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Two Explorative Case Studies into the Role of Regional Context for The Implementation of Lean Production

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Abstract

Although implementation of lean production has been widely spread, it has been noted that there is a gap in the current literature regarding studies that consider implementation of lean production from a regional context. Hence, the presented study addresses the impact and contingencies of regional context on the implementation of lean production. More specifically, the results of two case studies that were conducted in the United Kingdom are presented and discussed. The data collection included in depth semi-structured interviews with the managers and employees of the selected companies as well as observations of their processes. The results show that the regional context does in some degree impact the implementation of lean production and therefore the operational performance of the company. This research study attempts to cover the shortcomings of previous studies that have not covered the issue in detail and provides empirical evidence that adds new insight to the current literature in regard to successful implementation of lean production. Hence, the findings give direction to managers about different dimensions that contribute to the successful implementation of lean production.

Keywords

Lean production, implementation, regional context, regional dimensions, lean practices, lean design, and case study

1. Introduction

Although implementation of lean production has been widely spread, it has been noted that there is a gap in current literature about studies considering implementation of lean production from a regional context. Hence, this paper addresses the impact and contingencies of regional context on the implementation of lean production. Differently from other studies, such as Hines et al. (2004), that have not investigated lean production and its implementation in detail, this research as part of a doctoral study aims to take a more in depth look into lean production from perspectives that have not been sufficiently investigated before. To that purpose, and following the suggestion of Lewis and Grimes (1999) this paper is looking into the implementation of lean production from three lenses; lean production practices, lean production as design of production system and lean production as theoretical conception. Lean practices consider the type of practices and how they can be implemented (i.e. Bortolotti et al 2015; Rahman & Bullock 2005; Shah & Ward 2003); lean production as design includes the principles of lean and how to structure a firm using the principals of lean (i.e. Åhlström 1998 ; Bhasin 2013 ; Low et al. 2015) ; and finally, the theoretical conception of lean production, refers to the theory of lean production (i.e. Schmenner & Swink 1995 ; Wacker 1998).

This paper looks at the regional context for lean production and how that influences its implementation. The regional context on lean implementation is limited in the literature and mostly focus on one region or

few rather than generalising the study as contingency. This study is examining the contingencies of regional contexts, and the extent that may affect the implementation of lean production.

1.1 Research Objectives

Thus, this study aims at asserting the influence of the regional context on the implementation of lean production. Regional context covers what the members of society share and what leads to the behaviour of the people, i.e. employees, suppliers and managerial mind (Wiengarten et al. 2015, p.371). According to (Bhasin 2013, p. 118) that low number of British firms that fully adopted the lean production, and organisational culture is a factor that a firm should consider for the success of the implementation of lean. More generically, some (e.g. Yadav et al. 2010, p. 401) assert that firms struggle with implementing the concept of lean production, thinking that Toyota's success lies in their cultural roots and, hence, the concept is not transferable. However, Toyota has been successful not only in Japan but also USA. Moreover, some authors (e.g. Kull et al. 2014),(Wangwacharakul et al. 2014),(Wang 2008) have noted that the implementation of the concept of lean production varies for different regions, without going into much detail. This study will address the gap about the adoption of lean production in regional contexts. Hence, the study addresses three review questions:

1- To what extent the regional context variables affect the implementation of lean production as set of practices?
2- Are regional contexts a contingency on the design structure of lean production?
3- How the regional dimensions differ from a company to another?

To answer the previous questions, empirical study has been conducted having two case studies investigated

1.2 Scope and Outline of the Paper

This paper discusses the results of two case studies that were conducted in the United Kingdom and included in depth semi-structured interviews and observation with the managers and employees of the manufacturing companies. Following case study methodology allowed for investigating the phenomenon in a natural setting and attain in depth exploration using variety of techniques in data collection (Collis & Hussey 2013, p.68). Moreover, it allowed to explore the companies through complex interventions and relationships. The collected data were derived and analysed using analytic induction as part of the thematic analysis methodology.

This paper is structured as follows. First, the literature review which includes the lean production part and the regional context. Next, the methodology is presented followed by an analysis of the papers. After that, there is a discussion of the findings. The paper concludes with managerial implications, limitations and suggestions for further research.

2. Literature Review

It is necessary to look at what the concept of lean production constitutes. Although Womack et al. (1990) were the first researchers to propagate the conceptualisation of lean production, they never gave a specific definition for 'lean'. This lack of definition in literature about lean production has reverberated until today, as Petterson's (2009, p. 136) study notes. The only ones that have given a more specific description (rather than definition) of lean are Shah and Ward (2007, p. 791), who have mentioned that lean production is about social and technical systems. But even lean production practices and principles vary; some researchers list as few as five principles (Womack & Jones 1996, p. 141), whereas others list over twenty practices or principles with more details of every aspect (e.g. Kull et al. 2014; Shah & Ward 2003; Shah & Ward 2007; Yadav et al. 2010). This implies that the concept of lean production is relatively undefined.

Hence, this lack of definition of the concept of lean production offers a unique opportunity to evaluate literature; the distinction of three strands of research into lean production serves as base for the further analysis. The first stream of papers study the lean production practices, the type of practices and how it

can be implemented such as (Bonavia & Marin 2006; Bortolotti et al. 2015; Shah & Ward 2003; Rahman & Bullock 2005). Some other studies are addressing the principles of lean and mostly how to structure a firm using the principles of lean; studies addressed the principles of lean see (Åhlström 1998; Bhasin 2013; Low et al. 2015; Sobek II et al. 1999). The third strand addresses lean production as a philosophical concept, and how it might be a theoretical concept; few studies have mentioned it as a theory, such as (Schmenner & Swink 1998; Wacker 1998). Therefore, this section of the paper will look with more detail into three different lenses: (i) lean production as a set of practices, (ii) lean production as design of production systems and (iii) lean production as a theoretical conception as first and to the regional context.

2.1 Lenses for Lean Production

First lens, lean production as a set of practices, considers the process that a firm follows for implementing the lean system, its methods and tools, and its practices. The tools that can be applied to a firm such as Just-In-Time, Total Quality Management, Kanban, total preventive maintenance (Flynn et al. 1995; Shah & Ward 2003; Shah & Ward 2007). Practices of lean is what most of the studies were addressing in the literature; what are those practices, what the main and fundamental practices that have been applied for implementing the lean production.

More specifically, some studies addressed the practices of lean into more depth and categorise them to bundles or groups (e.g. people, process, tools). Shah & Ward (2003) grouped the practices into four bundles: Just-In-Time (JIT), total quality management (TQM), total preventive maintenance (TPM), and human resource management (HRM); with a total of twenty-two lean practices. (Rahman et al. 2010, p. 842) list 13 practices out of the practices identified by Shah and Ward (2003) and they have grouped them in four categories. Also, Shah and Ward (2007) identify 10 factors that a firm should have divided into supplier-related, customer-related and internally-related (the process inside a firm). (Chavez et al. 2013, p. 563) with the description of the internal lean practices that is mostly used on a shop floor of a firm, in another word hard practices and its effect on other dimensions such as quality and flexibility. Several studies have addressed the lean practices in slightly different way by dividing them into two: soft practices and hard practices such as (Kochan & Lansbury 1997; Rahman & Bullock 2005; Shah & Ward 2003; Yang et al. 2011) they all have mentioned the two sides of the practices. whereas soft practices are those that are focusing on people, managerial practices and relationships (i.e. continuous improvement, top management leadership, and customer and supplier involvement), whereas hard practices are concerned with technical and analytical tools (e.g. statistical process control or Kanban)(Bortolotti et al. 2015, p.184); they also noted that the reason that most of the companies struggle with adopting lean production or they are not getting the success they are looking for, lies mostly on ignoring the soft practices and applying only the hard practices.

The regional context may have a noticeable contingency on the lean practices, if some practices may not be suitable for other region's workers, (Oudhuis & Olsson 2015, p. 279) noted that regional contexts differences should be taking in perspective before implementing a production system.

Second lens, Different from the set of practices that focuses on the implementation, the second lens concerns the application of lean production principles (Bhasin 2012, p. 441) to the design of production systems. Also (Low et al. 2015) study how to apply the lean principles to the design of a factory. In this strand of research, some studies use the principles for designing the firm, whereas fall back on the 'pure' Toyota production system, such as (Black 2007 and Sobek II et al. 1999).
There is a number of studies mentioning the lean production principles as key to the design (Black 2007; Mund et al. 2015; Low et al. 2015; Sobek II et al. 1999; Yadav et al. 2010). Toyota production system can be captured by four basic rules; these rules concern: (i) activities (how people work); (ii) connections (how the people connect); (iii) how the production line is constructed (pathways); and (iv) continuous

improvement (Yadav et al. 2010, p. 402). The workers are the most important element of the system (they are called internal customers) that the system must be designed with aim to satisfy them (Black 2007, p. 3643). Womack and Jones (1996) proposed the five set of principles (value, value stream, flow, pull and perfection). These principals summarise the design from the product design through order delivery (Yadav et al. 2010, p. 403). (Low et al. 2015, p. 284) mentioned 11 key principles for lean production and the core is reducing the non-value-adding activities.

In this lens, the study is examining the regional contexts' contingencies on the lean production design. Some studies addressed applying the de principles on different regions without generalisation of the regional contexts such as (Low et al. 2015; Yadav et al. 2010). On the other hand, (Sobek II et al. 1999, p. 81) believed that applying the design principles of the Toyota production system has no relations to the regional contexts

2.2 Regional context

Hence, the contingency variables can be the dimensions that may define the regional context in this study. The cultural, financial, legal, and geographical dimensions can be the contingency variables that may play a role in implementing lean production practices. Dimensions can be considered as the different ways of looking at the regional context's role that may affect the implementation of lean production. More specifically, the geographical dimension would include the distance between a supplier and the collaborating manufacturing company to expand the most benefits from JIT (Cook 2001, p. 967), also Arkader (2001, pp. 91-2) mentioned the geographical dimension as barrier of JIT success in a company. The cultural dimension, can cover the international culture and the differences between two nations (Wangwacharakul et al. 2014) or different cultural perspectives in an organisation. The legal dimension, as few studied descriped it as regulation and certificates that sometimes get in the way (see Maleyeff et al. 2012; Rodgers & Wong 1996). Finally, the financial-economic dimension may consider the different ways that an organisation can look at its economic or financial performance that may be a challenge in the implementation (Ketokivi & Schoeder, 2004, p. 66). Therefore, different regional context dimensions can have a role in the implementation of lean production.

3. Methodology

Given the limited literature regarding research on this topic, and with aim to achieve a deeper understanding on the effects of regional context to the implementation of lean production, we applied an exploratory multiple-case study methodology (Creswell 2003; Yin 2009). According to Eisenhardt (1989) case studies are useful when the phenomenon has not yet received appropriate ascertainment within the literature and when theoretical knowledge lacks clearness with respect to the underlying issue. Moreover, the multiple cases may help to understand the meaning and nature of real-life events, such as processes, relations and changes on organizational and individual levels (Yin, 2009).
In this respect, and for the explorative purpose aimed towards understanding, the empirical data for the case studies was collected through multiple forms and sources of data (Miles & Huberman, 1994; Yin, 2009). These included mainly semi-structured interviews and observations. Multiple interviews with top management and shop floor workers were conducted which lasted between 60 and 75 minutes. All interviews were voice recorded and subsequently transcribed. The interview data were supplemented with data collected through secondary sources including project documentations, company guides, the companies' web sites and observations during the interviews and during the provision of guided tours in the companies' shop floor for demonstrating lean production processes followed by each company.

4. Empirical Research – Overview

The two case studies were conducted in two medium sized companies from the aerospace industry. The following sections will cover the companies' overview, process of data collection for each case as well as the different characteristics of each case regarding lean production design and implementation practices.

4.1 Case Study A

The first empirical case (A) concerns a company in aerospace industry, more specifically in overhaul components. The company started implementing lean production in 2003-2004 under different senior management. However, the current top management decided to modify the implementation practices to fit better the workers and the need for each practice. These modifications emanated from the knowledge base of top management in lean production implementation, and to the extent that this knowledge created base for successful implementation. The process followed by the company in processing aerospace components involves five main steps: (i) the component comes in, (ii) the company get assessed, (iii) orders placed for needed parts, (vi) components get reassembled, and finally (v) components are shipped back to the customer. In these previous steps For the analysis of the case study, these previous steps were assessed and investigated in regards to the performance of lean production implementation in the practices of the company as well as the design of the operation structure of the company. Furthermore, attention was paid in to finding out the effect that regional context contingencies (cultural, geographical, financial and legal) may have in the implementation process. Consequently, the main themes that the investigation of the company covered were the above mentioned four regional dimensions and what is the role of them on the implementation of lean production.

4.2 Case Study B

The second empirical case (B) is also a company in the aerospace industry and in overhaul components. The company started implementing lean production with aim to cut waste that was a result of over used power in their previous plant location when part of the manufacturing plant was moved over to India (the business moved to India). Another reason for adoption of lean production practices, was to raise the productivity by achieving a smaller footprint that can be designed for the current activity of the company. As a first step, the company redesigned its old plant location in India (?) in order to test and to see how the flow is going to be. This allowed them to figure out the best way to transport the lean practices design to the new footprint. The company moved to the new location that were they have a fully lean production system designed in 2015. Similarly, with case A, the research in case B focused on exploring and investigating the process of the company's production line ('flow line' as they call it). Moreover, the study also looked into the role of the regional dimensions in the implementation of lean practices. The process followed by the company is the same as in case A, involving five main steps: (i) the component comes in, (ii) the company get assessed, (iii) orders placed for needed parts, (vi) components get reassembled, and finally (v) components are shipped back to the customer. However, in this case the process is more complex as the components are larger in size than the first case's component. That means that it takes longer delivery time than the first case. More in-depth details of the findings follow in the next section.

5. Analysis and Findings

For the qualitative data analysis, the Nvivo11 software was used. The analysis followed the general thematic analysis approach indicated by Braun and Clarke (2006): i) familiarisation with the data, ii) coding, iii) searching for themes, vi) reviewing themes and v) defining and naming themes. Interview and focus group transcriptions were coded, checked and rechecked throughout the coding process for consistency. Whereas some themes were emerged from the literature discussed at the previous section, the analysis of the data gave rise to additional themes that capture the structure of the interview material. An overview of the main themes emerged during the data analysis is shown in Table 1.

Table 1 Main themes emerged from data analysis

Themes	Codes	Company A Illustrative quotes	Company B Illustrative quotes
Top management	Workers challenges; training; and decision making	*'unfortunately, not everybody wanted to be on that journey and I think the biggest problem of the implementation has just been down to the attitude of the people themselves*	*'So, people who aren't used to that, we're suddenly adding hours and hours to their day. I did come up with some flexibility to help support that, some different options—and, also, we added in some payments for them to help get them on board'*
Lean production as set of practices	Lean practices; JIT; Kanban; 5 S; and any practices the company preform	*'We've done loads of different ones. We've had the Kanban, we've had Push and pull but I think with a large volume of products that come through the door, unfortunately with the facility that we are doing, repair and overall, we're at the mercy of the inputs and then you've got to weigh that up versus what we need get out.'*	*'but the most important part of an engine assembly is the part that you don't have, and if you've got 100s of 1000s of parts having to come back together, one shortage, regardless of what it is, is the one that stops you building that engine. The complexity of manufacturing some of these parts goes beyond where you would consider 'just in time' in the automotive industry.'*
Lean production as design structure	Flow of production line; changes in process, organization structure and lay out of facilities	*'would be better to have two end to the plant to see the unit through and where it is exactly, while here the door that comes in and leaves it too we had to make a range of changes to the workshop of what shop is where they eventually are... to improve the flow'*	*'how we can afford the components better. So, it was all about get down here, squeeze the space, and get the business running. We've done that, we've done that pretty successfully I would say, and the challenge we face today is the volume of engines is going up, so space becomes a real premium and we actually need to start thinking about storing stuff vertically.'*
Lean as theoretical conception	Lean knowledge; the philosophy of lean production; and Swift even flow	*'with lean, we've made so many improvements through Lean and I'm not saying in any way that's negative, because we've made a lot of great strides on it but I don't think Lean leads to better quality'*	*'it did rely heavily on people being flexible and willing to enable it. It relied on very detailed plans. It relied on a lot of knowledge about the plant and equipment.'*
Geographical dimension	Supplier; location; and cluster	*'The biggest problem we've suffered over the past two and a half years as I see from external supply of parts overseas. Shortages of parts have caused us problems and some to our customers externally.'*	*'we're miles off 'Just in Time'. We know that we're not a car factory as I said, our supply chain is stretched, it's complex, it's global, and some of these suppliers are used by our*

			competitors, so everybody's trying to get the same resources, the same capacity. At the same time the market's growing and the capacity is not growing quick enough, and that's a challenge
Cultural Dimension	Organisational culture; national culture; and employees	*'the employees were big challenge in the implementation, because in the beginning the management wanted everyone to be involved in the journey, and wanted everyone to work on one hour a week on lean.. that resulted to employees that do not want to work on that project which resulted to useless projects working on without contributing anything. Just don't call it lean if it scares people out'*	*'I think people did initially, then they think we could actually make it work. People didn't think we could actually move down here. People thought that what we were trying to do was impossible, 'This is gonna be impossible'. people didn't want to move 'cause it's a journey, but we worked on that.'*
Financial dimension	Budget investment and support the new system	*'There's a financial issue because everything's not done to the highest standard. we can't afford do it right or whether we don't really know the right way to do it.'*	*'We took into account flow, we took into account where we could save space without big investment and we applied it.'*
Legal dimension	Certification and intellectual property	*'It's actually the regulation of the aviation authority under which the customer has to comply. Also, because they're aircraft components, they have to be certified in a specific way, then it gets a specific tag to certify that that is up to aviation standard.'*	*'The parts need to go there because they need to go to get repaired. So, we repair parts, but we will send parts. That's what I'm saying, so we'll buy new parts but we'll also send parts because their repair technology and their intellectual property is owned by somebody else—we can't repair the parts. So, our coating repair is done in Asia and it may be done under licence to MTU*

The following paragraphs will go in detail of the themes and the result gathered from analysing both casesand the regional dimensions and how is the role on the implementation process as whole.

5.1 Regional Dimensions

As a first step for the analysis of the case studies the focus is on the role that the regional context has in the implementation of lean production. The main themes that have emerged and will be discussed are the following dimensions: geographical, cultural, finance, and legal.

5.1.1 Geographical Dimension

The theme labelled as geographical dimension, is concerned with location of the company, location of the suppliers being in a cluster (Porter 1998), the relationship between the company and their supplier any geographical relation to the implementation of lean production. As their main supplier, the case A company uses an external supplier which is located overseas. According to the collected data, that results to a lot of shortages coming from the supplier's end, which in turn result to delays in delivery time, and therefore inefficient JIT and Kanban practices. Moreover, relying heavily on an overseas supplier that causes the shortages leads to higher inventory to cover the shortages and improve the delivery time. More specifically, the delivery of small parts can be delayed for over two months. This delay can cause the delivery time rate to go up massively. Therefore, the main problem identified in the study is the overseas location of the main supplier. To illustrate that, the senior management stressed that the company has been suffering from the shortages from the external supplier for over two and a half years. This issue also increases the WIP (work in progress) inventory and thus causes delays for deliveries to the customers.
Case B shares the same problem with supplier shortages and that makes their delivery time to increase to 90 or 100 days instead of 60 days that is the target of the company. However, because in this case multiple external suppliers are used for one component, the case B is more complex than the case A. That means that there are many lines of connection to deal with. Hence, and as the senior manager explained, that makes it very hard to meet the delivery time; mainly because most of the times none of the suppliers meet their delivery target. The shortages that the global supply does in the market and more specifically for case B that they had to raise the inventory level to keep up with the high demand. Case B uses a global supply that can involve suppliers of 4 different countries being involved for one component, and that is the main reason for the delivery time taking too long in this case.

5.1.2 Financial Dimension

The financial dimension for the case A is mainly concerned with the design of the production system. Because the company does not have sufficient available budget for investing on the lean production lay-out design, the company is using the minimum amount of investment to redesign the production system. The test-stands used for the components are massive in size, and the company has tried to move the line around them in order to create an easier way to have the flow line. However, even with this modification, the flow line does not run smoothly. The components go back to the same point that they started from for example, the plant has an entry door the component start from that door and after the component ready to ship back to the customer, it will go back to the same door, which is not U shape nor one-line production. That makes it slightly difficult to have more than five components at the line, as they would benefit more to have more than five on the line to raise the profit for the company.
In case B the company is not as short in investing on the design of lean system as the case A. As mentioned, the company in case B moved to another location to cut the waist of unneeded power and electricity, which made the company to design from scratch the production system in another location. Although the location was already built, and they just needed to fit the deign in the new footprint, the design was not as suitable as they hoped. Hence the company needed to make some improvements to ease the flow of components and to meet the higher volume of products coming in the plant. This indicates that the company did not have any major budget constraints when designing the lean production system. As the senior management explained, the company first fitted the design in and then using the available budget they made the necessary adjustments.

5.1.3 Cultural Dimension

The third dimension that was covered in the investigation of the companies' implementation journey is the cultural dimension. That is, focusing toward the workers' behaviour and more specifically the acceptance or concerns regarding lean implementation. In case A, the company went through two different management teams. Whereas the initial management team was the one to introduce the lean

production system to the company, it did not take the time to show and explain to the workers the reasons behind taking the decision to change its previous production system to lean production. That led to, as described by the interview participants, a 'fear culture' that got into the workers and made them dislike or even disapprove the change. The workers were forced to accept the change without knowing the reason behind it, which made the workers follow pattern they do not know why. When the current management took over, they decided to cut down some of the unnecessary practices and suggested to change the name of 'lean production' to something else that it would appear less fearful to the workers (they kept the name of lean). As the senior management stressed, the acceptance from the workers were one of the biggest challenges in the implementation of lean production.
In case B, the management took a completely different approach than the company in case A. Before adopting the lean production system, the management explained to their workers exactly the purpose of the change and why the company is going for it. They seek the consent of the workers and their collaboration in order to achieve a smooth transition to the new production system. The top management dealt with the situation, by preparing the employees for the change with provision of appropriate seminars or training and even with raises of the payroll.

5.1.4 Legal Dimension

The last dimension is the legal dimension which is related with possessing the certificate right for some of the aerospace parts and the intellectual property agreements that the companies must obey. This means that without the necessary agreements, the company cannot produce certain parts they need. The legal dimension is also concerned with the legal agreement that links each company with the main supplier overseas. These legal issues contribute on the factors that affect the implementation of lean production. Whereas, case A and case B, have this dimension as a contingency on the implementation of lean production, the legal factors are recognised as a way for controlling in this industry. For instance, in case B, the company imports a component part that is manufactured in Japan where they explicitly have the intellectual property for manufacturing it. That means that the company does not have the right to manufacture it in their facilities.

In Table 2 a cross-case analysis between case A and case B is illustrated to show how implementation of lean production is affected in the different dimensions.

Table 2 cross-cases analysis in regional contex

Theme	Case study (A)	Case study (B)	Note
Design of production system and the financial dimension	• Insufficient design of the lean system flow • Design need to be improved • Spaces not in-use • Investment in redesign • Getting 2 doors of entry and exit can help the flow	• Smooth design of flow • Getting tighter because of the higher volume • Getting 2 doors of entry and exit can help the flow	in the design of the production system, the analysis shows mostly the financial dimension can be more of an issue as it was shortages in the redesign investment.
Geographical dimension	• External supplier • Main parts are from the overseas supplier • Shortages in delivery from suppliers	• Complex of (external) suppliers • Local and global suppliers • Delivery time is high	In this theme, can be noticed that the suppliers are mainly the issue in the delivery time and raising the inventory level

	• High rate in delivery time • Medium to high inventory	• High inventory level	
Cultural dimension	• Workers were not happy • The organizational culture took too long to get the workers on board with the new system • Fear culture was developed • Workers were not aware of the company's mission and reasoning for change	• Workers know the reason of the change • Preparation from top management to the workers • Clarity of the company's mission and purpose of change • It was a challenge that the top management dealt with	Clearly the employees are always a challenge in the implementation process, however, in case (A) the reason of change was missing, therefore, the fear of change and rejection occur. In Case (B) the management were prepared for the change that was offered from the senior management to help with the change
Legal dimension	• Legally must get the component parts from the external supplier • Cannot use any other supplier even if they are locally	• IP regularity and certificates that prevent or limited the choices • Complexity of the product and the aviation rules to follow	Legally the shortages happen that out of the companies control, they just have to find a way to reduce their delivery time rate by working around this dimension

5.2 Discussion of Findings

The first finding of this study is related to the design of the lean production operation system and the layout of the plant. Whereas case B has a more efficient layout of the production system than case A, both cases appear to have design issues that delay or even interrupt the flow of the production line. It is surprising that although the two case companies have adopted a lean production philosophy, they have not incorporated many elements of the basic lean production system design as found in the Toyota's design structure (e.g. Black 2007; Sobek II et al. 1999). In contrast, the companies seem to follow a 'design follows function' working principle which according to Low et al. (2015, p. 298), when compared to designs according to lean production principles, can result to diminished operational performance. The reason behind that, for both companies, it was found to be the limited available financial budget allocated to the design of the production system. Hence, the financial dimension plays a crucial role and more specifically, the limited investment affects in a high degree the design of the lean production system and therefore the operational performance of the companies.

The second finding concerns the effect the geographical dimension has on the implementation of lean production. The location of the suppliers and ease of the supplier access play huge role in the success of applying the lean production. It was found that JIT is the practice mostly affected by the supplier access and location. For instance, the company in case A is only dealing with one overseas supplier which proves to be as one of their biggest challenges causing shortages in delivery time. The situation is even more complicated for the company in case B. Because the company uses multiple overseas suppliers, that makes the process of the delivery time even longer than dealing with one supplier as in case A. Therefore, the geographical dimension is found to be a barrier for successful implementation of lean production practices such as JIT, Kanban and Kaizen. This finding of the role of geographical dimension on the lean production practices supports the findings in literature of Cook (2001, p. 967) and Arkader (2001, pp. 91-2). Moreover, according to the analysis of the data gathered from both case A and case B, it is evident that

the role of the geographical dimension is the most challenging one for successful implementation of lean production.

The third finding is related to the organisational culture and more specifically to the workers' acceptance and their role for the implementation of lean production. Our findings agree with the suggestions of Bortolotti et al. (2015) and Semeds (1994) that the organizational culture of a company may have significant effect on the successful implementation of lean production. More specifically, in both cases of this study the top management had challenges with having their workers accept and support the change in the production system. The company in case A had the greatest challenge comparing to the company in case B. That was mainly because of the uncertainty in taking decisions and in explaining the reason behind the change to lean production to the workers, that led to a 'fear culture' towards the new production system (lean). The company in case A struggled to have the workers go along with the change, and as the top management said, '*it was the biggest challenge in the transformation'*. For the company in case B, the acceptance of the change from the employees was different; the top management prepared the employees by worked with them mainly through training and that made them understand the reason behind the change. At the end, and although the level of acceptance varied from a worker to another, all of them acknowledge the reason for the change. That helped the company in case B to transition and operate slightly better than the company in case A which followed a different approach for briefing and including their workers to the change of the production system.

The fourth and final finding in this study is about the legal dimension and how it may affect the implementation of lean production. The company in case A is dealing with one main external supplier that legally they must only deal with. While the company in case B is dealing with multiple external supplier globally which some of them are IP holders for certain parts and therefore the parts must come from them. Hence, whereas it is acknowledged that this dimension may affect in some degree the implementation of lean production, the companies have little to no control on most of the legal issues.

The four findings of this study show how regional dimensions can have different effects on the successful implementation of lean production. It is concluded that the most dominant regional dimension with the highest degree of effects is found to be the geographical dimension and the one with the least important effects is the legal dimension.

6. Concluding Remarks

Whereas the principles of lean thinking have been declared universal applicable the rich data collected for the two case studies point to the dimensions of the regional context playing a role in its implementation. In analysing the data collected from the two companies, the ambiguity of the conceptualisation of lean thinking and lean production has not been taken into account for this paper. With regard the dimensions, the most dominant is the geographical dimension, particularly the distance of suppliers and the complexity of managing the relationships with these suppliers. The perturbation for the implementation of lean production is caused by that international spread of suppliers, which increases delivery time, reduces flexibility and, hence, creates shortages. The second dimension that has an impact in the implementation is the cultural dimension, specifically the workforce accepting the change practices to those related to lean production. Across the two cases, differences were noted about managerial support with regard to changes lean production brought about. The third, less relevant dimension is the financial dimension. In both cases the implementation was sought with the minimum budget available, even though the purpose was increasing profitability and cutting waste. However, both cases did not do allocate additional budget, resulting in not implementing all necessary practices, organizational processes, organizational structures and adaptation of lay-out to achieve these objectives. The least pertinent dimension, the legal dimension, comes about through regulatory certification that limits the development and improvement through the implementation of lean production the companies are looking for. Therefore, all four dimensions for regional dimensions had an effect on the implementation of lean production in the two case studies, with the geographical dimension being the most dominant one.

In addition to factors that could be attributed to the four dimensions of the regional context, both companies experienced difficulties to meeting lead times due to supplier base. However, both cases are different in how the supplier base affected lead-times and the successful implementation of lean

production. In one case the supplier base is limited to a main supplier, whereas in the other one there are multiple suppliers in a complex way; the delivery performance of these suppliers, geographically on other continents, interrupt processing of orders and hinders the effectiveness of JIT practices. Exacerbating the reliability is that both companies have limited control over and influence on the suppliers; therefore, they are not in position to change the supplier philosophy or pattern. They can decide to manage the suppliers' input to improve the delivery time, for example, through slightly higher levels of inventory, but this is detrimental to the philosophy of lean production. This means that irrespectively of the implementation of lean production both have to consider how they can achieve turn-around times and lead-times given the erroneous reliability of their suppliers.

6.1 Managerial Implications

The cases also show that the dimensions of the regional context should be accountable during the implementation of lean production. Particularly the capability of the suppliers to deliver reliably plays a dominant role in achieving objectives related to lean production. At the same time, it should be noted that interventions to improve the performance of suppliers are limited due to lack of control mechanism and the limited alternative suppliers. Another point is the training and awareness of employees; successful implementation is only possible when training and management support has been provided (Stewart et al. 2010). A final point is that achieving full benefits of implementation of lean production is only possible when sufficient budget is made available for changes in process, organization structure and lay out of facilities. From the two cases, it seems that those three factors – spread of supplier base, training of employees, budget for investment – determine to what extent lean production can be implemented.

Cost efficient process of lean may lead to suggested solutions that can help with avoiding the late delivery and lead time. The first solution is change of suppliers where in this case is not an option as in both cases they do not have control over the suppliers; whereas the may change some of them, it is more complex than easy to change. The second option is regarding the inventory level and more specifically, keeping parts that are frequently used in components and have some ready component to replace the delayed ones. The previous solutions aim mainly to improve the delivery time for both cases -as they were slightly higher that their target, which is caused by international suppliers.

The two explorative cases studies are raising the awareness of the cost-efficiency in implementing lean production. In both cases, they implemented lean production in the maximum cost-efficient way possibly. That led to slightly negative effects in the design of the production system. Hence, awareness should be noted about managing the level of cost-efficiency and negative effect in the implementation.

6.2 Limitations

The study has four limitations that are discussed now. The first one is that both case studies touch place in the aerospace industry and more specifically, concern components. Although same findings may be specific to this industry, other companies in other industries may also benefit from this study; particularly those that produce overhaul of systems components or those that short lead time that involve external supply. The second is that the study has conducted in one region – United Kingdome – which may impact findings related to geographical proximity and the financial dimension. The third limitation is that only two cases were researched. However, there were similarities in findings. This point to saturation (Eisenhardt 1989), which means that there is a high likelihood that findings are generelisable accordingly for the specific industrial content of other firms. This means that although the study has limitation there is also confidence from the finding can be replicate for other firms and industries.

6.3 Further Research

This paper is a part of doctoral study, therefore, further empirical research will take place with multiple cases in different regions. The study suggest further research can be conducted in multiple cases with different industries to show the different process implementation and how the regional context can be a contingency from industry to another.

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