**Determinants and Barriers to Lean Implementation in Food Processing SMEs- A Multiple Case Analysis**

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**Abstract**

This study explored contextual or determining factors and their impacts on lean manufacturing in small and medium sized enterprises (SMEs) operating in food processing industries. In order to get an in-depth insight of the real situation at the work floor this study adopted a multiple-case-study research approach. The inherent characteristics of food industries, such as mandatory quality assurance requirements, low shelf-life of the food products and the extremely volatile demand and supply presented barriers to lean manufacturing adoption. In addition, the challenges of “change” in an SME environment are distinct from those faced by large organizations. The small size of the plant, the traditional setup and inflexible layout make it difficult to implement lean in food processing SMEs. The knowledge of contextual factors influencing lean manufacturing adoption in food processing SMEs will be a contribution to current knowledge. Many studies have explored lean constructs and tools, while far fewer have explored the crucial element of actually implementing these. The study will also help practitioners to anticipate potential obstacles and take proper measures to deal with them during lean implementation.

**Keywords**

Lean manufacturing, food processing industries, SMEs, determining factors

## Introduction

Editorial of this journal emphasized the need for more exploratory case research to get a better insight on industry specific contextual factors, especially when applying a new technology or management practice ([Childe 2011a](#_ENREF_23)). Childe in his editorial remark highlighted that the researcher should work closely with industries to develop an understanding of the challenges faced by industries while implementing such practices ([Childe 2011b](#_ENREF_24)). Henceforth, this study explored the crucial element of lean implementation in food processing SMEs to provide reseracher and practitioner a better insight into industry specific contextual factors that may have an impact on Lean outcomes in food processing industry. In order to explain the industry-specific differences and challenges in lean implementation, [Hines et al. (2004](#_ENREF_51)) stated:

“…when applied to sectors outside the high-volume repetitive manufacturing environment, lean production has reached its limitations, and a range of other approaches to counter variability, volatility and variety have been suggested ([Hines et al. 2004](#_ENREF_51))”.

Many studies reinforced the claim made by [Hines et al. (2004](#_ENREF_51)) regarding the effectiveness of lean manufacturing ([Ben Naylor et al. 1999](#_ENREF_11), [Christopher and Towill 2001](#_ENREF_25)). A considerable number of studies found that the implementation of lean manufacturing practices is difficult and organizations encounter several roadblocks in this long continuous improvement journey ([Abdulmalek and Rajgopal 2007](#_ENREF_1), [Sim and Rogers 2008](#_ENREF_107)). Several studies identified determining factors which make the lean journey either a success or a failure ([Dora *et al.* 2013b](#_ENREF_36)). In SMEs context, they can’t afford to falter in lean implementation as it may affect their existence as well ([Muscatello *et al.* 2003](#_ENREF_85)). The authors extend the current knowledge on lean in food processing small and medium-sized enterprises (SMEs) by providing insight from three broad perspectives in the next section: processing industry, food sector, and SMEs.

[Kochan *et al.* (1997](#_ENREF_63)) explained that the pace of change and the outcome of lean initiatives differ significantly across sectors and even across companies. In this context, food processing SMEs are ideal for examining the generalization made by Womack, et al. regarding lean manufacturing ([Womack *et al.* 1990](#_ENREF_128)). This study investigates the adaptability of lean manufacturing in a complex small and medium-sized food-processing enterprise environment. The result contributes to research and practice on lean manufacturing implementation in two ways: 1. it identifies factors that may distinguish between successful and unsuccessful lean implementation in food processing SMEs. 2. it explains how determining factors particular to food processing SMEs influence lean adoption. The knowledge of contextual factors influencing lean manufacturing adoption in food processing SMEs will be a contribution to current research. The study will also help practitioners to anticipate potential obstacles and take proper measures to deal with them during lean implementation. The remainder of the study is organized as follows. First, we conduct background research on processing industry, food sector and SMEs and thereby including literature on lean manufacturing application in the food processing industry. The following section explains the research model, methodology, results and discussion. The study closes with limitations, conclusions and future research agenda.

## Background Research

*Processing industry context*

Processing industries are principally defined as those where the primary production processes are either continuous, or occur on a batch of materials that are indistinguishable such as food, beverages, chemicals, or pharmaceuticals. One of the important differences between assembly and process industries are hidden inventories and machines that are difficult to move because of their size and connected pipes ([King and King 2013](#_ENREF_61)). Peter King wrote an interesting article "Making Cereal Not Cars” to demonstrate that lean application is not straightforward in process industries and needs adjustment ([King et al. 2008](#_ENREF_62)). [Abdulmalek et al. (2006](#_ENREF_2)) stated that extensions of lean manufacturing to the process industry have been much slower compared to discrete industries such as the automobile industry. Their study pointed out that the product and/or process characteristics may hinder a straightforward application of lean. They provided a fitting example saying production efficiencies related to large product volumes may impede JIT production, whereas process flexibility determines the relevance of lean practices. Lean manufacturing was designed for a low-mix, high-volume manufacturer of a limited range of assembled products. Consequently, adaptations are required in order to get the desired results in processing industries ([Irani 2011](#_ENREF_54)). Our research attempts to address this issue by developing a context specific framework aligned to the characteristics of food processing industry.

*Food sector context*

The food sector is based around a very heterogeneous group of products with different degrees of perishability, different manufacturing lead times, and dealing with supply issues to different customers, in different amounts, and at different frequencies. The result is that manufacturers must continuously balance the risk of waste against reduced product quality with the risk of stock-outs and dissatisfied customers. Previous studies have recommended to conduct research on lean implementation issues in the food processing industry ([Simons and Taylor 2007](#_ENREF_108), [Engelund *et al.* 2009](#_ENREF_41), [Mahalik 2010](#_ENREF_76), [Mahalik and Nambiar 2010](#_ENREF_77), [Dora *et al.* 2013c](#_ENREF_37)), especially in the SMEs ([Nabhani and Shokri 2009](#_ENREF_86), [Shokri et al. 2010](#_ENREF_106)). [Cox and Chicksand (2008](#_ENREF_28)) argues that without a proper understanding of specific characteristics of the food sector, the lean manufacturing practices may not bring the expected result or may even be unfruitful. A detail review of literature on lean manufacturing in food sector in table 1 highlights the key finding and limitations of the studies.

*SME context*

Similarly, the literature shows that there are several advantages and disadvantages of being an SME when implementing continuous improvement initiatives such as lean. . Some of the advantages of SMEs are: involvement of top management in day-to-day activities ([Mc Cartan-Quinn and Carson 2003](#_ENREF_80)), informal structure and culture which increases cross-functional exchanges and smaller teams that aid in efficient decision making ([McAdam 2000](#_ENREF_81)). Some of the major disadvantages of SMEs are: lack of resources ([Achanga et al. 2006](#_ENREF_3)), lack of training ([Koh et al. 2009](#_ENREF_64)), lack of long-term planning ([Mezgár et al. 2000](#_ENREF_83)), shortage of staff and lack of resources for major consulting ([Brun 2011](#_ENREF_20)). Moreover, studies also found that the implementation of lean manufacturing can be more costly for SMEs s and the impact of unsuccessful projects could be more severe ([Mabert et al. 2000](#_ENREF_75), [Muscatello et al. 2003](#_ENREF_85)). Additionally, [Bakås et al. (2011](#_ENREF_7)) reviewed the existing literature on lean manufacturing in SMEs between 1992- 2011. It is important to note that none of the studies focused on food industry, given the fact that 98 percent of the food processing companies in Europe are SMEs ([CIAA 2010](#_ENREF_26)).

*Lean in Small and medium sized food processing enterprises*

[Rajurkar and Jain (2011](#_ENREF_94)) presented a detailed review of literature on food supply chains management based on 134 papers published in reputed academic journals between 1994 to 2009 and concluded that there are only a few studies which focus on lean manufacturing in the food industry. Similarly, [Marodin and Saurin (2013](#_ENREF_79)) reviewed 102 articles appeared in reputed peer reviewed operations management and engineering journals between 1996 to 2012, and found that there are only three articles included food sector (from US and UK) in their study sample. Table 1 demonstrates literature related to lean manufacturing in the food sector and their methodology, key findings and limitation.

Table 1 Lean manufacturing in food sector

|  |  |  |  |
| --- | --- | --- | --- |
| Author, country | Methodology, sample | Key findings | Limitation |
| ([Zokaei and Simons 2006](#_ENREF_132)) UK | case study, (9 red meat chain) | * Identified waste in value chain
* Focus on two lean concepts - takt time & standard operations
 | * Narrowed the scope and outcomes of only two lean concepts
 |
| ([Lehtinen and Torkko 2005](#_ENREF_69)) Finland | Case study | * value stream mapping
* inventories and waste in chain
* reduced costs & increased customer satisfaction
 | * Only one practice is emphasized
* Neglect production process
* Determining factors missing
 |
| ([He and Hayya 2002](#_ENREF_50))US | Survey, (48 US food companies) | * JIT has a positive impact on food quality
* employee involvement & JIT delivery
* material management
 | * Neglect operational performance
* Ignore determining factors
 |
| ([Upadhye *et al.* 2010](#_ENREF_118)) India | case study,medium-sized biscuit manufacturing | * 5S, kaizen, quick changeover, and TPM can be effectively used,
* commitment from top management, and training, awareness and employees’ involvement important
 | * Neglect operational performance
* Ignore sector specific determining factors
 |
| ([Engelund *et al.* 2009](#_ENREF_41)) Denmark | Large-scale food production | * value stream mapping, kaizen and 5S
* improving production efficiency, product quality and working environment.
* JIT and pull failed
 | * Neglect operational performance
* Ignore determining factors
 |
| ([Scott *et al.* 2009](#_ENREF_102)) Canada | Survey, 46 food SMEs | * 10 out of 46 companies implemented lean
* companies implementing lean have fewer product recalls
* not sure if resulted in cost savings,
* quality and safety benefits were the biggest motivational factors
 | * Not focused to lean only
* More emphasis on QA practices
* No reference to implementation aspects
 |
| ([Cox and Chicksand 2005](#_ENREF_27)), UK | Case study, red-meat supply chain | * lean practices are not easy for all internal and external participants in the food chain
* recommended not extending lean beyond the boundaries of the firm
 | * Narrowed the scope and outcomes of only two lean concepts
 |
| ([Kumar and Antony 2008](#_ENREF_66))UK | Survey, 64 SMEs (7 Food and 57 non-food) | * 26.5 percent adopted lean manufacturing
* top management involvement, communication, cultural change and training were the critical factors
 | * Did not mention out of 26.5 % how many are food SMEs
* Ignore operational performance
 |

With this background this case study is to explore how and why determining factors that were previously identified in the literature might or might not explain lean manufacturing success in the food processing SME context. [Boynton and Zmud (1984](#_ENREF_19)) explains that determining factors are “those few things that must go well to ensure success.” This also relates to one important question in operations management literature - why do some firms perform better than others applying the same practice? Organizational behavior theorists improve our understanding of this fundamental question. Their theories focus on identifying, explaining, and predicting the determinants of organizational performance. Past studies have pointed out that to achieve the desired results of manufacturing practices, the firm needs to understand what types of organizational behavior fit with its operational strategy ([Rich and Bateman 2003](#_ENREF_96), [Dora and Gellynck 2015](#_ENREF_34)). The theory suggests that individual, organizational, environmental, and other factors contribute to organizational performance ([Ketchen and Giunipero 2004](#_ENREF_60)).

## Research design

To meet the research objective, a research model was set up through a comprehensive review of the literature on lean manufacturing, operations management, food processing and SME characteristics. [Sousa and Voss (2008](#_ENREF_113)) postulates that a robust model in the field of operation management should include practice, performance and determining factors. As a result, the model used in this study includes practice, performance and determining factors (Figure 1). The determining factors include two groups, one group contains the factors identified through previous lean literature (table 2), while the other one contains the contingency factors specific for the examined companies (table 3).

**Determining factors**

**Practices**

Supplier related

Customer related

Internally related

**Performance**

* Stock/inventory reduction
* Productivity improvement
* Lead or cycle time reduction
* Quality improvement
* Improve on-time delivery
* Commitment of top management
* Culture
* Piecemeal approach
* Training
* Multifunctional team
* Resources
* Organizational structure
* Remuneration
* Change agent
* Nature of process
* Nature of product
* Nature of plant

Figure 1 Research model

First, this study adopts the Shah and Ward’s proposition of lean manufacturing practices ([Shah and Ward 2007](#_ENREF_104)). Shah and Ward identify ten elements of lean manufacturing practices with respect to supplier-related, customer-related and the internally-related issues of the company. The ten elements included in their model are: (1) involved customer, (2) supplier feedback, (3) just-in-time delivery, (4) developing suppliers, (5) pull, (6) flow, (7) low set-up, (8) controlled processes, (9) productive maintenance and (10) involved employees. This paper emphasizes on internally related practices and keep the discussion on supplier and customer related practices limited. Customer and Supplier related practices will be included in future research when we extend our research from company level to Supply Chain level.

Furthermore, a thorough review of literature in the field of operations management was carried out to identify possible enabling and obstructing factors and its relation to operational performances ([Hsu and Sabherwal 2011](#_ENREF_52)). Similarly, the literature on operations management stresses the need for training on professional skills to make employees more multi-functional ([Lee and Allwood 2003](#_ENREF_68), [Dowlatshahi and Taham 2009](#_ENREF_38)). Research also highlights other critical factors for lean adoption such as piecemeal approach and organizational structure ([Näslund 2008](#_ENREF_89)). Piecemeal approach means adopting certain parts of lean manufacturing and ignoring its systemic nature ([Dowlatshahi and Taham 2009](#_ENREF_38)); is considered to be an obstructing factor in lean implementation. Literature on organizational change as well as lean manufacturing points out that employee skepticism about the management’s commitment to the change program has been suggested as an obstacle to organizational change ([Stanley *et al.* 2005](#_ENREF_114)). Skill of workforce and in-house expertise, for instance, soft skills and technical skills play an important role in the successful adoption of lean manufacturing ([Stock *et al.* 2007](#_ENREF_115)). Additionally, resources, mainly financial capabilities includes, for example, funds to cover training costs, external consultants or any other related investments play a significant role in lean adoption ([Bhasin 2008](#_ENREF_13), [Trkman 2010](#_ENREF_117)). Table 2 provides an overview of determining factors related to lean manufacturing.

Table 2 Determining factors based on literature

|  |  |
| --- | --- |
| Determining factors | Sources |
| Commitment of top management  | ([Fryer *et al.* 2007](#_ENREF_45)); ([Sanchez and Pérez 2001](#_ENREF_99)); ([Achanga *et al.* 2006](#_ENREF_3)) |
| Organizational culture | ([Stock *et al.* 2007](#_ENREF_115)); ([Bhasin and Burcher 2006](#_ENREF_14)); ; ([Hines *et al.* 2004](#_ENREF_51)); ([Mann 2012](#_ENREF_78))) |
| Skill and training | ([Worley and Doolen 2006](#_ENREF_129)); ([Sanchez and Pérez 2001](#_ENREF_99)); ([Karlsson and Ahlström 1996](#_ENREF_58)) |
| Resources | ([Hudson *et al.* 2001](#_ENREF_53), [Kumar and Antony 2008](#_ENREF_66)) |
| Multifunctional team | ([Sharp *et al.* 1999](#_ENREF_105), [Sanchez and Pérez 2001](#_ENREF_99))  |
| Organizational structure | ([Nahm *et al.* 2003](#_ENREF_87), [Demeter and Matyusz 2010](#_ENREF_32))  |
| Remuneration and Rewards | ([Watson *et al.* 1996](#_ENREF_125), [Hankinson *et al.* 1997](#_ENREF_49)) ([Robson and Bennett 2000](#_ENREF_98)) |
| Change agent | ([Carson and Gilmore 2000](#_ENREF_21))  |
| Piecemeal approach | ([Storch 1999](#_ENREF_116), [James 2006](#_ENREF_55), [Shah and Ward 2007](#_ENREF_104), [Dowlatshahi and Taham 2009](#_ENREF_38)) |

Further, based on the literature and the authors’ own observations, Table 3 summarizes the characteristics of the food processing industry with respect to plant, product and production process ([Van Wezel *et al.* 2006](#_ENREF_121), [Wang *et al.* 2009](#_ENREF_124)).

Table 3 Characteristics of food processing industry

|  |  |
| --- | --- |
| Component | Food Processing Industry Characteristics |
| Product | * Perishable product (raw material, semi and finished product)
* Variability in raw materials quality, supply, and price due to unstable yield
* Industry’s use of volume and/or weights (in contrast to discrete industries)
 |
| Production process | * Processes have a variable yield and processing time
* High variation of composition, recipes, products & processing techniques
* Production rate is mainly determined by capacity
* Divergent product structure, especially in the packaging stage.
* Variable yield and processing duration, variable product structure
 |
| Plant | * Processing and packaging are separated because of QA requirements
* Long sequence-dependent set-up time between product types
* Single purpose expensive machine, product variety and high volume
* Usually, the factory shows a flow shop oriented design
 |

Finally, there is a large body of literature published on lean manufacturing practices and its impact on firm’s operational performances ([Lewis 2000](#_ENREF_71), [Fullerton and Wempe 2009a](#_ENREF_46)). The most commonly cited benefits of lean manufacturing practices are quality improvement, increased productivity, reduced lead time, improved delivery time, and reduced costs ([White and Prybutok 2001](#_ENREF_127), [Shah and Ward 2007](#_ENREF_104), [Fullerton and Wempe 2009b](#_ENREF_47)). This study considers five operational performance indicators of lean manufacturing practices draw from the literature: 1. Stock/inventory reduction ([Fullerton and Wempe 2009a](#_ENREF_46)), 2. Quality improvement ([Cua et al. 2006](#_ENREF_29)), 3. Productivity improvement ([Shah and Ward 2003](#_ENREF_103)), 4. Lead or cycle time reduction ([Droge *et al.* 2004](#_ENREF_39)), 5. Improvement in on-time delivery ([Flynn and Flynn 2004](#_ENREF_44)).

Taking into account all of the contextual factors cited in the previous section, this study investigates whether any of the characteristics of food SMEs (process, product, and plant components and organizational factors) affect the prospects of success for lean manufacturing implementation. The specific research question investigated in this study is: how do determining factors (enabling and/or obstructing) influence the lean adoption. The next section outlines the research methodology.

***Methodology***

Lean manufacturing is a complex, multidimensional concept and relates to complex systems (e.g. the whole of the operations). To get in-depth insight and a valid analysis of the real situation at the work floor this study adopted multiple-case-study research. The case study method is considered to be the most suitable methodology with regard to the exploratory nature of the study, which combines both qualitative and quantitative data ([Panizzolo 1998b](#_ENREF_91), [Voss *et al.* 2002b](#_ENREF_123)). The multiple cases provide a deeper understanding of processes, which give us the chance to test the hypotheses, and “a good picture of locally grounded causality” ([Miles and Huberman 1994](#_ENREF_84)). The method allows studying the problem and the context to deduce both cause and effect ([Leonard-Barton 1990](#_ENREF_70)). This process aided with studying the phenomenon in its natural setting, and focused on contemporary events ([Yin 2009](#_ENREF_131)).

The present study was carried out within the scope of a European Union funded project - “Innovative Management System for the Food SMEs” (IMSFood). The objective of the IMSFood project is to support the implementation of lean manufacturing practices in four food processing SMEs in Belgium over a one-year period (January 2011 to January 2012). Twelve food SMEs were contacted to participate in the project for lean implementation as well as in the case study. Four food SMEs agreed to join the project and participate in the case study. The research team involved in the funded project was chosen based on their extensive training and consultancy experience in Lean and other continuous improvement initiatives implementation within manufacturing sector including food and drink industry. To communicate the need for change in the participating firms, Ghent University organized a five days training program on the lean manufacturing practices for the general manager and operations managers of the involved companies. Special care has been taken to select the key managers for the training program who could also act as a change agent after attending the training program.

This structure provided us with an exceptional opportunity to study four different cases of lean manufacturing adoption in food processing SMEs where both the conceptualization of lean manufacturing as well as the practical approach to its implementation were similar. By comparing these cases, the study explores how both enabling and obstructing factors affect the adoption of lean in food processing SMEs. Table 4 provides an overview of the four food SMEs that participated in the study.

Table 4 Description of the Food Processing SMEs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company | Product | Employees | Turnover (€) | Quality Assurance |
| A | Dried ham | 45 | 12 million | HACCP, ISO 9000 |
| B | Sausages | 22 | 06 million | IFS |
| C | Gingerbread | 70 | 15 million | IFS |
| D | Chocolate, cake | 21 | 05 million | HACCP |

This study conducted interviews, reviewed documents and made on-site observations before and after lean implementation in order to get an overall picture of how the processes and operations changed as a result of implementation ([Eisenhardt 1989](#_ENREF_40)). This combination of data types can be highly synergistic and is therefore referred to as a triangulation of method ([Jick 1979](#_ENREF_56)). Moreover, several strategies were used to establish the reliability of the study, as recommended by [Yin (2009](#_ENREF_131)), including detailed documentation of project steps, single interviewer to maintain consistency, and most importantly, establishment of a chain of evidence.

The objective of the interviews was to understand lean adoption in food processing SMEs by asking specific questions to understand the enabling and obstructing factors. During the study, a total of 45 interviews with operators, operations managers (OMs) and general managers were carried out, in addition to walk-throughs of the production processes. These interviews (each lasting approximately 30 min) were semi-structured and sought primarily to establish the general story of lean manufacturing practice implementation in those firms. During the Gemba walk (Gemba walk a Japanese term denote the action of going to see the actual process, understand the work, ask questions and learn), the researcher asked operators and OMs open questions related to lean initiatives, obstacles encountered during implementation and how those obstacles were overcome. After the Gemba walk, the researcher and the OMs moved to the meeting room for further discussion and to clarify queries related to the identified determining factors, such as cross-functional teams, culture, remuneration etc. In case of non-availability of information at the level of operators and OMs, top management was contacted. Additionally, appropriate measures were taken to reduce the observer bias such as training interviewers to ask questions the same way and only one researcher conducted the interviews throughout the research period ([Yin 2003](#_ENREF_130)).

Furthermore, this study followed the recommendation of ([Pettigrew 1990](#_ENREF_92)) in assessing the performance of the case organizations. The successful lean implementation is defined based on the operational performance. The defined operational performance indicators are stock/inventory reduction, productivity improvement, lead or cycle time reduction, quality improvement, improve on-time delivery ([Liberatore and Pollack-Johnson 2013](#_ENREF_72)). Following the recommendation of ([Pettigrew 1990](#_ENREF_92)) cross-case analysis was carried out with food processing SMEs adopting lean manufacturing practices successfully and unsuccessfully. The cross-case analysis method provides a pattern and helps in understanding each determining factor and its positive and negative influence on lean adoption ([Voss *et al.* 2002a](#_ENREF_122)). The following section describes each case study company and their lean implementation journey.

## Case analysis

The four food processing SMEs which participated in this study (A: producing ham, B: sausage, C: Gingerbread, and D: confectionery and chocolate products) reported the following motivations for implementing lean manufacturing practices (table 5).

Table 5 Motivations for implementing lean manufacturing practices

|  |  |  |  |
| --- | --- | --- | --- |
| A |  B |  C |  D |
| * Reduce cost of production
* Concerned about high labor cost especially in packaging
* To improve day-to-day operations
* Eliminate variation
 | * Optimal utilization of space
* Minimize the waste especially defects and rework
* Production smoothening
 | * Improve market share
* Reduce product weight variation
* Improve machine efficiency
* Customer satisfaction
 | * Establishing standard procedures
* Optimal utilization of space
* To improve day-to-day operations
 |

**Performance**

First, the overall improvement in operational performance is regarded as the result of a successful implementation of lean manufacturing practices. The five operational performance indicators are stock/inventory reduction, productivity improvement, lead or cycle time reduction, quality improvement improve on-time delivery were assessed by multiple participants in each firms. The participants were asked to rate the performance of the firm in each category on a scale (1=negative, 4=neutral, 7= positive). The score given by the participants was further verified to find and adjust discrepancies. A combination of the score provided by the participants, interviews and available documents helped us to consider whether or not a firm was successful in lean implementation. Table 6 shows the operational performance realized after the implementation of lean manufacturing practices. The score across each of the performance indicators reflects positive and negative developments in the food processing SMEs after implementing different lean practices. Negative sign explains the reduction in performance.

Table 6 Operational performance of case companies

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Indicator** | **A** | **B** | **C** | **D** |
| Stock/inventory reduction | **\_** | **\_** | **\_** | **\_** |
| Productivity improvement | **+** | **+** | **+** | **\_** |
| Lead or cycle time reduction | **­\_** | **\_** | **\_** | **\_** |
| Quality improvement | **+** | **+** | **+** | **\_** |
| Improve on-time delivery | **\_** | **+** | **+** | **\_** |
| Overall assessment | Less successful | Successful | Successful | Unsuccessful |

It can be seen from Table 6 that companies B and C have realized significant improvements in three operational performance indicators (productivity, quality, delivery). Both company B and C prioritized the reduction of rework and took several other measures which will be explained in further detail in the case analysis section. Within a short period of time both companies could benefit from less rework; the improved quality indicator reflects this. Similarly, the companies have managed to improve on-time delivery by working closely with the customers and through the nature of their personal business. In most cases, the beginning of lean initiative companies can be attributed to the companies' reaction to changing market forces and stiff competition. Specifically, in the case of company C, there was a continued decline in market share because of new entrants from the Netherlands. Unlike the other three companies, company D could not perform well in regard to any of the indicators. In all respects, the company was unsuccessful in lean implementation. Company A has achieved considerable results with respect to operational performances with only two accounts - improving quality and productivity. Company A initiated overall equipment effectiveness (OEE), total productivity maintenance (TPM) and workplace organization. It is interesting to observe that none of the food processing SMEs scored with respect to inventory reduction and lead time reduction. This may be attributed to specific characteristics of the food sector; as the demand is very unpredictable the firms could not streamline production and inventory planning. The typical characteristics of the food processing sector, such as compulsory cleaning times, long setup-times and start-up loss, create barriers for production planning. Additionally, the customers (retailers) place their demands on a JIT basis but want the product to have a long shelf life for commercial reasons. Hence, production to order with short lead times and low stocks increases the risk of stock outs. Due to these complex relationships, none of the participating companies could initiate and optimize practices related to pull or flow.

**Implementation**

**Case A:** Company A is a family-owned company started in 1969 as a small meat producing outlet, and later expanded as a limited liability company in 1980, specializing in naturally dried ham. In 2010, it employed 45 people with an annual turnover of 12 million. The traditional production method is the main selling strategy of the company. In this complicated production process, the pork is first salted with sea salt before resting for three weeks. Thereafter, the dry, salted ham is brushed clean and the meat is left to mature for two months in the cellar. The ham is then sprayed clean with water and after a few weeks of drying the cut end of the leg is rubbed with a mixture of lard, flour, pepper and salt. In the course of many years, the drying rooms have reached a state of bacteriological equilibrium in which natural fermentation can take place. Finally, the meat rests for another nine months to reach its full maturity. The dried and salted Ganda Ham, which ripens according to this natural and traditional process, is then sliced and packaged for store or distribution. The company takes credit for being the first Belgian meat company to obtain ISO 9002 quality certification. The company did not follow an established framework for lean manufacturing implementation. The general manager instructed the operation manager (also the team leader) to start implementing lean manufacturing practices in the packaging section. At the outset, a general training program on lean manufacturing principles was organized for the middle management and the operators.

One year of lean manufacturing implementation resulted in a few changes on the work floor. A few visual management techniques were initiated. There were initiatives taken by the management to collect data from the work floor, such as overall equipment efficiency, total productive maintenance and rework. Some of the important benefits of lean practice implementation at this SME were reduced machine downtime, improved quality and work environment. There was no initiative taken towards pull production. Similarly, the traditional production method and layout possess several bottlenecks for smooth flow, which requires a massive investment and space for any change in layout.

The study produced interesting observations regarding the influence of determining factors on lean manufacturing adaptation. For instance, the general manager, who is also the owner of the company was committed to implementing lean manufacturing practices, but was not very actively involved. The operations manager (OM) was assigned to implementing lean practices in the company. Due to a busy schedule, the OM passed the responsibility on to the junior colleague. It is an interesting observation that the responsibility was shifted when it came to improvements or the implementation of change initiatives like lean manufacturing.

Regarding the company culture, interviews and observations revealed that the communication between functional areas was not well structured in this company. It was also observed that the communication flow from the management to the employees and vice versa was not smooth. This lack of proper communication structure was a major obstacle in the adoption of lean manufacturing. The top management realized these limitations and took initiative to improve the communication flow by organizing regular review meetings to reach out to all stakeholders. It was observed during the study that the company was focusing on a single problem at a time instead of looking at the bigger picture. The packaging area for example was not properly organized and the number of operators in this section was greater than required. Based on this information, company A initiated lean techniques such as visual management and 5S in the packaging section, but ignored the other sections in the production process.

The training on lean manufacturing and leadership for employees as well as management was very helpful for the company. The company even sent a few key employees to a leadership development program. Teamwork or team feeling was a big concern in this company because of the lack of a formal communication system. During the interviews we found that a few employees were not keen on working together in a team. We observed a sense of rivalry among the employees and they complained about unequal treatment by the management. On top of this, dried ham–a traditional food product with very specific characteristics such as right aroma, maturity and quality parameters, combined with a very short shelf-life (six days)–gives little flexibility for the planner with respect to highly volatile customer demand. Additionally, the company has a traditional setup. The design of the layout is not optimal and not planned according to the lean manufacturing principles. The slicing and packaging machines are single-purpose. There are long set-up times (changeover) between different products because of cleaning and other quality assurance requirements. Financial resources were not a constraint for the company, but skilled human resources and time for improvements were. The company has a clearly defined remuneration system. However, there is no provision of bonus for the performance of the employees. Then again, the person assigned to oversee lean implementation was very motivated, which helped to initiate small steps to reach the efficiency objectives.

**Case B:** This sausage producing company put a lot of improvements into action during the lean manufacturing implementation. They made an assessment of downtime, rework and delivery. After one year, they had been able to reduce downtime by 25 percent and rework by 5 percent, and they improved delivery performance. The commitment of top management was exemplary in company B. The OM was assigned to implementing lean manufacturing and granted power to take quick decisions on the shop-floor. The OM actively participated in the lean manufacturing implementation and successfully guided the team. The motivation of employees and management for lean manufacturing implementation has been high. Even when it was difficult to find the time for improvement work, they still had their weekly meetings led by the team leader (operations manager). There was a drive for improvement and they continuously prioritized the improvement initiatives. The top management emphasized the importance of the training program and encouraged employees to get trained on lean manufacturing tools and techniques. However, company B also took improvement initiatives to fix isolated problems rather than looking into the whole value stream. This "firefighting" behavior dominated their long-term vision.

Company B showed great team work and team feeling. The management put a lot of effort into team building. The employees celebrate birthdays and special days with their colleagues during breaks. The initiatives such as after-work drinks also helped employees to better understand each other. The company has a modern setup. The design of the layout is planned to some extent. Due to quality assurance requirements, the cooking and cooling sections are separated by a wall. This causes extra movement for the operators which results in a waste of time. This is against the lean manufacturing principle because lean principle suggests a clear flow between different activities.

Because the top management is convinced of the benefits of lean manufacturing, resources were not a significant constraint for this company. With a proper lean training, the operations managers acquired knowledge and skills for lean implementation. The company could make substantial continued improvement with very limited investment. The OM had been given all rights to make appropriate decisions with respect to the improvement initiatives in the company. The company provides bonuses to employees based on their performances. One important aspect of case B is the role of the change agent. The OM who was assigned the role of implementing lean manufacturing in the company was very motivated and attended several lean trainings to enhance the knowledge base. He also gained the trust of the employees during lean implementation. He often promoted team building activities such as after-work drinks. These are the factors that helped the company to gain emphatically from lean initiatives.

**Case C:** In 2010, this gingerbread producing company initiated lean manufacturing with a formal communication from the top management to all the employees. The company made good progress in implementing lean principles over the year and improved operational performance in many respects. In the initial phase it started slowly because of the company board's extended decision-making process. However, after they approved implementation, it was quickly put into practice. The company was able to improve the product quality, reduce weight variation of the packets and reduce costs by reducing rework. Moreover, total productive maintenance was initiated to reduce machine downtime.

The top management of company C found motivated to implement lean principles in the production process. The OM was assigned responsibility to implement lean principles in the company. The company also recruited a mentor to guide the OM in leading improvement activities. The drawback found during the visit was that the detailed implementation plan had not been properly communicated to the employees at the shop floor; hence we observed a cold response from the employee side in the beginning phase. From the past documents and interviews we found that there was an undercurrent of dissatisfaction among employees. The reasons mentioned during the interviews were a new work classification system and remuneration system suggested and implemented by a local consultancy company in 2009 (a year before). This initiative backfired in the company and resulted in employee dissatisfaction and poor work culture. Initially, employees did not feel very motivated to support the lean improvement initiatives. The motivation came after a few months when the company started seeing the benefits.

Because the general top management was convinced of the benefits of lean, resources were not a constraint for this company. The top management committed resources to lean training programs for its employees. Regular training programs on lean tools and techniques were organized for the employees and managers. They allocated resources to purchase visual management tools such as display boards. There were regular team meetings where the improvement team discussed issues related to production, quality and maintenance. However, Company C also took improvement initiatives to solve the most pressing problems rather than looking into the whole value stream. As in other companies, firefighting behavior dominated over long-term vision. The company has a traditional setup. The design of the layout is not planned from a lean point of view. This family-owned company takes all major decisions in the board meeting. This was a major constraint for lean because the decision-making took a long time. The OM who was assigned to implement lean manufacturing in the company was enthusiastic. He attended several lean training programs and proved his usefulness in improving processes.

**Case D:** This luxury chocolate and cake producing company made very little progress in lean implementation in comparison with the other companies in this study. It is interesting to see how the determining factors affect the lean implementation in the case an under-performer compared to the other companies, which started the implementation at the same time and from similar starting points. The general manager/owner is very motivated to implement lean principles. However, the OM was resistant to change. This imbalance in leadership and support for improvement hugely affected the lean implementation. The general feeling in the company was that the production process is optimal and not much can be done. The observations and interviews provided clear evidence of the management's firefighting behavior. The general manager attended a few training programs on lean during the project's span but the operations manager did not attend any training. It was found that the autocratic behavior of the operations manager hindered the teamwork in the company. There was always a feeling of insecurity and suspicion among the employees.

The company produces luxury chocolates and cakes for high-end users, especially in star hotels. The majority of the products are exported to other countries. The process is mostly manual or semi-manual in nature. Production relies on very few machines. It has a very sophisticated packaging process. The company has a disadvantage in terms of available space. The design of the layout is not planned from a lean point of view. Financial resources were not a constraint for the company. However, human resources (skill and knowledge) were big constraints. This is a family-owned company. All decisions are made by the owner of the company although the special designing skill of the key employees also matters in organizational decision making. The company follows the standard remuneration guidelines of the government. The major stumbling block for lean implementation in company D was the lack of a change catalyst or change agent in the lean journey. During the study, several opportunities for improvement presented themselves, for instance unnecessary waiting, overproduction, chaotic order picking and rework. However, there was little effort to break the status quo due to the log jam between operations manager and general manager. It was not possible to just fire the OM because he was the top pastry chef in the country and the whole business relies on his exclusive specialized skill. This is unique case and very relevant for the food industry because the business often relies on specialized skill of the key employees (e.g. Chef).

The four food processing SMEs initiated lean practices at the same time. However, we can see a significant difference in their approach, difficulties with implementation, and varied operational performances. Table 7 presents a summary of key factors and decisions during lean implementation in the four food processing SMEs.

Table 7 key factors or decisions during lean implementation

|  |  |
| --- | --- |
| Company | Key factors or decisions |
| **Company A** | * Formation of cross-functional team
* Focus on only packaging area
* Major initiatives are OEE calculation, TPM, changeover, rework
* Improve communication through visual management
* Lack of employee involvement is prominent
* Send staff for leadership training
* No framework used to start lean implementation
* Not much room for changing the layout because of traditional production sequence and lack of funds to make big investment
 |
| **Company B** | * Committed general manager and allocated resources for staff training and full decision making support to operations manager
* Formation of cross-functional team
* Major initiatives are reducing rework, workplace organization, layout in packaging section, employee activity analysis and optimization
* Employee empowerment by middle manager to improve individual process
* The operations manager attended training and executed lean practice to demonstrate long-term commitment; this also helped in breaking down resistance to change
* Employees celebrate birthdays in the staff canteen to create good work environment
* Kanban system failed due to poor reliability of forecast and uncertain demand
* Developed and established in-house without resorting to external consultant
 |
| **Company C** | * Formation of cross-functional team
* OEE, takt time calculation, material balance, product costing, brainstorming, Ohno circle, fishbone and quality costing was used to identify and measure
* Committed general manager and allocated resources for staff training
* Major initiatives are reducing product overweight and variation, rework, TPM
* The operations manager attended training and executed lean practice
* Top-down and bottom-up communication channel established
* Initiated Kanban system but could not sustain
* Took the help of an external consultant
 |
| **Company D** | * Failed initiatives due to lack of involvement & commitment of a key employee
* The general manager was committed and extended all help but could not get the buy-in from his key employee (operations manager)
* The exclusive specialized skill (e.g. Pastry chef) creates a major barrier
* The employee holds the power because of exclusivity of his unique skill
* Struggled to find leader to lead the change
* External consultant visited and did the diagnosis but could not sustain
 |

##

## Result and discussion

In this section, all the determining factors that may enable and/or obstruct firms to successfully implement lean manufacturing practices are assessed. It is important to understand that many distinctive factors stated here have significant influence on any organization embarking on the implementation of lean manufacturing. However, determining how these factors play a role in lean implementation with regard to the unique characteristics of food processing SMEs provides valuable new insights. All four companies started the lean journey at the same time. The assessment results classify companies B and C as successful, company A as less successful and company D as unsuccessful. Describing each determining factor helped us understand the effects of each factor on the lean adoption in a food processing SMEs. Figure 2 presents an overview of the cross-case analysis, which reveals the influence of the determining factors (enabling and/or obstructing) on lean manufacturing practice implementation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Determining factors** |  **Company A** | **Company B** | **Company C** | **Company D** |
| Overall assessment | *Less successful* | *Successful* | *Successful* | *Unsuccessful* |
| *Commitment of top management* | **N** | **+** | **+** | **+** |
| *Culture* | **-** | **+** | **N** | **-** |
| *Piecemeal approach* | **N** | **N** | **N** | **N** |
| *Training* | **+** | **+** | **+** | **-** |
| *Multifunctional team* | **N** | **-** | **+** | **-** |
| *Resources* | **N** | **+** | **+** | **N** |
| *Organizational structure* | **-** | **+** | **-** | **-** |
| *Remuneration system* | **-** | **+** | **-** | **N** |
| *Change agent* | **+** | **+** | **+** | **-** |
| *Nature of the process* | **-** | **-** | **-** | **N** |
| *Nature of the product* | **-** | **-** | **-** | **N** |
| *Nature of the plant* | **-** | **N** | **-** | **N** |
| + Enabling | - Obstructing | N Neutral |

Figure 2 Determining factors (enabling and/or obstructing)

*Commitment of top management*

Commitment of top management refers to consistent financial support, encouragement, active involvement and supervision of the lean initiative. Especially in the SME context, management commitment is highly relevant due to their close and active involvement in day-to-day operations, in addition to financial support and team motivation functions. Lean implementation requires an initial investment with respect to training, hiring external consultants, providing materials for the visual management and allowing key employees to take the responsibility. These are critical elements for the SMEs and need close attention from the top management. To quote the operations manager in company B:

“Our general manager has full confidence in our team and provides all support for lean implementation. He is actively involved in several initiatives we have undertaken. He also allowed us to hire new interns, which gives us more time to look for improvement opportunities.”

The study found clear differences between successful and unsuccessful companies regarding these items. Company A's experience showed that lack of active involvement and supervision by the top management results in limited success. Following is the remark of an operator in company A:

“There is no communication with the top management. The management never asks about the opinion of the employees. We really want to help and make progress but the management is not open for this. The employees do not know anything about the company, the results, the other departments. We are always guessing about such things, for example why the second packaging machine is not being used. The only information we have is what to do today.”

Similarly, another employee reports the following regarding the top management’s attitude:

“Nobody knows which method is the best. They (management) just do it like they want to do. There were no meetings organized in the last two years to discuss how to improve things in the shop floor. The only meetings they have are crisis management meetings.”

In contrast, company D failed to motivate its key employees to support the implementation though the management showed commitment by providing financial support and active involvement.

Previous studies also emphasized that the commitment of top management plays a significant role in the successful implementation of lean practices ([Boyer 1996](#_ENREF_17)). Considering the typical characteristics of SMEs, where top management are personally involved in day-to-day operational activities ([Wessel and Burcher 2004](#_ENREF_126)), direct supervision ([Ghobadian and Gallear 1997](#_ENREF_48)), top management close to the point of delivery ([Deros *et al.* 2006](#_ENREF_33)), better understanding of processes and customers ([Beaver and Prince 2004](#_ENREF_10)) the commitment of top management is crucial for lean success ([Phelps *et al.* 2007](#_ENREF_93)). Moreover, it is important for the managers to develop an understanding of human elements such as morale, productivity, physical and psychological safety during lean implementation ([Childe 2007](#_ENREF_22)).

*Culture*

The concept of organizational culture has been formalized by several researchers ([Hines *et al.* 2004](#_ENREF_51), [Achanga *et al.* 2006](#_ENREF_3)). Culture represents collective norms and behaviors which encompasses trust, hierarchy, work environment, communication and fellow-feeling. The respondents were asked about internal and external communication, hierarchy, respect and blame game in the company. One of the major impediments to proper lean implementation in companies A and D was the absence of appropriate organizational culture with respect to communication, respect for fellow workers and continued blame game ([Nahm *et al.* 2004](#_ENREF_88)). It is found that the blame game was very much prevalent in company A. Following is the comment of an operator in company A:

“There is a very low trust level in the company, it’s very difficult to trust even your fellow colleague. Some of them are close to the top management and get all the benefits and more holidays. There is no equal treatment for all here.”

This is unlike company B, where the company culture has weighted very high with respect to work environment, employees relationship and trust. One employee of company B mentioned:

“We have a really good work environment. We celebrate birthdays of every employee together at the company canteen. We arrange ourselves who replaces whom when we go on holidays so that the work is not disturbed.”

Similarly another employee reports the following regarding company culture and conflict:

“We often solve arguments and conflict among ourselves and seldom take it to the top management level. Our immediate team leader helps us in sorting out small issues. Also, the after-work drink helps in conflict resolution and less friction at the workplace.”

The good performance of company B was to a greater extent attributable to the compact organizational culture. Company D serves as an example of how culture can act as a barrier for lean implementation. One operator in D described:

“We are not comfortable with the autocratic behavior of the chef (the operations manager). He imposes tasks which he considers best and does not take into account others' opinions. Sometimes he is also not nice to fellow colleagues.”

Similarly, during the case study it was observed that the successful companies, especially company A and B were organizing short meetings involving the middle manager and shop-floor employees just before the start of production to discuss the production target. At the end of the day both companies reviewed the performance of that day and discussed the action plans if required. On the other hand company D did not take such measures. Hence, we agree with the review that the short meetings can be a valuable tool for the companies (especially SMEs) to improve on communication gaps across the hierarchy and also help to maintain the momentum of lean implementation. This finding is consistent with the conclusion of [Mann (2012](#_ENREF_78)) and [Bhasin and Burcher (2006](#_ENREF_14)) that organizational culture is a vital factor for a successful lean adoption.

*Piecemeal approach*

Literature on lean manufacturing has a divided opinion on a piecemeal implementation approach. On the one hand, studies found out that a piecemeal approach, or adopting lean manufacturing practice in a certain section of the company and ignoring its systemic nature, limits the potential of lean ([James 2006](#_ENREF_55), [Dowlatshahi and Taham 2009](#_ENREF_38)). Some studies go one step further and say that a piecemeal approach can substantially hinder the lean journey ([Allen 2000](#_ENREF_5), [Bhasin and Burcher 2006](#_ENREF_14)). [Boyle *et al.* (2011](#_ENREF_18)) emphatically claimed that to derive the best out of lean it is critical to not only capture the piecemeal usage of individual lean but also to integrate lean thinking in a company’s business strategy. [Scherrer-Rathje *et al.* (2009](#_ENREF_101)) termed the piecemeal approach as Band-Aid approach because it only cures the surface while the problem remains inside. However, literature also claims that a piecemeal approach may be more suitable for those manufactures who lack resources to launch a full-fledged lean implementation project. Such a full-fledged lean implementation needs a great deal of planning, training and financial resources. Moreover, there is an important time lag between its implementation and receiving the rewards of lean. Waiting for the return of an investment is not always easy for a small resource constraint firm. [Achanga *et al.* (2006](#_ENREF_3)) demonstrated that nine out of ten SMEs who participated in their case study have successfully applied lean following a piecemeal approach. [Ramaswamy *et al.* (2002](#_ENREF_95)) found that SMEs trying to implement several lean initiatives simultaneously realized even greater gains. [Hines *et al.* (2004](#_ENREF_51)) demonstrated that the piecemeal lean application could result in the most productive car plants in Europe producing the highest level of finished stocks in Europe. With this background, our observation shows that all the food SMEs that participated in this study have applied lean in a piecemeal manner to fix certain problems, for instance to reduce rework, improve delivery time or reduce machine downtime. The reason may be that consultants recommend SMEs to look for quick wins ([Smith 2003](#_ENREF_111), [Ballé 2005](#_ENREF_8)). It also can be claimed that “which piece is being applied” has vital implications. As our study shows the piecemeal approach factor did not appear to explain success variance across four food processing firms. However, based on our findings we can conclude that though a piecemeal implementation of lean practices may not gain full benefits, the steps taken could help SMEs to improve their performance gradually.

*Training*

Several studies have demonstrated that training is vital for the success of lean implementation ([Sanchez and Pérez 2001](#_ENREF_99)). Our study also found that training plays an important role in the successful adoption of lean manufacturing. On the surface, “training” as a determining factor does give the impression of a success variance because all four case companies attended the training programs on lean. A deeper look into the training factor reveals two important insights. The first one concerns training on soft skills and on technical skills. Companies B and C, whose lean implementations were successful included both soft as well as technical skills in the lean training modules whereas company B and C ignored soft skill development. This finding is in line with past research ([Farris *et al.* 2009](#_ENREF_42), [Losonci *et al.* 2011a](#_ENREF_73)). Moreover, both companies (B and C) hired external consultants to deliver the training. The other important finding concerns the target audience who attends the training. In the case of companies A and D, the top management attended the training programs organized outside the company premises. In company D, only the general manager attended the training and the operation manager did not attend, which had an impact on lean implementation in the company. The majority of the studies on determining factors of quality management programs found that “leadership and management” is the key factor of successful lean implementation ([Soriano-Meier and Forrester 2002](#_ENREF_112), [Hines *et al.* 2004](#_ENREF_51)). However, it remains that skill of the workforce and in-house expertise are the vital factors for the success of lean manufacturing ([Kumar and Antony 2008](#_ENREF_66)). Our findings strengthen the claim that it is imperative to train employees on the basics of lean principles and get them involved at the inception of the quality initiatives in the firm. From the example of the companies B and C, it also becomes apparent that some of the lean initiatives failed due to minimal involvement of shop-floor employees during the early implementation stage or lack of training and knowledge about the initiative. Training and empowerment would make it easier for employees to take decisions in regard to their own processes and make improvements to these processes ([Kumar *et al.* 2011](#_ENREF_67)).

*Multifunctional team*

A large body of literature identified “multifunctional team” as a crucial factor for the successful adoption of lean manufacturing ([Sánchez and Pérez 2001](#_ENREF_100)). Our study explored two important elements (i.e., cross-functional team and size of the team) by asking questions to operators, supervisors and managers in the case companies. It found that a smaller team with 3 to 5 people is more effective compared to larger teams; a smaller team size helps in decision-making and consensus building. As seen in company C, smaller teams were very efficient in taking decisions and putting them into action. Similarly, a cross-functional team is an enabling factor for lean adoption. The operations manager in company C stated:

“We have two strategies to make our team multifunctional; one, we rotate our operators on a weekly basis in different functional departments (mixing, packaging, cutting, wrapping, etc.) so that everyone can have multiple skills and is aware of the others' work; two, while forming the teams, we take into consideration that each team is comprised of people with diverse skills.”

Moreover, the smaller teams also create a sense of ownership and responsibility to get things done among team members. Previous studies have focused on multifunctional teams ([de Haan *et al.* 2011](#_ENREF_30)). However, there is limited information on the role of smaller team size in lean manufacturing implementation. [Ramaswamy *et al.* (2002](#_ENREF_95)) suggest that buffer stock removal and lot size reduction are the most important issues for SMEs, and multifunctional workers as well as preventive maintenance the least important ones.

*Resource*

For the success of lean practice implementation, it is imperative for the top management to make resources available for the execution. A large body of research found that the availability of resources for successful implementation of lean manufacturing practices is an important factor, especially for SMEs ([Achanga *et al.* 2006](#_ENREF_3)). Our study explored various elements to assess the impact of resource availability in food SMEs such as human resources, technical know-how, finances to cover training costs and other investments. Previous studies crudely claim that SMEs lack resources ([McAdam and Reid 2001](#_ENREF_82)). Our study found that this claim is only partially true. The case companies have little difficulty with financial support for training, consultancy and other small investment. However, the firms lack financial resources to make big investments, for instance, changing a traditional layout to a modern cellular layout for better flow. Big investment is certainly an obstructing factor for lean implementation, but small investments like training and consultancy fees are not. Another important factor is lack of time among key employees and advanced statistical skills among staff; those were found to be the barriers of lean implementation. Additionally, there is financial support available for SMEs to implement QM practices through government agencies, but it is found limited. One respondent (general manager) report that:

“There are several subsidies we can receive from the government agencies which are earmarked for SMEs to make them more competitive.”

Hence, scarcity of resources can be considered as an excuse from the management to continue working in a fire-fighting mode to tackle day-to-day operations. Company B with 22 people at the production floor managed to implement lean practices and achieve success. Similar observations were made in the rest of the case companies. Broadly speaking, we agree with previous studies that SMEs lack resources ([Hudson *et al.* 2001](#_ENREF_53)). However, this concerns only the big investment. Smaller investments such as training cost, consultancy fees and visual display materials are not a problem for the firms.

*Organizational structure*

In this study, we examined three organizational structure characteristics: ownership, decision-making process and unionization. These factors are included, bearing in mind the chaotic environment of SMEs ([Bierly and Daly 2007](#_ENREF_15)). One of the major causes of limited success of lean in the companies A and D may be unionization. The top management found it difficult to ensure smooth implementation of lean practices because key employees were not convinced of the lean initiatives and their benefits. On top of this, the key employee of company A, who was the leader of the labour union, decided to go against the management's decision to implement lean and the union backed his decision. In company A, it was reported that, in order to reduce set up time (implement SMED), the company initiated video recording of worker’s activities. The video recording, however, had to be stopped soon after because the employee union did not allow the activities of the employees to be recorded. In addition to that, the ownership of the company and the decision-making process were found to be important factors of lean implementation. One of the key factors of success in company B is the quick decision-making process. In contrast, it took a long time to get approval for lean initiation from the board of directors in the case of company C. These findings support the claim that organizational structure does matter in the success of lean adoption ([Smeds 1994](#_ENREF_110), [Shah and Ward 2003](#_ENREF_103)).

*Remuneration*

Previous studies demonstrate a significant link between remuneration or reward and lean implementation ([Sim and Rogers 2008](#_ENREF_107)). [Karlsson and Ahlström (1996](#_ENREF_58)) found that the role of the remuneration system is vital for the success of the lean implementation process. Studies emphasize that the remuneration linked quality improvement practices have a better success rate than the ones without remuneration or reward. Our results regarding the claim that the remuneration system plays a big role in a successful lean implementation were mixed. One company, B, benefited from introducing a reward system for good employee performance. The general manager of company B reported that:

“The reward system is important in motivating employees to the new changes and, most importantly, to make it sustainable.”

However, company C, which was also successful in lean implementation has no proper remuneration or bonus system in place. Similarly, company A and D were found to be neutral in the remuneration scale. These findings are a contrast to the claim made by [Berggren (1993](#_ENREF_12)) who elaborates that remuneration systems can stimulate many small ideas and can help companies to make great changes. Similarly, [De Waal (2003](#_ENREF_31)) showed that the organizations that ignore fundamental change issues, such as appraisal and reward systems, may not succeed in creating the performance-based behaviors by employees. As our study shows, remuneration as a determining factor did not appear to explain success variance across four food processing firms. However, remuneration as a determining factor provides an important insight into the issues associated with lean manufacturing implementation in the context of food processing SMEs. It may be included in the not-so-critical factor category for lean implementation, especially in SMEs. It is rightly argued by [Panizzolo (1998a](#_ENREF_90)) that the aim of reward and encourage behavior should be based on personal initiative and on relationships rather than on hierarchy. [Feld (2001](#_ENREF_43)) proposed that the top management should walk the shop floor, explain what they want from their employees, reward those who follow and instruct those who do not. Similarly, [Antony *et al.* (2005](#_ENREF_6)) recommended that implementing quality improvement programs requires that organizations invest in training, leadership alignment, reward and recognition of team members, and communication of successes and failures.

*Change agent*

Apart from training as a critical determining factor, the success of lean initiative seemed to be directly associated with the quality of the change agent. The change agent is the backbone of any initiative taken in the firm; he plays multiple roles. He is the person who co-ordinates improvement activities and acts as a facilitator for the change process ([Bateman 2005](#_ENREF_9)). He must possess relevant technical knowledge and soft skills. A crucial task of the change agent is connecting the top management’s vision with the operators’ ideas at the work floor by means of sensitive communication skill. The change agent could be an internal person or an external consultant. Company A, B, and D have identified internal persons (operations managers) as change agents, and company C appointed an external consultant as a mentor. Some studies consider that an external consultant as a change leader is more effective than the internal ones because external change agents can interact both directly and indirectly with internal change agents to stimulate the change initiatives ([Birkinshaw *et al.* 2008](#_ENREF_16)). We do not agree with the claim that external consultant can be more effective than internal ones. An internal change agent with sound knowledge and good soft skills, who stays in the company unlike external consultants, who leave the company after finishing the project, may be more effective and sustainable for the firms. Several respondents clearly stated during interviews that the teams count on the leader (change agent). One operator in company D explained:

“How can we be motivated when our project leader does not believe in this initiative and its benefits?”

We also observed that, in company B and C, the operations managers (change agents) have clear understanding of the lean principles, soft skills and motivation to lead the team. One operator in company B stated:

“Our manager has a very charming personality and has the ability to bring everyone together. He sincerely listen to us and takes appropriate decisions for the benefit of the company as well as for the colleagues.”

It is clear from the cross-case analysis that the change agent plays a significant role in the successful implementation of lean manufacturing practices. Previous studies have not given prominence to the change agent factor as a critical success factor in lean implementation ([Achanga *et al.* 2006](#_ENREF_3)). However, studies focusing on large firms suggest that the change agent plays a significant role in successful lean implementation ([Smeds 1994](#_ENREF_110), [Kosonen and Buhanist 1995](#_ENREF_65)). The cross-case analysis among four food firms suggests that the change agent should be identified as a critical determining factor for lean implementation, given the special characteristics of SMEs.

*Nature of the process*

The study examined the nature of the production process and its influence on lean implementation. The nature of the food production process has been characterized as: 1. variable yield and processing time, 2. high variation of composition, recipes, products and processing techniques, 3. production rate determined by capacity, 4. divergent product structure, especially in the packaging stage, 5. variable product structure ([Van Donk 2001](#_ENREF_120)). This study explored how these factors influence lean adoption. Firstly, for the food processing companies the delivery times are usually short and customers (retailer) demand products with quality assurance compliance often on short notice. This phenomena creates a bottleneck in the production planning and makes it difficult to meet the customer's need. The operations manager in Company B stated:

“It often happens that we get an order for our products (sausages) at 8am in the morning to be deliver to the retailer at 13.00. It’s more difficult in the summer time. When the weather gets better, the demand for BBQ sausages shoots up, and we have to deliver the product. This makes it difficult to plan and assign workload to people and machines.”

In most cases the retailer pass the uncertainty in demand on to the producers. It means that retailer s place their order based on just in time principle; on top of that, they do not encourage producers to produce in stock because the long product shelf life is crucial from a commercial point of view. In this respect, cooperation and regular communication between retailer and food processor can help to rationalize the lead time. Moreover, a minimum shelf life of food products possesses a challenge for food processors. The product can be technically good, but retailers will not accept it because, from a commercial point of view, it has expired based on the best-before-use tag. The operations manager in company A stated:

“The retailers put pressure on us (manufacturers) to comply to different kinds of requirements on behalf of the end user customers, while for us establishing contact with the final consumer is very difficult; we do not understand the actual needs of the final consumer.”

One of the important issues found during the study is that the quality assurance requirements of the food processors present a barrier for lean implementation. An operation manager who worked for an automobile company before working at the food company stated the following:

“When you are in a car-making company, it is easier to implement lean practices; there is a lot of flexibility, you can do several things… but in a food processing company, it is not always easy because of many food safety and quality restrictions, for instance, microbiological issues, metal detection, plastic, foreign body etc. need special attention”.

Similarly, the manager from the sausage making company (B) pointed out:

“We wanted to remove this wall between the cleaning and cooling chamber because it prevents the operator from going directly from one chamber to the other and restricted the smooth flow. But we are not allowed because of quality assurance requirements.”

We also found that the frequent cleaning times and set ups are an integral part of the food processing sector in contrast to other industries, e.g. automobile companies. In most cases, these activities are sequence-dependent and need to be included in the production planning. Especially in both meat processing companies (A and B), there is a very long changeover time due to compulsory cleaning requirements in between product switch in the same machine. It was reported that the set up reduction was not easy and resulted in very little success.

One important observation is that, in all four case companies, the packaging section seems to have major bottlenecks. The reason may be attributed to the pack-to-order approach of the companies and with very unpredictable demand the packaging section is subjected to major pressure. The suggestions made by previous studies - to develop packaging lines with small set ups and standardizing the packaging materials ([van Dam *et al.* 1993](#_ENREF_119)) - seems not feasible for the food processing SMEs because of their constraints in respect to financial resources and meeting customer demands in a fiercely competitive market. Some studies also proposed to use advanced computerized planning systems to correctly plan the demand and production for the food industry ([Skok and Legge 2002](#_ENREF_109)). However, advanced planning systems need big investment and skill, which seems scarce in SMEs. The cross-case analysis among four food firms proposes that nature of processes should be identified as a critical determining factor for lean implementation, given the special characteristics of the food sector.

*Nature of the product*

The study examined the nature of the product and its influence on lean implementation. The highly perishable product (raw material, semi and finished product) and the variability in the raw materials' quality, supply and price due to unstable yield have a consequence on lean implementation. For instance, a product sensitive to external variables makes the implementation of certain lean practices difficult. Gingerbread–a traditional product with a unique recipe–presents multiple barriers to lean implementation due to huge variation. To quote the manager of the gingerbread manufacturer:

 “I wish we could pack bricks or metal boxes, which are hardly influenced by moisture, weather, temperature and several other natural factors. All these factors have a significant influence on our product. The weight and height of gingerbread can vary according to parameters which are difficult to control. And the height and weight has an impact on the packing machines, work plan and even on operators.”

[White and Prybutok (2001](#_ENREF_127)) found that lean practices are less likely to be implemented in non-repetitive systems. The cause of the lower implementation rates in non-repetitive systems is that lean practices were designed in–and have their roots in–a repetitive production system. Similarly, [Katayama and Bennett (1996](#_ENREF_59)) demonstrated that lean production is incapable of responding to large fluctuations in aggregate demand volumes. A manager in the sausage-making company provided an interesting perspective:

“The short self-life of our product also provides an opportunity to respond to the mistakes quickly.”

Similarly, one operator in the confectionery (company C) stated regarding the consistency in quality and doing right the first time:

“Doing right the first time is not always easy with a food product…because a small variation in recipe mix, temperature, baking time, or storing time of one of many ingredients can change the specification of the product. It is very complicated and very difficult to find the root cause of the problem.”

Another important issue is the demand fluctuation due to the change of weather. For instance, the manager in the sausage-making company mentioned:

“We make our production planning based on the weather forecast. There is a huge fluctuation in demand due to unpredictable weather.”

One important observation was the anomaly in processing time, product shelf life and storage. The following statement of the operations manager in company A (dried ham) portrays the complexity of food product, processing and selling:

“We have a long processing time (10 months) and the finished product has a short shelf-life between 2 and 4 weeks, and the customer (retailer) has a best-before-use criteria of at least two weeks.”

Moreover, slow-moving products have a risk of becoming obsolete. These factors make inventory management difficult for the food processors. Our study aligns with the claim that the application of lean manufacturing is not straightforward in a high product variety and low volumes environment such as the food sector ([Jina *et al.* 1997](#_ENREF_57)). The cross-case analysis among four food firms recommends that nature of product should be identified as a critical determining factor for lean implementation, given the special characteristics of the food sector.

*Nature of the plant*

The study examined the nature of the plant and its influence on lean implementation. The nature of the plant has been characterized as: 1. single-purpose expensive machines, product variety and high volume; 2. long sequence-dependent set-up time between product types; 3. processing and packaging are separated because of QA requirements; 4. usually, the factory shows a flow shop oriented design ([Van Donk 2001](#_ENREF_120)). All four food processing SMEs participating in this study have batch processing with between two and seven production lines and packaging lines. The design of the layout in company A, C, D is not planned from a lean point of view. In all case companies, due to quality assurance requirements, the production and packaging sections are separated by a wall. The sections are also known as blue zone and red zone; people in the red zone have to change clothes in order to enter the blue zone and vice versa. This causes extra movement for the operators which results in a waste of time. This is against the lean manufacturing principle because lean suggests a clear flow between different activities. The design of the traditional layout is not optimal and not planned according to the lean manufacturing principle. The slicing and packaging machines are for a single purpose. There are long set-up times (changeover) between different products, because of cleaning and other quality assurance requirements. Additionally, certain characteristics of the plant are so unique that it’s hard to change unlike in an automobile production unit. A good example can be found in the following statement of the operations manager in company A:

“Our drying rooms, after many years, have reached a state of bacteriological equilibrium in which natural fermentation can take place, and it’s not feasible to change the layout for most efficient movement.”

The cross-case analysis among four food firms indicates that nature of plant should be identified as a critical determining factor for lean implementation, given the special characteristics of the food sector. The following table 8 summarizes the determining factors and critical point of attention which focus on 1) food sector 2) SMEs and 3) general implementation issues and how they are related to practices and performances.

Table 8 Summary of determining factors and critical point of attention

|  |  |  |
| --- | --- | --- |
| Characteristics | Determining factors and critical point of attention | Linking the literature |
| Food processing  | * *Just in time order, inconstant yield and variable processing time* create a bottleneck in the production planning
* Long changeover time due to *compulsory cleaning requirements* in between product switch in the same machine
* Developing packaging lines with *small set ups and standardized packaging* is needed
* *High product variety and low volume environment* need better understanding and care during implementation
* Little option to *control moisture, weather, temperature* and other natural factors
* Often design of the *traditional layout* is not optimal
* *Quality assurance possess challenge* to smooth production flow
 | ([Van Donk 2001](#_ENREF_120)) support the finding ([van Dam *et al.* 1993](#_ENREF_119))Support the finding([Jina *et al.* 1997](#_ENREF_57)).supports the finding |
| SME  | * Organizational culture encompasses *trust, work environment, communication,* and fellow feeling is critical for SMEs.
* A piecemeal approach help SMEs to improve their performance *gradually*.
* Role of change agent is critical for lean success
* Training on *soft skills and technical* skills are equally important
* Developing *in-house trainer* is vital
* SMEs lack funds for big investment, *but smaller investments* in training, consultancy and visual material is not a problem
 | ([Mann 2012](#_ENREF_78)) supports the finding([Achanga *et al.* 2006](#_ENREF_3)) Don’t support the finding([Losonci *et al.* 2011b](#_ENREF_74))support the finding ([Kumar and Antony 2008](#_ENREF_66)) support the finding |
| General Implementation | * Personal involvement and *direct supervision* of top management is necessary.
* Better understanding of human elements such as *morale, physical and psychological safety* is essential.
* Smaller team size helps in decision making and consensus building
* *Unionization* can be a hindrance
* aim of reward should be based on personal initiative rather than on hierarchy
 | ([Wessel and Burcher 2004](#_ENREF_126)) support the finding ([Childe 2007](#_ENREF_22))support the finding([de Haan *et al.* 2011](#_ENREF_30))support the finding ([Shah and Ward 2003](#_ENREF_103))support the finding ([Panizzolo 1998a](#_ENREF_90))support the finding  |

## Conclusion

This study explored determining factors of lean implementation at four food processing SMEs in Belgium. It made three major contributions. One, while many studies have explored lean implementations in large organizations (mostly in discrete industries), fewer have focused on food processing SMEs. Since there is strong evidence that food processing SMEs operate differently from large organizations in other sectors, our study provided specific directions to food producers planning lean implementation. This was done by identifying determining factors that were considered critical to lean implementation success in the participating food processing SMEs. The food processing SMEs that managed these determining factors effectively had a higher probability of implementation success. Further, a set of point of attention has been identified that the managers of food producers would need to be aware of when implementing lean practices.

Two, the comprehensive interviews with operators, managers and owners provided insightful details to the factors that were influential in lean implementation. This study clearly showed, besides organizational factors, how the sector specific factors such as nature of process, product and plant were critical in lean implementation in the food sector. Through the interviews, we could identify that product perishability, behavior of the retailer, traditional production process and layout play significant roles in lean implementation.

Three, some of the findings are aligned with previous studies. However, some findings are counter-intuitive to existing knowledge. In particular, our findings confirm that factors such as commitment of top management, training, resources, organizational culture and structure were important to lean implementation success. Furthermore, our findings extend the knowledge about training modules on soft skill and technical skill, and most importantly the target audience (shop floor employees). The culture of the company (e.g. communication, respect, discipline) proves to be a very important determinant for successful lean implementation. It was observed that in the less successful companies, employees were complaining and blaming others for slow progress. The nature of the process was found to be a very crucial factor in lean adoption. The example of the naturally dried ham producing company and labor-intensive chocolate and cake making company demonstrated that due to the complex nature of the processes a straightforward lean implementation was not easy. It was difficult for the food companies to adopt lean because of the low shelf life of the food products and the extremely volatile demand and supply. Another finding is that the small size of the plant, the traditional set-up and layout and the quality assurance requirements make it difficult to replicate lean in food processing SMEs. Our research revealed that, out of several organizational factors such as structure, remuneration and change agent, the determinant that most affected the lean implementation was “change agent.” It is very important for the companies to find a motivated “change agent” who can serve as a catalyst for change. Moreover, the lack of a well-structured implementation plan for SMEs may be the reason why lean practices are less likely to be successful in SMEs. Further, sustainability is still a de-prioritized issue for most of the case companies. There is little effort to address environmentally important issues such as a responsible use of water and energy during the production process. In a nutshell, lean manufacturing is a complex process. As the examples show, sheer imitation of lean without understanding the context results in failure ([Robinson and Schroeder 2009](#_ENREF_97), [Dora *et al.* 2013a](#_ENREF_35)).

The limitation of our research with respect to comparability and generalizability cannot be ignored due to the degree of deviation in lean implementation, despite the fact that the companies are of similar size and from the same industry sector. The research was based on four food processing SMEs in Belgium and thus its results may not be generalizable to other countries. Previous studies indicated that country differences might influence aspects of lean implementation and performance ([Ahmad and Schroeder 2003](#_ENREF_4)). Moreover, this study focused on SMEs in the food sector, hence it may not be easily transferable to large organizations in other sectors. Finally, our research was based on personal interviews, which means that there is a possibility that the opinions and knowledge of interviewees may have been limited or biased. Given these limitations, this study yielded some important insights and suggested potential areas for further work. This study was an attempt to understand the effects of the determining factors on lean adoption through case studies. The detailed discussion and the quotes from operators, managers and owners may help practitioners confront challenges while undergoing lean implementation for efficient food production in a SME environment.

One important issue observed during the interviews that in general there is a certain level of confusion among manager regarding the lean implementation process. For instance, where to start, what to monitor, what to adjust, etc. to achieve the optimal results of lean manufacturing practices. It has been found that there is a clear need for a systematic implementation framework for lean implementation for food processing SMEs which can answer the above stated questions. Hence, our next research agenda is to propose a step-by-step lean implementation framework, tailor-made for the food processing SMEs.

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## Reference

Abdulmalek, F.A. & Rajgopal, J., 2007. Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. *International Journal of Production Economics,* 107 (1), 223-236.

Abdulmalek, F.A., Rajgopal, J. & Needy, K.L.S., 2006. A classification scheme for the process industry to guide the implementation of lean. *Engineering Management Journal,* 18 (2), 15-25.

Achanga, P., Shehab, E., Roy, R. & Nelder, G., 2006. Critical success factors for lean implementation within smes. *Journal of Manufacturing Technology Management,* 17 (4), 460-471.

Ahmad, S. & Schroeder, R.G., 2003. The impact of human resource management practices on operational performance: Recognizing country and industry differences. *Journal of Operations Management,* 21 (1), 19-43.

Allen, J.H., 2000. Making. Lean manufacturing work for you. *Journal of Manufacturing Engineering,* 2000, 1-6.

Antony, J., Kumar, M. & Madu, C.N., 2005. Six sigma in small-and medium-sized uk manufacturing enterprises: Some empirical observations. *International Journal of Quality & Reliability Management,* 22 (8), 860-874.

Bakås, O., Govaert, T. & Van Landeghem, H., Year. Challenges and success factors for implementation of lean manufacturing in european smesed.^eds. *13th International conference on the Modern Information Technology in the Innovation Processes of the Industrial Enterprise (MITIP 2011)*Tapir Academic Press.

Ballé, M., 2005. Lean attitude [considering attitude in lean production]. *Manufacturing Engineer,* 84 (2), 14-19.

Bateman, N., 2005. Sustainability: The elusive element of process improvement. *International Journal of Operations & Production Management,* 25 (3), 261-276.

Beaver, G. & Prince, C., 2004. Management, strategy and policy in the uk small business sector: A critical review. *Journal of Small Business and Enterprise Development,* 11 (1), 34-49.

Ben Naylor, J., Naim, M. & Berry, D., 1999. Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of Production Economics,* 62 (1-2), 107-118.

Berggren, C., 1993. Lean production—the end of history? *Work, Employment & Society,* 7 (2), 163-188.

Bhasin, S., 2008. Lean and performance measurement. *Journal of Manufacturing Technology Management,* 19 (5), 670-684.

Bhasin, S. & Burcher, P., 2006. Lean viewed as a philosophy. *Management,* 17 (1), 56-72.

Bierly, P.E. & Daly, P.S., 2007. Alternative knowledge strategies, competitive environment, and organizational performance in small manufacturing firms. *Entrepreneurship Theory and Practice,* 31 (4), 493-516.

Birkinshaw, J., Hamel, G. & Mol, M.J., 2008. Management innovation. *Academy of Management Review,* 33 (4), 825-845.

Boyer, K., 1996. An assessment of managerial commitment to lean production. *International Journal of Operations and Production Management,* 16, 48-59.

Boyle, T.A., Scherrer-Rathje, M. & Stuart, I., 2011. Learning to be lean: The influence of external information sources in lean improvements. *Journal of Manufacturing Technology Management,* 22 (5), 587-603.

Boynton, A. & Zmud, R., 1984. An assessment of critical success factors. *Sloan Management Review (pre-1986),* 25 (4), 17-27.

Brun, A., 2011. Critical success factors of six sigma implementations in italian companies. *International Journal of Production Economics,* 131 (1), 158-164.

Carson, D. & Gilmore, A., 2000. Sme marketing management competencies. *International Business Review,* 9 (3), 363-382.

Childe, S.J., 2007. Operations management and people. *Production Planning & Control,* 18 (8), 627-627 Available from: <http://dx.doi.org/10.1080/09537280701690498> [Accessed 2015/04/11].

Childe, S.J., 2011a. Case studies in operations management. *Production Planning & Control,* 22 (2), 107-107 Available from: <http://dx.doi.org/10.1080/09537287.2011.554736> [Accessed 2015/04/11].

Childe, S.J., 2011b. What are the hot topics in the management of operations? *Production Planning & Control,* 22 (7), 611-611.

Christopher, M. & Towill, D., 2001. An integrated model for the design of agile supply chains. *International Journal of Physical Distribution & Logistics Management,* 31 (4), 235-246.

Ciaa, 2010. *Smes in the eu food and drink industry* [online]. Confederation of the food and drink industries of the EU. Available from: <http://smes.ciaa.eu/index.php> [Accessed Access Date

Cox, A. & Chicksand, D., 2005. The limits of lean management thinking::: Multiple retailers and food and farming supply chains. *European Management Journal,* 23 (6), 648-662.

Cox, A. & Chicksand, D., 2008. Rethinking policy options for industry: Appropriateness in policies for industry and uk farming and food. *Public Administration,* 86 (3), 813-836.

Cua, K., Mckone-Sweet, K. & Schroeder, R., 2006. Improving performance through an integrated manufacturing program. *QUALITY MANAGEMENT JOURNAL,* 13 (3), 45.

De Haan, J., Naus, F. & Overboom, M., 2011. Creative tension in a lean work environment: Implications for logistics firms and workers. *International Journal of Production Economics*.

De Waal, A.A., 2003. Behavioral factors important for the successful implementation and use of performance management systems. *Management Decision,* 41 (8), 688-697.

Demeter, K. & Matyusz, Z., 2010. The impact of lean practices on inventory turnover. *International Journal of Production Economics*.

Deros, B.M., Yusof, S.R.M. & Salleh, A.M., 2006. A benchmarking implementation framework for automotive manufacturing smes. *Benchmarking: An International Journal,* 13 (4), 396-430.

Dora, M. & Gellynck, X., 2015. House of lean for food processing smes. *Trends in Food Science & Technology,* (0) Available from: <http://www.sciencedirect.com/science/article/pii/S0924224415000758>.

Dora, M., Kumar, M., Van Goubergen, D., Molnar, A. & Gellynck, X., 2013a. Food quality management system: Reviewing assessment strategies and a feasibility study for european food small and medium-sized enterprises. *Food control,* 31 (2), 607-616 Available from: <Go to ISI>://WOS:000316304600048.

Dora, M., Kumar, M., Van Goubergen, D., Molnar, A. & Gellynck, X., 2013b. Operational performance and critical success factors of lean manufacturing in european food processing smes. *Trends in Food Science & Technology*.

Dora, M., Van Goubergen, D., Kumar, M., Molnar, A. & Gellynck, X., 2013c. Application of lean practices in small and medium-sized food enterprises. *British Food Journal,* 116 (1), 125-141.

Dowlatshahi, S. & Taham, F., 2009. The development of a conceptual framework for just-in-time implementation in smes. *Production Planning and Control,* 20 (7), 611-621.

Droge, C., Jayaram, J. & Vickery, S.K., 2004. The effects of internal versus external integration practices on time-based performance and overall firm performance. *Journal of Operations Management,* 22 (6), 557-573.

Eisenhardt, K.M., 1989. Building theories from case study research. *Academy of Management Review*, 532-550.

Engelund, E.H., Breum, G. & Friis, A., 2009. Optimisation of large‐scale food production using lean manufacturing principles. *Journal of Foodservice,* 20 (1), 4-14.

Farris, J.A., Van Aken, E.M., Doolen, T.L. & Worley, J., 2009. Critical success factors for human resource outcomes in kaizen events: An empirical study. *International Journal of Production Economics,* 117 (1), 42-65.

Feld, W.M., 2001. *Lean manufacturing: Tools, techniques, and how to use them*: CRC Press.

Flynn, B.B. & Flynn, E.J., 2004. An exploratory study of the nature of cumulative capabilities. *Journal of Operations Management,* 22 (5), 439-457.

Fryer, K.J., Antony, J. & Douglas, A., 2007. Critical success factors of continuous improvement in the public sector: A literature review and some key findings. *The TQM Magazine,* 19 (5), 497-517.

Fullerton, R. & Wempe, W., 2009a. Lean manufacturing, non-financial performance measures, and financial performance. *International Journal of Operations and Production Management,* 29 (3), 214-240.

Fullerton, R.R. & Wempe, W.F., 2009b. Lean manufacturing, non-financial performance measures, and financial performance. *International Journal of Operations & Production Management,* 29 (3), 214-240.

Ghobadian, A. & Gallear, D., 1997. Tqm and organization size. *International Journal of Operations & Production Management,* 17 (2), 121-163.

Hankinson, A., Bartlett, D. & Ducheneaut, B., 1997. The key factors in the small profiles of small-medium enterprise owner-managers that influence business performance: The uk (rennes) sme survey 1995-1997 an international research project uk survey. *International Journal of Entrepreneurial Behaviour & Research,* 3 (3), 168-175.

He, X. & Hayya, J.C., 2002. The impact of just-in-time production on food quality. *Total Quality Management,* 13 (5), 651-670.

Hines, P., Holweg, M. & Rich, N., 2004. Learning to evolve: A review of contemporary lean thinking. *International Journal of Operations & Production Management,* 24 (10), 994-1011.

Hsu, I.C. & Sabherwal, R., 2011. From intellectual capital to firm performance: The mediating role of knowledge management capabilities. *Engineering Management, IEEE Transactions on,* 58 (4), 626-642.

Hudson, M., Lean, J. & Smart, P., 2001. Improving control through effective performance measurement in smes. *Production planning and control,* 12 (8), 804-813.

Irani, S., 2011. Choosing what works. *Industrial Engineer, IE,* 43 (8), 42-47.

James, T., 2006. Wholeness as well as leanness. *Manufacturing Engineer,* 85 (5), 14-17.

Jick, T.D., 1979. Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly,* 24 (4), 602-611.

Jina, J., Bhattacharya, A. & Walton, A., 1997. Applying lean principles for high product variety and low volumes: Some issues and propositions. *Logistics Information Management,* 10, 5-13.

Karlsson, C. & Ahlström, P., 1996. Assessing changes towards lean production. *International Journal of Operations and Production Management,* 16, 24-41.

Katayama, H. & Bennett, D., 1996. Lean production in a changing competitive world: A japanese perspective. *International Journal of Operations and Production Management,* 16, 8-23.

Ketchen, D.J. & Giunipero, L.C., 2004. The intersection of strategic management and supply chain management. *Industrial Marketing Management,* 33 (1), 51-56 Available from: <http://www.sciencedirect.com/science/article/B6V69-49KS4B4-4/2/99aee5927c421a45b4a279573f123724>.

King, P.L. & King, J.S., 2013. *The product wheel handbook: Creating balanced flow in high-mix process operations*: CRC Press.

King, P.L., Kroeger, D.R., Foster, J.B., Williams, N. & Proctor, W., 2008. Making cereal not cars. *Industrial engineer,* 40 (12), 34-37.

Kochan, T.A., Lansbury, R.D. & Macduffie, J.P., 1997. *After lean production: Evolving employment practices in the world auto industry*: Cornell University Press.

Koh, S.C.L., Gunasekaran, A. & Cooper, J.R., 2009. The demand for training and consultancy investment in sme-specific erp systems implementation and operation. *International Journal of Production Economics,* 122 (1), 241-254.

Kosonen, K. & Buhanist, P., 1995. Customer focused lean production development. *International Journal of Production Economics,* 41 (1), 211-216.

Kumar, M. & Antony, J., 2008. Comparing the quality management practices in uk smes. *Industrial Management & Data Systems,* 108 (9), 1153-1166.

Kumar, M., Antony, J. & Tiwari, M.K., 2011. Six sigma implementation framework for smes–a roadmap to manage and sustain the change. *International Journal of Production Research,* 49 (18), 5449-5467.

Lee, W.L. & Allwood, J.M., 2003. Lean manufacturing in temperature dependent processes with interruptions. *International Journal of Operations & Production Management,* 23 (11), 1377-1400.

Lehtinen, U. & Torkko, M., 2005. The lean concept in the food industry: A case study of a contract manufacturer. *Journal of Food Distribution Research,* 36 (3), 57.

Leonard-Barton, D., 1990. A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites. *Organization Science*, 248-266.

Lewis, M., 2000. Lean production and sustainable competitive advantage. *International Journal of Operations and Production Management,* 20 (8), 959-978.

Liberatore, M.J. & Pollack-Johnson, B., 2013. Improving project management decision making by modeling quality, time, and cost continuously. *IEEE Transactions on Engineering Management,* 60 (3), 518-528.

Losonci, D., Demeter, K. & Jenei, I., 2011a. Factors influencing employee perceptions in lean transformations. *International Journal of Production Economics,* 131 (1), 30-43 Available from: <http://www.sciencedirect.com/science/article/pii/S0925527310004913>.

Losonci, D., Demeter, K. & Jenei, I., 2011b. Factors influencing employee perceptions in lean transformations. *International Journal of Production Economics*.

Mabert, V.A., Soni, A. & Venkataramanan, M.A., 2000. Enterprise resource planning survey of us manufacturing firms. *Production and Inventory Management Journal,* 41 (2), 52-58.

Mahalik, N.P., 2010. Editorial. *Trends in Food Science &amp; Technology,* 21 (3), 115-116 Available from: <http://www.sciencedirect.com/science/article/pii/S0924224410000403>.

Mahalik, N.P. & Nambiar, A.N., 2010. Trends in food packaging and manufacturing systems and technology. *Trends in Food Science & Technology,* 21 (3), 117-128.

Mann, D., 2012. *Creating a lean culture: Tools to sustain lean conversions*: CRC Press.

Marodin, G.A. & Saurin, T.A., 2013. Implementing lean production systems: Research areas and opportunities for future studies.

Mc Cartan-Quinn, D. & Carson, D., 2003. Issues which impact upon marketing in the small firm. *Small Business Economics,* 21 (2), 201-213.

Mcadam, R., 2000. Quality models in an sme context: A critical perspective using a grounded approach. *International Journal of Quality & Reliability Management,* 17 (3), 305-323.

Mcadam, R. & Reid, R., 2001. Sme and large organisation perceptions of knowledge management: Comparisons and contrasts. *Journal of Knowledge Management,* 5 (3), 231-241.

Mezgár, I., Kovács, G.L. & Paganelli, P., 2000. Co-operative production planning for small-and medium-sized enterprises. *International Journal of Production Economics,* 64 (1), 37-48.

Miles, M.B. & Huberman, A.M., 1994. *Qualitative data analysis: An expanded sourcebook*: Sage Publications, Incorporated.

Muscatello, J.R., Small, M.H. & Chen, I.J., 2003. Implementing enterprise resource planning (erp) systems in small and midsize manufacturing firms. *International Journal of Operations & Production Management,* 23 (8), 850-871.

Nabhani, F. & Shokri, A., 2009. Reducing the delivery lead time in a food distribution sme through the implementation of six sigma methodology. *Journal of Manufacturing Technology Management,* 20 (7), 957-974.

Nahm, A.Y., Vonderembse, M.A. & Koufteros, X.A., 2003. The impact of organizational structure on time-based manufacturing and plant performance. *Journal of Operations Management,* 21 (3), 281-306.

Nahm, A.Y., Vonderembse, M.A. & Koufteros, X.A., 2004. The impact of organizational culture on time‐based manufacturing and performance. *Decision Sciences,* 35 (4), 579-607.

Näslund, D., 2008. Lean, six sigma and lean sigma: Fads or real process improvement methods? *Business Process Management Journal,* 14 (3), 269-287.

Panizzolo, R., 1998a. Applying the lessons learned from 27 lean manufacturers.: The relevance of relationships management. *International Journal of Production Economics,* 55 (3), 223-240.

Panizzolo, R., 1998b. Applying the lessons learned from 27 lean manufacturers.:: The relevance of relationships management. *International Journal of Production Economics,* 55 (3), 223-240.

Pettigrew, A.M., 1990. Longitudinal field research on change: Theory and practice. *Organization Science,* 1 (3), 267-292.

Phelps, R., Adams, R. & Bessant, J., 2007. Life cycles of growing organizations: A review with implications for knowledge and learning. *International journal of management reviews,* 9 (1), 1-30.

Rajurkar, S.W. & Jain, R., 2011. Food supply chain management: Review, classification and analysis of literature. *International Journal of Integrated Supply Management,* 6 (1), 33-72.

Ramaswamy, N.R., Selladurai, V. & Gunasekaran, A., 2002. Just-in-time implementation in small and medium enterprises. *Work Study,* 51 (2), 85-90.

Rich, N. & Bateman, N., 2003. Companies’ perceptions of inhibitors and enablers for process improvement activities. *International Journal of Operations & Production Management,* 23 (2), 185-199.

Robinson, A.G. & Schroeder, D.M., 2009. The role of front-line ideas in lean performance improvement. *The Quality Management Journal,* 16 (4), 27.

Robson, P.J.A. & Bennett, R.J., 2000. Sme growth: The relationship with business advice and external collaboration. *Small Business Economics,* 15 (3), 193-208.

Sanchez, A.M. & Pérez, M.P., 2001. Lean indicators and manufacturing strategies. *International journal of operations and production management,* 21 (11), 1433-1451.

Sánchez, A.M. & Pérez, M.P., 2001. Lean indicators and manufacturing strategies. *International Journal of Operations & Production Management,* 21 (11), 1433-1452.

Scherrer-Rathje, M., Boyle, T.A. & Deflorin, P., 2009. Lean, take two! Reflections from the second attempt at lean implementation. *Business Horizons,* 52 (1), 79-88.

Scott, B.S., Wilcock, A.E. & Kanetkar, V., 2009. A survey of structured continuous improvement programs in the canadian food sector. *Food control,* 20 (3), 209-217.

Shah, R. & Ward, P., 2003. Lean manufacturing: Context, practice bundles, and performance. *Journal of Operations Management,* 21 (2), 129-149.

Shah, R. & Ward, P., 2007. Defining and developing measures of lean production. *Journal of Operations Management,* 25 (4), 785-805.

Sharp, J.M., Irani, Z. & Desai, S., 1999. Working towards agile manufacturing in the uk industry. *International Journal of Production Economics,* 62 (1), 155-169.

Shokri, A., Nabhani, F. & Hodgson, S., 2010. Supplier development practice: Arising the problems of upstream delivery for a food distribution sme in the uk. *Robotics and Computer-Integrated Manufacturing*.

Sim, K.L. & Rogers, J.W., 2008. Implementing lean production systems: Barriers to change. *Management Research News,* 32 (1), 37-49.

Simons, D. & Taylor, D., 2007. Lean thinking in the uk red meat industry: A systems and contingency approach. *International Journal of Production Economics,* 106 (1), 70-81.

Skok, W. & Legge, M., 2002. Evaluating enterprise resource planning (erp) systems using an interpretive approach. *Knowledge and Process Management,* 9 (2), 72-82.

Smeds, R., 1994. Managing change towards lean enterprises. *International Journal of Operations & Production Management,* 14 (3), 66-82.

Smith, B., 2003. Lean and six sigma-a one-two punch. *Quality Progress,* 36 (4), 37-41.

Soriano-Meier, H. & Forrester, P.L., 2002. A model for evaluating the degree of leanness of manufacturing firms. *Integrated Manufacturing Systems,* 13 (2), 104-109.

Sousa, R. & Voss, C.A., 2008. Contingency research in operations management practices. *Journal of Operations Management,* 26 (6), 697-713.

Stanley, D.J., Meyer, J.P. & Topolnytsky, L., 2005. Employee cynicism and resistance to organizational change. *Journal of Business and Psychology,* 19 (4), 429-459.

Stock, G.N., Mcfadden, K.L. & Gowen, C.R., 2007. Organizational culture, critical success factors, and the reduction of hospital errors. *International Journal of Production Economics,* 106 (2), 368-392.

Storch, R.L., 1999. Improving flow to achieve lean manufacturing in shipbuilding. *Production Planning & Control,* 10 (2), 127-137.

Trkman, P., 2010. The critical success factors of business process management. *International Journal of Information Management,* 30 (2), 125-134.

Upadhye, N., Deshmukh, S.G. & Garg, S., 2010. Lean manufacturing in biscuit manufacturing plant: A case. *International Journal of Advanced Operations Management,* 2 (1), 108-139.

Van Dam, P., Gaalman, G. & Sierksma, G., 1993. Scheduling of packaging lines in the process industry: An empirical investigation. *International Journal of Production Economics,* 30, 579-589.

Van Donk, D.P., 2001. Make to stock or make to order: The decoupling point in the food processing industries. *International Journal of Production Economics,* 69 (3), 297-306.

Van Wezel, W., Van Donk, D.P. & Gaalman, G., 2006. The planning flexibility bottleneck in food processing industries. *Journal of Operations Management,* 24 (3), 287-300.

Voss, C., Tsikriktsis, N. & Frohlich, M., 2002a. Case research in operations management. *International Journal of Operations and Production Management,* 22 (2), 195-219.

Voss, C., Tsikriktsis, N. & Frohlich, M., 2002b. Case research in operations management. *International Journal of Operations & Production Management,* 22 (2), 195-219.

Wang, X., Li, D. & O’brien, C., 2009. Optimisation of traceability and operations planning: An integrated model for perishable food production. *International Journal of Production Research,* 47 (11), 2865-2886.

Watson, R., Storey, D., Wynarczyk, P., Keasey, K. & Short, H., 1996. The relationship between job satisfaction and managerial remuneration in small and medium-sized enterprises: An empirical test of ‘comparison income’and ‘equity theory’hypotheses. *Applied Economics,* 28 (5), 567-576.

Wessel, G. & Burcher, P., 2004. Six sigma for small and medium-sized enterprises. *The TQM Magazine,* 16 (4), 264-272.

White, R.E. & Prybutok, V., 2001. The relationship between jit practices and type of production system. *Omega,* 29 (2), 113-124.

Womack, J., Jones, D. & Roos, D., 1990. *The machine that changed the world*: Rawson Associates New York.

Worley, J.M. & Doolen, T.L., 2006. The role of communication and management support in a lean manufacturing implementation. *Management Decision,* 44 (2), 228-245.

Yin, R.K., 2003. *Case study research: Design and methods*: sage.

Yin, R.K., 2009. *Case study research: Design and methods*: Sage publications, INC.

Zokaei, K. & Simons, D., 2006. Performance improvements through implementation of lean practices: A study of the uk red meat industry. *International Food and Agribusiness Management Review,* 9 (2), 30-53.

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