CONCEPTUAL ANALYSIS OF LEAN MANUFACTURING (LM) PRINCIPLES FOR SMALL AND MEDIUM ENTERPRISE (SME)

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Declaration

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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This thesis is the result of my own investigation, except where otherwise stated. Other sources are acknowledged by giving explicit references. Bibliography/references are appended.

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LM : lean manufacturing

LE : large enterprise

SME : small and medium-sized enterprise

TPS : Toyota Production System

Abstrak

Pengenalan dan pelaksanaan Prinsip “Lean Manufacturing” (LM) dalam tempoh dua puluh tahun yang lalu mempunyai kesan yang ketara ke atas banyak perusahaan pembuatan. Walau bagaimanapun, ramai penyelidik menekankan fakta bahawa kaedah dan instrumen LM tidak sama rata untuk syarikat besar dan kecil. Perusahaan kecil dan sederhana (PKS) di Malaysia telah lama diabaikan dan kajian khas tentang topik ini jarang berlaku. Analisis projek ini untuk memanfaatkan prinsip-prinsip pembuatan kurus dalam PKS dan juga batasan untuk melaksanakan LM. Penyelidikan ini adalah gabungan analisis konseptual dan kaji soal selidik untuk menganalisis prinsip-prinsip LM yang sedang dilaksanakan oleh PKS di Pulau Pinang, Malaysia. Analisis konseptual dilakukan dengan menggunakan kaedah “Näsi's four elements”. sementara kaji soal selidik dibuat dengan “Google Form” dan soalan-soalan telah ditetapkan berdasarkan hasil analisis konseptual. Analisis juga dijalankan untuk mencari kesukaran dalam peringkat pelaksanaan dan untuk mengenal pasti faktor-faktor yang mengehadkan. Keputusan kajian awal ini menunjukkan bahawa lima LM prinsip terbaik yang dicadangkan untuk PKS ialah kawalan visual (min 4.43), “gemba walk” (min 4.43), refleksi tanpa henti (hansei) dan penambahbaikan berterusan (min 4.20), aliran proses berterusan (min 4.03) dan melahirkan pemimpin (min 3.53). Oleh itu, berdasarkan lima prinsip, PKS di Malaysia boleh menumpukan usaha dan sumber mereka untuk mencapai kejayaan pelaksanaan LM.

Abstract

The introduction and implementation of Lean Manufacturing (LM) Principles over the last twenty years has had a notable impact on many manufacturing enterprises. However, many researchers have highlighted the fact that LM methods and instruments are not equally applicable to large and small companies. Small and medium enterprises (SMEs) in Malaysia have been ignored for a long time and special investigations about this topic are rarely being focused. This project analyzed the benefits of LM principles in SMEs and also SMEs limitation in implementing LM. The research is a combination of conceptual analysis and survey questionnaire to analyse the LM principles which currently implemented by SMEs in Penang, Malaysia. A conceptual analysis was performed by using the method of Näsi's four elements while the survey questionnaire was created with google form with the questions were set based on the results of conceptual analysis. Analysis was also conducted to find the difficulties in the implementation stage and to identify the limiting factors. The results of this preliminary study show that the proposed best five LM principles for SMEs are: visual control (mean 4.43), gemba walk (mean 4.43), relentless reflection (hansei) and continuous improvements (mean 4.20), continuous process flow (mean 4.03) and grows leaders (mean 3.53). Therefore, based on the five principles, SMEs in Malaysia can focus their efforts and resources in order to achieve a successful implementation of LM.

CHAPTER 1 INTRODUCTION

1.1 Introduction

Womack and Jones, the American authors were the one of the first to study and analyse the methods and philosophy that implement successfully by Japanese car manufacturer Toyota. After World War II, Toyota transformed to car manufacturing from its core business which is building textile machinery. This is the time when the Toyota set out the of lean management. Toyota organized its production process in a flexible way, completely opposite to the widely used system of mass production. Lean has become Toyota's philosophy for over the past 60 years (Krijnen, 2007). The term "lean" was used in 1988 for the first time during the International Motor Vehicle Program. It was aimed to understand the differences in productivity between Japanese and Western industries. (Moeuf et al., 2016). Toyota has introduced some principles that can help to decrease the time required for setup and changeovers. The developments made by Toyota were adopted by other Japanese manufacturers, but none were as successful (Murray, 2018).

The word "lean" means uses less of everything which refers to lean manufacturing (LM) or lean production. LM involves only half of the human effort in the production or the enterprises, half of the manufacturing space, half of the investment in tools and half of the engineering hours to produce a new product in half of the time (Wahab et al., 2013). For participating organizations who implemented lean, they clearly will get many advantages, both direct and indirect, but it has never been an easy concept to define. Many practitioners and researchers have analysed lean in different ways which mean there is no agreement about what the exact meaning of lean is. However, researchers agreed that lean manufacturing can be a cost reduction mechanism and use to be a guidance for the enterprises to be a world class organization (Rose et al., 2011). Theoretically, LM is recommended by many researchers to apply to all type of enterprises as it considered as a strategic weapon in the competitive market.

There are many benefits of applying lean in an organization. LM helps to improve productivity and boosting up the satisfaction of employees. Indeed, LM is different compared to traditional manufacturing. The traditional manufacturing is more focus on

the inventory of the production while LM is against this concept. Lean is more focus on reducing the inventory as lean considers inventory as a waste in the organization. If the organizations want to apply the lean principles, they need to understand the differences between traditional manufacturing and LM (Gupta and Jain, 2013).

In another review of LM, the essential aspect of leanness is to use the resources efficiently through the elimination of waste as the aim of LM is to reduce waste and non-value-added activities. In simple words, the core idea of lean manufacturing is to maximize customer value while minimizing waste. The ultimate goal of implementing LM in an organization is to increase productivity, enhance quality, shorten lead times, reduce cost and so on (Wahab et al., 2013). Many studies and research show that during a production, the value-added activities have only around 5%; the remaining 95% is waste. LM implementation tries to remove that 95% wasted time and effort (Gupta and Jain, 2013). By applying the lean in the organizations, the waste can reduce to around 25-35% (Murray, 2018).

Nowadays, competition in the global market is tough and the companies need to constantly enhance and evolve. Therefore, LM is very important and has proven as a method to improve the business and beat the competition. In general, organizations can be classified into two groups: large enterprises (LEs) and small and medium-sized enterprises (SMEs) (Hu et al., 2015). SMEs have an important role in the manufacturing sector all over the world. In Malaysia, most of the companies are in the category of SME. There has 96% of establishments of SMEs in Malaysia which contributed 30.7% of the total manufacturing output and 26.3% of total value added in the year 2007. In addition, more than 400,000 or 31% of total Malaysian workforce was employed by SMEs (Rose et al., 2011).

SMEs are the lifeblood of economies and for them to survive in the challenging age, they need constantly to be competitive and produce high-quality outputs. Moreover, SMEs need to always enhance themselves because they are the suppliers of goods and services to larger organizations and lack of product quality would adversely affect the competitive ability of the larger organizations (Ghobadian and Gallear, 1996). In conclusion, SMEs should look forward to their existing system and fulfill the customer

needs. One of the approaches which are considered as the best management practice to all industries is LM.

In order to implement lean in SMEs, the organizational culture of SME required to be changed (Moeuf et al., 2016). Organizational culture can be defined as "a pattern of shared basic assumptions that was learned by a group as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those" (Tidor et al., 2012). In simple, culture can define as norms, values and informal beliefs held by people in an organization (Ghobadian and Gallear, 1996). Every organization has their own different culture. The key elements of an effective corporate culture are the organization's mission and goals, work environment, management style, organizational practices and policies, recruitment and career development, benefits and rights (Tidor et al., 2012). So, in order for SMEs to use lean as a system, the culture of SMEs need to be changed to a lean culture. On the other hand, many researchers have outlined that some of other inhibiting factor that limit the application of LM in SMEs. The limiting factors of implementation of LM in the SMEs would be discussed further in this research. Therefore, the aim of this research is to perform the conceptual analysis of LM principles for SMEs in Penang, Malaysia.

1.2 Research Background

This research focuses on SMEs in Malaysia as they account for 99.2% or 548,267 of total establishments in Malaysia (N Rohana, 2011) which play an important role in the economic development of Malaysia. The Malaysian government has allocated resource for the development of SMEs. Generally, the worldwide definition of SMEs does not have an agreement around the world. However, in Malaysia, the definition of SMEs is mainly based on annual sales turnover and the total number of full times. In Malaysia, enterprises that employ between 50-150 full-time employees are considered as medium (Khalique et al., 2011).

Due to the globalization of markets, all the companies especially SMEs need to reshape their organizations by using a good mechanism and continuously improve all facets of their operations (Ghobadian and Gallear, 1996). The demand for high-quality products is increasing and highly capable business processes by the large organization have left no choice for the SMEs to consider LM implementation (Rose et al., 2011). In order to let SMEs implement lean in their organizations, lean should be tailored to the specific needs of small and medium organizations (Dorota Rymaszewska, 2014).

However, several lean implementation approaches have been developed, but these methods are designed for mass production companies. Base on other researches, SMEs face some difficulties in implementing the LM. One of the factors that cause lean fail to apply in SMEs is there are limited resources, including capital and staff capabilities. SME may have only a few key employees and as their skills develop staff retention can be problematic (Pearce et al., 2018). Resistance to change by employees is a common failure to implement lean in an organization as the employees are fear of failure, fear of the unknown and complacency (AlManei, et al., 2017).

There are many more factors that studied and analysed by the researchers around the world on why lean is failing to implement in SMEs. However, there are also some researchers concluded that LM is suitable to apply in SMEs. The limiting factor of SMEs to apply lean will be further discussing in this research.

1.3 Problem Statement

Several LM principles have been developed and these principles have become a famous technique to improve the productivity of companies. It has already been proven that many large organizations have been implemented LM principles successfully. However, most of the SMEs have negative perspectives on LM which it is very common that they are fearful that implementing LM is costly and time-consuming. Moreover, most of the research are too focus on large manufacturing organizations in the overseas that might inhibit the potential development of SMEs in Malaysia by implementing LM. In Malaysia, there is a significantly lower uptake of lean in SMEs compare to large companies and SMEs are still unfamiliar with lean implementation. The success rate of lean implementation in SMEs is low since it reaches only 10% (Moeuf et al., 2016). Furthermore, many researches are focus on many types of principles and some only focus on the tools. Therefore, this research will be focus on the characteristics of SMEs in Malaysia and study the best principles of LM.

1.4 Objectives

The objectives of this project are as follow:

1. To study and understand about the Lean Manufacturing Principles by using conceptual analysis.
2. To examine the Small and Medium Enterprises' characteristics base on literature review.
3. To define the best lean manufacturing principles to implement in Small and Medium Enterprises via survey.

1.5 Scope of Work

This study will be focused on lean manufacturing of 14 principles that introduced by Toyota and thus these principles will be studied and analysed using conceptual analysis. Moreover, survey will be performed, and the questionnaires will be send via e-mail to the SMEs in Penang, Malaysia by identifying the LM principles that currently implemented in their organizations.

CHAPTER 2 LITERATURE REVIEW

2.1 Literature Review

2.1.1 Lean Manufacturing

Different researchers and authors around the world have different opinions and comments on lean manufacturing (LM). They also seem to have the different point of views on which characteristics should be related to the lean concept. However, among all the articles and journals, most of the researchers and authors have a common view about LM, which is LM is the powerful tool to eliminate waste (Nystuen, 2002; Dorota Rymaszewska, 2014 and Moeuf et al., 2016). The definition of waste is anything that does not add value to the product. (Gupta and Jain, 2013). The definition of lean may change over the time which is shown in Table 2.1 (Bhamu and Singh Sangwan, 2014).

Table 2.1: Definition of Lean Manufacturing (Source: Bhamu,2014)

No	Author	Definition of Lean Manufacturing
1	Krafcik (1988)	Compared to mass production it uses less of everything-half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever-growing variety of products
2	Womack et al. (1990)	Lean is a dynamic process of change driven by a systematic set of principles and best practices aimed at continuous improvement. LM combines the best features of both mass and craft production
3	Womack and Jones (1994)	Lean production can be defined as an alternative integrated production model because it combines distinctive tools, methods, and strategies in product development, supply management, and operations management into a coherent whole
4	Hayes and Pisano (1994	Briefly, it is called lean as it uses less, or the minimum, of everything required to produce a product or perform a service
5	Womack and Jones (1996)	The term lean denotes a system that utilizes less, in terms of all inputs, to create the same outputs, as those created by a traditional mass production system while contributing increased varieties for the end customer
6	Liker's (1996)	A philosophy that when implemented reduces the time from customer order to delivery by eliminating sources of waste in the production flow

7	Cooper (1996)	Lean production is a system designed to compete on the assumption that sustained product advantage is unlikely, and therefore rather than avoid competition, face it head-on
8	Dankbaar (1997)	Lean production makes optimal use of the skills of the workforce, by giving workers more than one task, by integrating direct and indirect work, and by encouraging continuous improvement activities. As a result, lean production is able to manufacture a larger variety of products, at lower costs and higher quality, with less of every input, compared to traditional mass production: less human effort, less space, less investment, and less development time
9	Cox and Blackstone (1998)	Lean production is a philosophy of production that emphasizes the minimization of the amount of all the resources (including time) used in the various activities in the enterprise. It involves identifying and eliminating non-value adding activities in design, production, supply-chain management, and dealing with the customers. Lean producers employ teams of multi-skilled workers at all levels of the organization and use highly flexible, increasingly automated machines to produce volumes of products in potentially enormous variety
10	Singh (1998)	Lean manufacturing is a philosophy, based on the Toyota Production System, and other Japanese management practices that strive to shorten the time line between the customer order and the shipment of the final product, by consistent elimination of waste
11	Naylor et al. (1999)	Leanness means developing a value stream to eliminate all waste, including time, and to ensure a level schedule
12	Storch and Lim (1999)	Lean production is an efficient way to satisfy customer needs while giving producers a competitive edge
13	Howell (1999)	A new way to design and make things differentiated from mass and craft forms of production by the objectives and techniques applied on the shop floor, in design and along supply chains aiming to optimize performance of the production system against a standard of perfection to meet unique customer requirements
14	Framework of the Lean Advancement Initiative (MIT, 2000)	[…] not being merely a set of practices usually found on the factory floor. Lean is rather a fundamental change in how the people within the organization think and what they value, thus transforming how they behave
15	Comm and Mathaisel (2000)	Leanness is a philosophy intended to significantly reduce cost and cycle time throughout the entire value chain while continuing to improve product performance. This value chain is composed of a number of links. The links exist within government as well as within industry, and they exist between government and industry

16	Liker and Wu (2000)	A philosophy of manufacturing that focusses on delivering the highest quality product on time and at the lowest cost
17	Cooney (2002)	Lean takes a broad view of the production and distribution of manufactures, developing a production concept that encompasses the whole manufacturing chain from product design and development, through manufacturing and distribution
18	Shah and Ward (2003)	Lean manufacturing can be best defined as an approach to deliver the upmost value to the customer by eliminating waste through process and human design elements. Lean manufacturing has become an integrated system composed of highly inter-related elements and a wide variety of management practices, including Just-in-Time (JIT), quality systems, work teams, cellular manufacturing, etc.
19	Alukal (2003)	Lean is a manufacturing philosophy that shortens the lead time between a customer order and the shipment of the products or parts through the elimination of all forms of waste. Lean helpful firms reduce costs, cycle times and unnecessary, non-value-added activities, resulting in a more competitive, agile, and market responsive company
20	Hopp and Spearman (2004)	Lean production is an integrated system that accomplishes production of goods/services with minimal buffering costs
21	Simpson and Power (2005)	Lean is a practice with the objective to generate a system that is efficient and well organized and devoted to continuous improvement and the elimination of all forms of waste
22	Narasimhan et al. (2006)	Production is lean if it is accomplished with minimal waste due to unneeded operations, inefficient operations, or excessive buffering in operations
23	Holweg (2007)	Lean manufacturing extends the scope of the Toyota production philosophy by providing an enterprise-wide term that draws together the five elements – product development process, supplier management process, customer management process, and policy focussing process
24	Hallgren and Olhager, 2009	Lean manufacturing is a program aimed mainly at increasing the efficiency of operations
25	Taj and Morosan (2011)	A multi-dimensional approach that consists of production with minimum amount of waste (JIT), continuous and uninterrupted flow (Cellular Layout), well-maintained equipment (TPM), well established quality system (TQM), and well-trained and empowered work force (HRM) that has positive impact on operations/competitive performance (quality, cost, fast response, and flexibility)
26	Alves et al. 2012	Lean production is evidenced as a model where the persons assume a role of thinkers and their involvement promotes the continuous improvement and

		gives companies the agility, they need to face the market demands and environment changes of today and tomorrow

From the definition of Table 2.1, it can be observed that lean can be a way, a process, a set of principle, a set of tools and techniques, an approach, a concept, a philosophy, a practice, a system, a program, a manufacturing paradigm or a model. Moreover, Rose et al. (2011) concluded that LM is focusing on continuous flow for production system in order to remove all the wastes and perform continuous improvement towards product perfection.

LM has many obvious benefits and some significant indirect advantages after successfully implement the lean and that is why lean has been increasingly recognized as a very important concept for all types of organizations to improve their operations (Hu, et al., 2015). Besides, LM can help to reduce the cost and improve the use of resources which can be subject to continuous postponements "until better times" (Achanga, et al., 2006). The organizations can expect a reduction of 90% in lead time, 90% in inventories, 90% in the cost of quality and 50% increase in labour productivity, as a result of implementing LM (Lathin and Mitchell, 2001). LM can help an organization to cut cost by between 15 to 70%, reduce waste by 40%, improve productivity by 15 to 40% and decrease the space and inventory by 60% (Gupta and Jain, 2013).

Some of the researchers and authors of overseas have proven the successful results of implementing lean from the case studies of various company. For example, many big companies like Tata Motors, HCL and Wipro have successfully implemented LM principles. Thara Engineering and Gold Seal Engineering Products Ltd are some small-scale industries that have improved their processes by the implementing of lean (Gupta. and Jain, 2013). In summary, past literature showed most of the researchers and practitioners highlighted that LM could reduce inventories, lead times, improved knowledge management, rapid product development and robust processes (Rose et al., 2011).

There are many useful LM principles that have been developed and implemented successfully in the companies. Rose et al. (2011) have proposed 17 lean practices which are practicable and fit small and medium scale characteristics. The authors recommended that the lean should be implemented in consistent way. This is because if implement the lean with inconsistency may not lead any organization to fully benefit from the lean practices. The most common and easiest LM principles to implement in the organizations are Kanban, Kaizen, 5Why and 5S (Hu, et al., 2015; Gupta and Jain, 2013; Rose et al., 2011 and Nystuen and Tamara, 2002).

2.1.2 Small and Medium Enterprises (SMEs)

It is useful to determine how SMEs are defined but there is no same point of view of the definition across the world as it has different definitions in different country. Different countries defined the SMEs in different ways, and it stated in Table 2.2 (Hu, et al., 2015). The European Union defines a SME as an enterprise having a turnover lower than €50 M and fewer than 250 employees. The author has identified that SME has distinctive characteristics when compared to big companies and the factors that become the obstacles of implementing the lean (Moeuf et al., 2016). While in Malaysia, SME was defined as a company with full-time employees between 5 to 150 and annual sales turnover between RM251k to RM25million (Rose et al., 2011).

Table 2.2: Examples of definitions of SMEs in different countries (Source: Hu, et al., 2015)

No.	Country/Area	Definition of SMEs
1	USA	No more than 499 employees (Manufacturing sector)
2	Canada	No more than 199 employees
3	EU	No more than 250 employees
4	Australia	No more than 200 employees
5	China	No more than 999 employees

Many researchers and authors have the common opinions and comments about the inhibitors of implementing lean in SMEs, which are because of the culture of the SMEs itself, such as difficulties to convince the managers about the actions to take (Moeuf et

al., 2016; Dorota Rymaszewska, 2014 and Achanga, et al., 2006), poor understanding of lean manufacturing concept (Gupta and Jain, 2013; Dorota Rymaszewska, 2014 and Moeuf et al., 2016), employees' attitudes (Gupta and Jain, 2013), lack of funding (Achanga, et al., 2006; Dorota Rymaszewska, 2014 and Hu et al., 2015) and lack of expertise (Moeuf et al., 2016). Culture has been defined as the way we do things around here while by definition is elusive, intangible, implicit, taken for granted but every organization develops a set of assumptions, understandings and implicit rules that govern day-to-day behaviours in the workplace. The researchers had different point of view on LM and there are no standard practices available for SME to adopt, but the common goal is with least investment (Rose et al., 2011). In summary, the researchers had the common factor of limitation of implement LM in SMEs which are financial capabilities, organizational culture, leadership and skill and expertise (Samantoroy, 2017; Achanga et al., 2006; Alkhoraif, 2018; Matt and Rauch, 2013; Rose et al., 2009; Hu et al., 2015; Alefari et al., 2017).

On the other hand, Dorota Rymaszewska (2014) has compared the studied organizations with Toyota company by identifying the organizational characteristics, manufacturing environments and potential challenges of lean adoption. Most of the researchers have outlined the strength of the SMEs that actually suitable to apply the lean in their organizations, such as more flexible in terms of changing their manufacturing processes (Dorota Rymaszewska, 2014; Ghobadian and Gallear, 1996 and Hu et al., 2015) and respond quicker to changing customers' needs (Dorota Rymaszewska, 2014). Achanga et al. (2006) has described the realisation of critical success factors that determine a successful implementation of LM within SMEs environment. Krijnen (2007) highlighted that lean is a very powerful tool to improve the business results and the only negative issue is the fact that there is no focus on service-related companies while all the examples are based on production companies. Although it all started with Toyota and other production companies, the author discovered that lean can be very useful in a service environment as well.

2.1.3 14 Principles of Lean Toyota Production System (TPS)

In 2004, Liker wrote The Toyota Way — 14 Management principles (Liker and Hoseus, 2008), after working in Toyota factories in Japan and United States for 20 years. The 14 foundational management have been behind the giant automaker's world-famous production system. Liker divided the principles into four categories which are philosophy, process, people and partners, and problem-solving. The two pillars of their lean system which support the principles of the Toyota Way are:

1. Continuous Improvement – challenge everything (create an atmosphere of continuous learning)
2. Respect for people – engage employees by promoting active participation in improving their everyday job.

The two pillars are illustrating in Figure 2.1 which the 14 principles are introduced base on these two pillars.

The Toyota Way	Continuous improvement	Challenge	1. Long-term philosophy
		Kaizen	2. Create flow
			3. Use a pull system
			4. Level out the workload
			5. Stop and fix the problem
			6. Standardise tasks
			7. Use visual control
			8. Use reliable, tested technology
			14. Continual organisational learning through *kaizen*
	Respect for people	*Genchi genbutsu*	12. Go and see for yourself to understand the situation
			13. Make decisions slowly by consensus
		Respect	9. Grow leaders who live the philosophy
			11. Respect, challenge, and help your suppliers
		Teamwork	10. Respect, develop, and challenge your people and teams

Figure 2.1: Summary of the Toyota Way, including the 14 management principles (Source: Coetzee et al., 2016)

Stewart (2011) explains the meaning of LM and TPS as the difference between them is that in LM the focus is on the tools, and with TPS the focus is on the system. There are many tools that can be used to implement the TPS, but not all are mandatory. Unlike LM, TPS should never be a toolkit; it is a sophisticated production system in which all the parts contribute to a whole. At its root, TPS will be focus to support and encourage

people to continue to improve the process that they are working on (Coetzee et al., 2016). Furthermore, The Toyota Way is not a system, process, or programme. Instead, it is a mindset that explains how thoughts and actions guide people to interact with each other daily. The Toyota Way can also be an organisational culture (Coetzee et al., 2016) and it is a fundamental for starting to implement the lean in a company. Therefore, in order to start to implement LM in SMEs, these 14 principles must be focused first before other lean practices. There are 14 principles introduced by Liker which are (Liker and Hoseus, 2008):

Principle 1: Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.

Principle 2: Create continuous process flow to bring problems to the surface. (Just in Time)

Principle 3: Use "Pull" system to avoid overproduction.

Principle 4: Level out the workload (heijunka).

Principle 5: Build a culture of stopping to fix problems, to get quality right at the first time.

Principle 6: Standardized tasks are the foundation for continuous improvements and employee empowerment (Problem Solving).

Principle 7: Use Visual Control so no problems are hidden.

Principle 8: Use only reliable, thoroughly tested technology that servers your people and process.

Principle 9: Grow leaders who thoroughly understands the work, live philosophy and teach it to others.

Principle 10: Develop exceptional people and teams who follow your company's philosophy.

Principle 11: Respect your extended network of partners and suppliers by challenging them and helping them improve.

Principle 12: Go to gemba and see for yourself to thoroughly understand the situation (Genchi Genbutsu).

Principle 13: Make decision slowly by consensus (use cross functional teams), thoroughly considering all options; implement decisions rapidly.

Principle 14: Become a learning organization through relentless reflection (hansei) and continuous improvements (Kaizen).

2.2 Conceptual Analysis

Before a phenomenon can be measured or quantified, a precise analysis and definition are required as the starting point for successful scientific research. In this research, conceptual analysis is proposed to use as the method to define the best lean manufacturing (LM) principles to implement in Small and Medium Enterprises (SMEs). Concept analysis is defined as an activity where concepts, their characteristics and relations to other concepts are clarified. It is very important for all kind of research with the creation of conceptual clarity. Basically, the purpose of concept analysis is to clarify ambiguous concepts in a theory, and to propose a precise operational definition which reflects its theoretical base. Conceptual analysis is aimed at clarifying conceptual and terminological problems and are a good option when no other methods are available (Nuopponen, 2010).

The goal of this project is to define the best principle of LM out of 14 principles that suitable for future use in SMEs for their production based on their characteristics. This analysis will examine the intrinsic worth that authenticity of presence in lean manufacturing in SMEs. This analysis will be focus on the 14 principles of Lean Toyota

Production System (TPS), limitation on implementing lean in small and medium enterprises (SMEs) and finally rank the principles that best suit on SMEs.

Typically, the methods used in conceptual research are thinking and analytical comparisons with existing literature and knowledge. Näsi (1980) stated that a conceptual–analytical part is included in all research projects, but that conceptual analysis can also, be used as an independent research approach. Literature and conceptual research were done for this study to find theoretical foundations related to the research issue. A theoretical framework will be provided in this research by analysing key definitions of Lean Manufacturing and how LM relates to other SMEs concepts.

Based on research, there are a lot of conceptual analysis method for different type of research. Figure 2.2 showed the various type of conceptual analysis method based on different type of field of research.

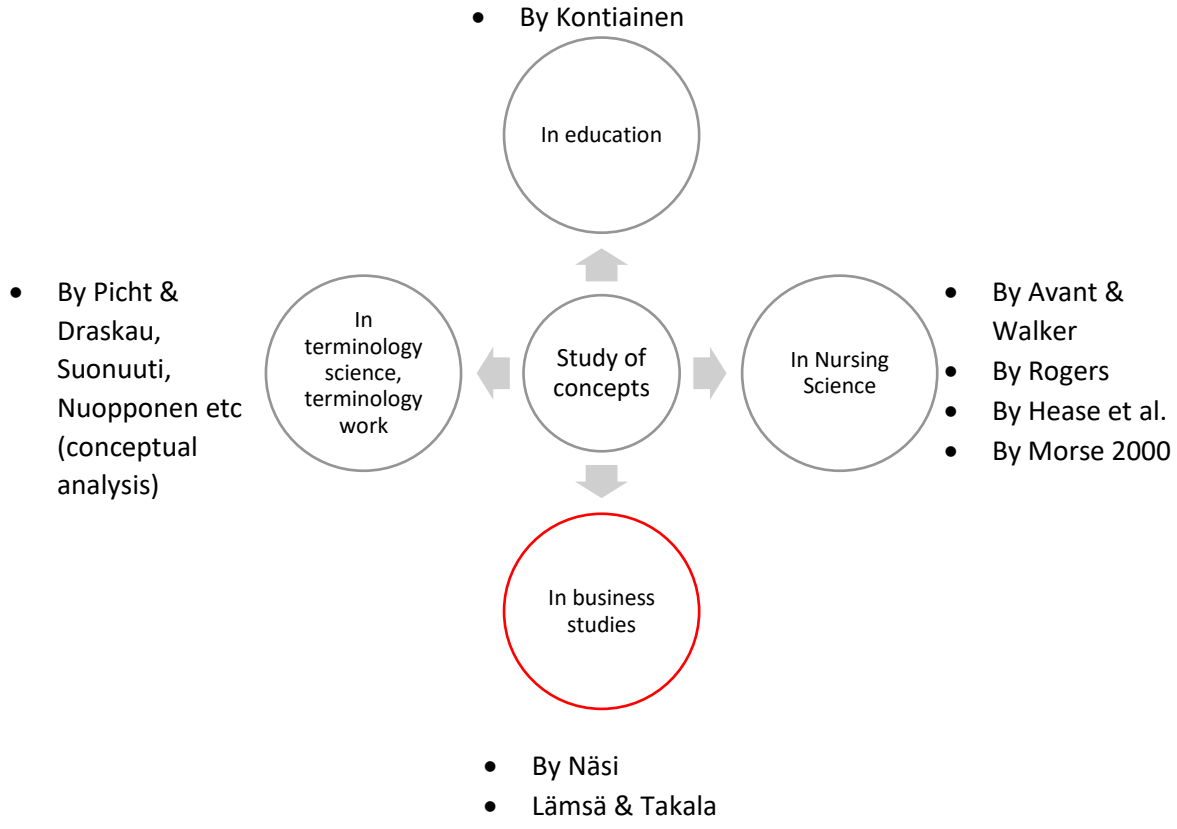

Figure 2.2: Various types of concept analysis method

For this research, the conceptual analysis method that suitable is the method that used in business studies. This is because business studies are a broad subject in the Social Sciences, allowing the in-depth study of a range of specialities such as accountancy, finance, organisation and marketing. Therefore, this method can use to study about the concept of lean manufacturing related to the concept of the SMEs organization.

2.3 Comparison of Lämsä & Takala and Näsi's four elements of concept analysis

2.3.1 Lämsä & Takala Interpretative research of concepts

Takala's and Lämsä's (2001) descriptive interpretative concept analysis is a method which focus on interpreting definitions which from different sources in order to enhance and understand a concept and relating the concepts to each other (Nuopponen 2010). Takala and Lämsä (2001) have divided the interpretative concept analysis into four different types as shown in Figure 2.3.

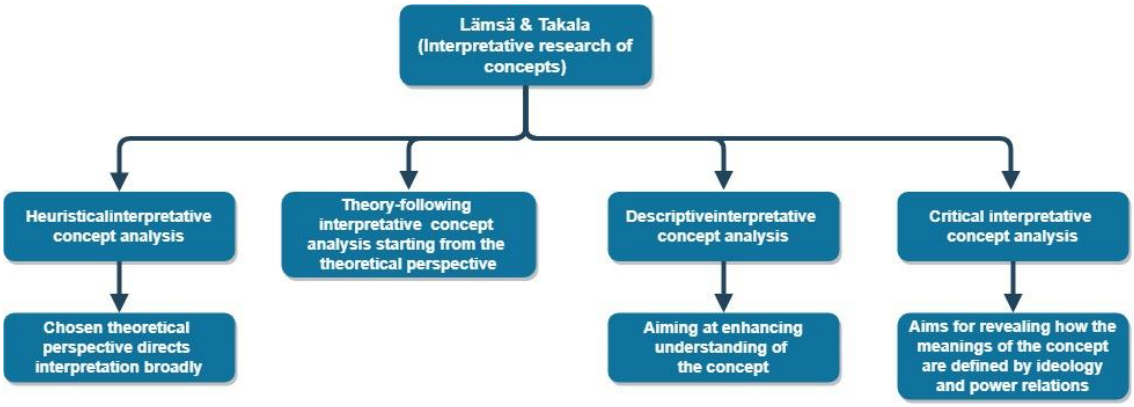

Figure 2.3: Four different types of interpretative concept analysis

This conceptual analysis is a descriptive interpretative concept analysis with the important presumption to understand description of the concepts without any critical objectives connected in the interpretation. Takala's and Lämsä's (2001) descriptive interpretative concept analysis aimed to determine the entirety of the meanings and possible changed meanings and to describe and to interpret that entirety, and to form holistic idea of the concepts. By following the principles of the hermeneutic cycle, the definitions and the meanings included in the concepts and in the definitions are studied and interpreted in an interpretative concept analysis concept (Pirttimaki., 2007). The

literal source material which is coherent and reliable relative to the research problem can get through when performing the data with interpretative concept analysis. The research objective and the way the research topic is outline required the important criteria in the choice. To perform this, understanding to the history of the phenomenon, current practices and compare them with each other from the immediate concept are required. The connection between the concepts and institutional practices are clarified as it is important in exploring new concepts and the development of their meanings. This interpretative concept analysis focuses on the theoretical perspective, the quality of the references used, and the references by which the concepts are chosen as subjects of interpretation (Pirttimaki., 2007). The understanding has proceeded according to the principles of a hermeneutic circle.

2.3.2 Näsi's four elements of concept analysis

Another method of conceptual analysis that suitable for this research is Näsi's four elements. Näsi (1980) says that it is not possible to describe an exact step-by-step procedure for concept analysis. The author suggests anyhow a set of interwoven phases for concept analysis. The four elements of Näsi's four elements are as shown in Figure 2.4, 2.5, 2.6 and 2.7.

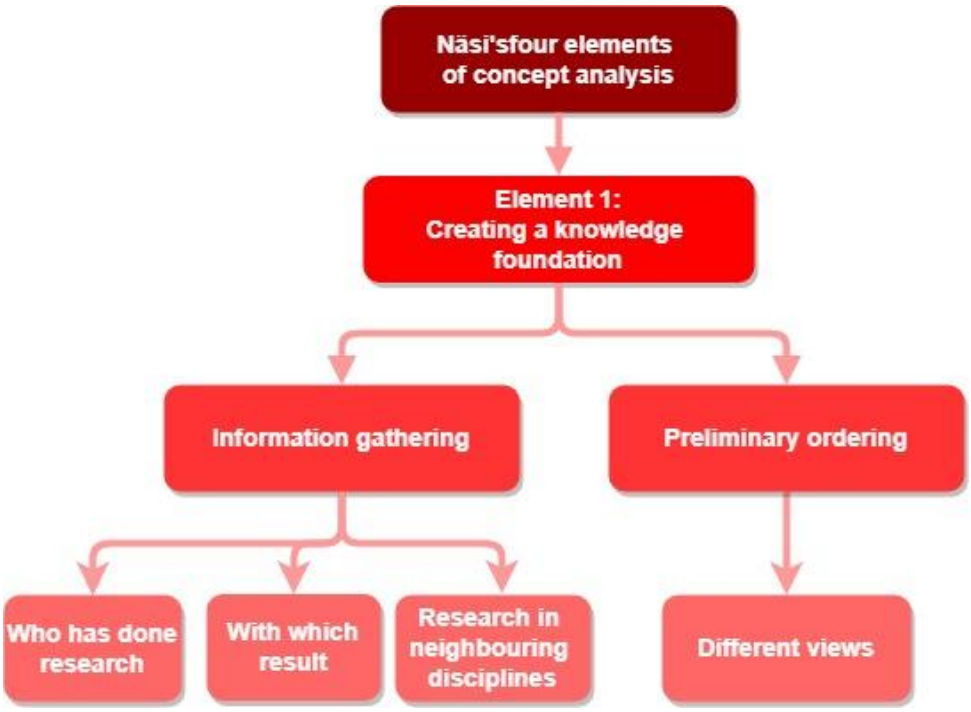

Figure 2.4: Element 1 of Näsi's four elements

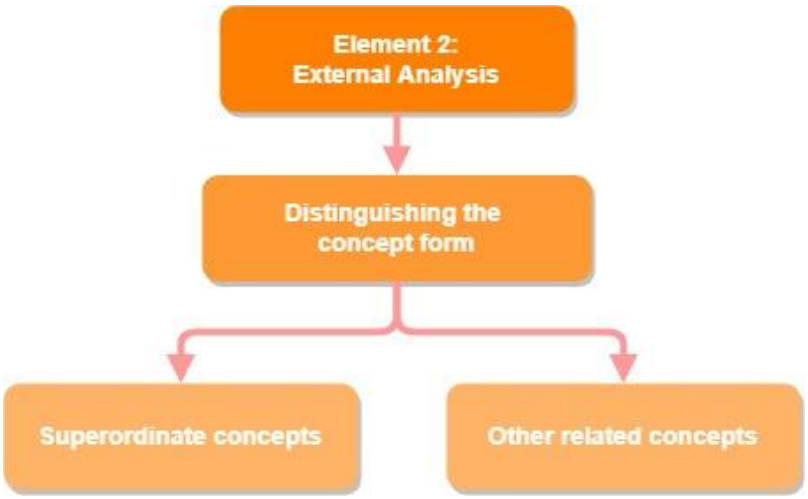

Figure 2.5: Element 2 of Näsi's four elements

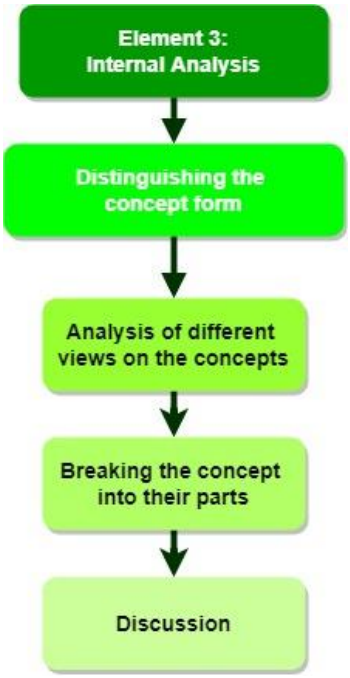

Figure 2.6: Element 3 of Näsi's four elements

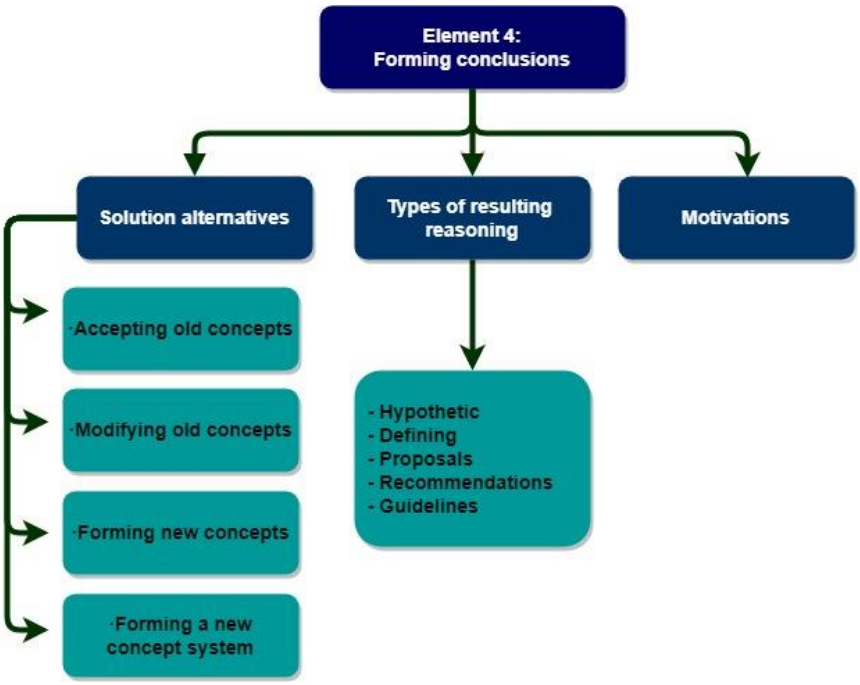

Figure 2.7: Element 4 of Näsi's four elements

At first, according to the Näsi's four elements, information on relevant research such as characteristics of SMEs, principles of LM and its results are gathered. The external analysis includes distinguishing and delimitation of the concepts that will be studied from superordinate concepts and with other related concepts. Important questions to be asked while analyzing concepts of discipline are: who has done research where the question of concepts is focal, with which results, and what is relevant research in neighbouring disciplines. In Näsi's internal analysis, concepts are broken down into a few parts, and then different view will be. Finally, solutions to concept problems are offered in the conclusion phase. Solutions could be modifying or accepting the old concepts or forming new concepts. Additionally, depending on the type and purpose of the study, Näsi will be distinguished between different types of reasoning (hypothetic, defining, proposal, recommendations, and guidelines). The discussion in terminology science has traditionally focused on contrasting normative and descriptive terminology work.

2.4 Best Method of Conceptual Analysis - Näsi's four elements of concept analysis

Takala and Lämsä (2001) gave more emphasis to interpretation of texts in their method for interpretative research of concepts, which has as its purpose to interpret meanings and definitions of concepts presented in written, textual form in the light of a chosen theoretical perspective. While, Concept analysis for Näsi (1980) means "target-oriented solving of conceptual problems; forming concepts through analytic and synthetic reasoning by using existing concepts and insight". Therefore, conceptual analysis of Näsi is more suitable for this research as this research involve study the existing LM principles and related to other SMEs concepts, such as characteristics of SMEs organization which is an existing concept too. Besides, the data also involve the opinions from the representative of the SMEs in Malaysia which Näsi's four elements of concept analysis is better in this case.

Moreover, Näsi (1980) has offered a more precise definition by stating that concepts are the counterparts of thinking-level which are presented on a linguistic-level by terms or other symbols related to an imaginary or an objective world; concepts describe compositions of mental images and meanings to contents. Precisely defined concepts are essential for scientific research. Especially, concepts and their definitions are key factors of a successful research when the measurement of a phenomenon is carried out. (Pirttimaki, 2007).

CHAPTER 3 RESEARCH METHODOLOGY

Firstly, the study will be performed by using the conceptual analysis method of Näsi's four elements. After that, survey for SMEs in Penang, Malaysia will be conducted. A google form will be prepared with the related questions based on the results of conceptual analysis and will send to the SMEs via e-mail. The data will be extracted from the reply of the company, then the data collected will be analysed and interpreted. Lastly, the best principles of lean manufacturing that can apply on SMEs in Malaysia will be defined.

3.1 Flow chart of conceptual analysis based on Näsi's four elements (Phase I)

Conceptual analysis starts with defining the problem and the purpose of using the concepts which is to determine the best principle of lean manufacturing to implement in the SMEs in Malaysia. The problem in this study is that the use of lean manufacturing concepts related to the SMEs is quite ambiguous and diverse. The concepts used to describe the problem vary between and within research fields of performance measurement and intangible assets.

The definitions and concepts are analysed and developed by performing both internal and external analysis of the concepts. Internal analysis will be needed to examine the details of the concepts and considering different views have been presented regarding them. External analysis will be performing separation of the concepts from similar concepts and identifying the upper-level concepts (Pirttimaki, 2007). The focus is mainly on the internal analysis in this study. This is due to the vast volume of varying views regarding to the concepts.

As a conclusion of the analysis, the definitions of the concepts are presented. As in any research, the results need to be verified. A practical measure of the successfulness of the new concept definitions is the extent that other researchers accept and adopt them. The success of a research depends on the clarity of the conceptualisation and how well others understand the concepts used.

In the following research, the conceptual analysis is carried out by first discussing the concepts related to LM and SMEs. Then, the different view of concepts related to both are analysed. Finally, make a conclusion on how the concepts relate to each other finishes the analysis. A detailed flow chart regarding this research is shown in the Figure 3.1 and 3.2.

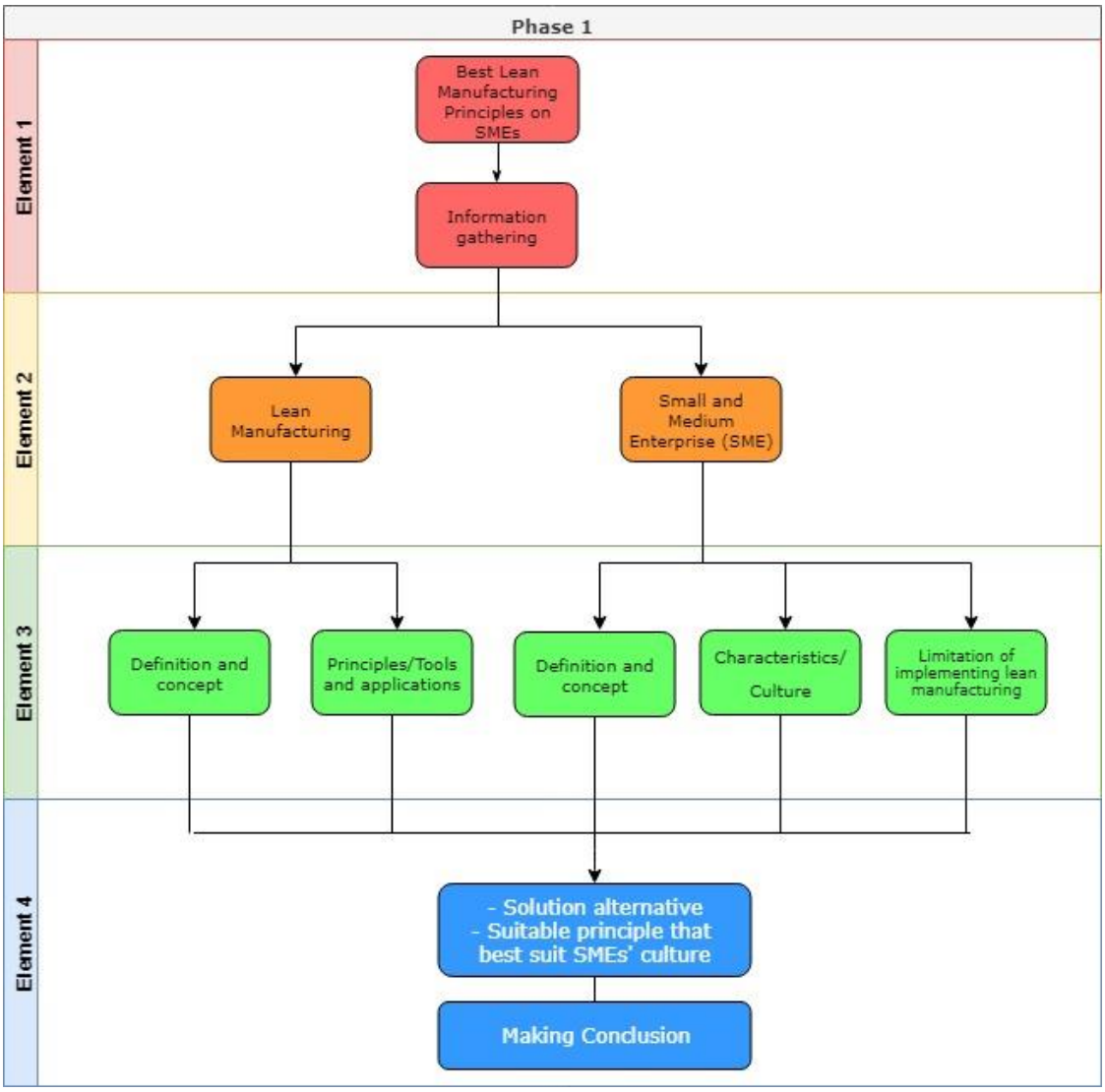

Figure 3.1: Flow Chart of conceptual analysis based on Näsi's four elements (Phase 1)

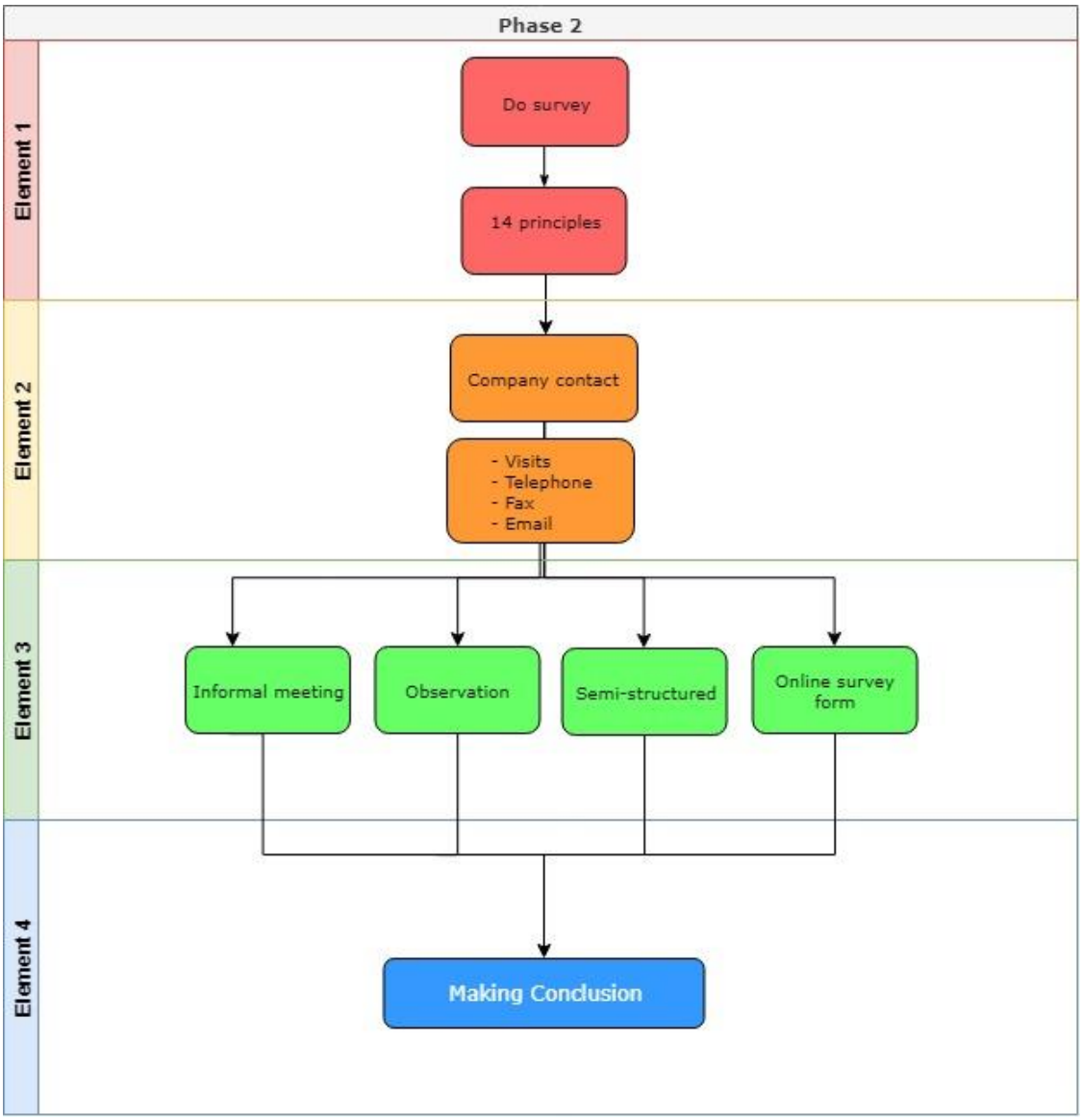

Figure 3.2: Flow chart of conceptual analysis based on Näsi's four elements (Phase 2)