th month based on the *founder's experience* and from the in-house team. At the same time, *getting competitor's information from suppliers* can help in understanding the process and material they are using.

    Arriving at the 24th month, a company can begin to look at *employing people with experience and work culture in related field*. At the same time, they can begin to use *process time benchmarking* and after that proceeding to conduct *pay structure benchmarking* at 30th month.

11. Pursuance of delivery dependability – The process started by keeping a record on supplier performance and selecting the best performers among them to *establish nominee supplier with proven delivery track records*. It should be done on the 12th month of operation. At the same time, *estimation on delivery time is compared to previous similar work to get best delivery prediction.* This is done by recording the process time of a particular product. Finally, at 24th month, a plan of *having a multi-skilled and flexible workforce* should get underway. This is followed by initiating the process of *implementing pull production*.

The time indicator of the framework shows the *latest start time* for those actions to be implemented. This is because the yearly scale was used instead of months, action taken may not be necessary exactly at the time indicated. This is because these actions can start earlier within the suggested time. For example, taking action at the 7th month instead of 12th month, as it is always advantageous to start at the earliest possible. Importantly, the ATF shows which action should be prioritised. The timeline is also useful for companies which have been in operation for some time to estimate the time needed to implement the required actions. Further validation is conducted in Chapter 6 (see *6.4*) to look at the applicability of ATF with an actual SME and to complement the findings.

4.5 Practical Implications and Contributions

The setting up of operations solely dependent on customer and market conditions will reduce the probability of having a set of established competitive priorities. In addition, the misleading signals from customer or market could haphazardly induce firms to move into inconsistent directions (Leung and Lee 2004). To prevent this, steps of actions are required to give a clear route to achieving competitive capabilities.

The framework provides a simple, practical structure that should be put in place in moving the operation forward. Attainment of an established set of priorities supported by additional areas, allows companies to have a good foundation in their operations, particularly SMEs which operates in informal nature and limited resources. This in turns will make them better in responding to the market and customer. Further, it allows them to have a set of established capability which will be good in the long run to attract and retain customers.

While it is worth mentioning that not having an establish capability is good in the short term (i.e. for new companies that are trying to attract customers and established themselves), in the long term, capability need to be built to make sure operations remain competitive, establishing good supplier base and gain the trust of the customer, and most important, to offer uniqueness to the market.

The ATF suggests quality and dependability as the first set of competitive priorities for companies which are not good at identifying their market. While it may be possible to pursue multiple priorities and imitate actions of a ‘good’ company, it can come at a great cost to invest in acquiring technology and human resource. In addition, there is a risk of failure which may result in closure and job losses.

The development of ATF outlines the need for having a strategy and tactics to execute them. It covers important areas and actions relating to becoming a stage 2 company as described in FSM. The timeline included within the framework demonstrates the importance of having an indicator, showing where and when to start. New established SMEs or SMEs that is without strategic planning could use ATF as a reference. The ATF extends the understanding of FSM by showing how an organisation can progress within the stages, as well as providing a time plan for them to do so.

The ATF can be used as a guideline for manufacturing SMEs in improving their operations and at the same time positioned themselves as a stage 2 companies within the FSM classification. Other than contributing towards providing decision areas and actions, the other contribution of ATF can be referred to the use of the timeline, which can be used as an indicator when initiating and adopting improvement programs. From a strategic point of view, actions within the decision areas can be used to chart short to medium term strategic planning. For example, the timeline provided in the ATF show which actions are important and need to be initiated earlier.

Apart from the timeline, ATF contribution can come in the form of checklist to be referred for operations improvement programme. It can act as an audit tool to look for actions that should be implemented within a manufacturing SME. Managers and owners can use ATF to cross-check actions that they have implemented and look for actions that they may miss. Also, they can initiate or move forward pre-planned actions based on time indication in ATF. Going further, the timeline on the ATF can be expanded to more than three years and act as a planner for operations improvement. Therefore, extending the usage of ATF to cover long term planning.

4.6 Conclusions

The chapter presents the ATF development process by explaining the use of data collection methods and its outcomes in creating a framework. The chapter links the related data collection methods carry out throughout the research with analysis. The aim is to provide a clearer picture of the process of collecting and analysing data to create a framework. Also, the chapter introduces the proposed framework along with its description. Additionally, ATF practical implications and contribution are discussed towards the end of the chapter. The following two chapters will elaborate on the result and analysis that contributed to the development of the proposed framework. In Chapter 5, the discussion will revolve around analysis from phase 1 questionnaire and phase 2 interview. Discussion for phase 3 Delphi, phase 4 questionnaire and framework validation will continue in Chapter 6.

Chapter 5: Phase 1 Questionnaire and Phase 2 Interview Results and Analysis

5.1 Introduction

This chapter will cover discussion on results and analysis from the data collection. The main aim is to provide insights on data interpretation based on methods deployed in answering the research question. The chapter contents evolve around results from the phase 1 questionnaire and phase 2 interview. The discussion on phase 3 and 4 will continue in Chapter 6, where it is centred on the result from Delphi and another questionnaire distribution, which contribute to the development of the proposed framework. The next section will discuss the result based on the phase 1 questionnaire, followed by interviews.

5.2 Phase 1 Questionnaire Results

Phase 1 questionnaire is conducted over a six months period simultaneously along interviews. The decision to conduct them simultaneously is due to the following factors:

1. To make sure contacts that were established from the questionnaire remain intact. Taking too long to follow up might make the company uninterested in making a further contribution. Conducting the interview quickly once the questionnaire is completed will make it easier to obtain access for an interview.
2. Any validation on the questionnaire answers can be done in parallel with the interview session, as the respondent may still remember the answer they provide in the questionnaire.
3. Time can be used efficiently as it reduced the waiting time and allows sufficient time for any further investigation when required.

The data were analysed using the SPSS statistical package. It is chosen due to the availability of license and user support provided by the university in the form of seminars and support staff. Accordingly, with the research purpose, univariate descriptive statistic was used to analyse the data. Descriptive statistics is used because it best describes the central tendency and agreement among questions. Therefore, it could indicate the most important and the least important competitive priorities pursued by the SME.

The questions require answers about the state of current operations of a manufacturing SMEs. To address this, the invitation was extended to the person holding a managerial position who possessed information regarding the operations. The questionnaire was answered by the operations managers, operations executive, factory manager and managing director of the UK and Malaysian manufacturing SMEs.

The Likert scale is used by selecting ranking from 1, which is strongly disagree and to 5, which is strongly agree. Therefore, the analysis of the questionnaire is by using the weighted mean average score (see *Table 5.1,5.2 and 5.3*). The results of the analysis are presented according to:

1. SME in general
2. Geographical location

3. Company size

A total of 214 SMEs were invited to participate. 21 of them responded, generating a response rate of 9.8%.

5.3 Respondents Profile

The profile of the respondent can be referred to *section 3.12* and *3.12.1* in Chapter 3.

5.4 Analysis of Competitive Priorities

Results regarding the competitive priorities are divided into three categories. They are assigned into overall results, UK manufacturing SMEs and Malaysian manufacturing SMEs. The results are displayed in *Table 5.1, 5.2* and *5.3* followed by the analysis made from the results.

5.4.1 Overall Results

Table 5.1: Summary of competitive priorities pursuance

	N	Minimum	Maximum	Mean	Std. Deviation
Quality	21	2.00	5.00	4.4762	.74960
Dependability	21	2.00	5.00	4.7619	.70034
Flexiblity	21	2.00	5.00	3.5238	.98077
Cost	21	2.00	5.00	3.3333	1.06458
Valid N (listwise)	21				

5.4.2 UK Manufacturing SMEs

Table 5.2: Competitive priorities for UK Manufacturing SMEs

	N	Minimum	Maximum	Mean	Std. Deviation
Quality	10	2.00	5.00	4.5000	.97183
Dependability	10	2.00	5.00	4.6000	.96609
Flexiblity	10	2.00	5.00	3.6000	1.07497
Cost	10	2.00	5.00	2.9000	0.99443
Valid N (listwise)	10				

5.4.3 Malaysian Manufacturing SMEs

Table 5.3: Competitive priorities for Malaysian Manufacturing SMEs

	N	Minimum	Maximum	Mean	Std. Deviation
Quality	11	4.00	5.00	4.4545	.52223
Dependability	11	4.00	5.00	4.9091	.30151
Flexiblity	11	2.00	4.00	3.4545	.93420
Cost	11	2.00	5.00	3.7273	1.00905
Valid N (listwise)	11				

5.4.4 Phase 1 Questionnaire Analysis

It is evident that most of surveyed manufacturing SMEs in the UK and Malaysia give more priorities on quality and dependability, where the mean value is close to each other (*Table 5.1, 5.2* and *5.3*). In the case of UK SMEs, the result is influenced by the role of most of the SME surveyed which acts as a supplier to larger companies. Therefore, they tend to focus more on the two capabilities, quality and dependability. This is due to the fact that this is a key indicator of reliable suppliers. The evidence can be supported by Nan *et al.* (2011) where they assert that those capabilities should be assigned more weight in selecting supplier as it proved to be effective in identifying suppliers with better performance.

Also, the result found dependability is the most important priority as fulfilling customer orders is important in ensuring future orders. It yields similar results compared to a study on Finnish SMEs where high priority is put on delivery and punctuality (Hilmola *et al.* 2015). The highest importance put on dependability is in contrast with the need to put quality as the base of obtaining other priorities as suggested by several works in the literature (Amoako-Gyampah and Acquaah 2008; Dangayach and Deshmukh 2003; Ferdows and Meyer 1990; Schmenner and Swink 1998).

However, Flynn and Flynn (2004) findings is an example of evidence that the sequence is not universal, as there are alternative to the sequence. For example, some manufacturing plants use dependability as the base of their capability. This is usually found on new manufacturing plants that are trying to establish their customer base or trying to survive in the marketplace (Leung and Lee 2004). Similarly, Hilmola *et al.* (2015) in examining competitive priorities of Finnish manufacturing SMEs found in surviving the growth stage and building up long term competence, SMEs tends to have a balanced approach to their competitive priorities.

In addition, it is important to stress that the findings are prone to the common method bias due to the result based on the method used. In addition, the sample size is small compared to previous similar

studies: Amoako-Gyampah and Acquaah (2008) - 192, Flynn and Flynn (2004) -165, Dangayach and Deshkmukh (2003) - 100. Only Leung and Lee (2004) used two case studies in testing competitive priorities. To address these two shortcomings, the same question will be asked again during the interviews. At the same time, interviews will investigate why those priorities are pursued and how it is addressed. It is intended to make sure that important process and decision to obtain the capabilities according to priorities is captured. This is to complement findings from the questionnaire by justifying why certain priorities have more weight than the other, rather than just re-assessing them.

In Chapter 2, quality and delivery are identified as the competitive priorities obtained by stage 2 companies (Barnes and Rowbotham 2004; Chase and Hayes 1991). However, Hayes and Wheelwright (1984: 396) and Martin-Pena and Garrido (2008b) did not explicitly state the priorities pursued by Stage 2 companies. The first questionnaire has yield results on the competitive priorities which indicate the utmost importance put on dependability and quality. Nevertheless, further validation using interviews will be conducted to provide confirmation on priorities pursued by stage 2 companies.

The result from interviews will be discussed in the next section. Once this is completed, the following section will elaborate on the conclusion that can be drawn from interviews and questionnaire findings.

5.5 Phase 2 Interview Results

Results from the interview showed that the first competitive priority is quality. It is the most important because it is required by the customer. Besides, being in the industry they are in; quality is paramount and the emphasis is given to address quality issues. Also, the interviews managed to discover quality dimensions that are given particular attention in production. It is important to highlight three companies being interviewed operates in the build to order environment. The following section elaborates more on the result of the interviews. At the end of every sections, a summary will be provided to highlight the main findings from each of the interview sessions.

5.5.1 Company A

Company A is a Japanese furniture manufacturing company based in Malaysia. The main operation is to manufacture ready to assemble furniture using raw materials from rubber trees. Their major selling point is products manufactured by using materials from sustainable sources. All products are exported to the Japanese market and orders are obtained from Japan, citing the reason why they did not compare themselves with local competitors. Besides, most top managerial posts are occupied by people who have experience in the company operations in Japan or previously working in Japanese companies (people who are familiar with the concept of Japanese manufacturing). The weekly capacity of the production is roughly 30 cubic meters, and the maximum production is 60 cubic meters of ready to assemble furniture.

Operating with just under 200 employees, it used 4 Ms (Manpower, Method, Machine, and Material) as their main problem solving techniques. Also, 5S housekeeping is conducted once every month. According

to an order of importance, the competitive priorities pursued are quality, environmental sustainability, delivery dependability, flexibility and cost.

The main performance measures (PM) used in production is yield. This is done by comparing items produced according to specification to a number of raw materials that have been put in. In ensuring they achieve quality, great importance is given to low yield with high-quality output. To complement this, just-in-time (JIT) is implemented informally or verbally, by producing only what is needed, when it is needed and the amount needed. By doing this, it will ensure quality can be maintained by producing what is deemed essential and in a controlled manner.

In addition to product quality, the company has a strict policy on getting raw materials from sustainable sources. This resulting in them putting greater importance on quality because according to Phusavat and Kachana (2007), environmental concern is considered as part of quality. To show its commitment, the company has obtained accreditation from the Forest Stewardship Council. Adding to sustainability, their product is perceived as a premium brand, durable and usually lasts to its expected lifespan.

The attainment of second priority, dependability is achieved by having a manufacturing plant in Malaysia which is near to the source of raw materials. There are two main reasons, first is because rubber tree took at least 24 years before it can be harvested from the rubber plantation and second, according to Pardomuan (2014), Malaysia, Indonesia and Thailand are the world top natural rubber producers, accounting for more than 70 per cent of global natural rubber output. Therefore, by having a manufacturing plant which is close to the source will ensure continuity of available raw materials, fulfil company commitment to sustainability and making sure the plant achieve its delivery promises.

In terms of management commitment, the company adopts the principle of ‘gemba’, where the management team regularly conduct observation on shop floor operations. The main aim is to encourage the spirit of teamwork, ideas exchange between management and shop floor workers and to encourage process improvement (Kaizen). Kaizen competition among workers is always organised to give a reward for new ideas, encouragement and motivation to continuously improve plant operations. Apart from that, the worker’s knowledge is gradually improved by organising in-house training at least six times per year.

Also, it is found the selection of tools such as 5S and 4Ms are heavily influenced by the shop floor worker’s level of education. Because the majority of the shop floor worker have O-Level education background (17 years of age in Malaysia), simpler tools and process makes it easier for everyone to understand them. The company believed continuous in-house training would eventually lead to more creation of knowledgeable and efficient workers. Additionally, industrial placements are offered when there are an opportunity and suitable candidates.

5.5.1.1 Summary of Findings from Company A

The top competitive priority for Company A is aimed at attaining quality and dependability capabilities. The quality dimension pursued are sustainability, durability, reliability and perceived quality. 4 Ms (Manpower, Method, Machine, and Material) is used as a main problem solving technique. In measuring performance, the yield is mainly used. 5S housekeeping is adopted within the plant to increase visibility. They do not compare themselves with local competitors due to the target market that is based abroad (Japan). Top managerial posts are mainly filled by employees who have experience in similar work culture. This is to ensure cultural fit, where employees' belief and values are in alignment with the employers'. In turns, it helps the employee to perform at their best and as a consequence increase the organisation's operational efficiency.

The education background of the shop-floor workers is important for the company in selecting types of process control or tools used in the manufacturing process. Additionally, this is influenced by the type of manufacturing process whether they are simple or complex (complex methods make them harder to understand and might derail the spirit of 'gemba' and 'kaizen'). Company A believes that knowledge creation and knowledge enhancement is a continuous process. The evidence can be referred to the practice of gradually assessing and upgrading worker's knowledge.

From the company's experience, continuous improvement initiatives can be realised if it gets full participation from the management and shop floor workers. Importantly, motivation and reward can be used as a tool to encourage and increase participation. To attain dependability, informal JIT is adopted. It can complement quality control initiatives by producing only what is essential, hence improving the quality control process and enabling pull production.

5.5.2 Company B

Company B is a manufacturing SME based in the Midlands, UK. Their main operations are designing, R&D and manufacturing rotary engines used in the aerospace, automotive and maritime industry. Their major selling point is powerful, less weight and less vibration engines. The weekly production capacity is to produce at least one engine and the maximum is two engines.

The comparison against competitors is informally conducted. First, is through the experience of the founder who has worked with a competitor before. His experience is used in trying to eliminate what are the weaknesses identified from the previous employer. The following statement shows ways the company does the comparisons with competitors:

- Information gathered from the supply base to understand the materials, methods and technology the competitor is using.

- Human intelligence is used by talking to people who had done visits to other companies and customers who have purchased products. As customer opinions seem to be polarised, they do provide some impression on the competitor products.
- An ongoing analysis in reviewing competitor's technology, marketing strategy, business development strategy, the technical capability of product and the way their product is manufactured.

The number of employees is under 50. The company used ISO 9000 as its main reference to problem solving and procedures. This is because, within the ISO 9000 document, containment issues, identification and short term and long term preventive action are addressed. It also includes the design reviews, physical test reviews of the engine performance. If there is a problem in the area, actions such as product re-design and process re-design may take place. To conclude, problem solving tools are embedded in the ISO 9000 which is being implemented. Other reasons influenced the implementation of ISO9000 is:

- Help to engage more with customers.
- To have a standardised control system.
- To use primarily as a business systems standard rather than quality standards.
- To have discipline in a control system to make sure the company operates in a consistent way.
- To continually improve.

The competitive priorities the company pursued are quality, cost, dependability, innovation and after-sales services. The company decides the priorities based on the market that they compete and also based on the customer requirement. They cite the industry they involved in: aerospace, automotive and maritime requires products to be manufactured at the highest quality where product performance is paramount. Therefore, the customers always enquire about the performance, before going into the cost and the ability of the company to deliver products when they required. In terms of innovation, the company continually conducts in house research to increase product performance. They added that the ability to innovate and to manufacture at the same time is the strongest point that they sell to their customers.

The company operates in a buy to order environment, where they will only procure raw materials when there is an order. They believed that they are loosely operating just-in-time, partly because of the operations which are carried out in a low volume manner. This is aided by the use of ERP (enterprise resource planning) system which makes all sourcing online. Therefore, everything that is needed can be delivered on schedule. In other words, the basic principle of JIT, which is producing only what is needed, when it is needed and the amount needed is evident within the company.

The size of the companies allows them to be flexible in organising the manpower to fill the gaps when there is a shortage. As a result, the management is involved in the day-to-day running of the operations. It is to make sure that the operations are not disrupted and there is no delay in deliveries. For example, some of the components have 5-6 months lead time and if the product delivered is non-conformance, the company needs a strategy to overcome the problem by mitigating the damage and reduce the risks. This is due to the importance the company put into keeping its promises because they believed it is a good indicator of whether their customers are staying with them for a long time.

Occasionally, the company uses the help of consultants when they are looking for investment, particularly on the financial aspect. It is done to make sure that it can position themselves strategically in order to make the investment happen (to show it represent its account and the way they operate) in short, it is to generate 'company worth statements' in the forms of data packs and information memorandum. This is important as to make note to investor that the company have the potential.

Next, they get help in terms of quality issues, where consultancy is to become an external auditor, guiding them to make sure that they perform as they should and help the company to continue to develop their quality systems. Finally, consultancy is used to help the company to position itself in the sectors, market and products, in a way to maximize value. Due to the fact that they are in the low volume and high-value market, brand perception and product perception is very important. Because they view themselves as being small, external advice is always useful as it gives them something that they may overlook.

There are two sets of procedure established by the company. First is the works order or work rider which is generated by the ERP systems to add to the traceability of anything the company are doing (materials, processes and labour) this is to reduce item procurement cycle time (Anuar and Yusoff 2011). Second is the build documentation, which describes a step-by-step process on how to build an engine. This is to ensure that the engines configurations are set in a controlled manner. This document has the flexibility to be altered in a controlled way (general revisions). The improvements or innovation on products is done by doing a 'leapfrog' approach, where the product is improved by taking the lesson learned from previous products. The technique of improving previous models is resource intensive. The approach adopted would not require the company to maintain too many technological levels at the same time.

Sometimes, when the company decided to add more capacity, they formed partnerships with similar companies to assemble components for them. At the same time, the partner companies will review the build documentation and gave feedback in improving the design or assembly. This allows the company to identify gaps within the document and allows them to continually improve. As the technologies are patented, they are quite open about this. In addition, 5S and employee skills matrix are other continuous improvement initiatives currently applied in the company.

To measure employee competencies and to enhance their knowledge, the company conduct a biennial appraisal. They use their own skills matrix (drawn up to show the job role and the expectation of knowledge from the job role which are graded from various levels. For example, from requirement training, until a staff can perform a certain job good enough up to the expert level where they can become a trainer). A staff is not only evaluated by internal staff of the company, but also by the external trainer. In terms of recruitment, the company emphasis more on employing people with experience rather than looking at their academic background. This is because of the availability of procedure in the company and the process of assembling engine which is relatively easy. Therefore, it is essential for the staff to have descriptions such as attention to detail, coordination, practical bias and hands-on experience which can only be obtained through doing similar work.

Aside from employee, other measurement includes the company ability to deliver to commitment, to make sure they can fulfil promises made to the customer and reject rates to components (measured internally and by looking at the supply chain). Besides, internal measures in delivery milestone to project and measurement against the budget to make sure operations remain on the budget (timescale and budget can go hand-in-hand).

5.5.2.1 Summary of Findings from Company B

Based on the customer requirement, the company state that the order of capabilities that they pursue are quality, cost, dependability and flexibility. However, in-depth probe shed the lights on the actual capability pursued which are quality, dependability, cost and flexibility. Quality dimensions are focused on attaining product performance and perceived quality.

The selection of dependability as second priority is based on evidence that several actions were taken to ensure delivery promises are fulfilled. These include the use of ERP systems to reduce procurement cycle time, having a flexible workforce when there is a shortage and measuring company ability to deliver their commitment. ISO 9000 was used as the main reference to problem solving and procedures. Works order are procedures used for procurement and build documentation is used as a reference for the manufacturing process.

PM includes measuring the delivery reliability, reject rates, lead time and operations cost. Pull production is applied by taking ‘buy-to-order’ approach. Comparison with competitors is conducted informally based on the founder’s experience, information from supplier and reviews from customers. To enhance employee knowledge, skills matrix is used as a reference. On the other hand, people with experience are given more priority in filling for available positions within the company.

The continuous improvement approach the company took is informal and they are implemented to make sure they remain relevant in the market and performance is improved from time to time. Regarding the nature of improvements, the FSM state that “regarding process technology, stage two companies often

adopt a strategic leap approach, often from R&D labs and suppliers". It is found the statement is true to company B, looking at the way they use to improve themselves by talking to suppliers, having an external panel review for training and getting help from research labs.

5.5.3 Company C

Company C is an SME based in West Midlands, UK. Their main operation is designing and manufacturing tooling for foundries, body engineering (collaborate with transport manufacturers) designing model for transport products, prototyping for design companies, machine fixtures and moulding tools. It has 18 CNC (computer numerical control) machines, among the largest locally and multi-skilled labour which can do woodworking as well as metalworking job.

The company has been in operation for 2.5 years and has 45 employees. The company operates by produce to order, so it does not have any stable production output and everything usually a one-off production. It cites orders are depending on many factors such as time of the year and the ability to accommodate customer requirements in a short time.

The company obtained the ISO9001:2008 certification to maintain and to show their commitment towards quality. In addition, they have a quality manager who will inspect any non-conformance to investigate the root cause. Usually, the root causes are investigated from 4 main factors. They are materials, manpower, methods and machine. According to the manufacturing engineer, the competitive priorities that they pursue are flexibility, quality, cost and dependability. Flexibility is the top priority because it allows the company to easily change their production and aim to respond to their customer quickly. As a result, there is no actual production planning and scheduling as it tries to fit in with customer requirements as best as they can. For example, they allow the customer to do changes before and after products have been manufactured.

Comparison with competitors is made informally by trying to talk directly to competitors and trying to get reviews from their customers. However, to do this, it is quite difficult because of the sensitive nature of jobs, in addition to companies and customers who are reluctant to share the information. Further, it is difficult to get a good comparison due to the small size of other local competitors. In fact, the management views the company as one of the largest in terms of capacity by having 18 CNC machines (compared to 2 or 3 with other local competitors) which allows them to have more variations, capacity and shorter turnaround time.

There is no formal PM being used currently by the company. They describe the nature of orders, which are non-standard and varies require them to be flexible in measuring performance. However, an in-depth probe on the process of an order identified two areas of performance measure which are cost and lead times. The example can be explained by the process of receiving and generating orders. The process is explained as follows.

A job will be calculated by the number of hours it needed to complete. It will be quoted by similar work the company had done in the past. The quotations are purely based on the experience of the people on the shop floor (by looking at the cards or drawing on the model, they know how many hours should be taken to finish the job). It is by circulating the drawing on the shop floor to get an estimation of a job. The quotations received from the shop floor will be validated by the manufacturing engineer to see whether it has been quoted correctly (over quoted or under quoted. It is to make sure that the price is competitive).

After a job has been completed, the manufacturing engineer will collect the worksheet that has been circulated around the shop floor. This is to measure whether the company makes a profit in a job by examining the worksheet and comparing actual with an estimated cost of a manufacturing job. It is intended to keep as a record, which is to be used as a point of reference in the future so that the price would remain competitive and at the same time making sure the company keep making a profit. During a quiet period, it tends to put their rate down to attract orders from the customer. This to minimise the risk of not having any orders at all.

Raw materials are ordered based on the estimation of the job. The company did not have any standardise measurement regarding defects from the supplier. This is attributed to the randomness of order, which is dependent on the type of materials used. The company usually try to use the same supplier, which has proven track records, but if they can't provide the item in a required time frame, it may have to look elsewhere.

The management always involved in the manufacturing operations of the company. They are involved from the stage of receiving the order by customers until it is delivered. The work procedures established in the company is the worksheet. When a job is designed, a worksheet is created per part or couple of parts (sometimes to maximise machine time, they put more than one part together in one worksheet). The worksheet includes all important information such as reference number, customer and revisions (sometimes the job has many revisions, so they know what type of revision that they are working on), operator in charge of the work, materials and other technical information. The company is working on to establish a set of standards. Due to the uniqueness of each customer requirements, it may take some time for them to do it.

In terms of continuous improvement, from time to time the company co-operates with design companies and foundries to improve its operations. Besides, they always tried to show their capabilities to as many customers or potential customers in attracting future orders. One of the ways is by promoting the company at tradeshows and exhibitions. The CEO and directors continually talk to the customers to get their feedback on improvement that can be made. Improvement on productivity is not only dependent on buying new machines, at the same time trying to improve the production, where currently they are working on introducing a production planning system to minimise the idle time for the machines.

The introduction of new technology in the company is justified by adding more capacity as well as reducing costs. Aside from that, the only best practice identified from the interview is the informal implementation of 5S. This is because some of the workers are resistant and they are so reluctant to change. Age played a role, as the majority of the workforce is between 50 to 60 years old. In addition, some of them have very basic literacy in computing. Thus, anything that has to do with a computer is not really appreciated.

The shop floor worker will be trained mainly when it comes to introduction to new technology, as workers are required to be re-trained (example such as new programming to minimise machining time). In the case of looking for prospective workers besides using agencies looking for skilled labour, the company collaborates with local colleges to look for a possible apprentice. The apprentice will shadow the more experienced employee until he is capable of doing the job by its own.

5.5.3.1 Summary of Findings from Company C

The age (2.5 years) of the company C manufacturing plant have a big influence on the competitive priorities they selected. They tend to be flexible by having the capability to respond to variations of order. This is done by not sacrificing any quality or delivery issues, with the purpose to get a good impression from customer thus attracting future orders.

While the interviewee gave the impression that they have the capability to be flexible, the evidence suggested this was actually achieved by the accumulation of quality and dependability initiatives that took place during the early stage of operations. This can be demonstrated by creating a dedicated position for quality (quality manager), certification of ISO 9001:2008 and using root cause analysis to investigate quality issues.

The importance placed on dependability can be proven by predicting the use of historical data on orders, a large number of machines and experience from people on the shop floor in quoting for lead time for a particular work. In addition, a list of nominee supplier is established to ensure dependability from the side of the supplier. In terms of employment, a multi-skilled person is given priority when looking for a new employee due to the nature of the business that involved variations of materials and products.

Comparisons with competitors are not conducted because they feel that there are no similar-sized companies to compare. However, customer's reviews are taken into consideration in products improvement. Significant investments on CNC machines are intended to obtain a competitive edge by increasing capacity and flexibility. Additionally, 5S is informally practised in the plant, while worksheet is used as the main work procedures. Finally, production is according to orders made by customers.

5.5.4 Company D

Company D is a shoe manufacturing company located in the East Midlands, U.K. They have 40 employees and have been in operations for 20 years. Their main operation is to manufacture shoes. The plant in the U.K is exclusively used to manufacture the Made in England (MIE) products, while they have other plants around the world (Vietnam, Lao, Thailand and China) to manufacture the cheaper version of their shoes. The normal daily production capacity is 300 pairs and it can do a maximum of 500 pairs. The company serves three types of customers which are:

1. Wholesale customers – customers can be anywhere in the world.
2. Retail customers – mostly from the high street retail store, in the UK, US and Asia.
3. Individual customers –one-off pairs customised specifically for individual customers.

According to the production manager, what makes the company unique is they always look their brand as a way of life rather than a commodity and people associate the product with cutting edge of fashion, being new all the time, with quality and long lasting. While there is constantly a lot of work going on in regards to inventory and material consumption, their technology is the selling point (the traditional process of shoemaking) which their reputation is based on. They make sure the products were made the same way at the beginning of their operation history 50-60 years ago.

All of the orders are recorded in a global order book and the factory only manufacture based on purchase orders. Therefore, everything that they made has a confirmed order and location it should be shipped. The activity is carried out before the materials are sourced.

To make sure other plants around the world produce the same standards of product, they appoint factory manager who has worked in the UK factory and used to be a shoemaker before. Therefore, if they come across a problem, they could use all their experience to solve them. 5 Whys are the main problem solving tools that they were using.

The competitive priorities that they pursue are quality, dependability, after sales service and cost. Quality is the first priority because of the price point of the product and the reputation of the brand which has been developed since the early operations of the plant. In order to maintain quality as the number one priority, several steps are taken which are:

1. Stage inspection which is required by every process. The process is categorised into four different work areas and quality inspection is carried out during each stage (Clicking – where the raw materials are processed, Closing – where the raw materials are sewn together, Lasting – put raw materials into shape and Presentation – where the last inspection took place before tagging and packaging is done).

2. There are specialised rooms with a different standard of products. They will use some corrective actions to put these products into the standards it should be, or it could be degraded and end up in a factory store and not being a full priced product.
3. The process on other factories in other parts of the world (Vietnam, Lao, Thailand and China) is tested to the same standards and have the same performance standards with the in UK factories.
4. Long term relationship with the supplier and continuous consultancy with them if any problems such as surface finishing or colour inconsistency.
5. Becoming a member of a body that sets standards in the shoe industry. Therefore, if any problem that can't be solved internally, the company will get opinions from this body.
6. A special consultancy area is created in the shop floor so that the production manager, shop floor supervisor and workers could meet and discuss daily operations issues.

In order to measure performance, there are three things that are measured on an hourly basis in the factory. They are:

1. Output right at the first time (what went well).
2. Re-work rate (what can we correct to go well).
3. Rejects.

Comparisons with competitors are made by looking at other factories in terms of process time and pay structure. The production manager who has 20 years' experience working in the manufacturing sector helped to add the information in comparing the company performance within the industry.

In terms of work procedures, there are three which have been established in the company:

1. Safe system of work – To create awareness on safety at work. Due to the some of the machines are sharp, hot or both so the company wanted to make sure everything is operated safely and people understand when there is an emergency stop in regards to rule in handling things out.
2. Stage samples – Half made shoes from around the process stage demonstrating what is a good and bad version of job should look.
3. Product version – The documentation is referred to stock keeping unit (SKU) identified by eight digit number. It describes a specification of each SKU by detailing the materials used, the sequence of the manufacturing process, standards, finishing techniques and how it is presented at the end.

Apart from work procedures, the company applies some best manufacturing practice. The practices that they used are process cell layout, 5S and control charts (to measure performance). Even though the production manager is a six sigma green belt certified, the factory did not go to a full sigma reading due

to the batch size which is so small and the work which is variable, as it may take some time to measure part per million.

Respectively at the end of a season, data gathered will be rolled back to look at performance for various changes in tooling or changes in materials. This is to make sure that relevant pre-emptive measures can be undertaken to improve the production process and products in the future season.

The shoemaking technique requires skilled people to do it as it needed to be finished mostly by hand. Thus there are a lot of experienced workers on the shop floor. In ensuring the continuity of the available workforce, the company took new people through its apprentice programme. The apprentices are trained in every area in the factory to obtain a basic understanding of every shoemaking process before they specialised in one.

They will spend a year in all four departments in the shoe factory learning the fundamental principles of shoemaking (the company believed there is a lack of educational institutions that offer the subject). Then a year later they specialised in one area whether they become a leather cutter, a machinist or lasting operatives or a finisher. From here, they develop their career path throughout the company.

5.5.4.1 Summary of Findings from Company D

The age of the plant (20 years) allows the company to develop their capability and their brand reputation. Order of competitive priorities is quality, followed by dependability, after sales service and cost. Focus on quality dimensions is given towards product perceived quality, product reliability, product performance, product durability and sustainability. Several steps are taken to maintain quality. They include stage inspections, preventive action on similar future products, communication among suppliers and R&D labs as well as having an apprenticeship scheme.

Comparisons with competitors are made through process time benchmarking, pay structure benchmarking and referring to the production manager's vast experience in the industry. To streamline production, work procedures are designed in the form of safe system of work, stage samples and product version. Turning to PM, there are three main measures used as indicators in production. They are output right first time, rework and rejects.

Best practices applied within the plant are cellular cell based on process, 5S, 5Whys and control charts. Pull to order is practised by getting purchase orders before sourcing the raw materials. By doing this, the factory only manufacture order which has already been confirmed by the customer and used raw materials according to the number of units ordered.

5.5.5 Overall Interview Summary from Company A, B, C and D

The results from interviews managed to uncover reasons behind the pursuance of dependability and most importantly, quality. The information is useful to identify tactics in obtaining quality and dependability capabilities, which is essential in moving towards stage 2 on the FSM. In addition, the research also found that:

1. Outside help is still required by company B, C and D. The help required is in the form of issues beyond the company's experience. They may include improvement on materials and manufacturing process. Additionally, advise are required when they are looking for investments, marketing and setting up quality systems.
2. Becoming affiliates of organisations that set standards on a particular industry will help companies in solving a problem which can't be dealt with internally. Further, it helps to get the latest information on the technology and process used in a particular industry.
3. The establishment of the various manufacturing research centre, particularly in the U.K provide a reference point in solving manufacturing issues faced by SMEs.
4. Partnership and collaboration between similar companies are formed with the intention to increase capacity, improving product design and manufacturing process.
5. The small number of employees involved in SME operations and the informal organisational structure allows top management to be involved directly in day-to-day operations of the manufacturing plant. Thus allowing intervention before a problem arise. In addition, it improves communication and allows for faster decision making.

The summary of actions, based on decision areas taken by stage 2 companies can be referred to *Table 5.4*. Next section will elaborate on analysis from the questionnaire and interviews by examining the competitive priorities and process of movement from stage 1 to stage 2.

Table 5.4: Summary of findings from interviews

Decision areas	**A**	**B**	**C**	**D**
Competitive priorities	1. Quality 2.Dependability 3.Flexibility 4.Cost	1. Quality 2.Dependability 3. Cost 4.Flexibility	1. Quality 2. Dependability 3. Flexibility 4. Cost	1. Quality 2. Dependability 3. After sales service 4. Cost
Quality dimensions	Product durability.	Product performance.	Product reliability.	Product durability.

	Perceived quality. Product reliability. Sustainability (Quality accreditation).	Perceived quality.		Product performance. Product reliability. Perceived quality. Sustainability.
Problem solving techniques	4 Ms (Machine, Materials, Manpower, Methods).	Embedded in ISO 9000.	4 Ms (Machine, Materials, Manpower, Methods). Embedded in ISO 9001 Certification.	5 Whys. Stage Inspection.
Work procedures		Build documentation. Works order.	Worksheet.	Safe system of work. Stage sample. Product Version.
Performance measures	Yield.	Delivery reliability. Lead time. Reject rates. Operation cost.	Lead time. Profit.	Output right first time. Re-work rate. Rejects.
Comparison with competitors	Employing people with experience in the related field and work culture.	Founder's experience. Customer reviews. Information from supplier.	Customer reviews. Employing people with experience.	Process time benchmarking. Pay structure benchmarking. Employing people with experience.

		Employing people with experience.		
Skills and training	Workers training 6 times a year. Industrial placement.	Skills matrix. Staff training. Apprenticeship.	Training when new technology is introduced. Apprenticeship.	Apprenticeship.
Best practice	Pull production. 5S.	Pull production. Flexible workforce. 5S.	Pull production. Multi-skilled and flexible workforce. Use of nominee supplier. 5S.	Pull production. Cell layout. Control charts. 5S.

5.6 Analysis of Interview and Questionnaire Results

This section explains the findings from the questionnaire and the interview. Results on competitive priorities from the questionnaire are validated by interviews. The details on how and why they selected are added from interview results. Further on, the following subheadings will explain the conclusion that can be drawn from the interviews.

5.6.1 Competitive Priorities

The results from the questionnaire and interview validate the competitive priorities pursued by stage 2 SMEs, which emphasise on attaining quality and secondly, dependability. Therefore, it adds clarity to the FSM by concluding in stage 2; the aim is to produce quality product consistently and at the same time started the process of pursuing dependability capabilities.

Chase and Hayes (1991) mentioned stage 2 company quality initiatives which meet the expectations of the customer on one or two key dimensions. Interviews identified those dimensions to come from a pool of 5 dimensions which includes product sustainability, product performance, product reliability, product durability and perceived quality. As a result, identifying the quality dimension focused by stage 2 companies, which has not been addressed previously. A second-round distribution of questionnaire (Phase 4) will be used to expand the findings by investigating the order of importance for these dimensions.

The research is aware of results from the phase 1 questionnaire showing dependability as the first priority, contradicting the cumulative capability model, where quality should be the first priority. The same case is also found during one of the interview session, with Company C stating that they are pursuing flexibility as the first competitive priority, rather than quality. This is can be explained by the following:

- There are possibilities that the answer provided by the respondent in the questionnaire and interview are based on current competitive priorities rather than the most important or first priorities. Therefore, implying quality as having lesser importance compared to dependability and flexibility.
- Interview with Company C has generated evidence that even though they are currently aiming to become flexible, the quality improvement initiatives have been put in place at the early stage of operations, demonstrating uncompromised stance towards quality.
- The above statement can be supported by looking actions in the decision areas, carried out by Company C which is similar to Company A, B and D that recognise quality as their first priorities. Similarities are in the form of actions in conducting comparisons with competitors, performance measures, problem solving techniques, quality dimensions and skills and training.

Regarding dependability, results from interviews show that keeping promises to the customer are considered essential in ensuring future orders. As a result, it explains the reason behind the selection of dependability as the most important priorities in the questionnaire. However, dependability is heavily reliant on several factors that are closely related to quality. This was identified during the interviews. They are:

- Sourcing raw materials by having to measure reject rates delivered by suppliers. While the main aim is to monitor the supplier's performance, it is also to ensure that items delivered meet quality expectations, which increase the chance of meeting delivery schedules.
- Having a nominee supplier who has good track records. Receiving non-conformance product from suppliers may delay production time thus effecting delivery promises made to customers.
- Adoption of 5S to increase shop floor visibility and create a safer working environment. It can create an efficient workspace and reducing process time.
- Employing people with experience in the related culture and training worker to become multi-skilled and flexible can give a significant contribution to the attainment of quality and dependability. Generally, a worker with experience could improve product quality by identifying, solving and preventing problems. Multi-skilled and flexible workers enable companies to fill gaps where there is a shortage to prevent delay in deliveries. Importantly, this is carried out without compromising quality.

To this end, it can be confirmed that there is an obvious link between quality and dependability. It can be compared by referring to the perceptual analysis made from the questionnaire with actual actions investigated by interviews. It demonstrates that keeping delivery promises is essential in creating good track records and a higher chance of future orders. This must come hand in hand with a quality standard that satisfies the customer.

The above notion is supported within the literature by Uyar (2009) and Sarmiento *et al.* (2007) when they conclude that quality is closely related to dependability. Citing suppliers that obtain high rates of dependability are also having a high level of quality within their production process. This is due to improvement on quality which can reduce lead times, amount of time spent on rework and the quantity of materials rejected. In the end, it can contribute to the improvements in delivery times (Amoako-Gyampah and Acquaah 2008). Also, interviews and questionnaire results show indication of implementing manufacturing best practices, where great importance is placed on dependability (Anuar and Yusuff 2011).

The results confirm the applicability of Ferdows and Meyer (1990) sand cone model (refer to section 2.6, *Figure 2.7*) at least for the first two capabilities (quality and dependability) by demonstrating they are reliant on each other. Further, the result managed to confirm the assumption that almost all companies compete based on similar competitive priorities, particularly the first two (quality and dependability), this is covered in four different types of industries namely wood and paper, automotive and transport equipment, iron steels and metals as well as textile footwear and clothing.

It is found that newly established manufacturing plant will have a balanced approach towards competitive priorities to establish their customer base. Company C is an example; given the age of their plants which is 2.5 years, they tend to be more flexible with the aim of building a good reputation among customers. This is demonstrated by having a large number of machines to respond to variations and changes. Flexibility, however, is not pursued until quality and delivery initiative are in place. Company C demonstrates this by having the post of quality manager, obtaining quality certification (ISO 9001:2008) and having a set of a nominated supplier.

The interviews also uncover decisions involved in pursuing two other competitive priorities, flexibility and cost. *Table 5.5* shows the decisions identified during the interview.

Table 5.5: Actions to attain flexibility and cost

Competitive priorities	**Actions**
Flexibility	1. Changes can be made before and after orders has been placed. 2. Having a large number of machine to respond to customer order during peak time. 3. Having multiple suppliers to respond to sudden production change. 4. Partnering with similar plants to increase capacity. 5. Serving multiple types of customer or orders (i.e. customised, mass, individual, retail and wholesale).
Cost	1. Prices are reduced during off-peak times. 2. Production is sourced to countries with low labour cost. 3. Materials are obtained from a low-cost source.

Details on *Table 5.5* were identified during the interview as steps taken to obtain flexibility and cost capabilities. It was presented to highlight additional actions that can be carried out to complement quality and dependability initiatives.

5.6.2 Comparison with Competitors

The interviews show the competitive priorities of those manufacturing SMEs are mainly dependent on customer requirements and the market they compete in. Four of the SMEs did not use any formal comparison with competitors except one which uses benchmarking. Majority of them use an informal approach of comparing with competitors by:

1. Referring to experience from the owner/founder of the company.
2. Employing people who have experience and work culture in related field.
3. Getting customer's reviews on other competitor's products.
4. Gathering information from suppliers to understand the materials, methods and technology the competitor is using.
5. Pay structure benchmarking.
6. Process time benchmarking.

The above list shows the sources of information on competitors, which allows manufacturing SME to identify information in achieving parity with their competitors. Referring to item 1 to 4 on the above list, it is found they are mostly using an informal way of conducting competitive and market analysis. Rather than using more advanced tools, these findings proved to be true according to Porter (2004: 72) mentioning there is no single correct way to collect competitor data. This is because such actions sometimes are not done explicitly or comprehensively in practice, added with difficulty obtaining big data required by in-depth competitor analysis. Further reading led to the Competition Intelligence System (CIS) (Porter 2004: 73).

The CIS provides a list of sources where data on competitors can be collected, which are divided into two sources: field data and published data. While published data is widely available, field data are more exclusive. Dependent on the size of the budget, they can be obtained from market research firms or personnel hired from competitors. Findings from interviews are compared with CIS to look for similarities and to provide guidance for stage 1 companies.

Table 5.6: Comparisons of field data from interviews and CIS

Field data	
From interviews	**CIS**
Experience from owner/founder of the company	Not mentioned
Employing people which have experience and work culture in related field	Personnel hired from competitors Engineering staff
Getting customer's reviews on other competitor's products	Not mentioned
Gathering information from supplier	Suppliers Distribution channels

While the sources from CIS are exhaustive (refer to *Table 2.6* in Chapter 2), there are two sources found to be similar to the CIS which is related to people and suppliers. In addition, two new information has

been discovered to complement list by CIS. They are experience from owner/founder of the company and getting customer's reviews on other competitor's products.

As a result, it validates the CIS and points to the essential sources Stage 1 companies could use in doing comparisons with their competitors. Hence for a start, companies know the source of information which can help them in the early stages of operations. *Table 5.6* displays comparison on field data from competitors obtained from interviews with CIS.

5.6.3 Workers Skills and Training

The interviews identified human factors played an important role in building up capability by continuously generating knowledge workers. This is in line with Ansoff (1984: 55) suggestion for firms to consider investment in training of personnel to increase capability.

It is found apprenticeship programme is undertaken in all interviewed plants. The reason the programme is adopted is to make sure skilled employee are available, and they understand the work culture, manufacturing operations and their company expectations. This was in line with the benefit highlighted by Kenyon (2005), stating:

- Apprentices productivity tends to be higher compared to other employees as they undergo formalised training at the start of their apprenticeship. This ensures the right expectation are set-out and reinforced regularly.
- Apprentices have a higher quality of work and efficient working practice, as from the start they are given correct tools to do the job and ingrained with current company culture.

For the companies, the apprenticeship programme reduces the need to continuously search for a suitable employee in the open market and forking out expensive salaries to pay for the highly experienced worker. In the long run, it ensures companies have the human capital to remain competitive and continues its survival. In a wider context, the apprenticeship programme could provide job opportunities for graduates as well as supplying the market with enough local skilled workers thus reducing reliance on the need to move operations to low-cost countries.

Besides the apprenticeship programme, skills development initiatives and reward structure promoting worker's contribution to improvement is among other steps taken in building up the manufacturing capabilities. Company A, for example, encourages their shop floor worker by giving rewards for the contribution of ideas which can continually improve their operation. This is by frequently organising 'Kaizen' competition for the shop floor worker. By doing this the company can appreciate good ideas from workers at the same time involving them in making decisions.

Company B provides another example by conducting biennial appraisal according to in-house developed skills matrix, where workers are trained according to job role and expectation until staff can perform a certain job good enough up to the expert level where they can become a trainer. Moreover, a worker is not only evaluated by internal staff of the company, but also by the external trainer. The initiatives taken by Company B shows that staff knowledge and skills are continually upgraded. This is useful in increasing job satisfaction and at the same time increasing company capabilities. In the future, the staff can be a point of reference to carry out certain troubleshooting tasks or quality conformance issues.

Besides producing skilled workers, examples provided by Company A and B shows that rewards, training and apprenticeship are also used to embed and embrace a quality culture in their organisation. This is in-line with the concept of TQM, where a culture of quality can be expressed by using reward and promotion systems (Omachonu and Ross 2004: 33).

5.6.4 Performance Measures (PM)

Voss (1992: 140) suggested that performance measures must focus on competitive variables the customer sees. It can be useful as a guide towards retaining higher customer satisfaction. Sarmiento *et al.* (2007) cited performance measures that are often used on the side of suppliers are lead times, delivery reliability rates and inventory level (on the side of the customer). Interviews found there are three performance measures and they are related to attaining quality, dependability and cost. *Table 5.7* shows the performance measures and its relations to the competitive priorities pursued.

Table 5.7: Performance measures for quality, delivery and cost

Performance measures	**Competitive priorities**
Yield Output right first time Reject rates Scrap Re-work rate	Quality
Delivery reliability Lead times	Dependability
Profit (comparing actual and estimation of a job) Operations cost	Cost

5.6.5 Work Procedures

The continuous improvement concept requires companies to have a standardised process and operating procedures. While this proves to be true to the classic assembly line, Berger (1997) argues standardisation in customer-specific order is difficult to implement and requires indirect system standards. Further, he acknowledges that most companies that operate in this environment relied mainly on skills. This is found to be true when looking on the result of the interview, where there is a preference in employing people with experience.

Alternatively, the apprenticeship scheme is used as a mean to employ skilled worker. This is because of through apprenticeship, future employees can learn manufacturing skills that are unique to a particular industry. At the end of the programme, an apprentice can be absorbed by becoming a full-time employee. As a consequence, SMEs could benefit from hiring apprentice which have the required skills and cultural fit to serve their organisation. In a wider context, the apprenticeship scheme will help to fill skilled worker shortage as well as reduce unemployment.

In Chapter 2, the establishment of work procedures are mentioned as one of the actions taken by stage 2 companies (Barnes and Rowbotham 2004; Chase and Hayes 1991). Based on interviews, there are several work procedures which can be established by stage 2 manufacturing plant. They are mainly created to give general assembly information on a product, safety aspect of operations and customer requirements. Specifically, they are known as:

1. Build documentation.
2. Safe system of work.
3. Work order/worksheet.
4. Stage sample.
5. Product version.

The above procedures are essential as a future reference, where it can be used by employees as a guide in the manufacturing process to ensure quality are always maintained at the highest level. Additionally, it provides a record, which can be used for product or process improvement. Ingvaldsen *et al.* (2013) suggested improvement on work procedures are the result of interaction between managerial and shop floor worker through a group-based problem solving, which was practised by Company D by setting up a special consultancy area for this purpose. In addition, the result shows that external sources are used to provide an improvement in the procedures. Company B sets an example, where their build documentation is reviewed continuously and has some flexibility to be altered. The alteration suggestion may come from other partnering manufacturing organisations.

5.6.6 Problem Solving Techniques

There are two approaches that were adopted by the interviewed companies in using the problem solving techniques. One is embedded within ISO 9000, where problems are being solved by referring to non-conformance procedures. They include guides on containment issues, problems identification as well as short and long term preventive actions.

The second approach is by using a systematic process of problem identification and containment referred to as root cause analysis. They are applied by investigating the cause of a problem to prevent recurrence. Specifically, there are three formal techniques that were identified. They are stage inspection, 4 Ms (machine, materials, manpower, methods) and 5 Whys.

Informally, shop floor worker experiences are also used as a reference in problem solving. They can help to reduce the time taken to identify problems, which contribute towards better delivery times and cost savings. This is reflected by the importance put on experience worker, starting from employing and developing them through training and apprenticeship programme.

5.6.7 Best Practice

There are several actions related to best practice, aimed at improving quality and dependability. First is the use of 5S to increase visibility and provide a safe working environment. It paves the way for more quality improvement initiatives. Second, is the use of control charts to monitor performance as were done by Company D.

Third, is informally implemented just-in-time (JIT), adopting the basic principles of pull production to only manufacture what was required and purchasing materials according to orders. The practice is aligned to manufacturing best practice, where made to order reduced the need for inventories and reducing waste in the manufacturing process. In the end, it contributes to cost efficiencies.

Fourth is having multi-skilled and flexible shop floor workers, enabling delivery promises to be made without compromising quality. This is aided by arranging the shop floor by according to process or products, creating a cell layout for more efficient production. Finally, is to establish a list of nominee supplier. The list is used to record high performing supplier based on the rate of quality products supplied and on time delivery. The suppliers on the list are given preference in sourcing for raw materials. This is to ensure quality and dependability from the side of the supplier.

5.6.8 Summary of Phase 1 Questionnaire and Phase 2 Interview Findings

It has been recognised in the literature review, competitive priorities for stage 2 companies are not explicitly mentioned in the seminal paper by Hayes and Wheelwright (1984: 396). It was addressed by Chase and Hayes (1991) noting that quality as the priority. Subsequently, Dangayach and Deshmukh (2006), Barnes and Rowbotham (2004) and Martin-Pena and Garrido (2008b) identified quality and

dependability as the priorities for stage 2 companies. However, only Dangayach and Deshmukh (2006) provide empirical evidence on the competitive priorities through 3 case studies, while others are limited to conceptual work.

Empirical evidence was used by this study to confirm and extend findings by the above authors. It is done by investigating competitive priorities by using questionnaire and interviews. The significant element of this approach is it combined two data collection methods to arrive at a conclusion, thus doubling the validation process. Based on the results presented in this chapter, drivers of improvement are found to be based on the priority that is set towards attaining quality and dependability capabilities. This is true for companies which are classified as stage 2 on the FSM. Consequently, it realised the objective to investigate drivers of improvement within manufacturing SMEs operations. *Figure 5.1* summarises findings of investigations obtained during phase 1 and phase 2 data collection.

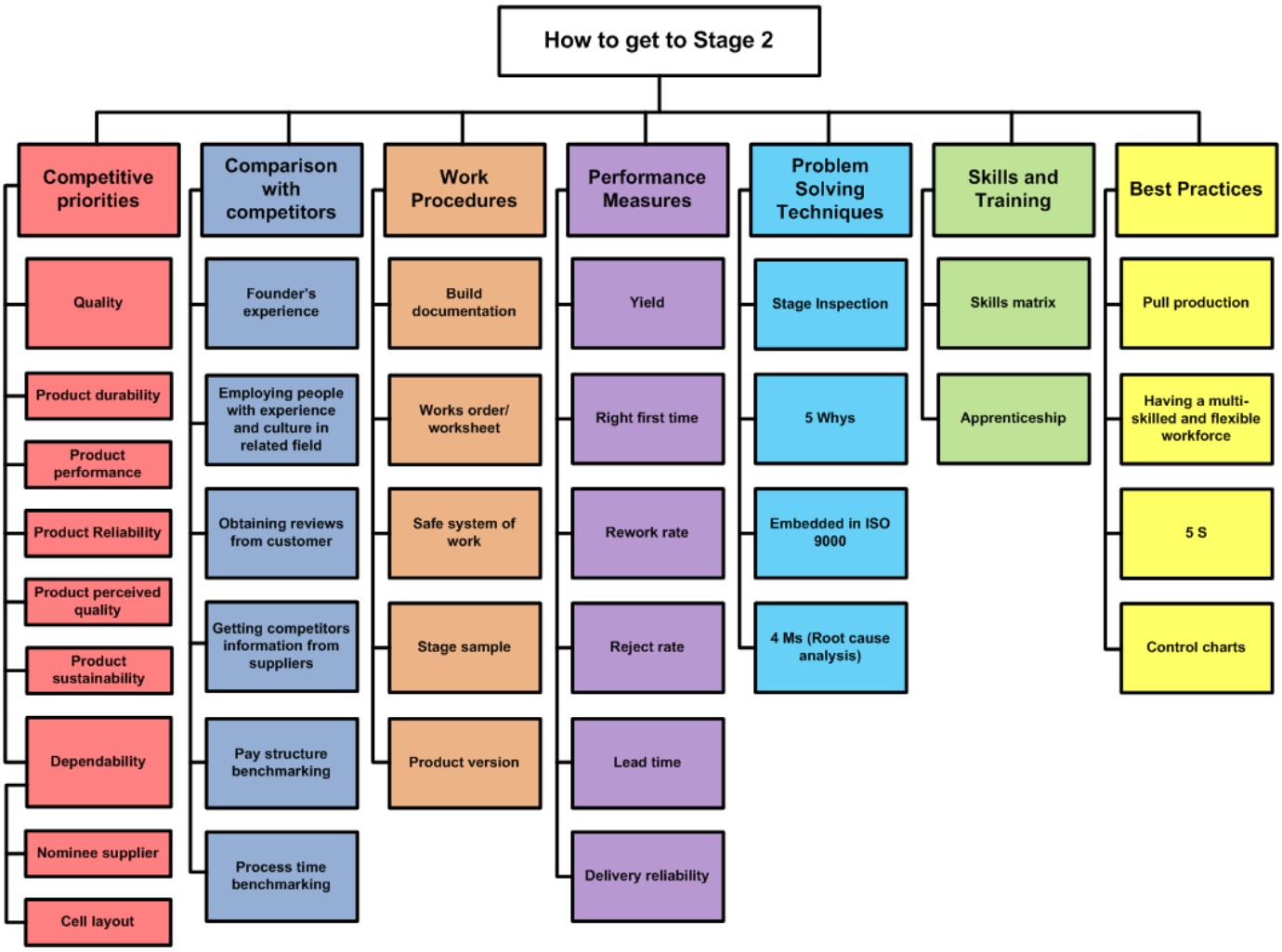


Figure 5.1 Decisions areas and actions allowing companies to be classified as Stage 2

Figure 5.1 shows seven decision areas identified with a different colour code. It covers competitive priorities, comparison with competitors, skills and training, work procedures, performance measures, problem solving techniques and best practices. In terms of original contribution, the completion of the interview sessions managed to reveal actions within the decision areas that indicate the improvement initiatives taken by stage 1 company to move to stage 2. The areas and actions will be assessed again after the completion of the Delphi sessions.

5.7 Conclusions

This chapter covers discussions around the outcome of phase 1 and phase 2 data collection. There are two objectives which have been met. First, is investigating drivers of improvement within manufacturing SMEs operations. Secondly, is how those improvements are pursued and obtained.

Results and findings presented in this chapter confirm that there is a strategic direction which drives improvement by stage 2 companies. The drivers are based on competitive priorities. Consequently, the improvements are pursued and obtained by carrying out actions within the seven decision areas presented in *Figure 5.1*.

The accomplishment of the above objectives complements the second research objective, which is to investigate areas of improvement. This was achieved in Chapter 2 through the initial investigation and review of the literature. Up to this point, there are 34 actions in the decision areas that have been identified. Further validation of the findings will be conducted in the next chapter. Chapter 6 will elaborate more on findings and suggestions from the Delphi sessions and subsequently results from the phase 4 questionnaire distribution.

Chapter 6: Phase 3 Delphi, Phase 4 Questionnaire and Validation Results and Analysis

6.1 Introduction

In the previous chapter, the analysis was concentrated around the result from the implementation of the phase 1 questionnaire and phase 2 interviews. It managed to provide outcomes for drivers of improvement and how it can be obtained. Chapter 6 is a continuation of analysis from Chapter 5, where the previous chapter result is being tested and validated. The discussion will revolve around Delphi and questionnaires, forming the third and fourth phase of data collection. Additionally, results from framework validation will be included. The discussion will start with the Delphi process, phase 4 questionnaire and framework development ending with validation of results.

6.2 Delphi Results and Analysis

In Chapter 3 (*section 3.6.7*) Delphi was mentioned to be used in increasing the validity of the data collected. A total of 6 hours were spent during the Delphi sessions (4 hours with the first panel and another 2 hours with the second panel). The process can be referred to in *section 3.12.3*. The following are the list of outcomes agreed by both panels. Additional areas are in *italics*:

1. A framework is suggested to be developed by employing either interviews or questionnaire. A minimum of 10 and a maximum of 30 samples are required.
2. A Gantt chart- type template needs to be constructed. It will include actions identified in Chapter 5.
3. *A timeline* is required to support the framework to provide a milestone. This is to the order of importance in initiating those actions.
4. A *strategic theme* should be established to set a target. This theme should be initiated by the top level management, communicated by the tactical level and implemented at the operational level.
5. It is important for SME to check *local health and safety regulations*, which differs from country to country.
6. *Visual management* should be included as (a short meeting every day to generate ideas for operations improvement, lasted about 5 to 15 minutes) this is part of continuous improvement initiatives.
7. *Rituals* should be conducted as soon as possible. It is a meeting organised to discuss previous day issues and to set objectives of the day.
8. It takes time to have a matured process layout (cell layout), therefore continuously *reviewing process layout* is recommended.
9. A gradual 5S implementation is the best way to achieve positive results. The first *3S* (Sort, Set in Order and Shine) should be introduced at the beginning to explain the purpose and to create awareness among employees.
10. This is followed by 4^{th} *S* (Standardisation) and 5^{th} *S* (Sustain) to create an audit procedure.

11. 4Ms should be changed to *Fishbone (Ishikawa) diagram*. It represents a generalised term for root cause analysis techniques as the automotive industry has started to implement 5Ms by adding 'Measurement' or 'Management'.
12. Control charts should be changed to *Statistical Process Control* to make it more general.
13. Benchmarking is conducted once quality systems are in place. This is to be appropriate at the end of achieving stage 2 and will act as a preparation to become a stage 3 company. It allows for parallel comparison to be made against competitors by continuously looking for gaps. Further on, opening up the opportunity to take a leading role in the industry.
14. The same is applied to *value stream mapping*, where it can be applied as the company are preparing to move into stage 3 or 4 on the FSM.
15. Plans for *middle manager training and coaching* should be established at the beginning. Middle managers skills development needed to be conducted first, so that it can be transferred to the operational level through training and coaching.
16. Emphasis should be given on attaining *quality*, followed by *delivery* and *cost*. Operations performance is usually evaluated based on these three indicators.
17. *Estimation of delivery time is usually compared to previous similar work*. This way, delivery prediction can be worked out according to company capability and experience.
18. Operational staff should be good at doing a specific task before they can be trained to become multi-skilled workers.

The above feedback provides additional findings that complement results from phase 1 and 2 data collection in Chapter 5. *Figure 6.1* provides a revised version of the decision areas and actions based on *Figure 5.1*. Box in the dotted line are changes made on the actions, while items in the grey box are the new actions added after the Delphi sessions. The guide is available as shown in *Table 6.1*.

Table 6.1 Descriptions of changes made after the Delphi sessions

Descriptions	**Boxes**
Changes made on actions	
New actions added after Delphi sessions	

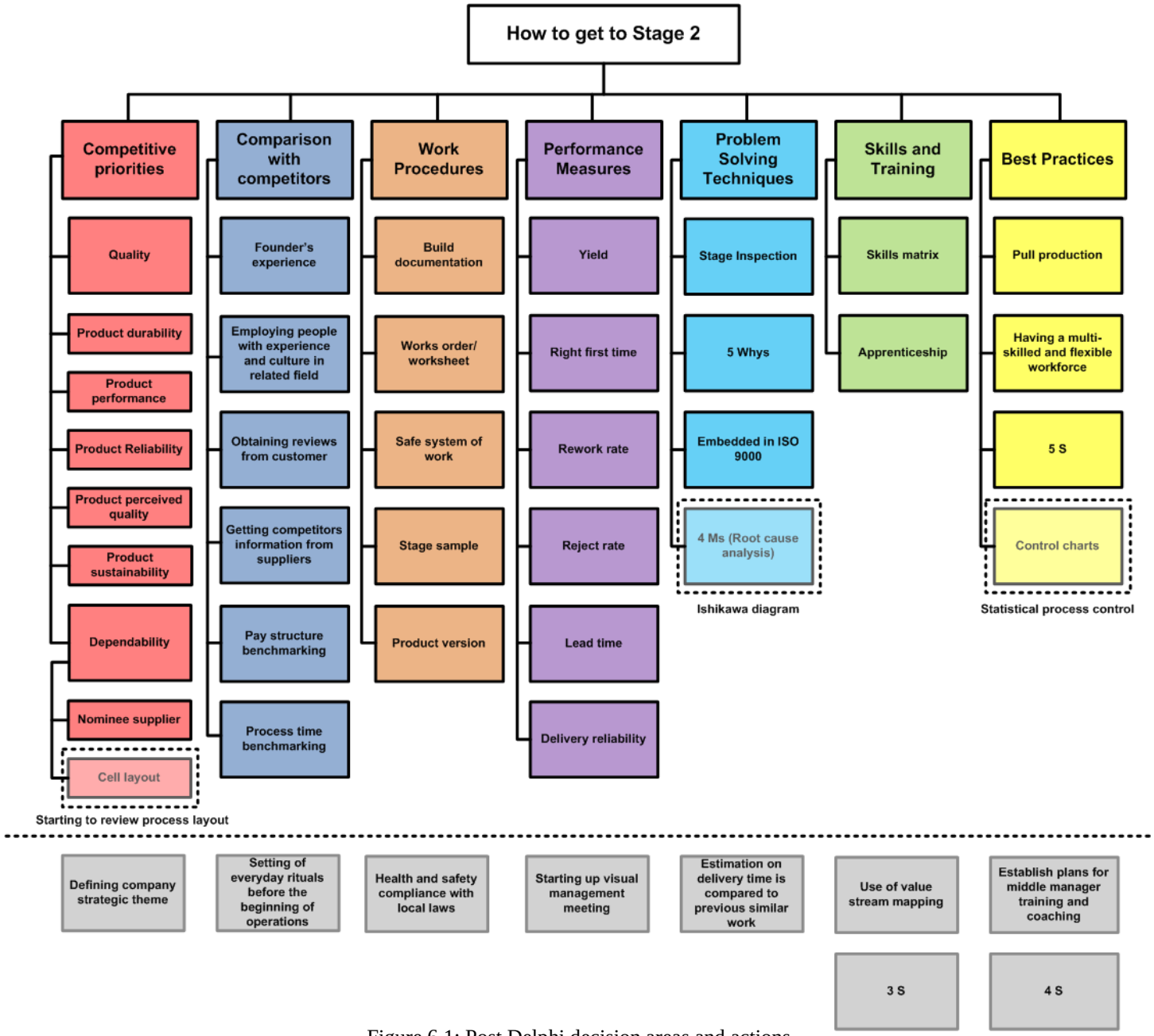


Figure 6.1: Post Delphi decision areas and actions

In order to heed the suggestions in providing a timeline on the framework, a set of 172 questions were developed and sent to selected business owners and experts. The information regarding the development of construct, respondent selection and distribution are explained in Chapter 3, section *3.12.4*. To this end, the work has managed to complete the objective of investigating areas of improvement. It extends findings on decision areas and action obtained from Chapter 2 and 5.

6.3 Phase 4 Questionnaire Results and Analysis

The questionnaires are distributed in a span of six months. Potential respondents are contacted through LinkedIn messaging and email inviting them to participate. A total of 152 invitations were sent out and 7 questionnaires were returned. A reminder was sent after two weeks. In total, 10 final questionnaires were received indicating a response rate of 6.6%. *Table 6.2* shows the summary results of the questionnaire.

Table 6.2: Summary of the mean and median covering actions in decision areas and its impact on cost, quality and delivery

		Months		Median (Mean)		
	Items (Actions in decision areas)	**Median**	**Mean**	**Impact on quality**	**Impact on delivery**	**Impact on cost**
1	Defining Strategic Theme	6.00	19.20	4.00 (4.30)	4.00 (4.20)	4.00 (4.30)
2	Product Performance	12.00	16.80	5.00 (4.50)	3.50 (3.60)	4.00 (4.10)
3	Product Reliability	18.00	17.40	5.00 (4.50)	4.00 (3.78)	4.00 (4.20)
4	Product Durability	12.00	21.00	5.00 (4.56)	3.50 (3.60)	4.00 (4.30)
5	Product Perceived Quality	12.00	18.00	5.00 (4.70)	3.00 (3.40)	4.00 (3.90)
6	Product Sustainability	24.00	25.20	4.00 (4.10)	3.00 (3.40)	4.00 (3.90)
7	Build Documentation	12.00	15.60	4.50 (4.40)	3.50 (3.60)	4.00 (3.60)
8	Works Order	9.00	13.80	4.00 (4.30)	4.00 (4.00)	3.50 (3.60)
9	Safe System of Work	12.00	20.40	4.00 (3.89)	3.00 (3.20)	4.00 (3.70)
10	Stage Sample	12.00	13.20	3.00 (3.40)	3.00 (3.10)	3.00 (3.30)
11	Product Version	12.00	20.40	3.50 (3.60)	3.00 (3.33)	3.50 (3.70)
12	Health and Safety	12.00	15.60	3.50 (3.60)	3.00 (3.00)	4.00 (3.80)
13	Visual Management	12.00	15.00	4.50 (4.40)	4.00 (4.10)	4.00 (3.80)
14	Starting to review process layout	12.00	15.00	4.50 (4.20)	4.00 (4.00)	4.00 (3.70)
15	Use of value stream mapping	12.00	16.20	4.00 (3.90)	4.00 (4.30)	4.00 (4.10)
16	Yield	9.00	15.00	4.00 (4.30)	4.00 (3.89)	5.00 (4.50)
17	Right First Time	9.00	19.80	5.00 (4.60)	4.00 (4.20)	5.00 (4.60)
18	Rework Rate	12.00	19.20	4.00 (4.11)	4.00 (3.80)	4.00 (3.50)
19	Reject Rate	12.00	20.40	4.50 (4.10)	4.00 (3.90)	4.00 (3.60)
20	Delivery Reliability	12.00	18.00	3.00 (3.50)	5.00 (4.30)	4.00 (3.80)
21	Lead Times	12.00	13.33	3.00 (3.40)	4.00 (4.20)	4.00 (4.20)
22	ISO 9000	24.00	31.80	4.00 (4.00)	3.50 (3.50)	3.50 (3.40)
23	Setting Rituals	12.00	18.00	4.00 (4.20)	4.00 (4.20)	4.00 (3.70)
24	Stage Inspection	9.00	17.40	4.00 (4.30)	4.00 (3.80)	3.00 (3.30)
25	Ishikawa Diagram	12.00	19.20	4.00 (4.30)	4.00 (4.10)	4.00 (3.70)

26	5 Whys	12.00	18.60	4.00 (4.40)	4.00 (3.90)	3.50 (3.60)
27	SPC	12.00	16.00	4.50 (4.40)	4.00 (3.80)	4.00 (3.60)
28	3S	12.00	18.00	4.00 (4.00)	4.00 (4.10)	4.00 (3.80)
29	4S	12.00	18.60	4.00 (4.30)	4.00 (3.80)	4.00 (3.90)
30	5S	12.00	21.60	4.50 (4.50)	4.00 (4.00)	4.00 (4.10)
31	Middle manager training and coaching	12.00	20.40	4.00 (4.10)	4.00 (4.10)	4.00 (4.40)
32	Skills Matrix	12.00	24.60	4.00 (4.00)	4.00 (3.90)	4.00 (3.90)
33	Adoption of apprenticeship/industrial training program	18.00	26.40	4.00 (3.90)	3.00 (3.60)	3.50 (3.80)
34	Founders Experience	18.00	19.20	4.00 (4.10)	4.00 (3.70)	4.00 (4.20)
35	Obtaining reviews from customer	12.00	22.20	4.00 (4.20)	4.00 (3.70)	4.00 (4.20)
36	Getting competitors Information from suppliers	18.00	23.40	4.00 (3.90)	3.50 (3.70)	3.50 (3.70)
37	Employing people with experience and work culture in related field	24.00	22.20	4.00 (4.10)	4.00 (3.89)	4.00 (3.90)
38	Pay Structure Benchmarking	30.00	33.60	3.50 (3.70)	3.00 (3.50)	4.00 (3.60)
39	Process Time Benchmarking	24.00	23.40	3.50 (3.80)	4.00 (3.80)	4.00 (4.20)
40	Establish nominee supplier with proven delivery track records	12.00	15.60	4.00 (3.70)	4.00 (4.20)	4.00 (3.80)
41	Implementing pull production	24.00	24.00	3.00 (3.40)	4.00 (4.30)	4.00 (3.90)
42	Estimation on delivery time is compared to previous similar work to get best delivery prediction	12.00	21.60	3.00 (3.40)	4.00 (4.10)	3.00 (3.30)
43	Having a multi-skilled and flexible workforce	24.00	22.80	4.00 (4.10)	4.00 (4.30)	4.00 (4.10)

Median is used to analyse the data to obtain central tendency measures, which is the typical time to implement the actions in the decision areas. Median is chosen because it is more robust to outliers and skewed data than the mean (de Vaus 2002: 222). Further, it is best to represent the data when the distribution is not symmetrical. Considering the sample size of 10, the magnitude of each response value may inflate or deflate the average thus providing a misleading summary in the distribution. Therefore, the use of the median is preferred as it is unaffected by extreme values (Fielding and Gilbert 2000: 97).

The median values from *Table 6.2* are used to construct a time versus actions framework as depicted in *Figure 4.3* (refer to Chapter 4: The Proposed Framework and The Development Process). It shows a 2.5 years plan on implementing actions to enable organisations to become a stage 2 company.

6.4 Framework Validation Results

A validation is arranged in order to increase understanding and to refine findings from the questionnaire. For this purpose, two participants are invited for interviews. The profiles of the participants are:

1. Participant 1 – Has over 15 years' experience within manufacturing, within a variety of environments and employed in roles such as production engineer, production engineering manager and production manager. He is currently working as an educator, specialising in operations management.

2. Participant 2 – Has 36 years' experience working in multiple roles within manufacturing. He is currently working as operations manager with a tier 1 SME for one of the UK leading automotive companies.

'Interview pack' consisting of ATF, terminologies and interview questions were sent to participants one week in advance before the interview date. This is to maximise the interview time in utilising most of them with discussions, rather than questions. In addition, it allows interviewees to prepare and plan their answers.

During the interviews, participants were asked about their opinion on ATF, the suitability of the actions and whether the timeline is reasonable and achievable. They were then asked about their experience in implementing those actions. Their feedback is compared to the ATF and any additional details are added to the framework. To make the comparison easier, it will be shown in a table format. This is shown in *Table 6.3.*

Table 6.3: Comparison of the timeline before validation (ATF Timeline) and after validation (Validation Timeline) together with its reasons

Decision areas	Actions	ATF Timeline	Validation Timeline	Reasons
Strategic theme	Defining company's strategic theme	6 Months	No suitable timeline.	Earliest as possible. When there is an award of new contracts. Anytime when there is a change in the business model.
Competitive priorities	Product performance	12 months	Establish from the start of operations and conducted throughout.	Perceived quality is always important and also service quality to make sure generating future orders.
	Product durability	12 months		
	Product perceived quality	12 months		
	Product reliability	18 months		
	Product sustainability	24 months		
	Service quality	Action not available before validation		
Work procedures	Works order	9 months	Usually, the quality auditor will require 6 months evidence of consistency of using these documents.	The plant is ISO 9001 certified. Therefore, quality management is in place. Everything is written down and visualise as well.
	Build documentation	12 months		
	Safe system of work	12 months		
	Health and safety compliant with local laws	12 months		
	Product version	12 months		
	Stage Sample	12 months		
Visual management	Starting to review	12 months	Establish from the start	It is done quite often. The layout is

	process layout		of operations and continuously conducted throughout.	always checked to see whether customer demand will have an effect. Also when there is an opportunity for cost efficiency.
	Starting up visual management meeting	12 months		
	Use of value stream mapping	12 months		
Implementation of performance measures	Right first time	9 months	Establish from the start of operations depending on what priorities are.	From a customer point of view, quality is the main one. If quality is the one that matter, they must be measuring right first time and delivery reliability, get the parts on time, right quantity and the right place.
	Yield	9 months		
	Reject rate	12 months		
	Re-work rate	12 months		
	Delivery reliability	12 months		
	Lead times	12 months		
	Stock turns	Action not available before validation	Earliest as possible.	It is important to start early as it is related to money in the bank and cash flow.
Certification and rituals	Setting of everyday rituals before the beginning of operations	12 months	Establish from the start of operations.	Basic maintenance is done first thing in the morning and at the end of a shift.
	Adoption of ISO 9000	24 months	18 months	It took us 18 months to complete the whole process. This is due to our small size and team. Therefore, there is not a lot of red tape and procedures to overcome.

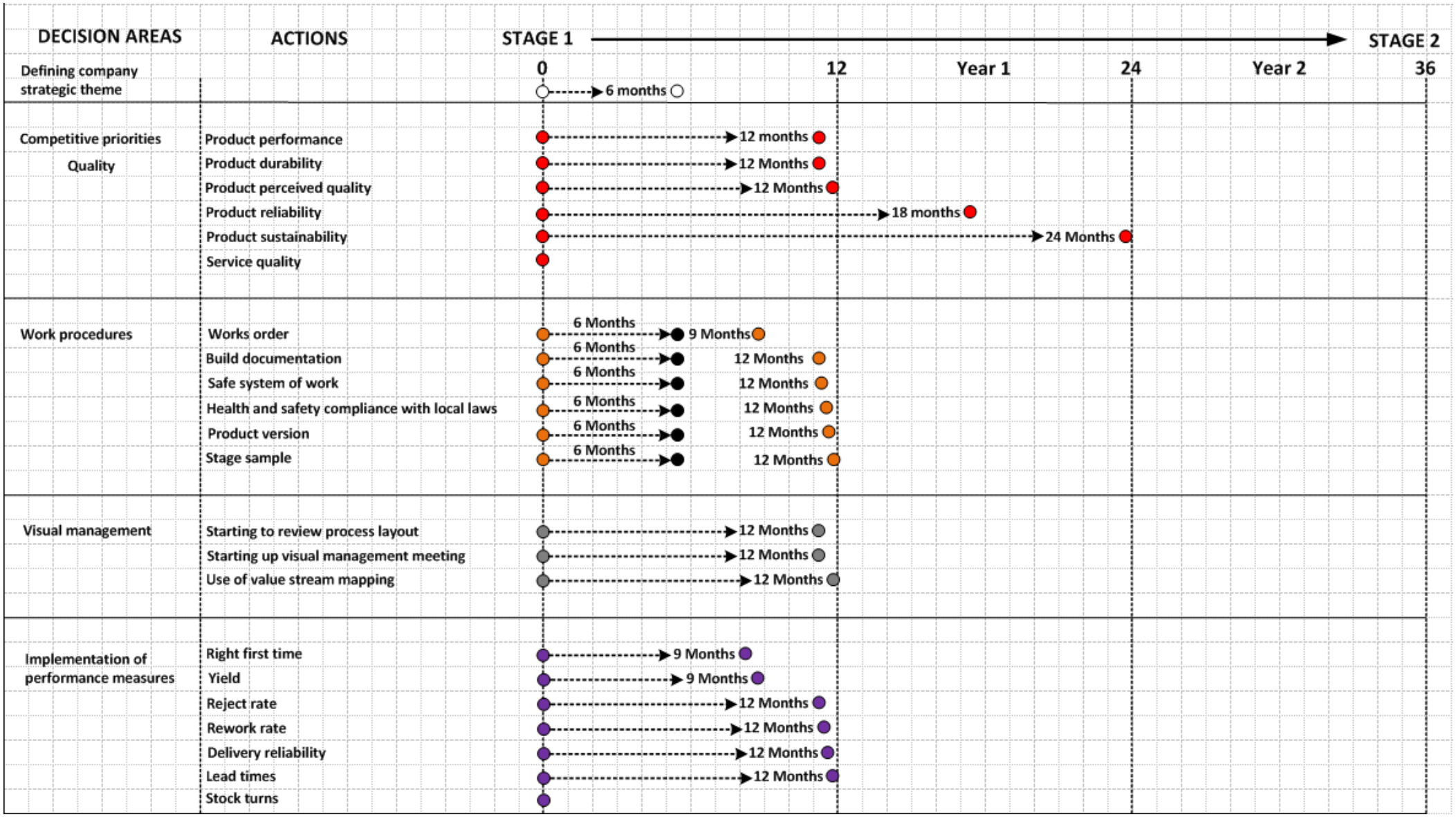
The use of problem solving techniques	Stage inspection	9 months	6 months	Problem prevention is applied in our plant. Entire products go to process FMEA before reaching the shop floor. Because these documents are included in the ISO 9001 certification, it will take the same time with the work procedures to get it ready.
	Statistical process control	12 months		
	Ishikawa diagram	12 months		
	5 Whys	12 months		
5S Deployment	5S	12 months	4 months	New employees are trained to be familiar with 5S. It takes a gradual introduction of 3S, 4S and the 5S, as the staff need to know why they are doing it and let them know the benefit.
	4S	12 months		
	3S	12 months		
Skills and training	Middle manager training and coaching	12 months	Establish from the start of operations.	To ensure all operators are fully trained and competent before they can work with the machine, the manager needs to be trained to manage the process and people.
	Establishing skills matrix	12 months	6 months	The plan can be completed in 6 months. Planning and focus are paramount.
	Adoption of apprenticeship/ industrial training programme	18 months	After 2 years.	Re-training program if there is a labour shortage.
Comparison with competitors	Obtaining reviews from	12 months	Conducted throughout.	We always like to look and we want to

	customer			look best. This is to make sure we win business and makes us feel better.
	Founder's experience	18 months		
	Getting competitor's information from suppliers	18 months		
	Employing people with experience and work culture in related field	24 months		
	Process time benchmarking	24 months		
	Pay structure benchmarking	30 months		
Pursuance of delivery dependability	Establish nominee supplier with proven delivery track record	12 months	Within 12 months or performance on 6 deliveries.	When there is 6 deliveries adherence, we consider the supplier as one of our nominees.
	Estimation on delivery time is compared to previous similar work to get the best delivery prediction	12 months	Establish from the start of operations.	Typically, the most important timing is how long raw materials get in. Typically, we know this from past experience and knowledge.
	Having multi-skilled and flexible workforce	24 months	Planned from the start of operations.	Start at the earliest possible to speed up the time of obtaining the capability.
	Implementing pull production	24 months	6 months	Small size allows us to get into pull situation, to roll and pushing.

Table 6.3 presents the results before and after the validation process. It shows the time both participants took in carrying out actions in the decision areas. Also, it justifies the reasons behind those timelines. Further discussion on the validation results will be discussed in the next section.

6.5 Validation Evaluation

The validation has resulted in the discovery of reasons behind time taken to implement actions in the ATF. Additionally, two actions have emerged as a result of the interviews. First is service quality, which adds another dimension to competitive priorities. Secondly is stock-turns, which adds to performance measures. *Figure 6.2* shows the ATF after the validation process.


DECISION AREAS
ACTIONS
STAGE 1
STAGE 2
Defining company strategic theme
0
12
Year 1
24
Year 2
36
6 months
Competitive priorities
Quality
Product performance
12 months
Product durability
12 Months
Product perceived quality
12 Months
Product reliability
18 months
Product sustainability
24 Months
Service quality
Work procedures
Works order
6 Months
9 Months
Build documentation
6 Months
12 Months
Safe system of work
6 Months
12 Months
Health and safety compliance with local laws
6 Months
12 Months
Product version
6 Months
12 Months
Stage sample
6 Months
12 Months
Visual management
Starting to review process layout
12 Months
Starting up visual management meeting
12 Months
Use of value stream mapping
12 Months
Implementation of performance measures
Right first time
9 Months
Yield
9 Months
Reject rate
12 Months
Rework rate
12 Months
Delivery reliability
12 Months
Lead times
12 Months
Stock turns

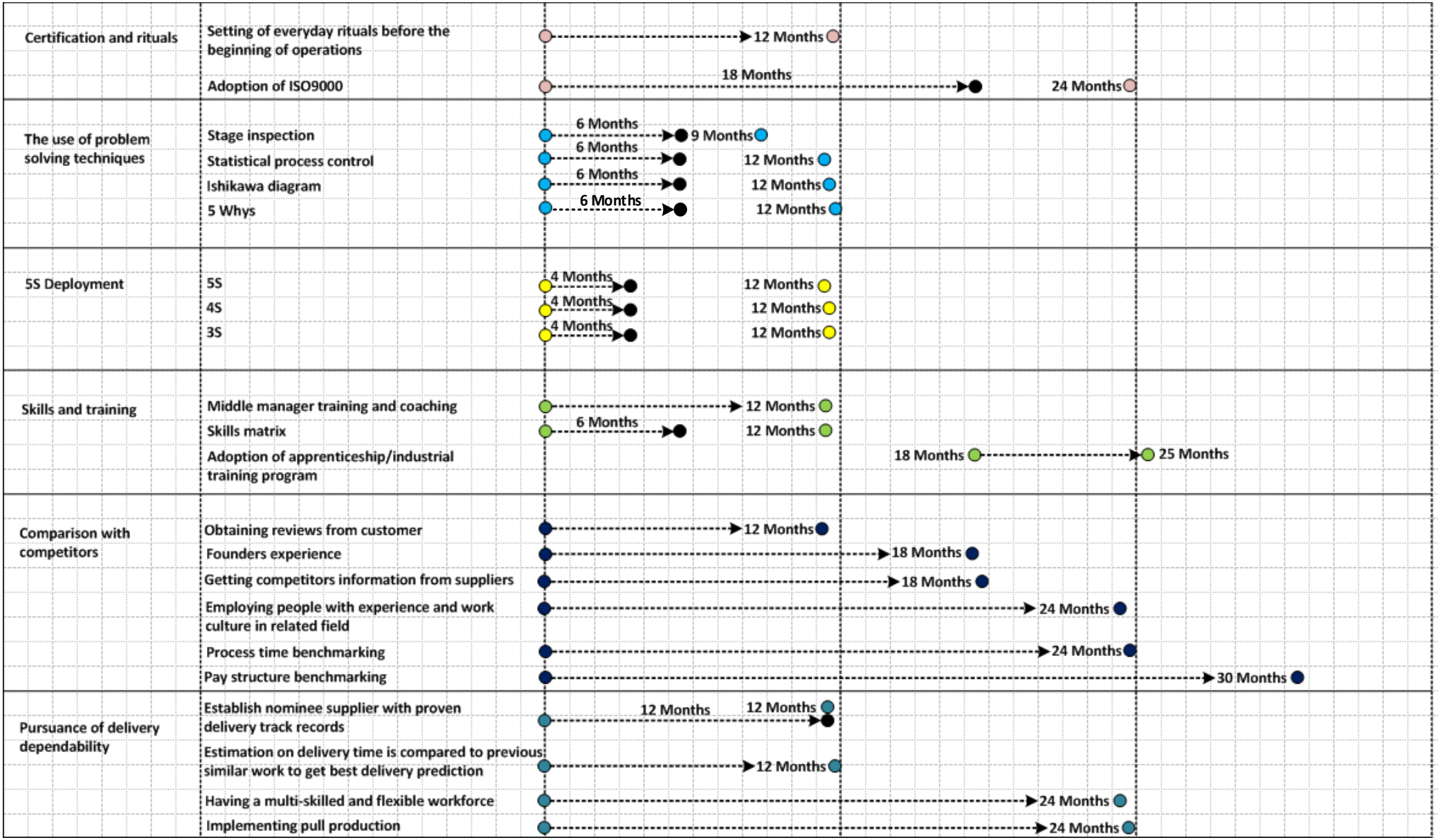
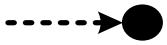


Figure 6.2: Post validation Action-Time Framework

Figure 6.2 shows the comparison between the timeline before and after the validation process. It shows the majority of actual time initiating actions in the decision areas are varied with the *latest start time* generated from the questionnaire. The difference can be observed by referring to the description of arrows shown in *Table 6.4.*

Table 6.4: Descriptions of arrows

Descriptions	**Arrows**
Indication of *earliest start time* to *latest start time*	
Indicating time when actions can be completed	

The variations are contributed largely by selection of time scale in the questionnaire. A yearly scale was chosen instead of months as it is considered more practical. This is due to the use of a monthly scale which could expand the length of the questionnaire and may deter prospective respondent. Considering the need for consistent answers and attracting more response, time was represented in years rather than months. Additionally, time in the questionnaire are rated exclusively based on the positive or negative impact that it has on quality, delivery and cost. Therefore, the sequence of actions in the timeline is influenced by its impact on the three capabilities. Despite this, the validation managed to capture the *earliest start time* those actions can be initiated. As a result, suggesting the implementation of actions which can start anytime between the *earliest start time* and *latest start time*. There are several decision areas which contain actions that can be completed within the *latest start time*. This is depicted in *Table 6.5.* The explanation will continue in the following paragraph.

Table 6.5: Summary of actions which can be completed within the *latest start time*

Decision areas	**Actions**	**Latest start time**	**Completion timeline**
Work procedures	Works order	9 months	6 months
	Build documentation	12 months	6 months
	Safe system of work	12 months	6 months
	Health and safety compliant with local laws	12 months	6 months
	Product version	12 months	6 months

The use of problem solving techniques	Stage Inspection	12 months	6 months
	Statistical process control	12 months	6 months
	Ishikawa diagram	12 months	6 months
	5 Whys	12 months	6 months
Certification and rituals	Adoption of ISO 9000	24 months	18 months
5S Deployment	3S	12 months	4 months
	4S	12 months	4 months
	5S	12 months	4 months
Skills and training	Skills matrix	12 months	6 months
Pursuance of delivery dependability	Establish nominee supplier with proven delivery track records	12 months	12 months
	Implementing pull production	24 months	6 months

Referring to *Table 6.5*, the time taken to complete the implementation of work procedures and problem solving techniques are closely related in obtaining ISO 9000 certification. To apply for certification, ISO auditors will require evidence on consistent use of these two actions. Based on the interviews, evidence of six months cycle is sufficient to satisfy the need of ISO auditors. It demonstrates these actions can be documented within six months. On the other hand, the process of obtaining ISO certification can be completed by another 12 months, making a total time of preparing documentation for the two actions and obtaining the certification to 18 months. This can be achieved largely because of the small size and teams, overcoming a lot of red tape and procedures.

The small size and teams also reduce the time needed to set pull production. It allows the process to be completed within six months. In regards to having a nominee supplier list, a company can make into the list when there is six delivery adherence. A supplier may get into the list after a year, depending on whether they can complete six delivery adherences within this time.

Next is the implementation of 5S. Referring to the validation timeline, 5S deployment can be completed within four months. This can be achieved by creating awareness towards 5S, explaining the benefit that it

brings and how it can improve operations. Therefore, employees will not feel pressured to do it, rather accepting ideas that it will make their work more efficient. Additionally, new employees are trained to understand 5S to help them familiarise the concept and subsequently speeding up 5S implementation.

Finally, is on the implementation timeline for the skills matrix. It shows that it can be fully implemented within six months, at the same time with actions related to problem solving techniques and work procedures. It is also found that less importance was put on the apprenticeship programme as it is initiated after two years, moving it seven months further from the *latest start time.* This is due to the importance put on re-training current employee if there is a shortage, rather than using apprenticeship to source for a skilled worker. At the same time, it implies the urgency to prepare the skills matrix in order to carry out this process.

Apart from completion time, the validation showed the decision areas and its actions are positively valid and consistent among the participants. Demonstrating they were actually implementing the actions and initiating them within the strategic planning timeline provided in the ATF. Importantly, it enhances the richness of data, by not only stating the importance based on quality, delivery and cost, also discovering other reasons such as:

1. The importance of doing a test-run, particularly when introducing new work procedures and quality improvement tools. These allow the process to stabilise and are part of CI initiatives which not only evident during the validation but also observed throughout the research.
2. Starting quality improvement initiatives as early as possible. Majority of actions are established once the plant has started operating. This is driven by four factors. First, is because of the founder's experience, it enables them to choose and select the most important quality improvement initiatives as well as integrating them. Second is because of the industry they are operating in, which requires emphasis to be put on quality. Third, is due to most actions which part of continuous improvement initiatives. Finally, is due to criteria set by customers, requesting suppliers to implement quality management systems or obtaining quality certification.
3. The small size of SMEs enables them to adapt to change quickly. Flatter and informal organisational structure improve communication, plus there is a lot less red tape and procedures to overcome in initiating improvement programs.

In addition to the above, empowerment is used to make a better transition of improvement initiatives among employees. This includes 'shared vision', involving them when there is a change of company direction, allowing process ownership and responsibility as well as recognition when there is an improvement. Finally, conducting training to allow a better understanding of improvement tools and techniques.

It is worth to mention that actions embedded in ATF are not the end of a process; rather a catalyst to begin the process of improvement with the aim of achieving parity with competitors. Therefore, moving towards becoming FSM Stage 2 manufacturing SME. In the end enable them to move further towards stage 3 and 4 along the FSM, obtaining other capabilities such as the ability to innovate and being a leader within its class.

6.6 Conclusions

The chapter explains the second part of the data collection which covers results from Delphi, questionnaires, development of the ATF and the validation process. The outcome of the Delphi was discussed at the beginning of the chapter. Based on Delphi results, questionnaires were distributed to get the typical time in implementing actions within the decision areas. To increase the understanding of previous results, validation in the form of a semi-structured interview was conducted and the findings were discussed towards the end of the chapter. To summarise, Chapter 6 has complemented the answer in Chapter 5 to 'how' can manufacturing SMEs improve its strategic role of operations and competitiveness. Importantly, the chapter provides answers to 'when' the improvement can start by establishing a timeline of movement from stage 1 to stage 2. In the end, a validation is conducted to investigate the reasons behind those timelines.

Through the development of ATF, the final research objectives on constructing time and action plan have been achieved. Additionally, it was validated to demonstrate its applicability within an actual manufacturing SME. This chapter also enhances and validate results from Chapter 5 by discovering additional actions that contributed to the movement towards stage 2 on the FSM. The result complements the objective to investigate the way improvement are pursued and obtained, which was achieved in Chapter 5.

In Chapter 7, the discussion will revolve around the summary of results and analysis of findings. The chapter will explain the way the research question is answered and the overall evaluation of approaches undertaken in completing the research. Also included are discussions on contribution to knowledge, achievement of objectives and the research limitations.

Chapter 7: Discussion and Evaluation

7.1 Introduction

To start the chapter, it is important to reiterate the aim of the work is *to investigate the actions, the reasons they are carried out and how they are integrated in order to improve the strategic role of operations and competitiveness within manufacturing SMEs.*

A research question is formulated to achieve the above aim. To provide an answer, the Four Stage Model (FSM) is used as a reference by investigating how manufacturing SMEs move from stage 1 to stage 2. The study contributed to the body of knowledge by investigating decision areas and actions which enables manufacturing SMEs to progress from stage 1 to stage 2 on the FSM. Additionally, the work produced a supplementary outcome, the ATF, which provide the latest start time to carry out actions in the decision areas. Towards the end, the outcome was validated to investigate the way actual manufacturing SMEs carry out those actions and factors that influenced it.

As a practical implication, this investigation provides a strategic plan for manufacturing SMEs to pursue quality and delivery capabilities. It provides guidance in the form of key decision areas, actions and time, allowing an organisation to plan and initiate actions to improve operational performance. As a result, enable them to achieve parity with competitors and lay the foundation to move further to stage 3 or 4 on the FSM.

The data used in this work was obtained using mixed method sequential exploratory design. It is based on input derived from interviews, questionnaires and Delphi sessions. This involved participation from the industry, academics and consultancies. The selection of methods and participant ensures the work is validated multiple times as well as involving views from multiple perspectives.

The work is important as manufacturing SMEs often forms an integral part of a supply chain, supporting larger organisations, providing specialist product and service as well as contributing to local economic growth. Hence, being competitive enable them to be innovative and be sustainable in the longer term. Considering this, the research can contribute towards the improvement of manufacturing SMEs, helping managers in timing, choosing and initiating actions which eventually lead to improved operations and competitiveness. Also, moving to stage 2 on the FSM.

As mentioned previously in the introduction chapter, the manufacturing industry accounts for 10 per cent of the UK economy and it is projected to boost the economy by further £30 billion by 2025. The strong competition proved to be a challenge particularly for manufacturing SMEs in realising this vision. Thus some guidance to improve operations are required, and this research is one as such. This research interested to put the focus on manufacturing SMEs based on three reasons. First, they are commonly known for a scaled down version of their bigger brothers, which implies they have the potential to expand, grow and obtain a bigger market share. Second, they are much more vulnerable to deterioration

and they are more at risk when times are hard. Finally, they are mostly localised, empowering local economy in different parts of a country and the source of skilled labour. Therefore, it is imperative to provide a guideline for manufacturing SMEs to be competitive. This chapter will provide the research summary, achievement of objectives, analysis of findings and research evaluation. Importantly, discussing the research contributions to the body of knowledge and its limitations.

7.2 Research Summary

To recap, this research is conducted to find answers on how to improve manufacturing SMEs strategic role of operations and competitiveness. The answers add details to the FSM by investigating the process of becoming a stage 2 company. The FSM is a taxonomy which describes the evolving role of manufacturing operations from being incapable of influencing competitive success (Stage 1) to a leader that sets industry standards (Stage 4). Although the FSM is a taxonomy that shows progression, there is no prior work that examines the progress. This has prompted the research to be carried out, investigating the process towards achieving stage 2. The investigation is focused on stage 2 because is it essential for stage 1 company to have a good foundation and continually improve themselves ultimately achieving a stage 4 status. Additionally, it is important for a stage 1 company to move towards stage 2 as they have no other stage to descend to and might face closure.

A mixed method sequential exploratory design was used to capture the process of becoming a stage 2 company. The combination of literature reviews, semi-structured interviews, Delphi and questionnaire are used to inform one another by identifying decision areas, actions and timeline, in the end creating ATF. The outcome will help SMEs to plan and integrate actions which will improve their organisation. In Chapter 2, few areas of investigation are identified in a search for answers to the research question.

Strategy to answer the research question started with identifying a stage 2 manufacturing SMEs and perceptual opinion on competitive priorities through the distribution of questionnaires. The next step involved the process of conducting interviews to identify decision areas, actions and reasons behind answers provided from the questionnaire. Once this is completed, the Delphi method is used to validate results from the questionnaire and interviews as well as getting opinions from the wider community of practice. Finally, another questionnaire is distributed to integrate time element with the findings from the questionnaire, interviews and Delphi. Next section will explain in detail the summary of these processes.

7.2.1 Identifying Stage 2 Manufacturing SMEs

In order to probe the progress, stage 2 manufacturing SMEs needs to be identified. To do this, 214 questionnaires were distributed. The approach is consistent with previous studies (Barnes and Rowbotham 2004; Dangayach and Deshmukh 2006; Dangayach and Deshmukh 2003; Gilgeous 2001; Jain *et al*. 2013; Rowbotham and Barnes 2004) in categorising companies according to FSM. Description provided by Hayes and Wheelwright (1984: 396) and Chase and Hayes (1991) were converted into a questionnaire to identify companies categorised as a stage 2. A total of 9.8% response rates were received

and 18 companies are qualified as stage 2 companies. The identification enables for interview invitation to be sent, to investigate the process of becoming a stage 2 companies.

7.2.2 Establishing Manufacturing SMEs Competitive Priorities

Competitive priorities have been continuously validated throughout the research: during questionnaires, interviews and Delphi. The result shows that quality is the first competitive priorities pursued by manufacturing SMEs to progress towards stage 2 on the FSM, consequently pursuing dependability as a second priority. This endorsed results of case studies conducted by Dangayach and Deshmukh (2006), listing quality and dependability among top three competitive priorities pursued by stage 2 companies.

7.2.3 Investigating Actions in the Decision Areas

Based on the evidence obtained from questionnaires, it is clear that quality and dependability are two competitive priorities that must be pursued to become a stage 2 company. In understanding how the movement to stage 2 is made, actions that lead to quality and dependability attainment are investigated. This was conducted by using interviews and complemented by Delphi sessions. The interview is used to investigate actions in decision areas that enable the progression towards stage 2. Delphi is used to get expert opinions and validating results from the interviews.

7.2.4 Investigating Typical Time in Integrating Improvement Actions

The time element was included as part of the investigation to provide a typical period in which actions in the decision areas are implemented. While it indicates on time to carry out those actions, it also fills the gap which is left by Hayes and Wheelwright (1984: 396), Chase and Hayes (1991) and other related work (*Table 2.4*) which did not provide sequence or links between descriptions provided on the FSM.

7.2.5 Answering the Research Question

How is the research question answered? To improve the strategic role of operations and competitiveness, SMEs need to move to stage 2 on the FSM. This is by setting competitive priority to focus on quality. It will enable manufacturing SMEs to obtain quality capabilities which can lead to several chain effects:

1. Improving dependability capabilities by reducing time spent on rework and rejects. To be able to deliver the product on time and as promised, the end product must be free from defects 'right at the first time'.
2. Improving customer's perception towards manufacturing products and services. This can be achieved through attainment of 6 quality dimensions mentioned in the ATF.
3. Increase the capability of producing quality products consistently. This can be done by eliminating firefighting by using formal problem solving techniques, to make sure every problem is handled in a systematic way. Work procedures are used to ensure instruction is standardised to produce consistent output, while performance measures are used to measure efficiency and red flagging any irregularities within operations. Further, having plans for middle

manager training and coaching, to increase their competencies in handling daily issues as well as transferring the knowledge to other employees.

4. Eliminating dependency on external experts to solve manufacturing strategic issues, limiting their involvement around technical issues. This done by referring to the company's founder/owner experience or by hiring people with experience and culture in the related field. The capability also can be developed over time by increasing staff efficiency through skills matrix and middle manager training.
5. Increase awareness of adopting industry best practice which contributes towards improving quality. This can be demonstrated by the use of quality improvement tools, conducting a comparison with competitors to look for industry trends, complying with health and safety policies as well as having an apprenticeship scheme.

7.3 Analysis of Findings

Apart from the size and volume of sales turnover, manufacturing SMEs are not too different from their larger counterparts, demonstrating the use of similar tools, technology, practices and competing with similar capabilities. In manufacturing SMEs involved in this study, CI initiatives are implemented as a substitute for formal MS. This is by constantly exploring opportunities to improve every aspect of operations. It can be observed through actions such as adopting best practices, employing skilled workforce and upgrading employee skills. The strategy adopted is driven by the need to adhere to quality and dependability required by the customers. Because they are not operating within an established market, strategic direction is short-term in nature, where changes in strategic direction are heavily influenced by the award of new contracts and changing customer requirement.

Adding to the above, the findings show that manufacturing SMEs adopted an informal approach in implementing strategies. This is demonstrated by informally executing several actions in the decision areas such as lean tools and comparison with competitors. While a formal approach is more structured and organised, manufacturing SMEs operations relies heavily on experience from owners, managers and shop floor workers, which work to their advantage. This allows for faster response to operational issues and made them adaptable to changes, allowing quick decision making. In addition, working with small size and teams allow them to quickly implement improvement initiatives by overcoming red tape and procedures.

Based on findings, it is likely for manufacturing SMEs to sustain its competitiveness and maintain their presence in the market for a long time if the right decisions are made. From this research perspective, the decisions can come from the selection of the right competitive priorities and actions that would support them. Further evaluation of the research findings is conducted in the following sections.

7.3.1 Competitive Priorities for Stage 2 Manufacturing SMEs

Chapter 2 provided the explanation on the selection of competitive priorities which is based on two foundations, according to trade-offs and building cumulative capability. Results from this study demonstrate that cumulative capability pursuance is currently practised among stage 2 manufacturing SMEs. This is in line with the sand cone model (Ferdows and Meyer 1990) and subsequent related studies (Grobler and Grubner 2006; Hallgren *et al.* 2011) which advocate the building up of capabilities, starting from quality to achieve the ultimate aim of cost efficiency.

Based on the discussion in *2.5.4* it can be summed up that there is no clear indication on competitive priorities by stage 2 firms provided by two seminal papers from Hayes and Wheelwright (1984: 403) and Chase and Hayes (1991). The nearest indication is the 'service quality', used to describe stage 2 service firms by Chase and Hayes (1991). Empirical data from the study managed to provide confirmatory evidence on competitive priorities pursued by stage 2 SMEs. Additionally, it proved that the stage 2 manufacturing organisation are pursuing similar competitive priorities with their service counterparts.

Also, it confirms Hill (2000: 32) order qualifiers, demonstrating the need to produce quality and dependability to get into or stay in the market. Further, validating Grant *et al.* (2013) notion on conformance to quality and dependability which are considered standard, and companies might not gain competitive advantage from these capabilities, underlining the basic capabilities required to compete. This is true to at least three different industries involved in the study (wood and paper, automotive and transport equipment and textile footwear and clothing) which named quality and dependability as the main priority in their operations.

In addition, the study found that companies which are in the early stage of operations tend to have a balanced approach towards the competitive priorities, preferring to adopt different priorities such as flexibility, with the aim of establishing a customer base and getting a good reputation among their customers. This implies the role of customers, in addition to the role of industry in determining the selection of competitive priorities. This action, however, is carried out once quality and dependability improvement initiatives have been in place.

It is essential for stage 1 companies, new companies and those that may not have any focus on competitive priorities, to turn their attention towards improving quality and producing them consistently. Further, this will allow them to attain dependability capabilities. The focus placed on the two priorities will indirectly establish a competitive strategy for these companies, subsequently allowing them to enter the market competition. There are 6 quality dimensions that were discovered in this study, they are product performance, product durability, product perceived quality, product reliability and product sustainability. Upon validation, *service quality* was added as another dimension, confirming that it applies to manufacturing companies. On this account, it complements the description provided by Chase and Hayes (1991) on service quality as a competitive priority in service firms.

"...I would say, for us, it is always the perceived quality- how the client perceived our product but also perceived quality of the service. They don't distinguish between the two. If you are a really good supplier, and if they don't like how you do business – you won't' progress with the client. You have to be a full-service supplier in all aspects. How good your relationship is - with day-to-day contact with your buyer as well as how good the quality of the product. So quality of the service and also the product is always first. "

- *Participant 2*

Reflecting on the FSM, stage 2 companies are said to meet one or two quality dimensions (Barnes and Rowbotham 2004; Chase and Hayes 1991). An investigation by Dangayach and Deshmukh (2006) found product performance and product reliability to be those dimensions. This research found that those dimensions are true for stage 2 companies and they continuously pursue other dimensions which are stated in the previous paragraph. The results demonstrate stage 1 companies should not only focus on attaining product performance and product reliability but need to put their focus in obtaining other dimensions to position themselves on a higher level of stage 2, and preparing to move towards stage 3. Importantly for stage 1 companies, they have to start service quality improvement initiatives as it allows them to build their customer's trust to enhance their chance of receiving future orders.

7.3.2 Actions in the Decision Areas

The adoption of improvement programs in the form of actions in the decision areas depicted in the ATF is driven by focused that put on attaining competitive priorities. It shows that the proposed framework is created with the aim to achieve specific competitive capability reflecting to stage 2 organisation. This is, in contrast, to merely adopting industry practice according to trends or copying competitor's actions. As a result, refining description of "industry practised is followed" by Hayes and Wheelwright (1984: 396) to "industry practised is followed according to priorities placed on quality and dependability".

Several improvements must be made by stage 1 company to enable them to compete. First is to reduce the role of external experts in making decisions about strategic manufacturing issues, this was mentioned by Hayes and Wheelwright (1984: 396) and Dangayach and Deshmukh (2006). The investigation in stage 2 companies found the decisions are made internally and is contributed by the following factors:

1. Experience from the founder/owner of the company allowing them to improve weaknesses found in the previous organisation that they have worked. Therefore, they could anticipate prospective risks that may occur in the future.
2. Continuously conducting comparisons with competitors, therefore getting intact with current development surrounding their market. This includes on-going reviews on current technology, marketing strategy and business strategy.
3. Competitive priorities which directed to the attainment of quality and dependability enable them to systematically improve their operations and reduce dependencies on external experts. This is

done by implementing actions associated with improving quality and dependability as depicted in the ATF.

4. Hiring people with experience and culture on the related field allows them to obtain information on industry practice, competitors and skills needed to solve issues related to operations.

In the case of external experts, they were still being consulted when there are issues which can't be resolved internally. In other words, beyond the company's experience. The external experts can be from a notified body, where these companies are their affiliates. Forms of consultation include solutions, suggestions and improvement on materials as well as the manufacturing process. Other than that, they could also be from consultancies where advice is required when they are looking for investment, marketing and developing quality systems.

Second is to keep track of employee skills through skills matrix and improving them from time to time, allowing stage 2 companies to have a 'knowledge database'. This can be useful in solving day-to-day problems and make sure employees are competent. Additionally, it ensures the skills required to perform a specific task are always available through continuous in house training.

"We use our own skills matrix, drawn up to show the job role and the expectation of knowledge from the job role which are graded from various levels for example from requirement training until they can perform a certain job good enough up to the expert level where they can become a trainer."

- *Company B*

"We do we have skills matrix for every operator. We have all health and safety item in the skill matrix, all the production areas on who can cut, who can sew, who can inspect and how good they are. It's a competency matrix as well. Not just what the skill they've got, but how competent they are. So can they train others."

- *Participant 2*

The third improvement is regarding the use of work procedures. Chase and Hayes (1991) and Barnes and Rowbotham (2004) mentioned in stage 2 companies work procedures are used to maintain operations efficiency. The investigation managed to discover the type of procedures (which is depicted in the ATF) and the reason behind its implementation. There are three motivations associated with the use of work procedures: to enhance traceability and consistency of a production system, providing assurance towards the customer and fulfilling standards which have been set by the industry notified body. Towards the end, it can be used to obtain quality certification.

"ISO 9000 is the quality control systems we in organisation use to make sure that we have traceability of our production systems, from receiving an order to dispatching an order and receiving the cash from the customer. Which inside of all of that is built this documentation we have here (our work procedures)."

"If I were to supply product to a company, I have first to prove that I am competence in identifying if I have a problem and if the customer says it received a problem, I can trace it back to point of source. If I want to operate in the automotive industry I should have the ISO 9000, if I don't have them I can't supply parts no matter where I am in the world."

- *Participant 1*

According to Dangayach and Deshmukh (2006) 'firefighting' is a norm in stage 1 organisations. The initiation of the above actions, in addition to the use of problem solving tools will eliminate 'firefighting' and provide a structured approach in handling issues.

Finally, it can be observed actions relating to lean tools are not adopted as a whole, rather focusing on selective tools. This is due to four factors; first to due complexity of some lean tools, which managers feel not suited to the educational background of their shop floor workers. Secondly is the simplicity of the manufacturing process, where only selective lean tools can be implemented to yield improvements. This supported the findings by Chavez *et al.* (2013) and Davies and Kochhar (2002), suggesting that lean practices are not universally applicable and companies should evaluate practices according to their circumstances.

The third factor is because of the positive experience of the founder/owner of using selected lean tools. Finally, is due to the fact that lean is a CI initiative that progress over a period of time through multiple incremental, iterative changes. This tie in with findings by Bamford *et al.* (2015) suggesting lean can be adopted partially and with iteration. It was enhanced further by Flynn and Flynn (2004) indicating companies that are pursuing dependability are still working on lean manufacturing initiatives. Therefore, lean tools listed within ATF are suggested to be implemented by companies in progressing towards stage 2 of the FSM. They act as a catalyst before further tools can be integrated once progress has been made.

Stage 2 SMEs in this study are observed to use four approaches in increasing their production capacity. They are by investing in new machinery, adjusting the price according to demand, outsourcing and by having a multi-skilled workforce. These approaches are driven by two main reasons which are to anticipate immediate and future capacity requirement. Immediate capacity requirement is found to be achieved by adjusting price during off-peak time to add to capacity losses. This way, it can attract potential customers and subsequently meet actual capacity capability through competitive pricing. Besides, production is outsourced to partnering SMEs to meet immediate capacity demand. On the other hand, future capacity requirement is achieved by providing training to the current staff with the aim of having multi-skilled workforce. This will enable the SMEs to respond to sudden capacity increase in the future by using current human resources effectively without the need to acquire additional manpower. Alternatively, investment is made to purchase new machinery to anticipate future capacity requirement.

The performance measures presented in the ATF reflects the focus placed on attaining quality and dependability capabilities. The results share similar findings with Sousa *et al.* (2006), suggesting on-time delivery and quality as top two measures used by SMEs in England. While their findings are representative of 52 SMEs, it implies that building up quality and dependability capabilities are actually a basic requirement for manufacturing SMEs in the UK to enter the market and compete. Also, the findings reveal that performance measures are used as the main medium to communicate a company strategy. These findings enhanced the research suggestion of placing priority on quality and dependability and measuring its performance consistently, particularly for stage 1 SMEs and SMEs which has no clear strategic direction.

Rompho (2018) suggests SMEs collect performance measurement and use it to make comparisons with top performing firms. During the interview, only one company (Company D) mentioned benchmarking as a way to compare with their competitors. This largely due to the established presence of the company, which has been in operations for 20 years, allowing them to set the benchmark. Therefore, other SMEs would be keen to share their measurements with this company, thus allowing comparison to be made. Also, the research found two companies (Company A and C) which did not even compare itself with competitors, citing the uncertainty about the size comparability of other companies and serving a different target market as the reason for not doing it.

In addition to benchmarking, informal way of doing comparisons with competitors are used. The use is contributed to the low cost of the application, ease of use, availability of information and difficulty of gaining formal information from competitors due to operational secrecy. Importantly, it can yield valuable data in the form of customer reviews of competitor's products, latest technology, materials and manufacturing methods. This underlines the need for manufacturing SMEs to conduct comparisons with competitors. Findings from this research suggest that this process must be done continuously to ensure that companies are aware of changes, enabling them to respond and subsequently stay in the competition.

7.3.3 Time Taken to Initiate Improvements

The year is used in the ATF to establish time and sequence of initiating actions in the decision areas. This is because of strategic planning, which is generally associated with years (Drago 1996; Karchaner *et al.* 2016; Oliver 2000; Harrison 1995; Hay and Usunier 1993). The creation and validation of the ATF discovered that actions which lead to becoming stage 2 companies are initiated within the first three years of operation. It established a linkage between strategic planning time and improvement initiatives by demonstrating that all the actions are part of short to medium term planning. This underlines the need for decision-makers to include these actions during the strategic planning stage or as earliest as possible to allow for smooth integration once the initiation of actions has taken place.

The ATF provided no end or completion time in the majority of its actions. This is due to those actions which are part of CI initiatives where iterative changes are encouraged. Nevertheless, the research

believed it is important to indicate the starting point so that managers will know when the ideal time to introduce changes and importantly, to include them within the short-term objectives during the strategic planning stage. Therefore, giving managers an indication of the timing to start the journey of becoming a stage 2 company.

Upon validation, actions such as work procedures, ISO certification, problem solving techniques, 5S deployment, apprenticeship programme, nominee supplier list, pull production, skills matrix are identified as actions that can be completed within a certain timeline (range from 4 months to 2 years). The implementation can be completed mainly based on conducting 'test runs', where these actions are properly recorded and fully implemented after a few iterations of testing, evaluation and revisions. For example, work procedures can be completed in 6 months depending on the time it can be finalised, while a supplier can make into a nominee list after completing six delivery adherence.

7.4 Objectives Re-visited

Providing answers to the research question leads to the accomplishment of the research objectives. In Chapter 1, six objectives are identified as a means to achieve the aim of this work. *Table 7.1* shows a summary of how the objectives have been achieved.

Table 7.1 Summary of objectives achieved

	Chapter	**Objective**	**How it was achieved**
1.	Chapter 2	Conducting a literature review on manufacturing strategy (MS) taxonomies.	All published work relating to MS taxonomies was reviewed in Chapter 2. This includes the first work by Miles and Snow (1978: 29) up to the latest work by Andersen (2012).
2.	Chapter 3	Creating appropriate instruments for data collection.	To probe the movement from stage 1 to stage 2 on the FSM, mixed method exploratory sequential design was adopted. It combined the use of questionnaires, interviews and Delphi.
3.	Chapter 2, 5 and 6	Investigating areas of improvements within manufacturing SMEs operations.	The investigation started by reviewing literature related to FSM. It was followed up by an initial visit to a manufacturing plant in the UK. This is to identify the decision areas to obtain a general idea on

			the development of MS. These investigations were validated and extended through interviews and Delphi.
4.	Chapter 2, 5 and 6	Investigating the drivers of improvement in manufacturing SMEs and;	The drivers of improvement were investigated and validated for a total of five times: during the literature review, interviews, phase 4 questionnaire, Delphi and finally during the validation interviews.
5.	Chapter 5 and 6	How those improvements are pursued, obtained and in the end;	This was achieved with the completion of interviews in Chapter 5. It was validated and extended during the Delphi session discussed in Chapter 6.
6.	Chapter 4 and 6	Developing a framework integrating the above findings by including time and action plan.	The ATF development and validation completed the achievement of this objective.

7.5 Contribution to the Body of Knowledge

As explained throughout the thesis, FSM provides a description to look at the operational effectiveness of a manufacturing function. While managers can use the FSM to assess the current state of their operations, the research found that adding details to the model could be useful in guiding them to improve. For this reason, it has been used as a reference to get answers to the research question established in this thesis. As a result, a guide (ATF) is developed to aid managers to identify decision areas and actions that need to be initiated. There are several contributions that were made by this research:

1. In Chapter 2 (section *2.5.2*) it is mentioned that strategy sets the general direction in which a firms' position will grow and develop: asking questions such as "Where are we now?", "Where do we want to be?" and "How shall we get there?" While the answer for the first two questions is available within the FSM, this research managed to provide an answer to "How shall we get there?" through its investigation. It adds details to the seminal work by Hayes and Wheelwright (1984: 396) and Chase and Hayes (1991) by coming up with actions and decisions that facilitate progression from stage 1 to stage 2, which are yet to be addressed in the literature. Additionally, it answers the question of "When should we get there?" by providing the latest start time as depicted in the ATF.

2. The work is the first attempt at providing confirmatory evidence on the competitive priorities pursued by stage 2 companies on the FSM. It managed to confirm quality and dependability as the two priorities which must be pursued to get to stage 2. This is backed by findings on 10 decision areas, consisting of 45 actions integrated with time in the ATF, pointing towards attaining those two priorities. Importantly, ATF establishes a time sequence, linking the decisions and actions with competitive priorities as described by the FSM. This fills the gap in the literature, by establishing a relationship between descriptions provided in the original framework by Hayes and Wheelwright (1984: 396) and Chase and Hayes (1991).
3. Echoing the statement by Slack *et al.* (2004) to reconcile the understanding of operations management research and practice, data from the investigation were collected from different operations management practitioners: SME owners, managers, academics and consultant. As a result, generating outcomes (ATF) which is unique in a way that it is developed by combining view from the community of practice and research.
4. The methodology is other unique features of this work. Currently, it is the only work on FSM which use more than two methods to generate outcomes. Also, it designed a research strategy which made a conclusion based on limited sample size, at the same time addressing validity concerns. The mixed-method exploratory sequential design was selected combining questionnaires, semi-structured interviews and Delphi. This approach allows the data to be validated multiple times, using different methods and techniques. Additionally, it provides an alternative to ethnography, action research and case studies which require prolonged access to collect data. In the future, the same approach can be used to answer a similar question in capturing movement within the taxonomy-type framework.

The research contributes to the understanding of strategic management by investigating the way theory works in the real world. The study fills the research gap by providing answers on how the movement from stage 1 to stage 2 on the FSM, which has not been addressed in the existing literature. It has created the ATF and testing them empirically. As a result, ATF offers a validated guide to help decision-makers to build up organisational capabilities to be on par with their competitors. In other words, it provides decision areas and actions they need to initiate to start the process of improvement. Additionally, it shows the importance of having a focus on competitive priorities and actions to support them so that they would remain competitive. This would be a useful guide for a new SME startup, SME which have yet to establish their strategic direction and SME which is categorised as stage 1.

7.6 Evaluation

The findings of this study need to be treated with caution as they result from what amounts to exploratory work. There is a clear need to replicate the study with a large number of samples to re-validate the results presented. Due to circumstances where most of the SMEs managers are occupied with daily operation tasks, many requests for questionnaires and interview were turned down, which implies the limited sample size that obtained in this study. To counter this issue, the research includes responses from

individuals who have previously worked, consulted with manufacturing SMEs together with individuals from manufacturing background. Therefore, their input would be useful in creating the ATF. Moving forward, to increase the chance of getting more responses access is suggested to be negotiated in advance. In addition, there are validity concerns which will be addressed in the following paragraph.

7.6.1 Selection of Experts

The use of experts in this study has its issue as there is no consensus on the true meaning of an 'experts' (Mullen 2003). Therefore, the selection of experts is conducted carefully to reduce the risk of using opinions which may not be representative of a targeted population. Academics and industry experts participated in the Delphi sessions was selected based on criteria that they must have the acceptable years of experience (7 years to oversee long term effects of strategy), has been working in manufacturing plant or involved in teaching subject related to operations management. These criteria are set to ensure the views that they provide in reviewing interviews result is in line with the current development of the research area. The same process is applied in selecting the respondent for the phase 4 questionnaire.

7.6.2 Type of Organisations

It can be argued that the description of organisations provided by the two seminal paper referred interchangeably within this research may not fit with the types of organisations obtained during the data collection stage. This is concerning the nature of the business. The first framework published by Hayes and Wheelwright (1984: 396) exclusively mentioned manufacturing where the work is based from, while Chase and Hayes (1991) article are published to fit service organisation in the FSM.

This study is aware of the validity issue that might arise due to a different type of organisations (manufacturing and service) represented by the two papers. However, the decision to combine both descriptions is down to the fact that modern SMEs are usually full-service manufacturer, providing support service such computer-aided design work, prototyping and design verification, remanufacturing and providing technical recruitment service. This also explains the use of "operations strategy" within the thesis title, which is to reflect the combination of manufacturing and services activities.

7.6.3 Applicability of FSM on SME Operations

Next is the issue on the applicability of FSM towards SME operations. It is not clear from the published article regarding empirical evidence the model was based on. However, "extensive field work" was cited as the foundation of their model (Barnes and Rowbotham 2004). On the ground that there is no reference made to the size of the organisation, it can be safe to assume that FSM is relevant in describing SME operations.

7.6.4 Geographical Location

Also, there is an issue regarding the application of FSM in different geographical location. Manufacturing SMEs and respondent involved in this study were from two different countries: the UK and Malaysia.

This study did not distinguish the results between the two countries and treated them as one. While the argument from the previous section (*7.6.3*) played a role in this stance, it can be noticed that when Chase and Hayes (1991) extend the work to service organisations, multiple companies representing different continent were included. They are used as examples to describe the different stage of the FSM. In addition to US-based organisations, reference was made by using Asian and European companies such as Scandinavian Airline Systems, Swissair and Singapore Airlines. It demonstrates the relevance of the model not only to the US but also Asian and European companies. As a result, it implies FSM as a general template that can fit with any manufacturing or services companies regardless of their geographical location.

Geographically, the study represents actions and decisions of manufacturing SMEs that is based within the Midlands region in the UK. This was based on the large part of the data collection effort that was concentrated within this area. While there are representations of Malaysian SMEs which may contradict this stance, it was found that decision and actions carried out by the U.K companies are similar to their Malaysian counterpart. It validates the above paragraph claims of FSM applicability regardless of location and shows that practised adopted in UK SMEs are indeed practised elsewhere, in this case, Malaysia. However, cultural issue that related to the change management needs to be studied separately as a management approach to introduce improvement and employee reaction may vary.

7.6.5 Application of Research Methods

In order to address the above concern, the same research question can be probed with more comprehensive methods such as case studies, action research and ethnography. This way it can increase the richness of data by a detailed assessment of the real situation in SME manufacturing plant. A clearer picture can be achieved by evaluating employee reaction towards improvement as well as supplier and management roles in facilitating improvements process. While this study has managed to capture that information, it may be limited as interviews put the researcher to act as an outsider to the organisations. As a result, limiting the information to only what the organisation want the researcher to know. As a consequence, Delphi and phase 4 questionnaire are deployed as an instrument for 'check and balance' to address any shortcomings identified from the interviews.

7.6.6 The Use of Yearly Time Scale in ATF

Ideally, the use of a more specific timescale such as weeks or bi-weekly within ATF would present more detailed information, thus portraying a bigger picture of the improvement process and making planning easier to conduct. This is best to be captured using other research strategies such as case studies, ethnography or action research. However, obtaining data should be a challenge as it requires prolonged access to a manufacturing plant. Based on this study experience, this is quite difficult to get due to secrecy and operations confidentiality. As an alternative, the yearly time scale is used. Because a questionnaire is deployed to obtain a consensus among experts, the yearly scale proves to be more practical as it reduces the time to complete the questionnaire and subsequently increases participation.

Importantly, the yearly scale represents strategic planning timeline which can give valuable information when forming short, medium and long term strategy.

7.7 Research Limitations

The strategy adopted in the research design was made to obtain reliable and valid findings. Nevertheless, it is acknowledged that this study has its limitations, which may be addressed in the future. The limitations are explained as the following:

1. The scope of study – There are boundaries that have been set regarding the research areas. This is to set a limit to ensure achievement of research objectives and completion are within the timeline set by university and sponsors. Firstly, within four stages of FSM, the major focus was given in investigating the improvement process from stage 1 to stage 2. Secondly, the data used in this study is limited to information given by SME managers, owners, academicians and industry practitioners. Therefore, excluding views from SMEs operational staff. Finally, the study is not an industry-specific; rather the data are grouped according to manufacturing SME specifications (number of employees and sales turnover).
2. Organisational culture – Findings observed in this thesis are limited to actions and decisions allowing companies to move to stage 2 on the FSM, together with the reasons they are implemented. The findings exclude the element of organisational culture such as beliefs, systems, habits, language and norms, which can affect the way actions and decisions are integrated. This is due to the considerable effort that is required to probe those elements, also the depth of data it may provide. Realistically, another research is required to solely investigate the role of organisational culture.
3. Change management – The manner in which manufacturing SMEs deal with the transition of actions and decisions in enabling them to move to stage 2 are not covered in the research. Questions on employee and supplier reaction towards change, as well as how change is handled are excluded during the data collection phases. The reason is to give more focus on probing the movement to stage 2, in addition to the limited time given by respondents to allow these question to be asked.
4. Recruiting target group – Recruiting the target group proved to a challenge in this research. Every opportunity to obtain prospective participant was utilised. This includes sending invitations to publicly available company contacts, LinkedIn, university alumni, notified body as well as attending workshops for part-time students in the hope of finding managers or owners from manufacturing SME who are willing to help. Invitation to participate in the study is usually turned down due to confidentiality on company information. This is in addition to many unanswered emails.
5. Sample size – Ideally data from a large sample of the population will increase the generalizability of the result. The research admits the data that was used are quite small (31 from questionnaires, 6 interviews and 2 Delphi). This is mainly due to the commitment required from

respondents to be involved more than once (questionnaire and subsequently interviews) during the data collection process, which many not willing to do.

It is observed there is an increased chance of gaining a higher response rate if the invitation to participate in the study is sponsored by a notified body. This is evident when there is good participation (10 questionnaires were returned out of 14 invitations sent to manufacturing SMEs in the West Midlands, UK) once they are sponsored by a manufacturing research centre. Also, it must the stressed that small sample of data had been offset by the use of multiple methods to carry out investigations, potentially designing a research strategy which can be used to investigate problems using similar sample size.

7.8 Conclusions

It can be conceded that the use of a larger sample size could strengthen the research claims. To compensate this shortfall, careful selection of methods and respondent are carried out. Data obtained in this study are derived from respondents with experience and knows the subject area. Validation that was conducted multiple times intended to increase the data confidence and ensures the outcome is relevant and applicable in answering the research question. Additionally, FSM was interpreted to best represent organisations that were described by the original authors. Towards the end, the study has managed to yield contributions that extend the work on FSM and provide outcomes that are beneficial in guiding manufacturing SMEs to improve operations and stay competitive. Chapter 8 will present the discussion around highlights of the findings, original contribution to knowledge, future research and concluding remarks. Also included is the personal reflections of the authors in conducting this research.

Chapter 8: The Research Conclusions

8.1 Introduction

The overall summary, analysis on findings, evaluation and contributions has been explained in the previous chapter. Moving towards the end of the thesis, this chapter will provide the overall conclusions. It will cover the highlights on overall findings and original contribution to knowledge, discussion on future research, concluding remarks and personal reflections.

8.2 Highlights on Overall Findings

The work has managed to uncover important findings relating to the strategic role of operations in manufacturing SMEs. CI initiatives are generally adopted as a way to realise a formal strategy. The strategy is viewed in the form of constantly looking at the opportunity to improve operations. The approach is largely informal, driven by the priorities placed on producing quality products and services as well as delivering them on time and as promised.

6 quality dimensions are given the most attention (*refer to 7.3.1*). The pursuance of quality enables SMEs to effectively pursue dependability as the second priority. With increasing quality, product defect and error could be reduced. As a consequence, cutting down the need for rework and at the end improve dependability performance. Additionally, it validates Dangayach and Deshmukh (2006) and Martin-Pena and Garrido (2008b) work by agreeing that stage 2 organisations seek for dependable delivery and producing high-quality products.

Going further, the work investigates decisions and actions associated with the pursuance of the above competitive priorities. The process is guided using the original description of FSM by Hayes and Wheelwright (1984: 396) and Chase and Hayes (1991). There are several findings that add details to the original description. First, Hayes and Wheelwright (1984: 396) mentioned that external experts are frequently consulted in stage 1 companies to solve strategic management issues. Based on evidence that was gathered, these experts advise are still needed in stage 2 organisations. However, their role is reduced to only solving problems related to materials, process improvement and investment decisions.

Second, the same authors mentioned that industry practice is being followed by a stage 2 organisation. But they stopped short in clarifying the type of industry practice that was adopted. The thesis managed to provide further clarification by coming out with actions which reflect on the adoption of the industry practice. They include the use of selected lean tools, getting industry accreditation and adopting ethical business and employment practice. Third, Chase and Hayes (1991) described that in stage 2, the workforce is following a set of work procedures in carrying out their duties. Again, there is no mentioning of specific work procedures which is being followed. As a result of the investigation, the information is made available by identifying work procedures as depicted in the ATF.

Finally, it is described in stage 2 the first line managers control process, in contrast to controlling the workforce in stage 1 (Chase and Hayes 1991). The transition from controlling the workforce to the process was made based on the emphasis that was put on human resource planning. The evidence can be seen with actions regarding staff procurement and training. The use of a skills matrix is intended to create a competent workforce to align with the skills required by the organisations. Successively, reducing the need to monitor the workforce as they can perform a given task without much supervision. This is complemented by the adoption of the apprenticeship programme and policy of recruiting a skilled workforce to serve the same purpose and also to gather intelligence.

The way the line manager controls the processes, however, is not clearly stated or explained. The result of the investigation shows that performance measures are used for this purpose. It helps managers in stage 2 companies to monitor product quality and delivery performance. If there is any deterioration or unacceptable readings from these measures, appropriate problem solving techniques will be deployed to address them.

The above explanation highlights the important findings in enabling an organisation to improve the strategic role of operations. The investigation managed to discover approach, decisions and actions that lead organisations to achieve parity with competitors by becoming a stage 2 company. It provides a detailed extension to the original description of stage 2. As a result, increasing understanding of how the FSM should be interpreted and operationalise. ATF is created to show the integration of actions and decision within short to medium term strategic timeline. This increase the practical application of FSM, by guiding manufacturing SMEs with a time tactic to effectively implement those actions.

8.3 Highlights on Original Contribution to Knowledge

The results and findings from this study present theoretical contributions to the literature and offer practical implications for manufacturing SMEs. Simultaneously, it provides methodological contributions as a guide for future research. The originality of the work lies in the new knowledge discovered as a result of an initial attempt by this study to investigate progression from stage 1 to stage 2 on the FSM.

To date, the study presented in this thesis is the only work on FSM that combined more than 2 methods in generating its findings. The approach permits views from research and community of practice to be used in gathering and validating data. Also, it is used to offset the limited sample size obtained in this study, which could be replicated for research with identical restrictions. The approach can be used as an alternative to case studies, ethnography and action research by shortening data collection time without compromising data richness and integrity. Eventually, it can be a future methodological reference to examine taxonomy-type framework.

The research is original in a way that it adds detail to the seminal work by Hayes and Wheelwright (1984: 396) and (Chase and Hayes 1991). Based on the review of the literature, this study is the first attempt at

investigating the process of progression from stage 1 to stage 2 on the FSM. It yields a theoretical contribution by validating competitive priorities, establishing decision areas and actions which was not previously addressed in the literature. Significantly for the first time, the findings are integrated with strategic planning timeline, demonstrated by the creation of ATF. This in turns establishes a practical guideline which can be referred by SMEs to plan in carrying out operations improvement initiatives.

In terms of value, the research outlines the need to focus on attaining quality and dependability capabilities by implementing decisions and actions within a typical timeline. Practically, the emphasis given to these capabilities will increase product and service value. Internally, the side effects can be in the form of increase worker satisfaction, productivity, number of skilled workers and job retention. As a result, paying a better salary to employees and profit to companies due to the ability to charge product at a premium price. Externally, from a consumer point of view, they will have an array of product selection with value for money with better service quality.

Academics can play a role in helping the manufacturing SMEs by recalibrating education courses offered, particularly in vocational institutions to be aligned with the skills needed by these SMEs. Also, more grants should be made available to support research in SMEs. At a policy-making level, regulation should be drafted to better protect SMEs by providing funding and assistance. This is due to their role in generating the local economy by creating jobs and supporting their larger counterparts. As was found during the investigation, the establishment of the manufacturing research centre and labs are proven to be essential, where they are becoming a point of reference for SMEs to get help. Consistent funding should enable these organisations to expand and continuously provide specialist support for SMEs.

8.4 Opportunities for Future Research

There are few opportunities for future research raised as the result of methodological limitations, resource and time constraints. In the face of these limitations, the study has garnered insights which contributed to the understanding of operations improvement process. This will be beneficial towards manufacturing SME owners, managers and shop floor workers. A number of areas are identified as an agenda for future research.

First, there is a need for subsequent research to validate the study. Its exploratory nature has opened up the opportunity for an additional research effort that will generalise findings on manufacturing SMEs. Increasing the sample size will enhance understanding and further justifying the outcome of this study. This can be done by establishing a collaborative effort with the manufacturing research centre, registrar of companies and industry governing body. As were demonstrated in this study, getting a reputable sponsor for data collection will increase participation.

Second, studies which focus exclusively on a particular industry will give industry-specific understandings relating to the practical application of the FSM. Additionally, investigating the role of

culture in each of every stage would be beneficial in planning for organisational change. Information on how improvement initiatives are introduced and received by people within an organisation could complement the findings presented in this report.

Third, there is a need for regional or country-specific studies concerning developing nations in probing towards stage 2 progression. This is because of the majority of previous studies in FSM which concentrated in developed countries such as the UK and US. It is important for future research to look at a developing nation perspective as these countries consist of nations that have the lowest income per capita in the world (United Nations World Economies Situation and Prospect 2018: 144). Similar studies will enable local industries to evaluate specific requirement that may be beneficial in increasing competitiveness for them and their workers.

Fourth, it is also interesting to conduct a longitudinal study to investigate progression towards stage 3 and 4. An alternative approach, case studies could be used to explore the cause of progression, and the time it can be completed. This would give further insights on critical events that lead a firm journey in obtaining higher stage on the FSM. Additionally, a more specific timeline can be identified, therefore capturing more detailed actions and decisions.

Fifth, results presented in the research are dependent on information provided by SMEs managers and owners, academicians and industry practitioner. A similar study using data from the operational level which includes factory supervisors and shop floor workers may discover alternative actions, decision and timeline. Those findings may be useful in understanding the issues that may arise resulting from improvement initiatives implementation. This information could potentially fast track the process of transforming into stage 2 companies.

Finally, it is important to explore how and why companies can descend from one stage to another. It could provide information on the sign of operations deterioration. This will allow proactive action to be triggered and prevent organisations from falling into the lower stage of the model or even going out of business. As demonstrated in this thesis, mixed methods design could be used to serve this purpose.

8.5 Concluding Remarks

The size limitations and informal structure possessed by manufacturing SME should be utilised as an advantage, enabling quicker integration of improvement initiatives. As a result, allowing them to respond accordingly to the environment that they operate, in this case, their competitors. The guidance provided in this work could be a stepping stone towards implementing further actions, clearing the path in achieving a higher status on the FSM.

The completion of this work was highly dependent on the full use of available resources and alternative actions. The use of mixed methods may make the study difficult to replicate. On the other hand, it may

help confirmatory and exploratory studies at the same time. As were discussed earlier, there are clear limits to the validity and reliability of findings from this work. Therefore, accepting they are, at best, indicative findings, especially with respect to the interpretative nature of the FSM.

The descriptive depiction for each stage of the FSM may open up for a variety of interpretations. Academics and practitioners are likely to provide a different version of understanding to describe the state of operations for each stage of the FSM. This is added with the use of a narrowly-based sample (a total of 39 samples). Nevertheless, the use of mixed methods and purposive sampling during the data collection stage is implemented to make sure the data obtained best represents the manufacturing SMEs. As a result, introducing a new research design which can be an alternative to other longitudinal research design.

On the other hand, there are several interesting observations can be made throughout the research. Those observations include understanding decisions and actions taken by manufacturing SMEs to improve their operations, drivers of the decisions and actions as well as its timeline. While this work covers the progression towards stage 2 of the FSM, improvement should be an ongoing process as achieving low-cost while maintaining quality are no longer enough as the strategic approach to operations has evolved into the knowledge-based competition.

8.6 Personal Reflections

Conducting PhD research has been one of the most challenging experiences, professionally and personally. It has been an interesting journey starting from arriving in the UK until the submission of this thesis. A lot of challenges have come out along the way. Collecting data was the most significant; many refuse to participate due to confidentiality concerns and inability to provide required access as well as time constraints. The impact of this issue is reduced by increasing the number of SMEs contacted, approaching local manufacturing research centre and personal contacts within the university.

On the bright side, there are two important lessons learned. First, is not to rely on a single source of information. As part of the study, contact has to be established with external organisations and individuals. The purpose was to collect appropriate data which will be used in the study. It is difficult to control the response time and rates of external organisations. This has contributed to some lag on the original project timeline. To reduce the impact, the number of contacted prospective organisations is increased. They were approached through multiple sources: social media, business directory, personal and university contacts.

Second, is to plan and prepare for an alternative. In the beginning, the plan was to conduct an in-depth case study in a single company. Negotiation for access took three months, and towards the end, no agreement was made. Realising that prolonged access is hard to obtain, added with determination to fill the research gap leads to the use of mixed method exploratory sequential design. They are more resource

efficient compared to a case study; it does not necessarily require prolonged access, larger samples and can involve multiple respondents.

The research has provided new knowledge and valuable experience. This is in the form of dealing with external organisations, experts and the opportunity to study about UK based manufacturing SMEs, which uniquely identified by their manufacturing process and location. Beyond the research skills, there is other knowledge which may be useful. They include professional and academic writing, presentation skills, time management, working with others and assessing task priorities. Additionally, learning to self-motivate by being able to push through negative emotions to reach the goals was crucial in ensuring research completion.

On a personal note, strategy studies have always attracted my attention. Being born to a family that runs a small enterprise, I always have been curious to know why there are companies which perform better than others. It was satisfying to come out with research that provides answers to the question. I hope findings from this research would give benefits to academics and practitioners.

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Appendix 1: Strategy Terminologies Used Throughout the Thesis

Business strategy – By which enterprise established strategies for specific business activities, specific sectors and market and specific business units which operation is organised (Morden 1999: 116).

Competitive strategy – Is pursued by either opting for cost leadership or differentiation (Bowman and Faulkner 1997: 3; Mintzberg and Quinn 1996: 83).

Corporate strategy – Is about selecting an optimal set of business and determining how they should be integrated into the whole organisation (De Wit and Meyer 2010: 303)

Operations strategy – Concerned less with individual process but more on total transformation on the whole business. It concerned on how the competitive environment is changing and how operation cope to meet current and future challenges. It is also have to do with how the company manage its operation resources and process in the long term to ensure sustainable advantage (Slack and Lewis 2011: 7).

Manufacturing strategy – Is a set of manufacturing policies designed to maximize performance among trade-offs among success criteria to meet the manufacturing task determine by the corporate strategy. Top management are responsible to set a coherent manufacturing strategy which support or lead the corporate strategy (Skinner 2007).

Strategic alignment – Putting together a set of manufacturing capabilities that will enable organisation to pursue chosen competitive strategy over the long term (Hayes and Wheelwright 1984: 33).

Appendix 2: Participant Information Sheet

Participation Information sheet (Questionnaire)

1.	Information about the project:	To study the role of operations in manufacturing strategy development. The research will help me understand how companies develop their manufacturing competencies, set manufacturing objectives, select best practices and compare themselves among competitors.
2.	Why I have been chosen	To understand the role of operations in strategy development, I need to conduct a survey to get information from manufacturing companies on how daily operations are conducted.
3.	Do I have to take part	Participation is voluntary and you are free to withdraw at any time without giving reason and without cost.
4.	What do I have to do	Answer questionnaires relating to the current state of your company operations.
5.	What are benefits of taking part	Information will be useful to understand the way companies operations develop their manufacturing strategy and the way it contributed to achieving better operational capabilities. A report based on this research is available upon request when the study is completed.
6.	Data protection and confidentiality	Responses will be completely anonymous; your name will not appear anywhere without your consent
7.	What if things go wrong? Who to complain to	Content removed on data protection grounds
8.	What will happen with the result of the study	The result will be used in academic publications and reports
9.	Further information/Key contact details	Content removed on data protection grounds

Participation Information sheet (Interview)

1.	Information about the project:	To study the role of operations in manufacturing strategy development. The research will help me understand how companies develop their manufacturing competencies, set manufacturing objectives, select best practices and compare themselves among competitors.
2.	Why I have been chosen	To understand the role of operations in strategy development, I need to do an in-depth interview to get information from experts with experience in manufacturing operations.
3.	Do I have to take part	Participation is voluntary and you are free to withdraw at any time without giving reason and without cost.
4.	What do I have to do	Answer 20 questions relating to the current state of your company operations.
5.	What are benefits of taking part	Information will be useful to understand the way companies operations develop their manufacturing strategy and the way it contributed to achieving better operational capabilities. A report based on this research is available upon request when the study is completed.
6.	Data protection and confidentiality	Responses will be completely anonymous; your name will not appear anywhere without your consent
7.	What if things go wrong? Who to complain to	Content removed on data protection grounds
8.	What will happen with the result of the study	The result will be used in academic publications and reports
9.	Further information/Key contact details	Content removed on data protection grounds

Appendix 3: Informed Consent Form

Content removed on data protection grounds

Informed Consent form

I would appreciate your assistance in this research project on studies of the role of operations in manufacturing strategy development. This research will help me understand how companies develop their manufacturing competencies, compare themselves among competitors, select best practices and set manufacturing objectives. If you have any questions regarding the research, contact me at the given details above. Thank you for your help.

All you need to do is to answer up to 20 interview questions. The interview should take approximately one hour. If you do not wish to participate, simply discard this request. Responses will be completely anonymous; your name and your company information will not appear anywhere without your consent.

I will need to use data in any / all of the following ways. Please delete as appropriate:

a)	I consent to being audio-recorded	**Yes / No**
b)	I consent to audio being used in coursework	**Yes / No**
c)	I consent to anonymous audio / transcripts being used in coursework	**Yes / No**
d)	I consent to anonymous observation data for publication and reports	**Yes / No**
e)	I consent to use of interview data for coursework	**Yes / No**
f)	I consent to anonymised data being used for publications and reports	**Yes / No**

By signing this consent form, you confirm that you have read and understood the information and have had the opportunity to ask questions:

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I will be given a copy of this consent form. I understand that completing and answering questions constitutes my consent and voluntarily agree to participate in this study.

Name of Participant	Date	Signature

Address:

Email:

Content removed on data protection grounds

Online Informed Consent form

I would appreciate your assistance in this research project on studies of the role of operations in manufacturing strategy development. This research will help me understand how companies develop their manufacturing competencies, compare themselves among competitors, select best practices and set manufacturing objectives.

All you need to do is to answer up to 45 questions. Participation in the study is entirely voluntary; you can withdraw from the survey at any point, without giving a reason for doing so. Please be assured that the information you provide will remain strictly confidential and anonymous. Answers will be reported so that no individual or organization will be identifiable from any publication presenting the results of the survey. By responding to the questionnaire, your consent to take part in the study is assumed and that you agree to the use of anonymised quotes in publications. If

Content removed on data protection grounds

Appendix 4: Phase 1 Questionnaire

Based on the statements, please rate your answer on the following scale:

1 - Strongly disagree

2 - Disagree

3 – Not sure/undecided

4 – Agree

5 – Strongly agree

Name:
Email address:
Designation:
Years in operations:
Number of employees:
Industry sector:

The questionnaire has 16 questions and should take about five minutes to complete. Participation in the study is entirely voluntary; you can withdraw from the survey at any point, without giving a reason for doing so. Please be assured that the information you provide will remain strictly confidential and anonymous. Answers will be reported so that no individual or organization will be identifiable from any publication presenting the results of the survey. By responding to the questionnaire, your consent to take part in the study is assumed and that you agree to the use of anonymised quotes in publications.

No	Statement	Scale				
1.	We always compare ourselves to competitors	1	2	3	4	5
2.	We always focus on improving what we do best rather than comparing ourselves with competitors	1	2	3	4	5
3.	Quality is the most important objective	1	2	3	4	5
4.	Top priorities are to deliver the right product, the right quantity and as promised	1	2	3	4	5
5.	Customers have the flexibility to change their order, once the order has been placed	1	2	3	4	5
6.	The main aim of production is to keep the cost down	1	2	3	4	5
7.	Performance measures/indicators are used primarily to control standards	1	2	3	4	5
8.	Performance measures/indicators are used primarily to improve performance	1	2	3	4	5
9.	Occasional strategic issues are solved by using outside help	1	2	3	4	5

10.	We have a formalised problem solving process	1	2	3	4	5
11.	Management only intervenes in manufacturing operations if there is a great need to do so	1	2	3	4	5
12.	Some work procedures have been established in the company	1	2	3	4	5
13.	New technology is introduced when it became necessary for survival	1	2	3	4	5
14.	New technology is introduced when it can justify cost savings	1	2	3	4	5
15.	Equipment is bought from the same source as our competitor or from the best supplier around.	1	2	3	4	5
16.	Comments:					

Appendix 5: Phase 1 Questionnaire Statements and Objectives

No	Statements	Objectives
1.	We have a formalised problem solving process	The question aims to identify stage 2 companies, where workers follows a set of procedures Chase and Hayes (1991). The question may look the same with Q10, but the main objective is to look for companies which already have 'problem solving' procedures in place. Problem solving is selected because continuously eliminating identified problem is a foundation of best practice, in contrast with imitating 'good' techniques from successful companies, which may lead to disappointing results (Rusjan 2005). In-depth probe will be conducted in interviews to identify what are the tools used. This is to fill the gap of providing 'tools' for best practice adopted by stage 2 companies, which was never highlighted in previous similar research.
2.	Quality is the most important objective	To make it easier to understand, a simple statement is selected in helping manager to make the right choice according to their company operations. The statement is intended to identify the most important competitive priorities currently pursued by stage 1 and 2 companies. Question 2 – To identify stage 2
3.	Top priorities is to deliver right product, right quantity and as promised	
4.	Customer have the flexibility to change order, once the order has been placed	
5.	The main aim of production is to keep the cost down	

		companies, because their main goal is to at least achieve consistency in terms of quality (Barnes and Rowbotham 2004; Chase and Hayes 1991; Martin-Pena and Garrido 2008b). In addition, attention to quality is a base of a good practice (Narasimhan *et al.* 2005). Question 5 – To identify stage 1 companies, which are focus on cost cutting (Barnes and Rowbotham 2004; Chase and Hayes 1991). Question 3 and 5 used to identify manufacturing capabilities pursued by stage 1 and 2 companies. In addition, it is to test the applicability of the cumulative capability of the Sand Cone model (Ferdows and Meyer 1990) and competitive priorities by Alceu *et al.* (2015) and Laungen *et al.* (2005). Answer provided will be useful in identifying which are the most important capabilities pursued by the manufacturing SMEs.
6.	Performance measures/indicator is used primarily to control standards	Previous questionnaires testing the FSM did not specifically mention the use of performance measures in their survey (Barnes and Rowbotham 2004; Dangayach and Deshmukh 2006; Jain *et al.* 2013). However, in the original article Hayes and Wheelwright (1984: 396) highlights the importance put by management to control the operation so it does not go off track.
7.	Performance measures/indicator is used primarily to improve performance	

		Because 'control' can be achieved by implementing performance measures (Mathur *et al.* 2011; Teeratansirikool *et al.* 2013), their use to control operations from going off track can be closely associated with the way stage 1 companies are using it. In addition, Q7 can be used to determine whether the companies are on the higher stage of the FSM (2, 3 and 4), where the use of performance measures are primarily to improve business performance, indicating the true purpose of performance measure as were suggested by Bourne *et al.* (2004) and (Nenadal 2008).
8.	Occasional strategic issues are solved by using outside help	The question is to identify stage 1 companies, according to FSM. Answers which agree with this statement will be further asked in the interview on the type of problem they usually seek for outside help.
9.	Management only intervenes in manufacturing operations if there is a great need to do it	The question is to identify stage 1 companies, according to FSM. Question in interviews will identify types of disruption which require management to intervene.
10.	Some work procedures have been established in the company	This question is to identify stage 2 companies according to Chase and Hayes (1991) FSM. Further question in interview will look into procedures that have been created by stage 2 companies. This is to enable companies in stage 1 to know types of procedures they must first establish.
11.	New technology is introduced when it became	Q11 is intended to identify stage 1

	necessary for survival	company, while Q12 aim to identify stage 2 companies. The description is taken from original text from Chase and Hayes (1991). A company will fall into stage 1 if they answer it positively in Q11 and stage 2 if they do the same for Q12.
12.	New technology is introduced when it can justify cost savings	
13.	Equipment is bought from the same source as our competitor or from the best supplier around.	To identify stage 2 companies according to FSM. A company will fall into stage 2 if they have a positive answer for this question.

Appendix 6: Interview Guide

This interview is structured to complement questions which have been put in the survey. The aims of the interview are:

1. To find what are the best practice and problem solving tools used by high performance manufacturers and why they are being selected.
2. To identify the role of management in operations.
3. To find out the reason behind the selection of main competitive priorities.
4. Justification of new technology investment.
5. The way performance measures/indicators are used by the company.
6. The process of conducting competitor analysis.

Interview questions

1. What are the weekly production output and the maximum production capacity?

2. Are there any problem solving tools or formal approach used to solve daily production disruption? If yes, what are the tools used?

3. Is the educational background of shop floor workers/operators having an influence on the selection of above problem solving tools?

4. Please state if there is other reasons that influenced the selection of above problem solving tools.

5. How comparisons are made by the company with its competitors? Any analysis tools used? What are the processes involved?

6. What is unique about the company that makes it different from its competitors?

7. From the table below, please arrange the company competitive priorities according to the order of importance. Please write in the box provided. *E.g.**1**, **2**, **3**, **4**,**5**,**6**,**7** (**1**.Most important – **7**. Least important)*

Please insert your rank here.	Competitive priorities
	Quality – Products are manufactured with high quality and performance standards.
	Dependability – Deliver right product, right quantities and as promised.
	Flexibility - The ability to react to changes in production, changes in product mix, modifications in design.
	Cost – Production and distribution of product at low cost.
	Innovation – Introduction of new product and process
	After sales service – Attend to customer requirement after products has been sold.
	Environmental protection – Minimise repercussion of manufacturing activities on the environment.
	Others (please specify):

8. From table above, can you provide reasons why the company pursues competitive priorities ranked as ***'1'***?

9. What are the measures taken to ensure the company addresses the number ***'1'*** priority?

10. What are the main areas covered by the performance measurement/indicator used in the company?

11. Can you give example of strategic issues that is occasionally solved by using outside help?

12. Specifically, can you describe the type of problems in manufacturing operations which require management intervention?

13. Can you state the type or areas of operations, where the work procedures have been established in the company?(e.g process control or documented work instruction)

14. Is there any continuous improvement (CI) initiatives adopted by the company? If yes can you state those initiatives?

15. Are there any manufacturing best practice followed?

16. Which one of them is adopted at the initial stage of operation? Or can you explain in stages (which one first, second, third, fourth) are being implemented in the company?

17. What justifies the introduction of new technology in the company?

18. How often workers are trained? Is there any specific period or according to needs?

19. How you ensure the continuity of available workforce?

Appendix 7: Interview Questions and Aims

No	Questions	Aims
1.	What are the weekly production output and the maximum capacity of production?	To get an idea on how much average production and the maximum it can perform. The question will be use to lead to identifying the degree of production flexibility of a plant.
2.	Are there any problem solving tools or formal approach used to solve daily production disruption? If yes, what are the tools used?	Tezel *et al.* (2015) and Rusjan (2005) suggested the use of problem solving techniques once work procedures have been established to improve the process further. In addition, it is part of CI initiatives that enables company to achieve a structured CI status (Bessant 1999). Therefore the question purpose is to discover the type of problem solving techniques used by a stage 2 companies, which can be replicated by a stage 1 company to achieve a similar status.
3.	Is the educational background of shop floor workers/operators having an influence on the selection of above problem solving tools?	To measure how the educational background effect the type of problem solving techniques used. The question aims to validate the generalisability of problem solving tools, whether they can be applied regardless of educational background of the shop floor staff.
4.	Please state if there is other reasons that influenced the selection of above problem solving tools.	To understand the reasons behind the selection of the problem solving tools.
5.	How comparisons are made by the company with its competitors? Any analysis tools used? What are the processes involved?	To find out the type of analysis and the source of information on competitors are obtained.
6.	What is unique about the company that makes it different from its competitors?	Perceptual information on how managers feel about competitive advantage their company possesses.

<table>
<tr>
<td>7.</td>
<td>Please arrange the company competitive priorities according to the order of importance (1 - 7).
<table>
<tr><th>Please insert your rank here.</th><th>Competitive priorities</th></tr>
<tr><td></td><td>Quality – Products are manufactured with high quality and performance standards.</td></tr>
<tr><td></td><td>Dependability – Deliver right product, right quantities and as promised.</td></tr>
<tr><td></td><td>Flexibility - The ability to react to changes in production, changes in product mix, modifications in design.</td></tr>
<tr><td></td><td>Cost – Production and distribution of product at low cost.</td></tr>
<tr><td></td><td>Innovation – Introduction of new product and process</td></tr>
<tr><td></td><td>After sales service – Attend to customer requirement after products has been sold.</td></tr>
<tr><td></td><td>Environmental protection – Minimise repercussion of manufacturing activities on the environment.</td></tr>
<tr><td></td><td>Others (please specify):</td></tr>
</table>
</td>
<td>The question is asked again to validate answers provided in the questionnaire.</td>
</tr>
<tr>
<td>8.</td>
<td>From table above, can you provide reasons</td>
<td>The main aim is to investigate steps</td>
</tr>
</table>

	why the company pursues competitive priorities ranked as *'1'*?	taken to address the number 1 priority. At the same time, same question is also used to investigate rank '2'.
9.	What are the measures taken to ensure the company addresses the number *'1'* priority?	Answers from this question will be used to create constructs in the following questionnaire.
10.	What are the main areas covered by the performance measurement/indicator used in the company?	It is a follow-up question which has been asked in Phase 1, to uncover the main PM used in the company.
11.	Can you give example of strategic issues that is occasionally solved by using outside help?	To investigate types of strategic issues that require help externally (Hayes and Wheelwright 1984:396)
12.	Specifically, can you describe the type of problems in manufacturing operations which require management intervention?	To know problems that require management intervention (Dangayach and Deshmukh 2003) and (Barnes and Rowbotham 2004)
13.	Can you state the type or areas of operations, where the work procedures have been established in the company?(e.g process control or documented work instruction)	To obtain information on types of work procedures used (Chase and Hayes 1991).
14.	Is there any continuous improvement (CI) initiatives adopted by the company? If yes can you state those initiatives?	Investigating whether CI is formally or informally implemented in the plant.
15.	Are there any manufacturing best practice followed?	Identifying 'industry practice'(Hayes and Wheelwright 1984:396)
16.	Which one of them is adopted at the initial stage of operation? Or can you explain in stages (which one first, second, third, fourth) are being implemented in the company?	To get the sequence of best practice implementation based on answers provided in 15.
17.	What justifies the introduction of new technology in the company?	Other justification of new technology apart from to survive in the marketplace or to reduce cost (Chase and Hayes 1991)
18.	How often workers are trained? Is there any specific period or according to needs?	To investigate reasons organising workers training and how consistency can be achieved by making sure workforce is continually available.
19.	How you ensure the continuity of available workforce?	

Appendix 8: Delphi Session Guidelines

Delphi session guideline:

1. Do you understand the meaning of decision areas and actions?
2. Do you think SME's CEO, Operations Manager, Factory Manager would understand them?
3. In your opinion, could these actions improve the operations of manufacturing SMEs?
4. Any comments that you would like to make on the decision areas or actions?

Appendix 9: Phase 4 Questionnaire

The questionnaire should take about 15-20 minutes to complete. Participation in the study is entirely voluntary; you can withdraw from the survey at any point, without giving a reason for doing so. Please be assured that the information you provide will remain strictly confidential and anonymous. Answers will be reported so that no individual or organization will be identifiable from any publication presenting the results of the survey. By responding to the questionnaire, your consent to take part in the study is assumed and that you agree to the use of anonymised quotes in publications

Objective:

The purpose of the questionnaire is to define the sequence and criticality of the strategic actions taken by your company overtime to develop the business. The aim is to develop a framework to guide new startups in key areas to create a 'step-by-step' execution in improving performance. Your expert input and experience is valuable in determining actions that need to be taken at least for the first five years of operations.

Instructions:

1. Please select the statement based on the most appropriate time the actions should be carried out.

1y = Year one	2y = Year two
3y = Year three	4y = Year four
5y = Year five	>6 = Year six and above

2. Once the above action is selected, please rate its impact on quality, delivery and operating cost.

-- Highly negative	= Neutral	++ Highly positive
- Negative	+ Positive	

Designation:
Years of experience in manufacturing:
Industry sector:

No	Actions	Timeline						Impact on		
								Quality	Delivery	Cost
								-- Highly negative to ++ Highly positive		
Strategic Theme										
1.	Defining company strategic theme	1y	2y	3y	4y	5y	>6y			
Competitive Priorities										
2.	Product performance	1y	2y	3y	4y	5y	>6y			
3.	Product reliability	1y	2y	3y	4y	5y	>6y			
4.	Product durability	1y	2y	3y	4y	5y	>6y			
5.	Product perceived quality	1y	2y	3y	4y	5y	>6y			
6.	Product sustainability	1y	2y	3y	4y	5y	>6y			
Work Procedures										
7.	Build documentation	1y	2y	3y	4y	5y	>6y			
8.	Works order	1y	2y	3y	4y	5y	>6y			
9.	Safe system of work	1y	2y	3y	4y	5y	>6y			
10.	Stage sample	1y	2y	3y	4y	5y	>6y			
11.	Product version	1y	2y	3y	4y	5y	>6y			
12.	Health and safety compliant with local laws	1y	2y	3y	4y	5y	>6y			
Visual Management										
13.	Starting out visual management meeting	1y	2y	3y	4y	5y	>6y			
14.	Starting to review the process layout	1y	2y	3y	4y	5y	>6y			
15.	Use of value stream mapping	1y	2y	3y	4y	5y	>6y			
Implementation of performance measures										
16.	Yield	1y	2y	3y	4y	5y	>6y			
17.	Right first time	1y	2y	3y	4y	5y	>6y			
18.	Re-work rate	1y	2y	3y	4y	5y	>6y			
19.	Reject rates	1y	2y	3y	4y	5y	>6y			
20.	Delivery reliability	1y	2y	3y	4y	5y	>6y			
21.	Lead times	1y	2y	3y	4y	5y	>6y			
Certification and rituals										
22.	Adoption of ISO 9000	1y	2y	3y	4y	5y	>6y			
23.	Setting of everyday *rituals* before the beginning of operations.	1y	2y	3y	4y	5y	>6y			
The use of problem solving techniques										
24.	Ishikawa diagram	1y	2y	3y	4y	5y	>6y			
25.	5 Whys	1y	2y	3y	4y	5y	>6y			
26.	Stage inspection	1y	2y	3y	4y	5y	>6y			
27.	Statistical process control	1y	2y	3y	4y	5y	>6y			
Implementation of best practices										
28.	3S	1y	2y	3y	4y	5y	>6y			
29.	4S	1y	2y	3y	4y	5y	>6y			
30.	5S	1y	2y	3y	4y	5y	>6y			
Skills and training										
31.	Middle manager training and coaching	1y	2y	3y	4y	5y	>6y			
32.	Establishing a skills matrix	1y	2y	3y	4y	5y	>6y			
33.	Adoption of apprenticeship/industrial training program	1y	2y	3y	4y	5y	>6y			
Doing comparison with competitors										
34.	Founder’s experience	1y	2y	3y	4y	5y	>6y			

35.	Obtaining reviews from customer	1y	2y	3y	4y	5y	>6y			
36.	Getting competitor's information from suppliers	1y	2y	3y	4y	5y	>6y			
37.	Employing people with experience and work culture in related field	1y	2y	3y	4y	5y	>6y			
38.	Pay structure benchmarking	1y	2y	3y	4y	5y	>6y			
39.	Process time benchmarking	1y	2y	3y	4y	5y	>6y			
Pursuance of delivery dependability										
40.	Establishing nominee supplier with proven delivery track record	1y	2y	3y	4y	5y	>6y			
41.	Implementing pull production	1y	2y	3y	4y	5y	>6y			
42.	Estimation on delivery time is compared to previous similar work to get the best delivery prediction	1y	2y	3y	4y	5y	>6y			
43.	Having a multi-skilled and flexible workers	1y	2y	3y	4y	5y	>6y			
44.	Comments:									

Terminologies

1. Defining company strategic theme

   To provide a sense of direction or goal to pursue for a particular organisation.

2. Competitive priorities – Quality

   Product performance - product's primary operating characteristics and how it should perform undertaking its intended tasks.

   Product reliability - ability of a product to perform as intended (without failure and within specified performance limits) for a specified time in its lifecycle application environment.

   Product durability - the amount of use customers get from a product before it breaks down and replacement is preferable to continued repair.

   Product perceived quality - Image, a measure of impact of a product or company name, reputation, pricing, advertising etc. on the customer evaluation of the product.

   Product sustainability - reducing environmental and social impact in products and its manufacturing process.

3. Work procedures

   Build documentation - A step by step manufacturing instruction for a particular product.

Works order/work sheet - Authorization for cost to design, develop, and produce a specific product. These documents can be embedded into one or another (example: approved works order by customer are converted into worksheet to be distributed on to the shop floor).

Safe system of work - Document established to show the correct way of handling machines or performing a specific tasks unique to the organisations.

Stage sample - A sample of product that shows good and bad output in different manufacturing stage.

Product version - A sample of a group of same products which has different specification and finishing.

Health and safety compliance according to local laws - Health and safety procedures which complies with the local regulatory standards.

4. Visual management

Starting out visual management meeting: Brief and frequent stand up meetings to clearly understand and visualise the current state of activities and enable planning for improvement. Ideally to be conducted in less than 15 minutes.

Starting to review the process layout: Starting reviewing the physical location of human, machine, stock, workstation, workgroup and activity in a manufacturing plant. This is conducted to minimise material handling cost, customer or worker travel time and get the maximum out of a plant capacity.

Use of value stream mapping: Technique to document, analyse and improve the flow of materials required for production.

5. Implementation of performance measures

Yield - A proportion of correct items (conforming to specification) which get out of a process compared to the number of raw materials put into it.

Right first time - Items in minus total of rework and rejects divided by items in (Items in - (rework + scrap) / items in).

Re-work rate - Percentage of failed assemblies that can be repaired and restored.

Reject rate - Percentage of failed assemblies that cannot be repaired or restored.

Delivery reliability - Ratio of the number of delivery made without any error (regarding time, place, quantity and quality) to the total number of deliveries in a period.

Lead times - Total time required to manufacture an item. (example: time taken from an order to shipment or from an order to finished goods inventory)

6. Rituals and certification

ISO 9000 - Standards that provide guidance and tools for companies and organisations to ensure products and services consistently meet customer's requirement and quality is consistently improved.

Rituals - A short meeting conducted every day at the beginning of operations to discuss previous day issues and objectives of the day.

7. The use of problem solving techniques

Stage inspection: An inspection procedure conducted at every/different stages of manufacturing process. This approach helps to control the quality of products by allowing fixing to be done at the sources of defects immediately after they are detected.

Fishbone (Ishikawa diagram): Cause and effect diagram to identify possible causes of an effect or problem.

5 Whys: Iterative interrogative technique used to explore the cause and effect relationship for a particular problem, with the primary goal to identify root causes of an effect or problem. It is done by repetitively asking WHY questions.

Statistical process control: Method of quality control by using statistical method. It is applied mainly to monitor and control a process.

8. 5S Deployment

3S (Sort, Straighten, Shine)
4S (Sort, Straighten, Shine and Standardised)
5S (Sort, Straighten, Shine, Standardised and Sustain)

9. Skills and training

Skills matrix: Is a table that shows skills held by individuals in a team and skills gaps within a team. It is used to assess requirement for the on-the-job training and review and code standards of performance.

10. Comparison with competitors

    The items on this section are about the source and ways companies compare themselves with their competitors.

11. Pursuance of delivery dependability

    The item on this section implicates actions taken to obtain delivery dependability capability.

Appendix 10: Validation Interview Guidelines

The action-timeline framework (attached as Ac-Ti Framework.pdf) shows the *latest start time* for *actions* within the *decision areas* in improving operations for manufacturing SMEs. The *actions* are represented by different colours placed on a 36 months grid. It is intended as guide by providing tools, actions and its implementation time in improving operations, particularly for manufacturing SMEs.
Sequence of *actions* on the action-timeline framework is determined by completed questionnaire from 10 respondents consisting of operations managers, factory managers and SMEs owners. This interview is conducted to complement data obtained from the questionnaires.

The main aim of this interview is to get a second opinion on applicability of the action and timeline framework - also at the same time validating and refining the framework.

Questions:

1. Referring to the action-timeline framework, do you agree with the *latest start time* for *actions* within the below *decision areas*:

    a. Defining company strategic theme.
    b. Work procedures
    c. Visual management.
    d. Implementation of performance measures.
    e. Certification and rituals.
    f. The use of problem solving techniques.
    g. 5S Deployment.
    h. Skill and training.
    i. Comparison with competitors.
    j. Pursuance of delivery dependability.

2. Please provide reasons for the above answers.
3. Based on your experience, can you suggest the ideal time to implement actions on the above *decision areas*. Please provide reasons behind those suggestions.