ABSTRACT

While lean is thought to benefit performance, effective implementation is challenging perhaps owing to firm idiosyncrasies. It may be possible to identify specific lean tools that align with a job shop manufacturing process and improve lean implementation. This cross-sectional empirical study investigated the applicability of four selected lean tools (5S’s, Visual Management, Kaizen and Workers Involvement) in a job shop manufacturing setting.

KEYWORDS: lean manufacturing, job shop, operational performance, workers involvement, and managers’ satisfaction

INTRODUCTION

Lean production is applicable in different industries, but the benefits of a lean implementation vary based on the organizational settings (Hong, Dobrzykowski, & Vonderembse, 2010; Mackelprang & Nair, 2010). Lean focuses on the elimination of all kind of wastes (Shah & Ward, 2007) by changing the way all work activities are performed at different organizational levels (Emiliani & Stec, 2005). Various organizations and services are willing to implement lean based on the promise of eliminating waste and reducing operational costs. Creating a successful lean implementation trajectory is challenging since each lean implementation requires different strategies based on different organizational variables (Lewis, 2000). We know from contingency theory that the internal and external constraints that impact organizations make it difficult for one approach to communication, management, etc. will not work for all organizations.

Lean has been successfully implemented in companies with product technology similar to Toyota, high volume, low variety, and cosmetic customizations, which is an assembly line manufacturing setting (Lander & Liker, 2007). The unchanged lean formula is applicable to a small segment of manufacturers which operate with similar external and internal constraints,
while to work for the rest, this formula needs to be adapted to the company’s circumstances (Jina, Walton, & Bhattacharya, 1997).

When attempted in a job shop, the lean implementations have not been as successful because each job shop is different, it is difficult to standardize the production approaches, and small firms do not possess as many resources as the large ones which is a barrier to the providing the needed flexibility (Pepper & Spedding, 2010). Although many researchers have investigated the implementation of lean manufacturing concepts and tools, the applicability of these to high value, low volume product production, which is frequently labeled a job shop manufacturing setting, has not been determined (James-Moore & Gibbons, 1997).

In order to be profitable, the low volume production needs the implementation of lean manufacturing (Hogan, 2005). The implementation of the lean practices has been related to improved operational performance measures such as the cost of quality, scrap and rework, and productivity, as well as reduced cycle time and customer lead time (Shah & Ward, 2003). The purpose of this study which was framed by contingency theory was to investigate the relationship between the levels of implementation of the 5S’s, Visual Management, Kaizen and Workers Involvement lean tools and perceived operational performance. Based on recent research results, these tools were selected based on their applicability to the low volume, high variability production as found in a job shop.

Moreover, this study determined if there was a relationship between management’s satisfaction and the operational performance of the firm. Specifically this study addressed two research questions related to the job shop manufacturing setting:

RQ1: Which of the selected lean tools influence operational performance in a job shop manufacturing setting?
RQ2: Is operational performance associated with management’s satisfaction with lean transformation in a job shop manufacturing setting?

LITERATURE REVIEW

Lean Manufacturing Implementations

The lean production with synonyms as Just in time or Toyota Production System (TPS) was established by Toyota Corporation (Kilpatrick, 2003) (Chen, Li, & Shady, 2010). For a successful lean implementation intense changes concerning work organizational and cultural issues are required at all organizational levels and departments (Sohal, 1996). Black, (2007) proposed seven preliminary steps for successful lean implementation, see Table 1.

<table>
<thead>
<tr>
<th>Table 1: Steps for successful lean implementation</th>
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<tr>
<td>1. Education of everybody in the plant on lean production philosophy and concepts,</td>
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<td>2. Top-down commitment,</td>
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<td>3. Financial decision based on the lean practices as lean accounting,</td>
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<td>4. Selection of measurable parameters that track organizational changes,</td>
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<td>5. Full involvement of production workers,</td>
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<td>6. The company must share the gains with those who contributed, and</td>
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<td>7. The middle management reward structure must support the system design.</td>
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On the other hand, stability, continuous flow, synchronized production, pull system, and leveled production are defined as the five phases of lean implementation (Allen, 2000). When implementing lean, it has to be taken in account that lean capabilities are plant specific (Crute, Ward, Brown, & Graves, 2003). However, each organization is unique, consequently to work, the Toyota production development system must be reshaped to match the uniqueness of each industry and integrated to the entire system (J. Liker, Sobek, & Ward, 1998).

The most important business principles of the Toyota Production System are respect for people and continuous improvement. Successful lean implementation depends on human resources, they are the initiative of processes, business, and continuous improvement activities (Dibia & Onuh, 2010). Toyota Production System is successful because every team member identify problems, eliminate wastes and reduce inventory (Smith, 2006). In lean manufacturing environment, the shop floor workers coordinate the production flow, through minimizing work in process inventory and throughput times (Alfnes & Strandhagen, 2000). Teamwork and group problem solving are key to the variance and uncertainty management, leading to decentralized decision-making (Forza, 1996).

**Lean tools and construct definitions**

The following lean tools were selected based on recent studies regarding their applicability to low volume, high variety products which is typical for a job shop manufacturing setting (Adler, Goldoftas, & Levine, 1999; Bodek, 2010; Dennis, 2007; Kilpatrick, 2003; Lane, 2007).

**Visual Management (VISM)** is the extent to which value-added information is displayed to everyone (Hogan, 2009; Dennis, 2007; Adler, Goldoftas, & Levine, 1998; Kasul & Motwani, 1997; Parry & Turner, 2006; Melton, 2005; Kilpatrick, 2003). It is a method for a shop floor performance’s measurement (Melton, 2005) and communication aid synchronizing a real time operations and processes (Parry & Turner, 2006). Visual management is simple signals providing immediate and obvious understanding of a situation within a short period (Kilpatrick, 2003).

**5 S System (FIVES)** is defined as the extent to which the workplace is organized and standardized (Dennis, 2007; J. K. Liker, 2004; Veech, 2004; Melton, 2005; Kilpatrick, 2003). The goal of implementing the 5S’s is creating a self-explaining, self-ordering, and self-improving workplace (Dennis, 2007). The first S stands for Sort—keep only what is needed; the second S stands for Straighten—create a place for everything; the third S stands for Shine—cleaning so that abnormal and pre-failure conditions are exposable; the fourth S stands for Standardize—to create rules to maintain and monitor the first 3s; and the fifth S stands for Sustain—create self-discipline for continuous improvement (J. K. Liker, 2004).

**Kaizen (Continuous Improvement) (KAIZ)** is defined as the extent to which employees contribute to the company’s development through suggestions aiming elimination of all kind wastes (Boyer, 1996)(Alukal, 2007)(Dennis, 2007)(Imai, 1997). Kaizen refers to the gradual improvement made over time(Manos, 2007). It is a Toyota management philosophy involving everyone working for the company to contribute to continuous improvement activities with goal increasing quality, safety, and productivity (Haak, 2006; Detty & Yingling, 2000).

**Workers’ Involvement (WINV)** is defined as the extent to which employees are motivated to participate in continuous improvement and problem-solving activities (Fullerton & Wempe, 2009) (Bodek, 2010). Employee’s motivation to contribute and implement small but constant
improvements to the shop-floor activities is the most important factor for the Kaizen success (Imai, 1997). Self-efficiency motivates team members to participate in problem-solving and continuous improvement activities (Veech, 2004). Another motivator is the involvement of production line workers to participate in identification of defective parts (Sánchez & Pérez, 2001). Overall, the human side of lean is very important in implementing a team-based environment in which employees follow the standards and use all tools and lean techniques (Alukal, 2007).

**Operational Performance** (OPPER) is defined as the extent to which the firm’s operational performance indicators focus on the key operational success factors leading to financial performance (Venkatraman & Ramanujam, 1986).

**Satisfaction** (SATISF) is defined as the extent to which “one’s feelings or attitudes toward a variety of factors affecting the situation” are summed (Bailey & Pearson, 1983, p. 192) (Legris, Ingham, & Collerette, 2003, p. 192). However, the employee’s satisfaction is a critical factor in determining the success or failure of the system implementation (Doll & Torkzadeh, 1988).

**Job Shop Manufacturing Setting**

One of the reasons that the manufacturing operations element is the most complex and difficult for managing is the range of products and processes (Fine & Hax, 1985) (Skinner, 1969). The first product and process matrix, linking the process life cycle with the product life cycle was proposed by Hayes & Wheelwright (1979). According to the product-process matrix, the most appropriate manufacturing process depends on the number of products, degree of standardization and product volume. Matching the process type: job shop, batch shop, assembly line and continuous flow with the product characteristics is the traditional approach for managing process and technology (Fine & Hax, 1985).

A job shop is a firm producing small batches of a large number of different products, requiring a different set of sequences of processing steps (Chase & Aquilano, 1995; Hayes & Wheelwright, 1984). Because of the variety of individual products and the lack of dominant flow pattern, job shops are using diverse workstation types with different product routes (Montreuil, 1999). A job shop is characterized by small to medium volume, constantly changing product mix and variability in the job demand, which makes it uneconomical to set up a production line (Montreuil, 1999); (Hayes & Wheelwright, 1984). Other job shop characteristics are large amounts of in process inventory, making it difficult to know the exact location of a specific job at a specific time (Hayes & Wheelwright, 1984). In addition, a job shop relies on knowledge of the workers (NetMBA, n.d.)

The processing requirement, dictates the route of each job through the machine center, consequently, some pattern in the workflow cannot be distinguished because of the wide variety of jobs and processing requirements (Graves, 1986). The flexible path flow of the produced products makes calculating job shops’ capacity a very difficult task (Hayes & Wheelwright, 1984). On the other hand, pure job shops do not exist because there is a more or less dominant flow (Oosterman, Land, & Gaalman, 2000).

**Lean Implementations in a Job Shop**

According to researchers, The JIT lean tool is difficult to apply to a job shop setting, as an alternative, the company can use other lean strategies to increase the efficiency of their
operations (Stump & Badurdeen, 2009). Moreover, the implementation of heijunka is very challenging in a high variety production setting (Hüttmeir, de Treville, van Ackere, Monnier, & Prenninger, 2009).

The Toyota production system is working well for low variety, high volume productions which are characteristics of an assembly line setting, but when applied to a high variety, low volume which is a job shop setting- kanban is not manageable and machine cells cannot be dedicated to one product (Masson, Smith, & Jacobson, 2007).

**Lean Benefits**

In order to be profitable, the low volume production as found in a job shop needs the implementation of lean manufacturing (Hogan, 2005). When a job shop is converted to a lean environment, the results are labor saving, reduced inventory and customer lead-time (Howard & Newman, 1993). Despite the difficulties, with the implementation of lean, the job shop can convert to a continuous manufacturing process and gain the benefits associated with it (Huq & Pinney, 1996).

**THEORETICAL DEVELOPMENT/MODEL**

“Contingency theory assumes that the better the ‘fit’ among contingency variables (e.g., between technology and organizational structure), the better the performance of the organization” (Weill & Olson, 1989, p.61). Consequently the effectiveness of one organization is contingent on how well context and structure fit together (Drazin & Ven, 1985; Shenhar, 2001) The unchanged lean formula is applicable to companies similar to Toyota with high volume, low variety, and cosmetic customizations products, which is an assembly line manufacturing setting (Lander & Liker, 2007) while for other settings, some adaptations are needed (Jina et al., 1997).

Since a best lean implementation approach appropriate for all organizations, does not exist. A successful lean implementation requires a customization of the lean practices to the organization’s environment (Browning & Heath, 2009). As seen from Table 2, the characteristics of a job shop are completely different than the characteristics of the assembly line setting, providing some justification as to why the same formula for lean implementation in not working in two different environments.

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<th>Table 2: Job shop-Assembly line characteristics</th>
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<td>Volume</td>
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<tr>
<td>Assembly line</td>
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<tr>
<td>Job shop</td>
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It is crucial to determine which of the lean tools are relevant (Corbett, 2007). The theoretical framework for this study can be found in Figure 1.
The relationships between the implementation of lean practices and operational performance has been investigated by several researchers (Fullerton & Wempe, 2009; Shah & Ward, 2003). Since the lean implementations lower the operational cost, they have been linked to the improvement of operational and financial performance in many industry sectors (Reichhart & Holweg, 2007; Shah & Ward, 2003; Hofer, Eroglu, & Rossiter, 2012). Shah & Ward (2003) found that the lean practices are significantly and positively associated with operational performance.

In lean manufacturing, Visual Management is the communication center synchronizing the continuous improvement activities with knowledge management (Parry & Turner, 2006; Welo, Tonning, & Rølvåg, 2013). This tool distributes essential information to all employees, leading to performance consistent with the company's goals (Karlsson & Åhlström, 1996; Kasul & Motwani, 1997), and supports the lean implementations by identifying waste, variability and overburden (Cottyn, Van Landeghem, Stockman, & Derammelaere, 2011). Example of visual management tools are displays of process cost reports, financial status reports and standard work charts (Parry & Turner, 2006). Because the needs of an individual process determine which visual tool to use and where (Mann, 2010), visual management is a highly recommended lean tool for application in a low volume, high variability environment (Lane, 2007). The hypotheses addressed by this study follow:

**Hypothesis 1a: The use of Visual Management is positively related to the operational performance of the firm.**

When the lean transformation starts, 5S's is the first implemented tool, applicable to every department in the organization and providing immediate return on investments (Dennis, 2007; Kilpatrick, 2003). 5S’s is a method for organizing and standardizing the workplace, and sustaining the results (Kilpatrick, 2003). Creating a self-explaining, ordering, and improving visual workplace is the purpose of 5S (Dennis, 2007). Because the 5S’s are universally applicable to each situation, this study hypothesizes:

**Hypothesis 1b: The use of 5S’s is positively related to the operational performance of the firm.**

Kaizen, also known as continuous improvement is based on the employees' creativity and idea generation (Alukal, 2007). Eliminating manufacturing and administrative wastes through employees' engagement, Kaizen is the link between lean and growth (Hettler, 2008). Employees contributing to the company development with waste eliminating suggestions is the hearth of Kaizen events (Boyer, 1996). The most important element of continuous improvement is workers' training in problem solving (Adler et al., 1998). The foundation for lean production is well trained and multi-skilled workers, creating an environment which promotes continuous improvement (Boyer, 1996). Because the job shop relies on the knowledge of workers, this study hypothesizes:

**Hypothesis 1c: The use of Kaizen is positively related to the operational performance of the firm.**
A number of studies have confirmed that creating and sustaining high level of shop floor employees’ involvement is crucial for the successful implementation of lean manufacturing (Adler et al., 1998; Fullerton & Wempe, 2009). Only the front line workers can identify and fix small problems, decide when to stop the line, develop the standardization, and generate the kaizen ideas (Adler et al., 1998; Dennis, 2007). Working out a plan for a personal growth is a good motivator because the employees feel that they are in charge of their own lives, and by contributing to the organization they are contributing to their growth (Bodek, 2010). Because the job shop relies on the knowledge of workers, his study hypothesizes:

**Hypothesis 1d: The use of Workers’ Involvement is positively related to the operational performance of the firm.**

Satisfaction has been linked with the needs addressed by the system (Ives, Olson, & Baroudi, 1983). However, managerial satisfaction is a critical factor in determining the success or failure of the system implementation (J. E. Bailey & Pearson, 1983; Doll & Torkzadeh, 1989). Consequently this study hypothesizes:

**Hypothesis 2: The operational performance of the firm is positively related to management’s satisfaction with the lean program**

**METHODOLOGY**

To collect the perceptions of the manufacturing experts knowledgeable about lean implementations a descriptive research approach was utilized. The population used for this study was manufacturing managers, leaders or engineers: 1. working for located in US manufacturing companies which were involved in a lean journey 2. having knowledge of lean manufacturing. Members of the Lean Enterprise Institute (LEI) or members of Continuous Improvement, Six Sigma, and Lean LinkedIn groups constituted the sample for this research. A survey instrument was developed to investigate the relationships between the levels of utilization of the four lean tools and the managers' satisfaction with the lean program one instrument was developed. Shah and Ward (2007) proposed empirically validated reliable measurement instrument for measuring Workers Involvement (WINV) implementations, from which this study adjusted. The content validity of the instrument was established through comprehensive literature review and Q-sort pilot testing (Davis, 1996; Moore & Benbasat, 1991). Moreover, survey items’ readability was addressed through Q-sort pilot testing (Moore & Benbasat, 1991). As a result, the number of the survey items was reduced and the readability was improved. The survey reliability was confirmed by Cronbach alpha coefficients greater than 0.74 (Davis, 1996).

A Likert-type scale was selected to measure the level of implementation of different lean tools in a job shop setting. When employing a Likert-type scale, the respondents make an evaluation of the statement based on magnitude and the responses are numerical (Leedy & Ormrod, 2005). The coding chosen for the Likert-type scale was: 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, and 5-strongly agree.

Surveys were disseminated to two groups of individuals knowledgeable about lean practices: the 300 members of Lean Enterprise Institute and 700 members of Continuous Improvement, Six Sigma and Lean Group in LinkedIn. The usable response return rate was 26.2 %. A lean training or certificate confirmed the lean expertise of the individual respondents. Six Sigma
Black Belts or Six Sigma Master Black Belts constituted the largest group of respondents (53%). A Lean Certificate was reported by 13.8% of the respondents, and Six Sigma Green Belts holders made up 21.7%. Those with only lean experience or lean training constituted 11.2% of the survey respondents.

For studies addressing theory development, the appropriate procedure is Partial Least Squires (PLS) (Joe F. Hair, Ringle, & Sarstedt, 2011). A PLS method was used to test the research hypotheses. If the latent variable scores are used in consequent analysis, the best approach to assessing the measurement model validity and reliability is the PLS-SEM (Joseph F. Hair, Sarstedt, Pieper, & Ringle, 2012).

ANTICIPATED FINDINGS

This study investigated the relationship between the levels of implementation of 5S’s, Visual Management, Kaizen and Workers’ Involvement lean tools and Operational Performance of the firm in a job shop manufacturing setting. It was expected that the 5S tool would be applicable to each environment and this first implemented lean tool would be positively related to operational performance. Moreover, it was expected that Workers Involvement and Kaizen would be positively related to the operational performance, because job shops rely mostly on the knowledge of workers. In addition, this research investigated whether the managers’ satisfaction with the lean program is related to the operational performance of the firm.

LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The results of this study were impacted by at least two limitations. The results may have been different if the population was not limited to the US, but included all manufacturing companies. A replication of this research should include manufacturing managers from other countries. A second limitation was that the level of implementation was based on the perception of respondents to this study. Future studies should measure the level of implementation based on a more objective approach by assessing actual events and observations rather than self-reporting.

REFERENCES


