Lean Strategy Implementation Challenges

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A thesis presented for the degree of

Master of Science

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May 12, 2020

Abstract

A Lean strategy is widely recognised for improving competitiveness in many manufacturing organisations. However, the majority of the organisations that attempt to implement Lean only on the shop floor do not completely succeed on it, as organisations face many critical factors like culture, training, and management support when implementing a new strategy. Hence, there is a need to address this topic of research. This research aims to investigate where potential breakdowns occur in the hierarchical levels within an organisation when trying to implement a Lean Strategy. The approach is based on findings from other authors and the variables of the study are linked with human behaviour. Moreover, the research contains data obtained from a questionnaire to analyse the perspective of two cases studies based in the Northeast of England and Mexico. This research consists of scheduled interviews applied to different hierarchical levels of the two organisations. The findings of the study will be used to improve the implementation of a Lean strategy in an organisation.

Statement of copyright

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1. Introduction

Improving competitiveness is the key for organisations to survive in the marketplace [1]. Organisations must develop flexible strategies that respond to rapidly changing customer needs. Lean is a strategy known for improving organisational productivity, reducing costs and increase quality [2]. However, there is a gap in implementing Lean and obtaining the desired results and not all the companies that attempt to apply Lean achieve successful outcomes [3].

Less than 10% of the organisations in the UK successfully meet Lean benefits [4]. Due to the high failure percentage of Lean implementation, previous research has outlined some critical factors such as organisational culture, management commitment, Lean training, communication & leadership cited by different authors such as Alagaraja, Bhasin & Shetty [2, 5, 6]. One of the remaining gaps related to this research is to establish a relationship between the critical factors and the success of implementing a Lean strategy in organisations [7].

The purpose of this study is to identify these critical success factors as well as to determine the importance of a strategic alignment between the shop floor and other hierarchical departments to succeed at implementing Lean in the whole organisation. This study aims to fill in these gaps and therefore, highlight what the organisations are not doing correctly to achieve an excellent Lean strategy implementation and thus, obtaining full Lean benefits.

The method used to assess this problem is an interview based on the critical success factors and an analysis of different organisation responses compared to their performance, and the relationship between the shop floor and the rest of the organisation. This method is considered as well established due to the previous research used to identify the critical factors described in this study.

Finding the gap that enables Lean success implementation will benefit business competitiveness and profitability. This research will give an overview of the Lean literature, describe critical factors that affect Lean implementation found by previous research and will develop a questionnaire to identify which of the challenges faced by Lean are significant to its implementation success.

This investigation analyses the perception and the degree of Lean implementation of companies from the UK & Mexico. The questionnaire was implemented as an interview in different organisations at different departments and hierarchical levels. The outcome will be the identification of the critical factors that Lean faces and a proposed strategy to overcome the barriers identified, which could be used to help future research.

This chapter describes the Lean context and the issues that organisations face when implementing Lean. The problems and the approach to deal with them is presented throughout this research.

Problem definition

Marvel & Standridge [8] argued that few organisations attain significant improvements by applying lean. The most successful Lean initiatives are considered those that include roadmaps or frameworks. However, there is a low rate of success that might be attributable to a lack of utilisation of the initiatives or a problematic understanding of those frameworks, according to Anand & Kodali [9]. Like all initiatives, each one should provide guidelines for all the steps required to succeed in the Lean transition. Organisation then must follow these elements systematically to achieve the transformation process. Nevertheless, because each organisation is different, it is difficult to standardise a method to implement Lean. Therefore, we can only highlight the factors and some of the steps required as essential to ease the Lean transformation.

The importance of this research has influenced authors to study and develop frameworks, roadmaps and assessment checklist to improve Lean implementation in organisations. Authors like Karlsson and Ahlstrom [10] developed an operational model that assess the organisational needs regarding Lean implementation. Other authors, such as Davies and Greenough [11], developed a template describing Lean practice. Sanchez & Perez [12] developed a Lean production assessment list. Succeeding in improving and ease the way Lean is being implemented will help organisations to increase their competitiveness within the market and therefore, their profit [13].

Although the benefits of Lean are more visible in the shop floor and manufacturing areas of an organisation, strategic alignment between the shop floor and the rest of the department's are essential to succeed with Lean. Hence, a Lean strategy should include the overall organisation for its success.

This research focuses on the main critical factors found by different authors in previous research. The purpose of this study is to discuss the critical factors and their importance to achieve a successful Lean implementation. The factors are divided into Strategy alignment of Lean with the overall organisation strategy, the influence of cultural differences, leadership, management commitment & engagement with Lean, the importance of communication and Lean training.

This study aims to investigate the following questions: 1. whether functional departments and hierarchical levels should consider shop-floor Lean processes to make decisions? And 2. What steps should the organisation follow to implement Lean successfully? This work aims at highlighting a practical path for a Lean transition within an organisation. This aim will be achieved by analysing case studies of organisations and their specific Lean implementation initiatives in comparison with the reviewing literature.

Within this research, we will attempt to meet the following objectives:

- Investigate and identify critical Lean success factors from previous research.
- Develop a methodology for collecting Lean implementation information from the cases studies.
- Evaluate Lean implementation information & perception of the organisations involved
- Identify the critical factors at attempting to implement Lean
- Propose an effective strategy to deal with the essential factors identified

The first chapter covers context, approach and objectives. Moreover, an introduction to the critical issues faced by Lean is mentioned. The chapter ends by defining the objectives of this research.

The next chapter discussed reviews the relevant literature, such as Lean definition, principles, tools, and factors that are critical for the Lean implementation. The chapter begins by giving an overview of Lean concepts. Then the critical factors and problems identified in previous research are stated.

Chapter three outlines the methodology used to approach the research problem and meet the objectives described in chapter one.

Data analysis from the interviews and results are shown in chapter four. The chapter ends with the discussion of the results obtained from chapter three.

Chapter five explains the results of the study, and a summary of the research, including limitations and recommendations for future investigations.

This research is based on previous studies and critical factors already identified by the literature review plus the analysis of the organisation case studies carried out by this research.

The investigation analyses perceptions and degree of Lean implementation in companies in the UK and Mexico. The study consists of a questionnaire applied as an interview in two organisations, in different departments and hierarchical levels. This study seeks to provide an identification of the critical factors that Lean faces and a proposed strategy to overcome the barriers identified.

2 Lean Literature review

The purpose of this research is to identify the factors that enable Lean implementation success. This chapter reviews Lean context and some background such as the evolution of the methodology, principles and tools and also describes the barriers that Lean faces when attempting its implementation; these barriers are selected from previous research findings and are described in the chapter. This chapter also helps to develop a better understanding of the problem organisations face.

2.1 Context review

One of the main challenges of any organisation is to reduce production cost. Organisations deal with global market challenges such as competitiveness and efficiency, hence the need of organisations to plan and develop new strategies. Lean is a strategy that aims to reduce waste by eliminating non-value added activities, thus reducing costs and increasing efficiency and competitiveness. According to a previous study, Lean is considered as one of the most critical methodologies that organisations could use to improve competitiveness [3].

Lean has been evolving and aligning as part of the strategy of multinational companies that have had experienced Lean's vast benefits such as increase of quality, productivity, customer satisfaction and a reduction of costs which increases profit. Organisations such as Caterpillar, GE & Toyota are real success examples of the enormous benefits that Lean can develop [14]. Moreover, Lean has been applied not only in manufacturing organisations but also in other business sectors such as services, health, education and energy.

Nevertheless, although by the considerable benefits that can be reaped from Lean, only a few companies had achieved implementing Lean as part of their organisational strategy. In contrast, others fail in meeting the desired results [3]. Moreover, this failure to implement Lean will result in a waste of time, resources and a motivational decrease. Studies have shown that less than 10% of organisations in the UK have accomplished an entirely successful Lean implementation [2], and previous researches arose that failure to implement a Lean strategy is most commonly due to a lack of understanding of the Lean approach [15].

There are a few studies based on Lean implementation and the critical factors that enable its success. A study done in Malaysia found that management engagement and commitment, communication and assessment are considered significant for successful Lean implementation [4]. Other studies have found factors such as lack of communication, culture, lack of approach understanding and lack of commitment [4]. However, more details and research is needed to find conclusions that are more accurate and close the gap between the critical factors and Lean implementation success.

2.2 Background review

2.2.1 Lean through time

Lean origins in Japan, it was developed after the second world war by the automotive company Toyota. The outcome of the war resulted in a significant fall of the country's economy; resources went down, hence, the need to use them carefully resulted in the development of the Toyota production system to improve productivity and eliminate waste or non-value added activities [15].

The Japanese Toyota company experienced a high performance with his production system which was soon established in all multinational manufacturing sites. The Toyota company improvements were so significant that many companies wanted to copy the system that Toyota used to increase their own performance.

Managers and employees perception from the Toyota Company stated that the factor behind such success is the cultural roots and not Lean practices [16]. In 1990, the term Lean was popularised in western companies by Womack & Jones with their book "the machine that changed the world" [17]. A book where the Toyota production system is described and the term Lean is highlighted. The authors describe Lean and define five principles that Lean has: define value, value stream, flow, pull and continuous improvement.

Lean is defined as a management philosophy focussed on identifying and eliminating waste throughout a product's entire value stream, extending not only within but also along with its entire supply chain network [15]. Although many authors have different definitions of Lean, it can be summarised as the elimination of waste from all aspects of the operations system and process[15]. However, Lean should be embraced in the overall strategy and not just only the manufacturing area. In this context, waste or Muda in Japanese terms "anything other than the minimum amount of equipment, materials, parts, space and time, which are essential to add value to the product" [15]. Womack and Jones define waste as all the activities that absorb resources and do not create value for the customer [17]. Therefore, valued activities are those the customer is willing to pay and that are needed for the successful completion of the process [6]. In addition to this, Taiichi Ohno categorised waste into seven types; however, years later, untapped human potential was introduced as the octave classification of waste[4], figure 1 shows how Lean classifies waste [18].

Figure 1 Lean wastes

2.2.2 Lean vs six sigma

Lean involves many practices such as Just in time (JIT), Total quality management (TQM), Total productive maintenance (TPM), continuous improvement and supplier management & effective human resource management [3].

Before the merger of Lean and Six sigma, the concepts were separated. Lean focuses on reducing waste, and Six sigma concentrates on the statistical analysis and process control. Six sigma + lean is a systematic development and combination of tools and methods for improving processes. It derives the elimination of waste and defects from an analysis of processes based on facts. When being well implemented, it increases customer satisfaction and company value. When applying it consequently (continuously), it provides an integrated approach for changing the company culture [19].

2.2.3 Lean principles

Research shows that Lean implementation practices should support the organisation business strategy; otherwise, it will not be stable, and the benefits will not be sufficiently obtained [20]. Womack & Jones [17] stated that Lean is a set of principles and that these are critical to remove the non-value added activities and to obtain higher competitiveness.

1. Value: Identify the value from the customer perspective
2. Value stream: Map the value stream process to understand how value flows through the organisation.
3. Flow: Create a flow along the value chain by reducing waste.
4. Pull: Establish a customer pull system, where everything needed is provided on time.
5. Perfection: Pursue perfection through continuous improvement.

With the Lean principles approach, customer needs and requirements are studied so the product can meet the customer specifications [6]. According to many authors, following these principles step by step can lead an organisation to success when implementing Lean [3].

2.2.4 Lean tools & techniques

Lean also consists of a vast set of tools and techniques that help to identify and remove waste [9]. These tools can be applied to any organisation. However, they should not be implemented in isolation but embrace and support the overall strategy. Some of the tools are:

- JIT: the approach of this tool is the zero inventory levels. It consists of getting the required parts and quantity in the required area when it is needed.
- JIDOKA: this is the Japanese word for automation. The use of intelligent machines that start-stop, change and display signals allow the workers to focus on inspection of the product improving quality [21].
- Visual control: the use of dashboards, markers or flags are part of the communication of the process, which helps to make decisions. Moreover, you can determine bottlenecks, process issues, targets and priorities.
- TPM: is a total system of preventive maintenance for life and the maximum effectiveness of the equipment [21].
- SMED: developed by Shingeo Shingo, 'Single Minute Exchange of Dies' seeks to reduce the setup time by a quick changeover of tools.

- KANBAN: Means visual control in Japanese and aims to control the inventory and production scheduling in JIT environments [21]. Moreover, Kanban uses cards or signals to control the flow of the materials within the process.
- 5S Workplace organisation is a method to organise the workplace by keeping it clean, maintain standards and sustain the discipline needed for high quality work [1]. The words in Japanese are 'serie, seiton, seiso, seiketsu and shitsuke,' which mean sort, set order, shine, standardise and sustain.
- Value stream mapping (VSM): is a tool used to map every process. It is used to document, analyse and improve the flow of information and materials required in a process.

It has been proven that waste can be reduced by applying these tools. These set of tools have been implemented by organisations and proven to reduce cycle times, inventories, set up times, equipment downtime, rework, scrap and other wastes [6]. Therefore, a good understanding of the tools is critical to meet Lean goals success. Hence, the importance of tools assessment in the methodology of this research.

2.3 Lean strategy

An organisation's strategy requires to explain where it wants to go (the why), and how to intend to get there (the plan). Therefore, it is necessary to cascade the top-level strategies into the division, departments and finally to individual responsibilities, action plans, quantifiable goals and timeliness [2]. Integrating all the organisational levels as part of the structure and aligning Lean to the business strategy will enable a successful Lean implementation.

A strategy is defined as the direction and scope of the activities of an organisation over a long-term, which develops an advantage for the organisation by configuring their resources within a challenging environment and thus, meet the market needs and fulfil stakeholders requirements [22]. A strategy is a pattern of decisions that determines and reveals its objectives, purposes or goals [13]. Developing a strategy considers decisions such as the company mission, market, and competence. Hence, if an organisation wants to succeed in implementing Lean, an alignment between the shop floor and other departments is critical. Moreover, support the business strategy by being in line with the organisational philosophy, mission, vision, values, and plans; thus, achieving performance success and long-term competitiveness [20].

Previous research claim that to reach organisational success and longevity is essential to develop a strategy and strategic implementation [5]. However, it is usual to apply Lean at the operational level. According to previous researchers, Lean exists at two levels, the strategic and the operational, and the distinction of these levels is crucial to understand Lean as a whole [23]. Therefore, focusing on one level instead of extending Lean to the overall organisation provide the insufficient understanding and inadequate deployment of strategy implementation [5]. Lean techniques are mostly manufacturing related, and one of the main reasons that so few companies achieve successful Lean transformations is that they focus on Lean efforts only in the operations area [24]. A strategy concerns the whole organisation; therefore, aligning and developing Lean with the overall strategy should be considered as the first step for Lean implementation. Hence, the purpose of this study is to fill the missing link between Lean failures and strategy implementation success by assessing some cases studies comparing their actual implementation with the factors highlighted in the literature review.

Companies try to replicate the Toyota Production System strategy as their method of implementing Lean. However, this can be a cause of failure instead of success. Every organisation is different and has different conditions; therefore, there is a need to recognise that there is not a unique recipe for Lean implementation. Implementing a tool might follow the same process, but linking the tools to the organisational strategy is different for each organisation. That is why replicate organisations process or strategy is one of the main reasons to fail at implementing Lean [2]. Therefore, successful Lean companies have their version of the Toyota Production System (TPS) [5].

Moreover, when there is not alignment between the strategy and the organisation aims, instead of improving, the inappropriate approach could lead to a waste of time, resources and costs. Hence, the need for a systematic method to implement a Lean strategy is essential [25].

When trying to develop a new strategy in an organisation, it is necessary to be aware of the changes in behaviours that this might cause to the individuals. A culture shift is critical and essential for strategy implementation; otherwise, Lean will fail [2]. In addition to this, develop an organisational strategy successfully consider the following factors; a clear idea of the needed change, how to deal with the culture to ensure success and skills that other managers need to implement the strategy successfully [26].

2.4 Enablers of a Lean strategy implementation

Most of the organisations that struggle to implement Lean are SMEs. The contribution that these small and medium-sized companies make to the private sector output in all the economies of the world is significant, 90% of the world's business and they also employ 50% of the workforce, the rest is employed by large organisations [27]. However, the struggle to remain competitive is high, and avoiding failure requires a change. Research has shown that SME's face issues such as less financial and people resources as well as less management experience, lack of training in Lean, strategy and vision and resistance to change [27]. Therefore, filling the gap of Lean implementation factors with success will develop these companies to improve the overall economy.

The process of implementing Lean is an overall change and challenge for any company. Although many organisations have implemented Lean manufacturing, only a few of them attain significant improvements [9]. A study made in the UK reported that less than 10% of the organisations succeed on Lean [2]. Therefore, the main issue to success on Lean is to overcome these challenges to obtain the desired benefits, hence the aim of this research.

Many researchers have contributed to highlighting critical factors regarding Lean implementation. Critical success factors (CSF) are defined as "those few things that must go well to ensure success" [28]. According to previous research, these factors are; visible top management commitment; a clear definition of customer requirements; an understanding of core business processes and their critical characteristics; rewarding and recognising the team members; communicating the success and failure stories, and selecting the right people and the right projects [16]. Other investigations obtained four essential factors of Lean: leadership and management; finance; skills and expertise; and culture of the recipient organisation [3]. These critical factors must be identified, assessed and faced to overcome the challenges of a Lean implementation.

Many arguments are claiming that one of the main reasons for failing in Lean implementation is the incorrect interpretation of the real concept and approach of Lean [3]. Moreover, research has shown that the reason that enhances Lean misunderstanding are cultural differences like behaviours, attitudes, communication, and leadership [3].

In addition to this, misunderstanding of Lean enables the misapplications of their tools, whether using the wrong tool to solve a problem or using one single tool to try to solve all the issues [9]. A study made in Qatar showed that 50% of the individuals assessed claimed that the lack of knowing how to implement a Lean tool is a critical failure factor [4].

The reasons that the study revealed are the mindset of fear to change, cost and time and lack of knowledge in concepts. Resistance to change is due to a lack of training and understanding of the tools. Besides, research has shown that hiring consultants could help coach executive leaders in implementing Lean [24]. Hence, external consultants could enhance organisational knowledge on how to apply Lean correctly.

The factors mentioned previously such as, resistance to change, understanding of the tools, reward and recognition of team members, management commitment, and more, are considered as critical in the Lean strategy implementation, hence their inclusion in the interview of this research as part of their assessment.

Furthermore, the results of another Indian study showed critical factors that the organisation faced at implementing Lean. The results showed lack of management focus, lack of management support, lack of capital fund, lack of training, lack of implementation know-how, company culture and no financial targets available for implementation of Lean manufacturing as significant factors that Lean faces. However, further research is needed to ensure that this study could be generalised with other companies in other countries.

S. No.	Lean Manufacturing Benefit	1	2	3	4	5	Element Mean	Mean	t value calculated	Result	S. No.
1	Lack of management focus	1	4	13	20	21	3.949	1.007	**2.1559**	H_o accepted	
2	Lack of urge to create sense of urgency	0	8	19	19	13	3.627	0.981	-0.3079	H_o rejected	H_{a3} accepted
3	Lack of management support	1	3	16	18	21	3.932	0.998	**2.0462**	H_o accepted	
4	Lack of long term vision	1	6	16	17	19	3.797	1.063	0.9404	H_o rejected	H_{a3} accepted
5	Lack of labor resources	0	4	20	20	15	3.780	0.911	0.9546	H_o rejected	H_{a3} accepted
6	Lack of capital fund	0	3	17	22	17	3.898	0.885	**2.0132**	H_o accepted	
7	Lack of communication	0	7	23	16	13	3.593	0.967	-0.5816	H_o rejected	H_{a3} accepted
8	Lack of idea innovation	1	4	20	24	10	3.644	0.905	-0.1898	H_o rejected	H_{a3} accepted
9	Mediocre Consultants	1	5	15	28	10	3.695	0.915	0.2392	H_o rejected	H_{a3} accepted
10	Lack of time	0	2	26	19	12	3.695	0.836	0.2617	H_o rejected	H_{a3} accepted
11	Lack of training	1	1	18	20	19	3.932	0.926	**2.2046**	H_o accepted	
12	Lack of understanding about Lean	0	4	18	27	10	3.729	0.827	0.5794	H_o rejected	H_{a3} accepted
13	Lack of implementation know-how	0	5	15	19	20	3.915	0.970	**1.9702**	H_o accepted	
14	Conflicts with Other Initiatives like TQP,TPM,JIT	0	6	23	24	6	3.508	0.817	-1.4845	H_o rejected	H_{a3} accepted
15	Disparate Manufacturing Environments	1	4	17	12	25	3.949	1.074	**2.0227**	H_o accepted	
16	Demand Volatility	2	3	22	20	12	3.627	0.981	-0.3079	H_o rejected	H_{a3} accepted
17	Conflicts with ERP Implementations	1	3	15	26	14	3.831	0.913	1.3809	H_o rejected	H_{a3} accepted
18	Company culture	1	3	17	16	22	3.932	1.015	**2.0116**	H_o accepted	
19	Employee resist to change	1	9	24	20	5	3.322	0.899	-2.9425	H_o rejected	H_{a3} accepted
20	Middle management resistance	1	11	18	20	9	3.424	1.021	-1.8268	H_o rejected	H_{a3} accepted
21	No direct financial advantage	1	14	25	7	12	3.254	1.092	-2.8990	H_o rejected	H_{a3} accepted
22	Financial benefits not recognized	1	8	21	19	10	3.492	0.989	-1.3583	H_o rejected	H_{a3} accepted
23	No financial targets	1	5	12	20	21	3.932	1.032	**1.9787**	H_o accepted	
24	Past experience of failure	0	20	22	11	6	3.051	0.972	-4.8625	H_o rejected	H_{a3} accepted
25	Lack of Staying Power	0	13	28	14	4	3.153	0.847	-4.6987	H_o rejected	H_{a3} accepted
				Population mean			3.608	N=59			

Figure 2 Lean critical factors faced by Indian industry [21]

The description of the critical success factors show how they affect the organisations in implementing a Lean strategy; this is supported by previous research and related to the methodology of this research.

2.5 Training

Training is considered another critical challenge for Lean. For sure, knowledge and training are crucial for practising any activity. In what Lean believes, there is a need to reinforce Lean training within organisations. Previous research showed that a lack of adequate training is one of the main factors that negatively impact the success of lean implementations [24]. Despite the high importance and percentage companies considering Lean, 91% of the companies find it essential; however, 64% felt that they did not have a proper understanding of Lean, and even 55% revealed not to have a Lean training programme [2]. Therefore, despite companies considering Lean implementation as essential, training and Lean knowledge is still a challenge to face for success.

Interest in companies for Lean is so that some companies even invest in training for their employees. Research shows that developing people will develop the organisation itself. Moreover, a study has shown a link between resistance to change and training skills [24]. Lack of knowledge and Lean skills causes resistance to change among managers [9]. A solution to overcome these challenges is to develop a Lean education training program and an assessment to measure the training impact and performance [9] ; this is an important factor that will be evaluated in the methodology if this research. However, it is essential first to train the top management and then a selected team, an example is CAT company where most middle and top managers are Lean black belts. Besides, companies should not just see value in developing internal Lean experts, but also to hire external consultant's experts [24]. Successful Lean companies invest in training for employees. Developing a Lean training programme, even though investment could be high, are worth the benefits of Lean. From top management to shop floor is the way Lean should be implemented in any organisation. Managers are needed be trained first and then their employees, the sequence starts from the top; managers and team leaders will train other teams, and so on.

2.6 Culture

If one is to consider the implementation of Lean as part of the overall organisation strategy, it is crucial to understand that for any strategy implementation to be successful there must be a focus on a culture shift within the facility to secure sustainable change within the Lean philosophy [29]. A problem found in British organisations is that employees work under pressure and have to deliver benefits in the first year of Lean implementation. Yet, more, the failure of Lean can be attributable to a rush attempt of cultural change and fast results [2]. However, ensuring success is a long-term focus and developing a Lean learning culture will require a decade or more. Therefore, successful Lean companies recognise that developing a Lean culture is a lengthy and never-ending process [24]. Hence, continuous improvement, also known as "perusing for perfection" (fifth Womack Lean principle) is critical to success on Lean.

The term culture in an organisation consists of shared values, symbols, behaviours, and assumptions that distinguish the members of one group from another. Culture is how an organisation meet its goals and mission, solve their problems or the behaviour of the individuals within the group, in short words, organisational culture is "the way things are done around here" [30].

To understand the culture within an organisation, we have to identify and clarify the elements that affect an organisational culture, which is; trust, communication, leadership & reward system [30]. An organisation is divided into three levels of culture: individual, groups (departments) and the organisation itself [31].

To achieve the organisation's goals is crucial that individuals, as well as groups, accomplish their own goals first. However, if an individual is not motivated to carry out his tasks, or if the group/department has trouble working in teams, the organisation will not succeed with their goals.

Furthermore, with this statement, we can link effectiveness with individuals, teams and the organisation. When staff is empowered and committed it is more likely to meet all the goals and needs, knowledge and evidence are developed, used and shared, and therefore success in the first two levels of culture and then in the overall organisation [30]. However, there are several factors linked to cultural change: Management support; leadership; involvement and participation; attitude; teamwork; and open communication enable culture effectiveness. A positive relationship is generated between cultural change and Lean strategy success.

The alignment of many factors develop an organisational culture. Research shows that organisational culture involves six major categories shown in figure 4. Information systems, people, process, leadership, reward system and organisation structure are considered significant types to take care of when developing Lean organisational culture [32].

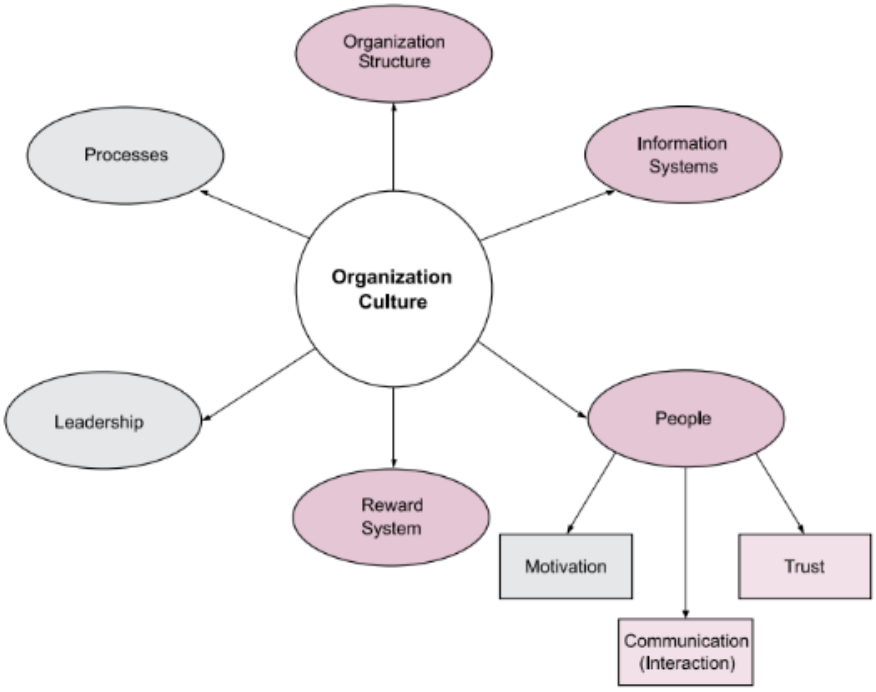

Figure 3 Culture [32]

A recent study showed other factors that enable the development of a culture shift. The study found that the reason why people work determines the performance and also the reason is categorised into the following six concepts:

1. Play: motivation by the work itself.
2. Purpose: when the work fits with your identity, and you value the impact of it.
3. Potential: This is when you find that the work benefits your identity and enhances your potential.
4. Emotional pressure: when external forces threaten your identity, you work to avoid disappointing yourself or others.
5. Economic pressure: when you work to gain a reward or avoid punishments.
6. Inertia: work without identifying the reason why you work.

However, the previous concepts are also divided into enablers of performance (the first three) and hurters (the last three). Besides this, the same research proposed how to deal with these constraints.

To develop motivation and commitment, leaders should follow the following steps:

1. Meetings with the team: This could be once a week. However, it is crucial to analyse the following questions: what did I learn this week? (Play reason), what impact did I have (impact reason) and what do I want to learn next week (purpose reason). Enhancing this will increase an individual's motivation.
2. Explain the reason behind the work of your team. Start defining the importance and impact of the project and how will it help the customer instead of only asking for the results.
3. Know where the individual would like to be in two years and a plan to help them to reach their potential.

2.6.1 Employee's involvement

Employee involvement is considered as one of the main factors that enable success in implementing Lean. Knowing the employee's perspective is essential because they are the ones in the best position to offer suggestions for improving the work that they do. Research has shown that employee engagement and sustainment of Lean are strongly correlated [24]. Later, other researchers claimed that involving employees to the continuous improvement process influences successful transformation. There is a link between people engagement, cultural change and success of Lean [2].

Lean culture results from engaging employees from all parts and levels of the organisation in a consistent means of continuous improvement [24]. However, involving employees is about to give them trust to participate and to suggest improvements to the process for decisions to be made. Employee engagement, according to previous research, is vital for success [2].

2.6.2 Rewards system

Motivating people to realise their tasks will improve their performance and productivity. Therefore, there is a need to implement motivational tools to reach and increase performance levels [4]. Recognition and reward systems are used to reach new long-term goals by helping to increase employee's commitment and motivation. In a meta-review of 45 incentive studies, show that reward systems have a significant positive relation with productivity [33], however, those are mostly financial rewards, is mostly about money. Although this is the first thought to consider, research shows that this is many times not the best option. Participants who deemed Lean to be successful in their organisation mostly spoke about non-financial rewards.

In contrast, those who felt the deployment was not successful talked about both financial and non-financial rewards [34]. The reward system aim is not focusing on the value of the award but the recognition of the effort and success of the staff members. To success encouragement, these rewards can be given even though the achievement is not accomplished yet [35]. These rewards are linked to the six reasons shown in the previous topic; if there is no purpose, financial rewards instead of enhancing motivation will increase the motivational pressure. Hence, non-financial rewards are critical to improve commitment, engagement, and motivation and thus, increase performance levels, as long as the purpose is recognised by the individual. Moreover, rewards have more impact if they are done publicly, and they can be used to reward departments and thus, encourage teamwork.

2.6.3 Empowerment

According to Menezes, wood, & glade, some of the practices that support Lean implementation is empowerment, teamwork and culture [36]. Empowerment is defined as the act of building, developing and increasing power through cooperating, sharing and working together, being communication the key of its success [35]. Some of the benefits of empowerment are customer satisfaction, skills enhancement, sense of achievement by having a sense of real impact and organisational effectiveness [35]. Thus, organisations should seek to empower their employees if they want to respond to rapid changes. Empowerment allows flexibility to customer market demands which is critical in the market nowadays. However, active management and leadership are needed to develop empowerment.

2.6.4 Assessment

Sometimes there is a gap between the expected outcomes and the current situation. Measuring the performance and having a baseline is essential in every process, as you can track their issues and improve [2]. There is a link between implementation success and team performance evaluation. Therefore, internal audits are essential to develop the motivation of employees and to maintain their focus on strategic change, performance, and as a result, communicate to employees the importance of the lean initiative [33]. A Lean performance measurement system is an essential factor that provides information to the organisation, especially managers, to make decisions and take actions according to the results obtained [25].

Another essential factor in succeeding on Lean is the presence of an external consultant. An example of this is the company Machinery Inc. that in their second attempt of implementing Lean, they hired a Japanese consultant that used to work with Toyota Company [37]**.** A mentor or consultant, therefore, is essential to be in the Lean journey, as it could be helpful to determine corrective actions**.**

2.6.5 Communication

Communication plays a leading role in the culture of an organisation as product or cause, thus, supporting lean practices in manufacturing, especially for companies that are in the early stages of lean implementation [3]. If there is not an excellent communication among the different departments of the organisation, each of them will act independently of each other, and thus, failing at the strategy implementation. However, what is excellent communication?

Previous research shows that there is a need of clear communication between shop floor's day and night shifts and value streams [38]. Although clear communication is understood as a precise method of sending and receiving responses, especially in problems.

Moreover, communication about Lean results is an essential factor to succeed. Researchers revealed that communicating Lean pilot project success increased the support from the shop floor and managers to expand Lean practice through all the organisation [24]. Thus, communicating success cases encourage managers and employees to develop a better Lean strategy. Hence, this interview aims to demonstrate that clear communication between shop floor and other departments is one of the factors that enable a Lean strategy to succeed.

Also, the involvement of employees within the process and different departments is crucial to develop clear communication. By involving people from various departments, some of the barriers among them can break down, and the relationship will be enforced, which will make more comfortable to work with different departments in future collaborated projects [39]. However, it is essential to have clear communication and include all shifts within the process changes. Even though each organisation has different issues, not being transparent with the strategic goals might confuse employees.

It is essential for managers to transparency in communication; meetings are necessary so all the team knows the goals.

2.6.6 Senior management commitment

Another critical factor that retains Lean success, according to many studies is top management involvement. Developing a change within an organisation needs buy-in from senior management. Previous research has found that to develop a Lean culture is needed a wiliness to change the actual perception of the organisation, starting from top management to the shop floor [40]. Therefore, to succeed in lean implementation, organisational culture development is one of the main factors to take care of, and that can only start from the top of the organisation.

For top management, a full understanding of the Lean approach is critical before its development within the organisation. A case of success in the Netherlands revealed that top-level managers must have a good knowledge of Lean and not just support it without its knowledge [24]. One example is the Caterpillar company, where most of the managers have a Lean certification. Therefore, the way things are done in the organisation has to start from the top of it.

As evidence claim, top management commitment in the implementation process is a significant facilitating factor [24]. However, the complete success of the application of Lean philosophy depends on close cooperation between the shop floor and management [4]. There are critical factors that any organisation faces and should be vital at dealing with them. For a changing culture success, it is essential to deploy communication, trust, structure and reward systems, where leadership by managers is a critical role. Leadership, however, could be demonstrated by directly involving at the implementation and participating in Lean improvement activities [24].

There is a link between commitment and motivation. Moreover, those factors are linked to Lean transformation success. Commitment means being involved and directly participating in Lean improvement activities [24]. Also, the importance of leadership and commitment needed by top management to embrace and roll out the Lean approach activities is recognised [4]. Furthermore, a study made with Indian manufacturing companies identified a lack of involvement of high management as the primary input to eliminate other barriers [4]. There is a clear relationship between management as a main critical factor that enables Lean strategy success or failure.

There are three principles linked between managers and Lean implementation [41]. One of them is (1) expert teams; people trained with Lean knowledge. Develop a performance reporting process (2), including short daily meetings, visual displays and financial performance; that enable to track improvements, and the use of non-financial reward system (3). These three principles are linked with engagement, communication and training, factors that will allow success at developing a Lean strategy.

Even though culture change is considered a critical factor to develop Lean success, what is the reason to fail on a cultural shift? An overload of information on Lean affects the real understanding of the approach [42]. Thus, misunderstanding of Lean by confused and not certain information causes a misapplication of Lean tools [3], and as a result, failure to develop it. A study made in Qatar showed that 50% of people lack knowing how to implement Lean, and 44% indicated culture as the main factor to fail [4]. Without culture development, Lean will eventually fail. Culture plays a significant role not only for Lean but also for the development and sustainability of any strategy, and therefore, this is an important factor included in the interview.

2.7 The Toyota way 4P model

The Toyota way revealed 14 management principles that the Toyota Company used to succeed with Lean. Figure 3 shows the Toyota way principles, which are divided into the 4P model; philosophy, process, people & partners and problem-solving [43].

One of the main reasons for low success rate in Lean is focusing on training and tools rather than human management, where culture plays a critical role in Lean strategy implementation success [44]. However, the first step is a management buy-in and commitment to Lean and therefore, employees involvement within the continuous improvement process can be developed [19].

Moreover, the organisation needs to consider and be aware of the motivational factors affecting the team members, which foster leadership, teamwork, respect, empowerment and thus, organisational culture. According to Toyota critical factors to success in Lean strategy implementation, the first step at an attempt to develop Lean is considered the change of the corporate culture [45]. An open and proactive culture where continuous improvement is the daily job for all the departments. In addition to these, top management factor is vital to success of the Lean implementation, active management with visionary leadership and encouragement for employee's involvement and empowerment with a clear vision, communication and strategy [45].

This model is used in the methodology of this research. Some of the questions used in the interview are based in the Toyota way 4P model. Therefore, its importance to be mentioned in the literature review.

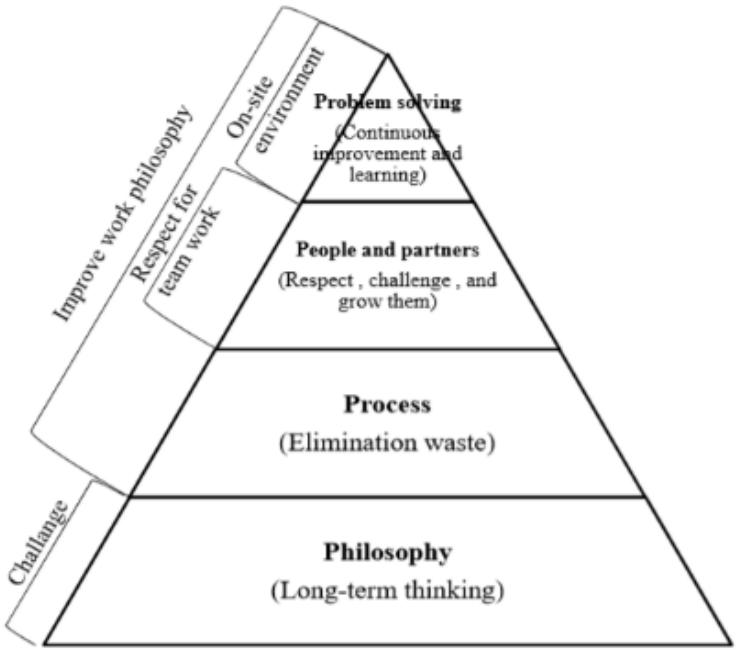

Figure 4 Toyota 4P model [44]

2.8 Shop floor relationships with the departments

Many authors have previously defined the Lean concept. One of them is that Lean is a management philosophy that aims to eliminate waste throughout the value stream but not only within the organisation but also the supply chain network, where it includes customers and suppliers [37].

The transition where an organisation becomes Lean is mostly focused on the shop floor rather than considering all departments. The problem is that instead of involving all the supply chain, organisations just develop a set of tools in some of the processes, resulting in just small steps but not a complete Lean cultural change. Doing Lean is not the same as becoming Lean, where there must be an alignment to the overall organisation strategy.

Machinery Inc. stated that to become Lean at functional areas and hierarchical levels, alignment and communication ranging from the shop floor to senior management is essential. In this organisation, when they first tried to implement, Lean communication regarding the Lean projects was not shared with other employees from different functional areas. Besides, their pilot project was only focused on selected processes of the shop floor, communication with the members of other processes in the shop floor was not encouraged, therefore not even all manufacturing areas knew about the Lean pilot project. Lack of communication caused a lack of support from other departments due to a lack of awareness of what Lean is. If communication was shared and all employees would have been aware of Lean, support and motivation would have changed the outcomes.

One of the aims of this research is to identify if relationship of shop floor with the other departments is important to succeed in Lean. For that reason, this is an important factor to assess in the methodology of this research.

This chapter has shown that it is essential to see Lean as a philosophy rather than just an operational perspective. An alignment between the shop floor and the other functional areas is considered critical to success at a Lean strategy implementation. Moreover, the assessment and awareness of the other critical factors described in the literature review play an essential role in a successful Lean implementation. To summarise these factors importance, we found in the literature review that a Lean training programme starting from the management is one of the factors to take care of to fully understand the tools, techniques, and huge impact of a Lean approach.

The importance of involving the employees within the process and different departments or levels of the organisation, which is linked to the development of a clear communication, that results on the development of an organisational culture. However, the organisational culture development only starts from the top of the organisation, with the senior management commitment/involvement. Hence, its importance.

On the other hand, lack of communication could lead to misinformation amongst departments and make them act independently, as in a different direction. Thus, failing to succeed on Lean or any strategy implementation. To conclude, the alignment of all these key factors reviewed on the literature could lead to the success of the Lean strategy implementation, and that is the reason why these factors are part of the methodology of this research and will be part of the questions used in the interviews with the 2 cases studies.

3. Materials and methods

Chapter two discusses the literature of the main topics involving Lean and the critical factors found by previous research. This chapter will describe the methodology used to approach the aims of this research.

The research approach

This research methodology is based by used methods. This study aims to highlight the elements that enable a Lean implementation & the relationship between shop floor and the rest of the organisation. This methodology includes the literature review, a collaboration with two organisations and employee interviews. The location of the organisations is in the UK and Mexico.

According to previous research and to the purpose of this research, the best method to collect data is by interviewing employees [6]. Therefore, an interview method is used in this study. Moreover, the steps used for the development of the interview's questionnaire are divided into 1. Define the research area; 2. Identify the sample; 3. Decide how to collect answers; 4. Design the questionnaire; 5. Run a pilot interview; 6. Carry out the main interviews and 7. Analyse the data. To give more objective results and different perceptions, employees interviewed were chosen from various departments and hierarchical levels. In this study, the sample includes Shop floor supervisors, Quality manager, Lean black belt, R&D, and others.

The questionnaire was developed based on previous research [2, 6, 17, 44]. Those studies aimed to determine a Lean strategy approach in various organisations, the division of Lean principles and the importance of People within Lean strategy implementation developing thus the 4P Toyota model; which is already described in the literature review.

This research focuses on the two organisations cases studies and the effect of the critical factors described in the literature review and the relationship between the shop floor and functional department's activities. The study also determines the perception of Lean from the different departments and hierarchical levels; such perceptions are benefits of Lean, the progress they have had experienced and the critical barriers.

The goal of this research is to create a methodology that will assess Lean implementation and will identify the critical factors in implementing a Lean strategy.

The objectives of this research will be the following:

- Identify critical factors from previous literature
- Develop a method to assess these factors
- Collect and analyse the data of different case studies
- Identify the essential factors that enable lean strategy implementation
- Propose a model to assess Lean implementation

Our research question is:

Must shop floor processes be considered in any activity carried out by the rest of the organisation?

Methodology steps

The methodology is based on previous research on critical factors found by many authors. The method used in this research is divided into the seven phases mentioned before, which are; defining the research, identify the sample, selection of the method, designing the questionnaire, run the pilot interview, application of the interview and analysis of data. The steps with their approach are defined in table 1:

Steps	**Approach**
1. Define research	Lean strategy implementation critical factors and the relationship between the shop floor and functional departments.
2. Identify sample	Different departments and hierarchical levels from two organisations selected.
3. Select method	A questionnaire presented as an interview.
4. Design questionnaire	A questionnaire-based on literature review
5. Run the pilot questionnaire	Members of the university analysed the pilot questionnaire.
6. Application of the interview	The final interview was applied to the sample identified
7. Analyse data	Data was collected on the Likert scale and analysed in Excel.

Table 1 Methodology steps

Questionnaire development

Previous investigation has shown essential findings related to critical factors in Lean implementation. Lean principles, tools and critical factors were gathered for previous research to develop this questionnaire. The questionnaire is divided into three sections, including the factors described in chapter two of this thesis which are strategy, culture, training, management support, lean assessment, communication & employees' engagement.

Once the factors were stated, the next step was to develop the questions that would measure each of the elements. The structure of the items is a 5-point Likert scale (level of agreement) going from "strongly disagree" to "strongly agree". The rate is from one to five, where one is the lowest and five the highest—rating the statement that better represents the current situation of their organisation. This scale is the most common format used for assessing participants considered as the most useful scale available [6].

Demographics is the first section; it will help to understand the background information of the individuals. In this section, aspects such as age, gender, education, working experience, job title, Lean background and company size are covered.

The next section is Lean background. This section will ask attempts of Lean implementation, years of Lean implementation within the current company working with, current stage of Lean; whether it has positive results or just starting to implement it. It also will ask the number of Lean projects performed, who decides which project to develop, factors faced, Lean concepts knowledge and use within the company, and if there is a Lean assessment. Moreover, this section will cover questions related to the importance of the tools applied by the organisations compared with the perception of the individuals interviewed.

The next section has the Likert scale questions related to the 4P model and including the Lean principles. In this section, information related to Lean tools, waste, Lean principles and activities that the organisation practice will be asked.

Figures 5, 6,7,8,9 and 10, show the questionnaire:

LEAN STRATEGY QUESTIONNAIRE

Most of the companies that take the Lean journey have experienced huge benefits in terms of efficiency, productivity and profitability. However, there is a gap that enables a Lean strategy to succeed or to fail. This gap has been researched, and previous investigations have found some critical factors. This survey aims to identify which of the factors are significant to succeed in Lean strategy implementation.

Company:
Age:
Gender:

Demographics

1.1 What is your educational background?

A) N/A
B) College
C) Bachelor's degree
D) Master's degree
E) PhD

1.2 What is your job title?

1.3 Which is your formal Lean qualification?

A) None
B) Yellow belt
C) Green belt
D) Black belt
E) Master black belt

1.4 How many years of experience do you have with Lean?

A) No experience at all
B) Less than 1 year
C) Between 1-3 years
D) Between 3-5 years
E) Between 5-10 years
F) More than 10 years

1.5 How many years have you been working in your area?

A) Less than 1 year
B) Between 1-3 years
C) Between 3-5 years
D) Between 5-10 years
E) More than 10 years

1.6 What is your perception of Lean strategy in your organisation?

A) I do not know what a Lean Strategy is
B) Lean is not suitable for our organisation
C) There are better ways to improve
D) There are some useful elements of Lean strategy that can be applied
E) A Lean strategy is the best way to improve any organisation
F) Other (please specify):

Figure 5 Questionnaire part A

Lean Background

2.1 Have there been any attempts to provide formal Lean training throughout your organisation?

A) No, any knowledge is from personal interest
B) Some had Lean training, but there has not been any chance to put the learning into practice
C) Training is available for team leaders and project team members
D) There is a formal structure for Lean capability building, but not everyone attends the sessions
E) There is a training programme that ensures that the organisation has the optimum blend of Lean
A) Other (please specify):

2.2 How many years have your organisation been implementing LSS?

A) N/A
B) Less than 1 year
C) Between 1-3 years
D) Between 3-5 years
E) Between 5-10 years
F) More than 10 years

2.3 Which statement describes your current stage of LSS implementation best?

A) LSS is not considered in this organisation
B) Early positive results
C) LSS extended to other functional areas of the organisation
D) Significant financial results
E) Institutionalised
F) Other (please specify):

2.4 How many LSS projects have been implemented in your organisation?

A) None
B) Between 1-5
C) Between 6-10
D) Between 10-20
E) Above 20

2.5 In your organisation, who decides which project to implement?

A) Top management
B) Financial area
C) Lean teams
D) Process owners
E) Others (please specify):

2.6 How do you rate the avera of Lean projects in your organ

A) Unsuccessful
B) There is no evaluation
C) Irregular
D) Regular
E) Successful

2.7 Are changes in Lean susta

A) Do not know
B) Changes are suggested but n implemented
C) Changes last a few days
D) Changes last a few months
E) Changes are sustainable

2.8 What are the main barrier have faced at implementing L projects?

2.9 Rank the top 5 critical fac implementing LSS projects. U numbers 1-5 only once.

( )Top management commitmer
( )Leadership
( )Organisational culture
( )Communication
( )Training
( )Financial issues
( )Lack of Lean assessment
( )Inadequate Lean awareness & understanding

2.10 Rank the top 5 wastes in importance in your organisati numbers 1-5 only once.

( )Transportation
( )Inventory
( )Motion
( )Waiting
( )Over-processing
( )Overproduction
( )Defects
( )Untapped human potential

Figure 6 Questionnaire part B

2.11 Rank the top 5 tools in order of importance as you perceive them in your organisation. Use the numbers 1-5 only once.

( )TPM
( )VSM
( )Poka-yoke
( )Kanban
( )5S
( )SMED
( )FMEA

4P MODEL

In this section, the Toyota way model will be assessed. This model includes; philosophy, process, people & partners and problem-solving, which are the fundamental principles of the Toyota culture. Please answer each statement as your perception of it within your organisation.

PHILOSOPHY: At the most basic level, the Company is seen as a tool to generate value for the customer.	**Importance**				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
There is a clear mission that gives meaning and direction					
There is a clear long-term vision of the company					
Organisation goals are set ambitious, but realistic					
There is a continuous track of our progress against our goals					
Goals are well-aligned across all levels					
Lean is applied to all levels, not only the operational level (shop floor)					
Staff from different departments share a common perspective					
Our organisational strategy is linked to Lean implementation					
There are a Lean assessment and internal audits that measure Lean performance					
It is easy to work with staff from different levels of the organisation					
Quality targets are derived from the customer requirements					
All members have a deep understanding of customer requirements					
There is a measure for customer satisfaction					
Customer feedback is discussed in meetings					

Figure 7 Questionnaire part C

PROCESS: non-value added activities are eliminated to reduce waste. Processes should be pulled and thus, creating flow and a continuous production process.	**Importance**				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Value stream has been mapped in most of the processes					
Waste is recognised by all the departments within the organisation					
Waste has been identified and attempted to be reduced					
Processes are engineered to reduce human errors					
Reworks and scrap are actively reduced					
Tools for identify root causes such as Pareto and fishbone diagrams are used					
When a problem/defect is identified, the root cause of the fault is investigated immediately.					
Preventive maintenance of tools and equipment is scheduled					
Products are classified by groups with similar processing requirements					
Families of products determine the layout					
5s is implemented to organise workstations					
WIP is limited and actively minimised					
Lean implementation has caused a batch sized reduction					
There is a system that calculates how much is produced at each work station					
JIT is part of the daily routine					
Kanban system is used					
Customer pull is a better objective than management push					
Production is pulled by the next station demand					
Finished products are shipped immediately					
Deadlines are met for every shipment					

Figure 8 Questionnaire part C

PEOPLE AND PARTNERS: people are considered as the most important factor to pursue growth and create value for the organisation.	Importance				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
There is a supplier partnership program					
Suppliers are involved in process planning					
We always receive delivery on time from suppliers					
Items received from suppliers are mostly defect-free					
There is a low staff turnover					
Employees are highly involved in their work					
Authority is delegated so people can act on their own					
There is an employee suggestion system					
There is a non-financial reward system					
If there is a reward system, rewards are made publicly					
Management participates and supports Lean projects					
Managers facilitate resources when needed					
Top management is trained on Lean					
Organisation cares and invests on staff skills					
There is a Lean formal training programme available for all employees					
The shop floor is trained on Lean					
There is a Lean department or Lean expert team					
Projects are led by a Lean trained belt					
There is external support (consultants) when implementing Lean projects					
There is an assessment to measure Lean training impact and performance					
Cooperation across departments is encouraged					
Information is shared and communicated so everyone can get it					
Communication across departments is easy and clear					
Goals are clearly communicated to employees					
Communication with management is clear					
When a project succeeds or fails, it is communicated to everyone					

Figure 9 Questionnaire part C

PROBLEM-SOLVING: solving root problems and continuously improving and learning.	Importance				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Defects result in learning and improvement rather than employee penalisation.					
Attempts to change usually meets with resistance					
There is a prioritisation methodology of competing projects					
Projects are documented, and their results are used to support future projects					
Procedures are updated when changes are implemented					
Performance metrics are displayed on the shop floor					
Team meetings are conducted regularly to revise KPI's, project advance and improvement suggestions.					
Improvements are controlled and sustained					
The organisation's profit has grown over the past 3 years					
The unit cost of manufacturing has decreased					
Improvement plans are driven into day-day activities for all processes even if they do not present problems					
Lean has benefit organisational performance					

Figure 10 Questionnaire part C

Data collection

The first attempt was to collect data from three different organisations within the UK. However, one main difficulty was the access to key personnel in participating companies, only one of these organisations was evaluated, plus a Mexican organisation that agreed to take part in the study. An interview was used to collect the data from both organisations. This interview was answered by 2 organisations and different numbers of their hierarchical level, the number of people assessed was 9 participants, 5 from the UK and 4 from Mexico. The respondents were organisations with Lean implementation experience and the people interviewed from both organisations were similar job positions.

The organisation in the UK involved in this study has a global presence, and the organisation in Mexico is experiencing growth. Both are considered as large size companies, with Lean background. The people involved in this questionnaire will be selected from different areas of the organisation to assess different perception; Managers, supervisors, different departments and shop floor employees.

The first case study is a sizeable manufacturing company based in Newcastle-Upon-Tyne. The organisation currently produces oil and gas projects, technologies, systems and services across subsea, onshore/offshore and surface projects. The organisation size is large, and they have attempted to implement Lean before. The organisation has employees with the job title of business excellence, which are in charge of implementing Lean within the organisation.

Initial contact with the organisation was made via a student placement programme with Durham University. The objective was to improve how data was collected and managed in the sheath extrusion process. The current conditions were that some data was collected; however, data was gathered but never analysed. Moreover, the collection method was antique, by hand. Sensors and control systems were suggested to automate the data collection and management with a supervisory control and data acquisition (SCADA) system. By implementing it, the equipment could be controlled and monitored, communication will be more precise, and efficiency and productivity could improve. Moreover, communication between departments like design, shop floor, R&D and quality will increase.

The limitations of this project were the lack of time and information shared by the company, as well as the absence of the business excellence department, which was not available during the two weeks placement. Nevertheless, the company has attempted to implement various Lean tools like Kanban in the shop floor, and some Overall equipment effectiveness (OEE), Total productive maintenance (TPM) and FMEA (failure mode error analysis) documents.

The second case study is a health sector organisation that has many facilities located in Mexico and one in Los Angeles, California. The organisation develops laboratory studies, x-ray, pregnancy tests and glasses. The manufacturing area of this organisation is focused on glasses production. This organisation is considered as a large size company, and the Lean skill is medium. Lean is significant to reduce costs and achieve the organisational aim to provide health service to low-income people in the country. There is a Lean department called continuous improvement area, which is in charge of applying the Lean tools to the overall organisation.

Data collection was carried out between November and December 2019. The questionnaire was answered by both organisations and different members of their hierarchical level. The number of people that answered the interview was nine.

The primary data collection method was semi-structured interviews. In the UK, it was possible to go to the organisation itself and talk face to face with the employees. However, in the Mexican organisation due to long-distance limitations, the interviews were via video call. The total number of responses is nine. The interviewees had appropriate positions for this research, and they were selected from various departments to obtain different perceptions. Each interview lasted between 30 and 40 minutes. The questionnaire is divided into three sections. The first one consisted of six questions which talked about demographics; Educational background, Lean qualification, years of experience, etc. The second section consists of 11 questions, and it is focused on the Lean background, attempts to provide Lean training, amount of projects implemented, main barriers faced at implementing Lean and rank of wastes. The third and last section is focused on the critical obstacles divided into the Toyota 4P model described in the literature review [44]. Both of the organisations have had experiences with Lean implementation. Therefore, they are good candidates for this study. The data from all responses were mapped and analysed in Microsoft excel. The breakdown of the employees in both organisations is summarised in table 2.

Participants	UK organisation	Mexican organisation
Quality	1	1
Engineering	1	0
Business department	1	2
R & D	1	0
Site manager	1	1
Total = 9	**5**	**4**

Table 2 Breakdown of participants

Validity of the data

For reliability test, Cronbach's Alpha test was utilised. This test is useful to determine the stability and consistency of the data [3]. If the value is greater than 0.7, the validity of the data is accepted. The results of the Cronbach's test are in figure 11. Each of the items were tested and the result was greater than 0.70. Therefore, the data is considered acceptable.

Cronbach's Alpha	
Number of items	72
Sum of item variances	75.56
Variance of Total scores	2371.1
Cronbach's value	**0.98**

Figure 11 Cronbach's Alpha results

The results are greater than the lower limit of the Cronbach's Alpha test. Therefore, we can agree that the data used in this study is reliable.

Besides the collection of the data, there were many difficulties at obtaining these results, which are the following:

- First, two organisation that were already scheduled for the interview, cancelled at last minute.
- There was a difficulty in finding more companies that agreed to take part, due to lack of time and disposition.
- That is why the Mexican organisation option came out, and due to long distances, the interviews were done by video and phone calls.
- Another challenge which was not that inconvenient was travelling up to Newcastle on train every day for 2 weeks
- During the interviews, it was hard to contact people due to their work, and that is why the interview time planned was longer than expected.

Summary

In this chapter, the steps used to develop the methodology are described. Moreover, it shows some figures of the questionnaire used for the interview and the description of the case studies. This chapter explains why the methods were chosen and how will they be performed to collect and analyse the data needed to obtain the desired results. The results of the interview are expected to close the gap of previous research by applying this study to different levels, including shop floor (blue collar) and to analyse the consultant's perspective.

4. Results

In this section, we describe the results obtained; first, the results of the demographics section, then the Lean background at then the 4P model analysis. Due to the small sample of the dairy scheduled interviews obtained, a statistical analysis is not possible. Therefore, increasing the sample is an option for future survey based research. As the study cannot be analysed statistically, an analysis with the data obtained is shown as similarities and differences observed between the organisations assessed. Each of the section is focused on a particular element of Lean. The interviewees were asked to answer the questions according to their perception. The data, which is presented and interpreted on a Likert scale, was analysed and compressed into different charts.

Demographics section

The first question asked the participants their educational background to gather educational demographics of the respondents. Results of these questions are shown in figure 11. Out of 5 categories were provided, everyone selected two of them: Bachelor's and Master's degree.

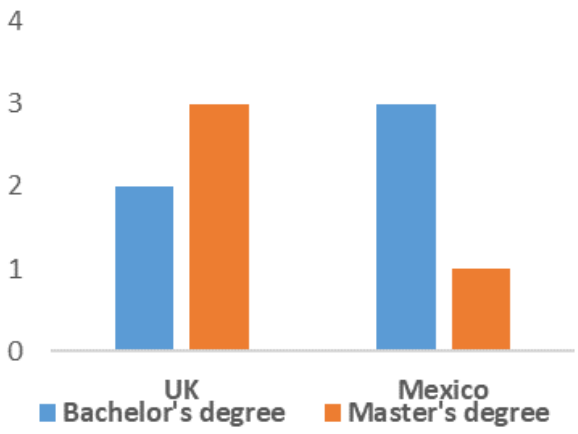

Figure 12 Educational background

The next question asked about the formal Lean qualification. This question aimed to identify the level of Lean that the respondents have. Results are shown in figure 12. Five categories were provided, and three of them were selected: none, green and black belt. Based on the results of Figure 12, we can say that the Mexican organisation participants are more prepared than the participants in the UK organisation.

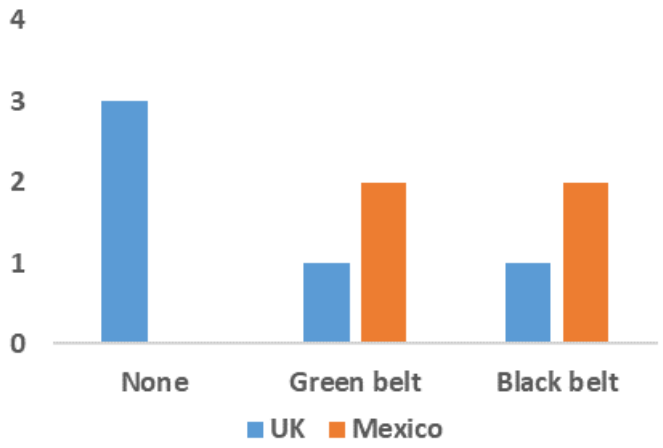

Figure 13 Lean qualification

The next question asked the experience that they had with Lean implementation to know if they had applied Lean before or not. Six categories were provided, and the results were varied from "no experience at all" to "more than ten years of experience", however not all the categories were selected. Results in Figure 13 shows the results, the organisation in the UK has more experience at implementing Lean, and according to the Mexican organisation the Lean department started about 3 years ago.

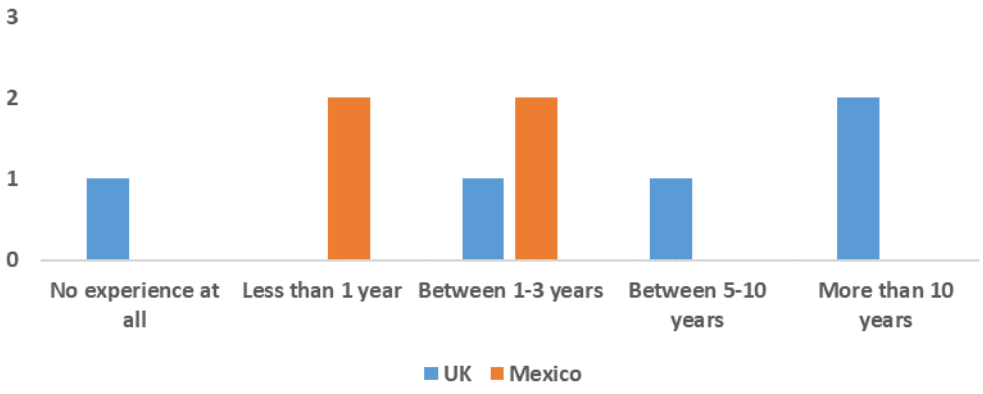

Figure 14 Experience implementing Lean

The next question asked about the years that the employees had been working in their area. The purpose is to know if they have enough experience in their area to give a perception of it. Categories were five, from “less than one year” to “more than ten years”. Results are shown in figure 14.

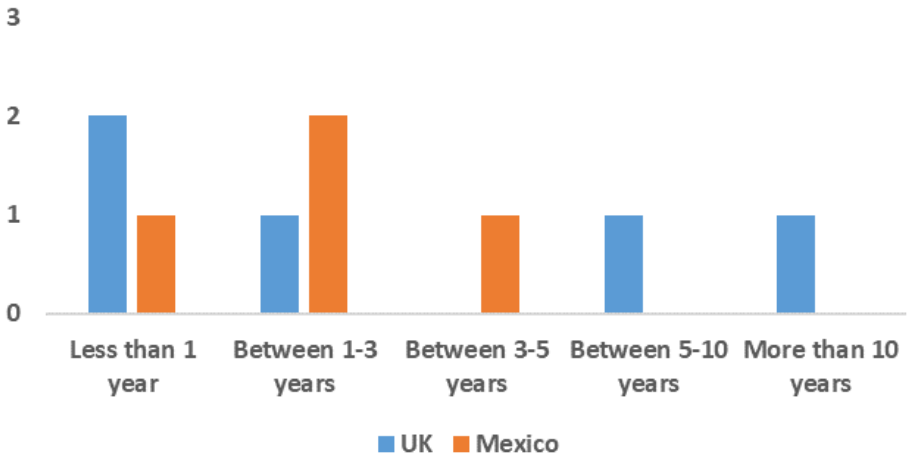

Figure 15 Years working in the same area

The last question of this section asked about their perception regarding the Lean strategy in their organisation. Overall Lean is successful if al employees have an homogeneous perception, if not is a management issue. This question aimed to compare perceptions between departments. Figure 15 shows that the Mexican organisation considers a regular and successful Lean impact, whether all the participants in the UK organisation consider Lean impact below their expectations.

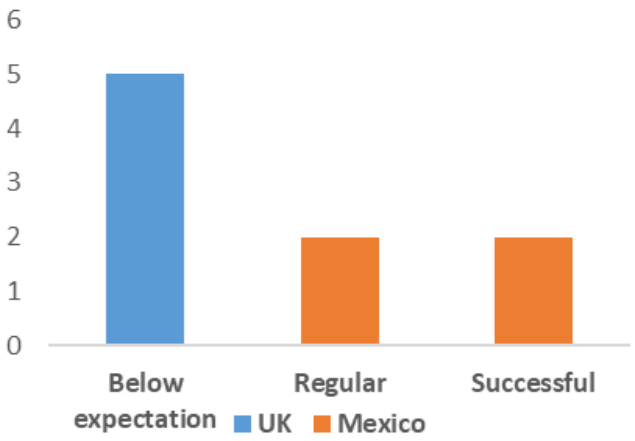

Figure 16 Lean impact perception

Demographics conclusion

ITEM	UK	MEXICO
Lean approach	Not clear	Clear
Training programme	No programme	Lean trained personal
Lean previous attempt	Failed	The first attempt going well
Lean implementation	Early results	Lean spreading to departments
Lean projects evaluation	Irregular	Regular- successful
Sustainability	Irregular	Successful

Respondents from the organisation based in the UK do not seem to know their approach to Lean. Lean was attempted to be implemented ten years ago, but the organisation failed. However, nowadays, early results were demonstrated by applying a few projects. The evaluation of the projects and the Lean performance is below expectation, and sustainability of the changes made are unknown or forgotten.

On the other hand, in the Mexican company, the entire respondents are trained on Lean. The organisation has a programme where employees can have access to Lean training. The Lean department, however, is relatively new, just three years since this organisation adopted lean. Their perception is that Lean is the best way to improve the organisation. The amount of projects is good, and the results have been extended to different areas. The impact of the projects is considered between regular and successful, and changes are sustainable.

Lean background section

The first question of this section asked if there have been any attempts to provide Lean formal training to the organisation. The purpose of the matter was to assess one of the critical factors mentioned in the literature review, which is training. According to the literature review, a training programme is critical to succeed in Lean implementation. The results in Figure 16 shows that Lean in the Mexican organisation has been adopted as a training programme. On the other hand, the UK organisation provides training just to some of their employees.

Figure 17 Lean training programme

The second question asked about the experience of the organisation with Lean. This question aims to know the number of years that the organisation has been attempting to implement Lean. It is also to compare perceptions from different employees regarding their knowledge of Lean in their organisation. Figure 17 results show unclear communication for both organisations due to their wide responds. However, the UK organisation has more years in the Lean journey than the Mexican organisation.

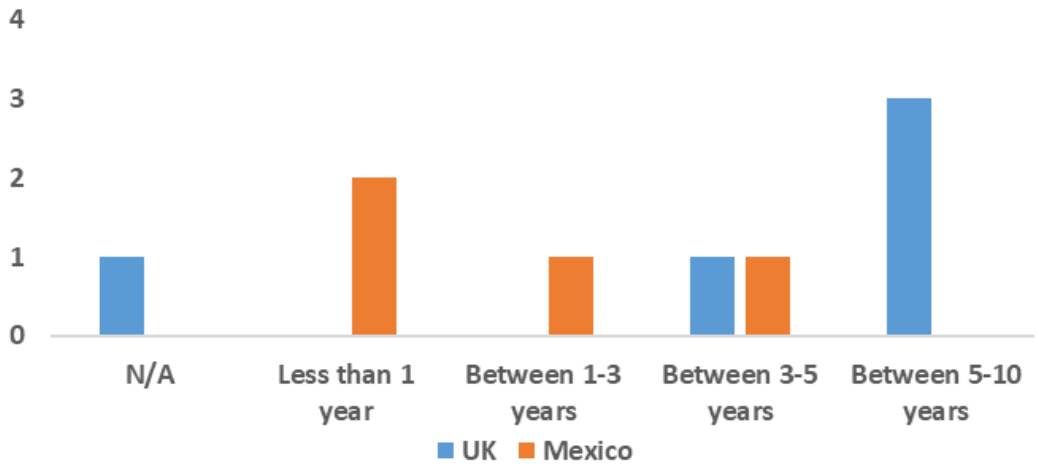

Figure 18 Years of implementing Lean

The next question asked about their perception of their current stage of Lean. This question helped to compare opinions from different departments. A homogenous perception of employees results in successful Lean implementation. Results in Figure 18 shows that the Mexican organisation is more likely to have this homogenous perception and also shows the positive results and consideration of Lean by other areas of the organisation. The UK organisation still differs in perception; however, positive results are being experimented.

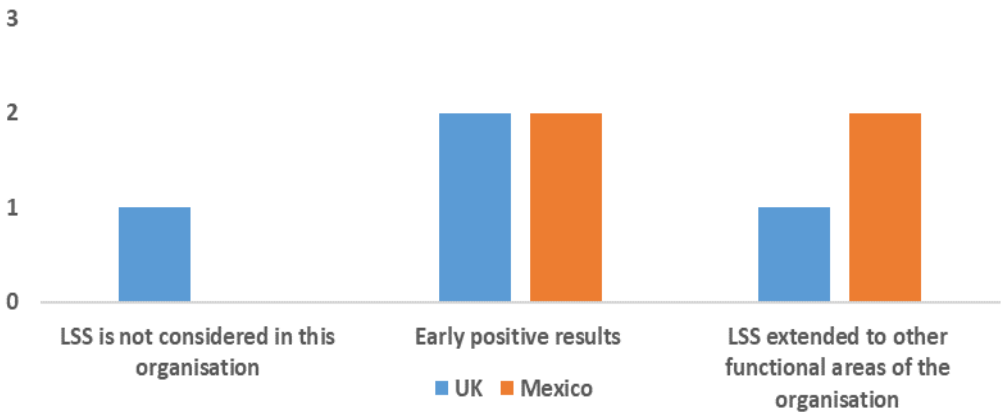

Figure 19 Lean current stage perception

Next question asked the number of projects that the organisation has implemented and if departments share the same perspective. The results in Figure 19 shows that even though the Mexican organisation is new at implementing Lean, it has implemented more projects than the UK organisation, which has more years in the Lean journey.

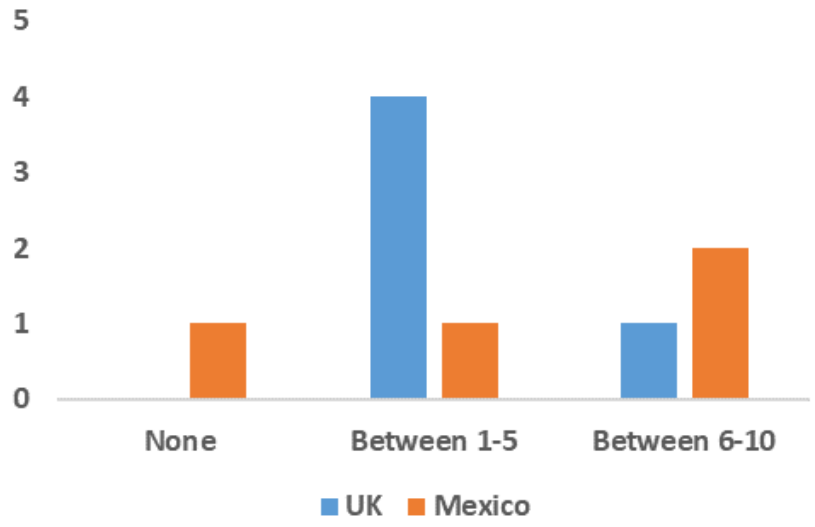

Figure 20 Amount of projects implemented

Next question asked about how decides which project to implement. The purpose of this question is to know if employees are empowered to make decisions. Results are shown in figure 20:

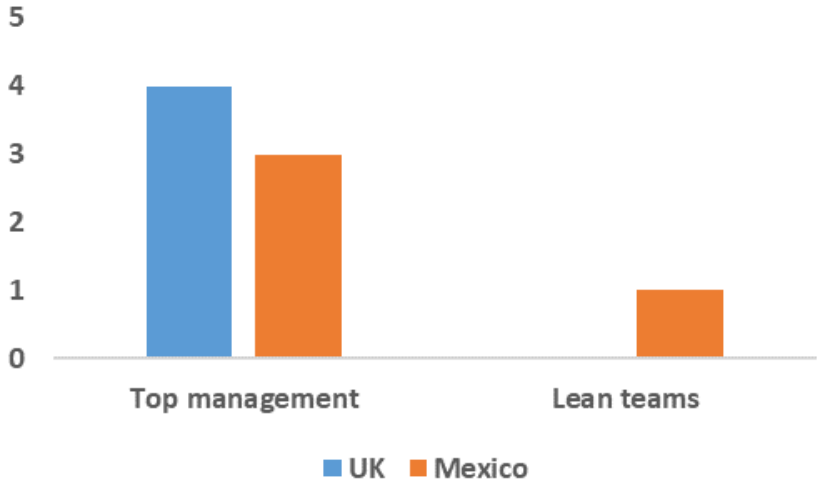

Figure 21 Decision of projects

The next questions asked about the sustainability of the changes made by Lean projects. This question aims to know the perception of the employees, and if Lean changes are sustainable. Figure 22 shows the results. The Mexican organisation shows that their results are sustainable, whether the organisation in the UK improvements are not sustainable.

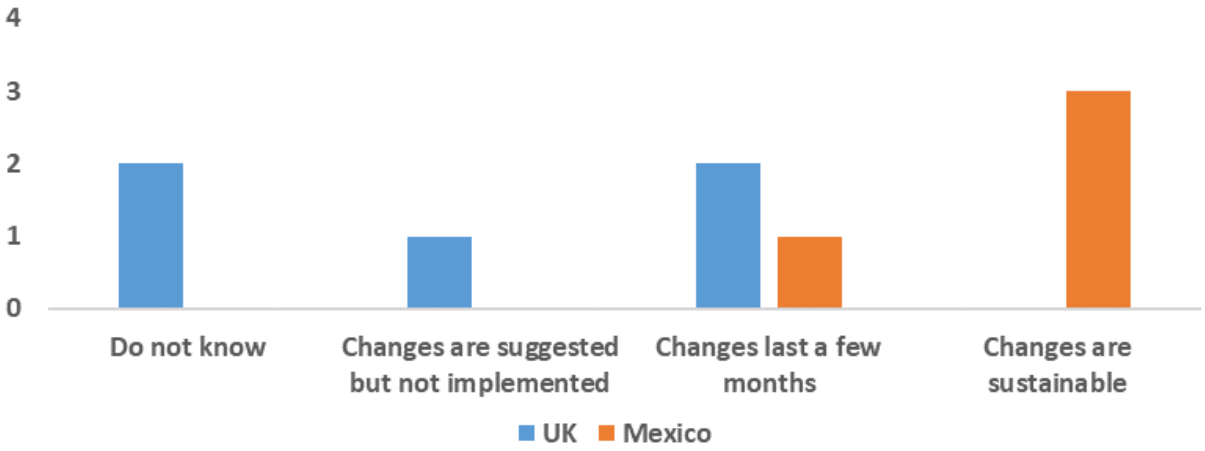

Figure 22 Sustainability of changes

The literature review describes some factors that are critical or important to succeed in implementing Lean. According to previous research, these factors are either enablers or cause of failure for a Lean strategy. First, the participants were asked to mention which barriers they have identified at attempting to implement Lean, without giving any options to rank. Figure 23 shows what they answered. Both organisations have different obstacles to concern at; however, they both have faced culture and top management commitment as a barrier to implementing Lean.

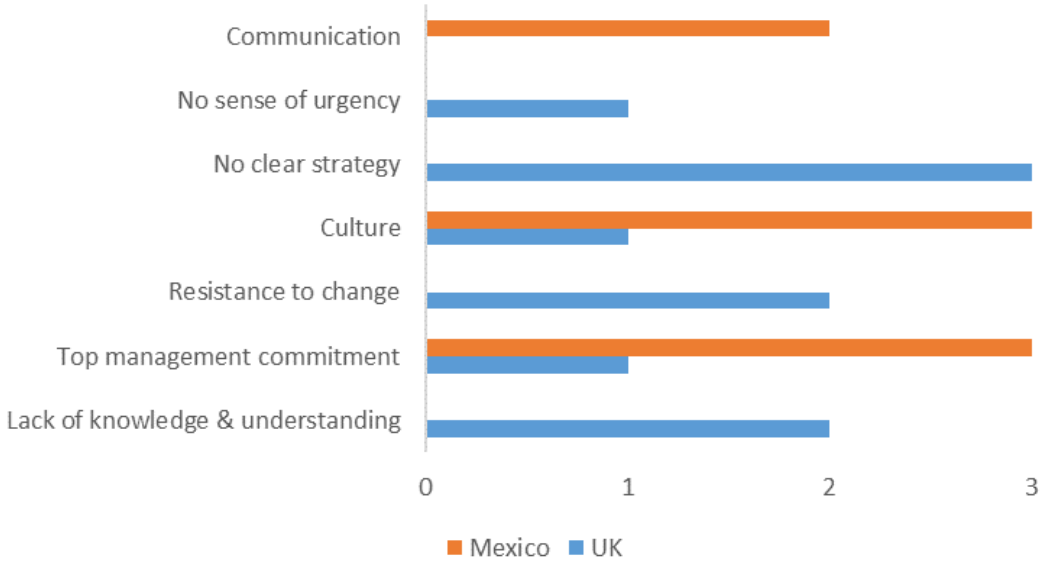

Figure 23 Main barriers identified in implementing Lean

The next question gave some examples of the critical factors described in the literature review. The respondents chose which of the elements are considered crucial to their perception. Figure 24 shows the results of both organisations. Top management commitment, as well as culture, had the highest qualification, which is aligned to the previous question.

Figure 24 Lean success factors

The literature review highlights that Lean should be aligned with the overall strategy, including the mission, vision and goals. This question asked the participants to select the type of waste that they considered as most essential to be aware of within their organisation. The perception of the respondents must be in line with the overall strategy of the organisation, in other words, aiming of the same outcomes. The data in figure 25 shows that the UK organisation perceives waiting and over-processing and defects as the most critical issues. On the other hand, the Mexican company selected different types of waste. This question might differ from different organisations, as they might not have the same problems either processes.

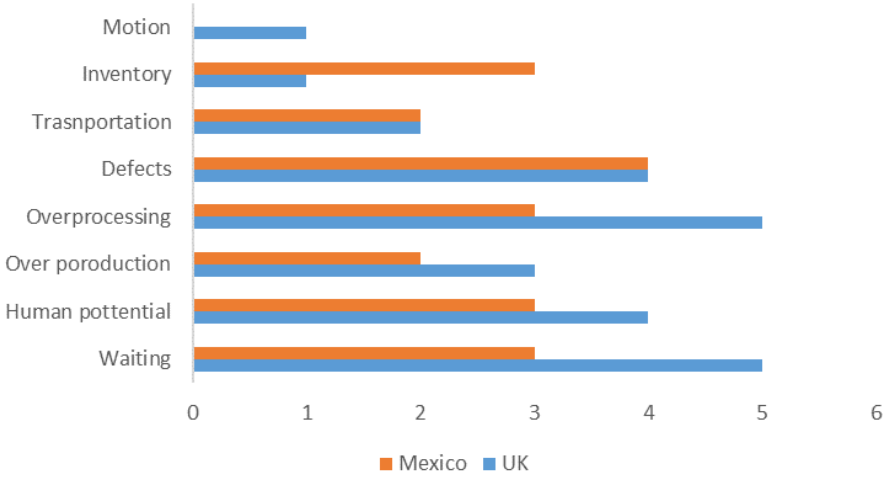

Figure 25 Type of waste importance

The literature review also mentioned the importance of tools at implementing a Lean strategy. Not only one tools for all the processes. However, as the previous question said, not all the processes need the same tools. This question, therefore, asked the participants to mention the tools that they consider most important for their processes. Figure 26 shows the results.

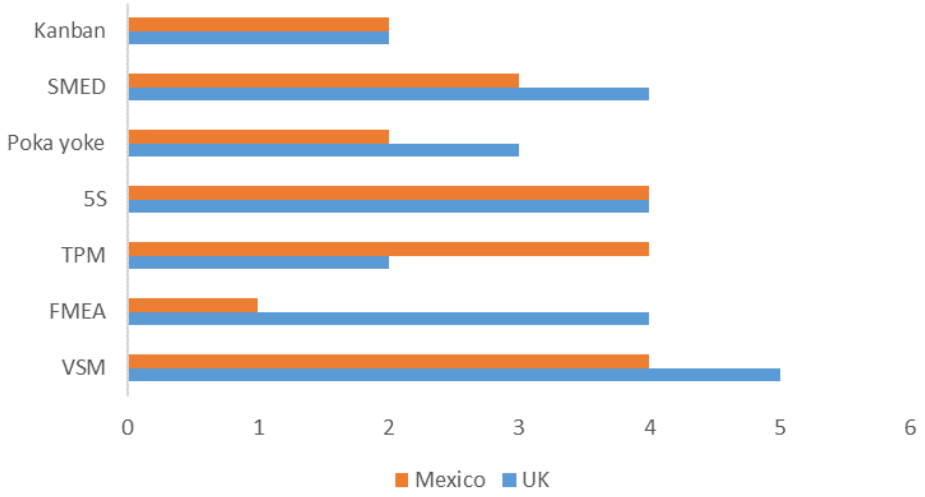

Figure 26 Lean tools importance

The last question of the second section asked the participants the reason for using Lean. This answer should be in line with the strategy that their organisation aims. They could answer more than only one goal, therefore the number of responses. Mexican organisation agreed that quality improvement is the reason of why they use Lean. The organisation located in the UK decided that reducing time delivery and increasing profitability is their reason to be in the Lean journey. Results are shown in figure 27.

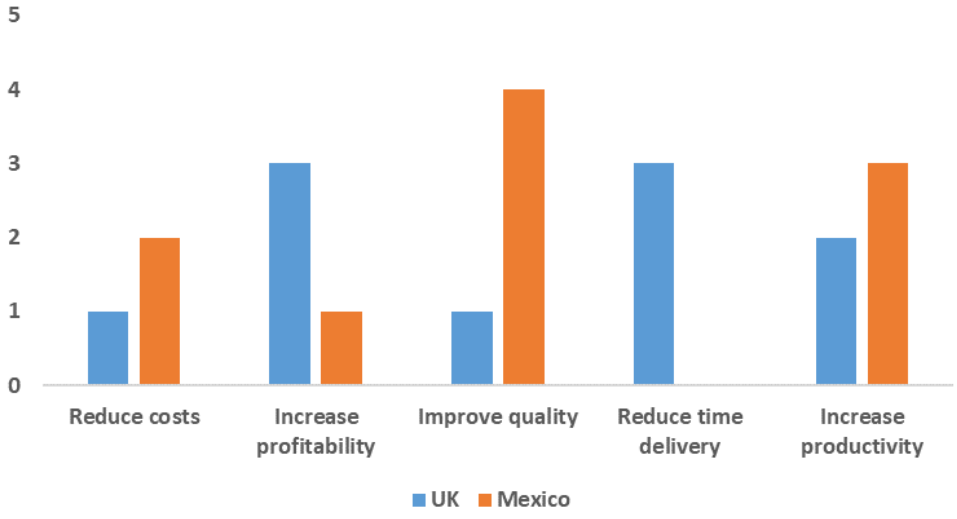

Figure 27 Reasons to implement Lean

Lean perception conclusion

UK employee's perception of Lean barriers is that their problem arises by the lack of knowledge & understanding of what Lean is. Moreover, there is no clear strategy or approach, and there is resistance to change. They perceive management commitment, culture, training and lack of understanding as their primary Lean barriers. However, according to figure 26 results; they all consider that the essential tools are Value stream mapping (VSM), Failure mode errors analysis (FMEA), and single minute exchange dice (SMED). Also, the reason they adopted Lean is to increase profitability and to reduce time delivery, agreed by all the respondents. Hence, same vision.

The organisation in Mexico perceives top management commitment and culture as the barriers that affect their implementation. They are focused on defects, inventory and untapped human potential waste. The perception of the importance of tools is agreed among the respondents being VSM, TPM and 5S. Besides, the reason why they adopted the Lean approach is the aim to improve quality and increase productivity. The answers of the interviewed match, these show alignment in the aims amongst the employees from different departments. A factor that is explained in the literature review and that enables the success of the Lean strategy implementation.

4P model results

The third section of the questionnaire is the development of the Toyota 4P model, which includes the critical factors that affect a Lean implementation, previously mentioned in the literature review. This section assesses in a Likert scale the respondent's perception in the extent of agreement with the items (questions) related within their organisation. The level of agreement is the extent of how the respondent agrees to each item of each section, or how he perceives that the item is correct. The levels of agreement go from 1 to 5, from "strongly disagree" to "strongly agree". The Toyota 4P model is divided into 1. Philosophy, 2.Process, 3.People, 4. Problem-solving. Which is a simplification of the Lean principles on Womack's' work, with the difference that the Toyota model includes "People" as a Lean success factor.

Philosophy section

Philosophy defines the company as a tool that generates value to the customer. This section includes the first Lean principles "Value", and includes factors such as the mission, vision, aims of the organisation and the customer focus. This section of the 4P model consists of 14 questions, where strategy alignment, Lean assessment, customer satisfaction measure, quality targets and organisational strategy is assessed. Figure 28 shows the results of the entire Philosophy section based on the perception of the interviewed according the extent of acceptance of this factor.

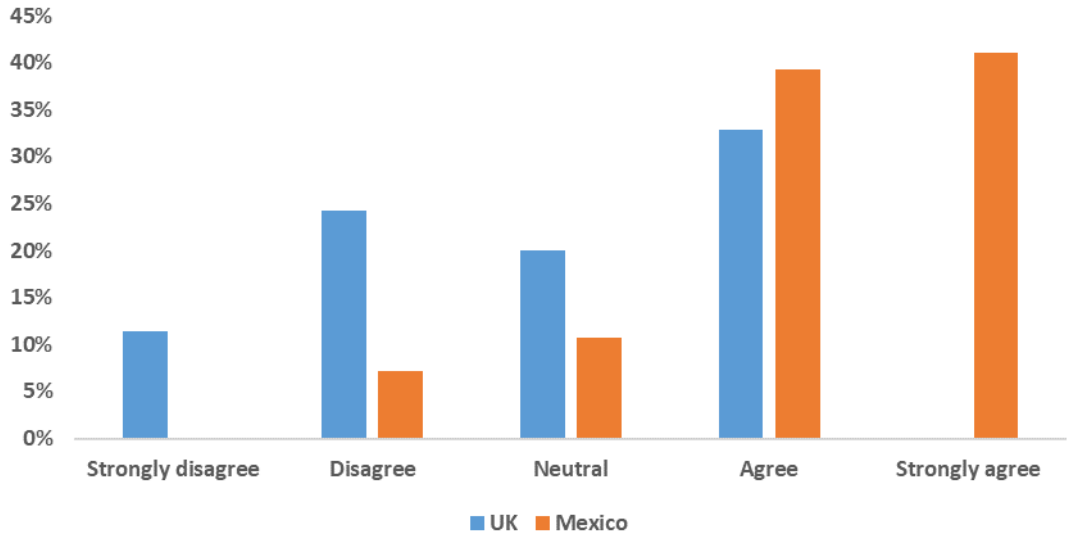

Figure 28 Extent of agreement of a good philosophy approach

Results show the level of agreement or disagreement in which the respondents perceive their organisation. According to the results, we can conclude that the organisation located in the UK lacks vision, Lean is not applied in all levels, departments do not share the same perspective, and there is no assessment or internal audits regarding Lean. However, there is a good relationship among people from different levels and departments. Their percentage of agreement of a good organisation's strategy is 33%.

On the other hand, the organisation in Mexico has a clear mission and vision, their goals are aligned and tracked, people from different departments share a common perspective, cooperation among departments is encouraged, and customer satisfaction is measure and feedback discussed. However, Lean is still spreading to other areas. As the graph shows, their percentage of agreement is 80%, which shows an excellent Lean strategy.

Process section

Process section includes the elimination of non-value added activities to reduce waste, a pull process and flow creation. These three concepts are part of the Lean principles. This section includes 20 questions that are focused on the process mapping, identification of waste, reworks and scrap reduction, application of Lean tools such as 5S, JIT, TPM and Kanban, and delivery deadlines. Figure 29 shows the results according to the level of agreement of the respondents.

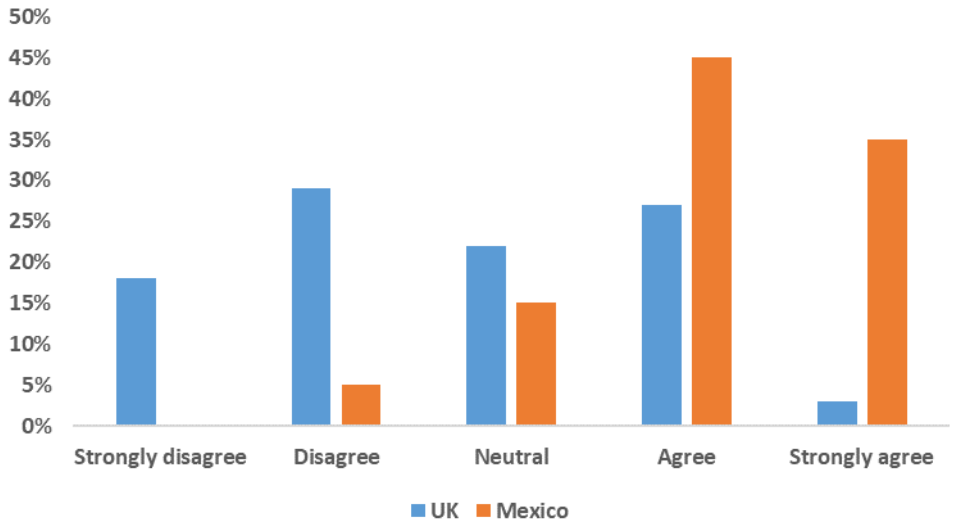

Figure 29 Extent of agreement of a good process approach

As the graph shows, the process factor is perceived as not well focused. Issues like waste elimination is not encouraged, waste is not recognised and not even attempted to be reduced, VSM despite being known as necessary is not applied. Tools such as TPM and 5S are not yet tried to be implemented. Hence, the issues with meeting deadlines. Results show a 30% of agreement.

The Mexican organisation shows the opposite; every process is mapped, waste is attempted to be reduced, tools such as TPM and 5S are part of the daily routine. This approach has resulted in WIP reduction and deadlines are met for every shipment. Hence, their 80% agreement.

People (culture) section

People section, which is highlighted in the literature review, is considered as the most essential factor to pursue growth, and create value for the organisation. This section includes 26 questions regarding the critical factors mentioned in the literature review; supplier partnerships, employee's empowerment, rewards systems, management commitment, training and communication.

In the UK organisation, suppliers are not involved in their processes, but employees are, authority is delegated. However, managers are not trained in Lean tools; they do not fully participate in Lean projects and resources are not provided when needed. Shop floor employees are not trained on Lean either and there is no consultant support. Hence, their 38% agreement.

Otherwise, the Mexican company has a supplier partnership where they are involved in the processes, and the items are always defect-free. Employees are highly committed, and management is trained and active in Lean projects and providing resources needed. The shop floor is not prepared in Lean, but they do have an external consultant for Lean projects. Hence, their 66% of agreement.

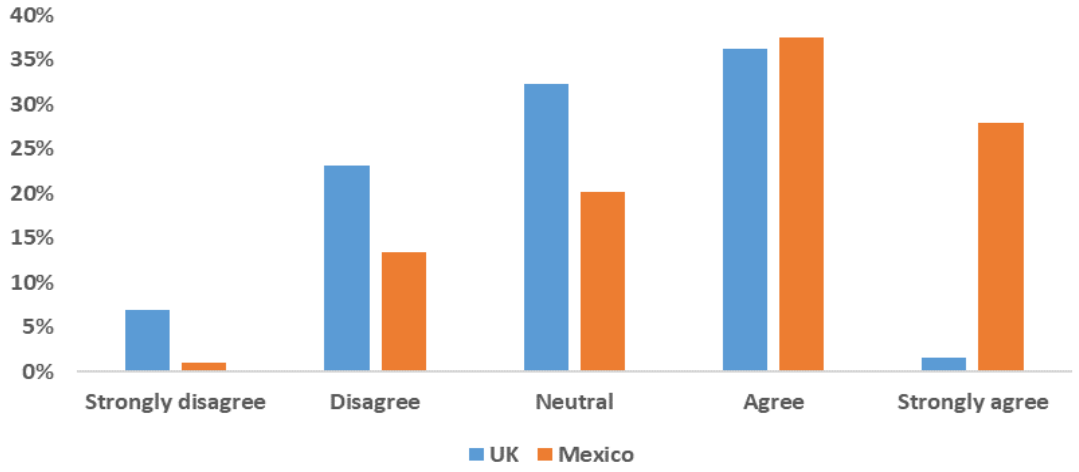

Figure 30 Extent of agreement of People focused approach

Problem-solving (continuous improvement) section

This section is considered as the fifth Lean principle, continuous improvement. It contains 12 questions that include project prioritisation, documentation, processes updates, team meetings, KPIs measurement and organisational performance.

In the UK results show resistance to change, no prioritisation of projects, no useful documentation neither sustainability of improvements. People think there is not that much financial improvement, which interview leads to an overall 43% agreement.

In Mexico, projects are prioritised, documented, and procedures are updated. Visual Metrics have a presence on the shop floor, and KPI's are usually discussed in meetings. Improvements are controlled and sustained, and the overall profitability of the company has increased over the past years. Hence, their 86% agreement.

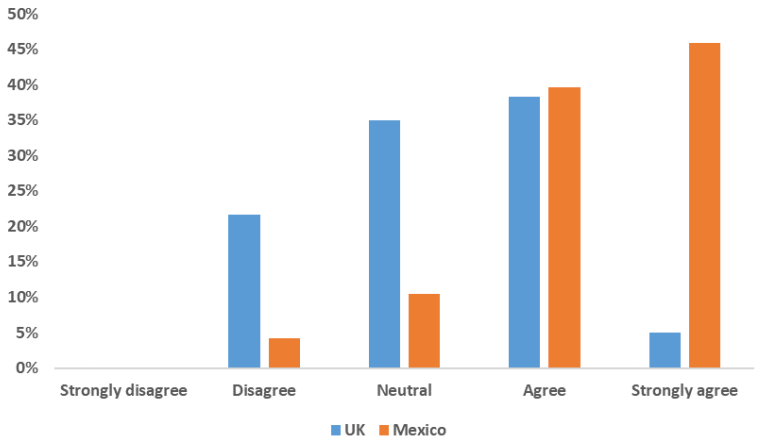

Figure 31 Extent of agreement of Problem solving focused approach

This 4P model section assessed the level of agreement of the respondents to each of the item asked according to their perception. In general, the UK organisation showed a low percentage of an agreement to the Lean success factors. However, the Mexican company showed an excellent rate, indicating a good focus on the factors that enable Lean success.

This chapter has shown the results taken from the analysis of the data collected from the different participants on the two cases studies. The results were divided into the questionnaire sections, were each of the section as well as each question is described. Each section was focused on a Lean factor and the data obtained was interpreted on a Likert scale and analysed with Excel. Moreover, it shows the perception of each participant regarding each of the questions assessed. The results are discussed in the next chapter, as well as limitations, conclusion and future research for this study.

5. Discussion & Conclusion

This chapter will discuss the findings of the research and propose a path for implementing a Lean strategy. The chapter also discuss the research issues and their development, the outcomes, and how this research contributes to the gap mentioned. Moreover, it will mention the conclusion of this research as well as its limitations and future applications.

According to Shetty [6], the best approach to obtain the needed that for this type of research is by interviewing employees with the help of a questionnaire. Hence the method used by this investigation.

After the analysis of the answers and by exploring and comparing the similarities and differences between both organisations, a set of conclusions are developed from this work:

- We can say that Linking Lean strategy to the overall organisational strategy is fundamental to assess Lean success. The cases are shown in this study support those activities that staff at various departments need to be aware of when implementing Lean such as; Customer focus, Management commitment, clear communication among managers, employees and different departments, and goals communicated to everyone.
- Regarding processes, VSM is the most important factor to identify waste and then to eliminate it. Other tools are applied after the process mapping. Communication between the floor shop and functional departments is essential. The alignment of these departments with Lean activities helps those areas to eliminate waste in their processes.
- Both of the organisations care about involving and motivate their staff. According to the literature review, culture is the most critical factor in implementing Lean [32].
- Regarding Problem-solving factor, visual metrics on the shop floor and KPI's discussion in meetings make a difference to track and sustain improvements. Hence, more profitability.

The different approach of the two organisations at Lean implementation is clear. The critical factors mentioned in the literature review do have an impact on the Lean strategy development. However, the organisation in the UK is a worldwide operating company and the Mexican organisation even though it is a large company is still a national company. Therefore, other studies should assess the difference between these types of organisations and Lean transition.

Figure 32 represents a visualisation of a framework of how the critical factors are related to Lean success based on the essential elements found by previous research, the Lean principles defined by Womack and Jones book “the machine that changed the world” and the Toyota 4P model [44]. The focus on the factors in Figure 32 is important to develop a whole Lean strategy across all the value stream.

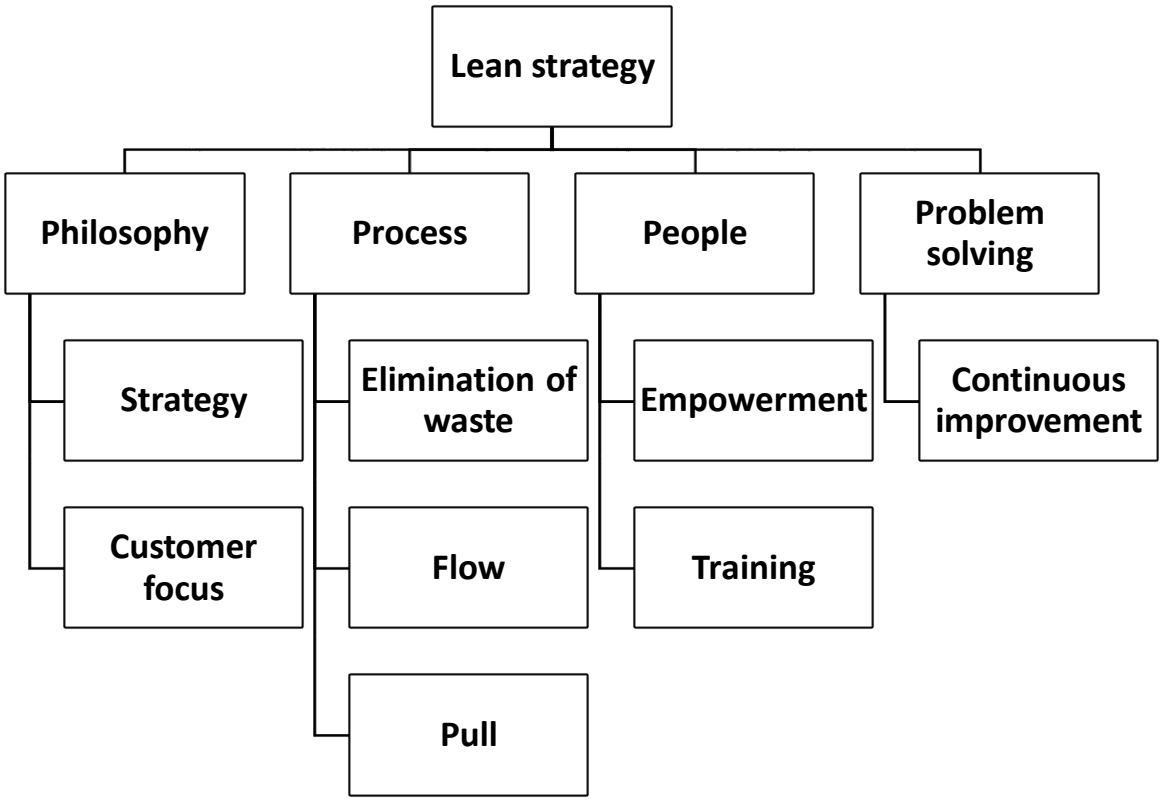

Figure 32 Lean strategy elements

According to the literature review and the results from the analysis of the organisations that took part in this research, Figure 33 shows some of the steps that are considered essential or critical at implementing Lean. Therefore, focusing on these steps could help to facilitate Lean strategy implementation and overcoming of the barriers found in the literature review.

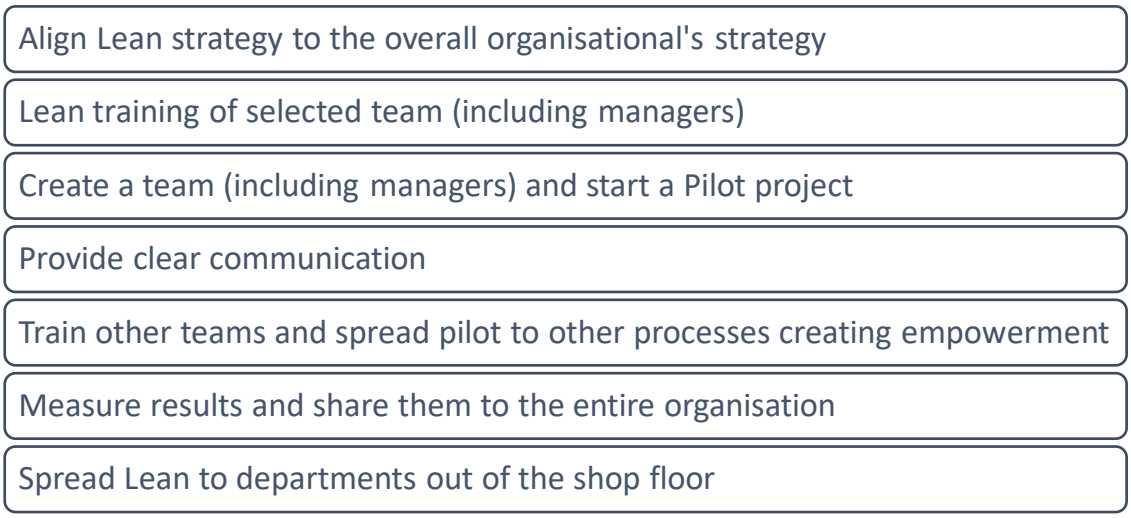

Figure 33 Lean steps consideration

This study identified the following restrictions that this research challenged:

- Organisations were not open to the study due to data protection policies.
- The questionnaire could be uploaded on the internet in platforms like LinkedIn and Google forms would be used so it could be answered by many stakeholders involved with Lean, this to obtain more responders and increase the sample size, which will increase the credibility of the study.
- For this specific research, the participants needed are key PMs and BBs, very busy people that could be difficult to interview.
- Due to the sample size, we could not do a statistical analysis.
- Multiple regressions analysis: This analysis could be applied to assess the strength of the relationship among these factors and Lean success and correlation analysis to evaluate the strength between the factors.
- Further work and a bigger sample are required to increase the validity of the study. This means more responses across different organisations and hierarchical levels to obtain statistically significant data.

To summarise, this study has aimed to identify the critical factors of success in Lean strategy implementation and Lean strategy implementation relationship between the shop floor and functional departments of the organisation. The study is based on two cases studies, one located in the Northeast of England and the other in the North-West of Mexico in which participants were selected from different levels and departments of the organisation. The study showed the results of the evaluation of the various factors that affect Lean strategy implementation. Mexican organisation's results were higher than the organisation based in the UK, this represents a homogeneous perception of Lean. The questionnaire also found factors such as management commitment, communication, and training as critical to developing a successful Lean strategy implementation. The proposed framework shows the essential factors to bear in mind in the Lean journey; this might help the organisation to focus on factors such as people and communication rather than just Lean tools on the shop floor. To conclude, this research will contribute to future studies at exploring the critical factors that enable an organisation to success on Lean strategy implementation.

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