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Survey of Lean Management Practices in Pakistani Industrial Sectors

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Abstract

This research was undertaken to study the implementation and adoption of Lean Management practices across several industrial sectors in Pakistan. A total of 100 companies were surveyed across 5 industries. The objective was to determine if there was disparity in the implementation of Lean practices and to provide a yardstick to measure that disparity. Furthermore, this study identified Lean management best practices across several industries in Pakistan, thus providing benchmarks for other industrial sectors**.** The data collected was analyzed using various descriptive statistical methods. The results indicated robust adoption and implementation of Lean practices in Pakistani industry, though there were few areas which still require greater acceptance, and hence implementation rates in these areas are modest.

Key Words: Lean Management, Empirical data, Pakistan, Lean Practices, Industrial sectors.

Article Type: Research paper

1 Introduction

Lean is often referred to as "an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability" (Shah and Ward, 2007). Lean management (Lean) has been extensively researched in the developed world, and in the past decade Lean research has started to focus on the developing world for example, Taj and Morosan (2011), Wickramasinghe and Wickramasinghe (2012), Ghosh (2013), Nawanir et al. (2013), and Ravikumar et al. (2015). The terms of Lean Management/Manufacturing, Lean Practices (LP), and "Lean" have all been used in literature when investigating the role that Lean plays in the development and maturity of the firm as well as its performance. Despite the research work carried out in the developing world, little has been done in the Pakistani context. This paper attempts to fill this gap. The purpose of this research was to study the implementation and adoption of Lean practices across several industry sectors in Pakistan. The objective was to determine if there was disparity in the implementation of Lean practices and to provide a yardstick to measure that disparity. Furthermore, this study identified Lean management best practices across several industries in Pakistan, thus providing benchmarks for other industrial sectors.

Researchers have studied the adoption of Lean in various contexts, for example, Saurin et al. (2011) studied this phenomenon in manufacturing cells and linked its adoption to improvement in performance of the industry, while Bhasin and Burcher (2006) studied it in the context of cultural norms in UK firms. More recently, Nordin et al. (2012) argued that the low rate of adoption of

Lean can be attributed to the organizations inability to effectively manage organizational change. Other researchers such as Yadav et al. (2010) and Belekoukias et al. (2014) have effectively argued that even partial implementation of Lean has a positive impact on organizational performance and operational efficiencies.

Literature shows that Asian firms too, have adopted this methodology. For example in India, Vinodh et al. (2015) have studied the importance of lean in the Indian automotive industry, while Bhamu et al. (2013) studied it in the case of an automated production facility and Ravikumar et al. (2015) studied the implementation in context of Micro, Small and Medium Enterprises.

In addition to these studies, research looking at other developing economies in Asia is also available. For example an excellent piece of work by Samarrokhi et al. (2015) has investigated the effects of Lean and Six Sigma on the competitive advantage of Malaysia's manufacturing sector. Another study was conducted by Nawanir et al. (2013), who looked at the impact of Lean on the operational and business performance of Indonesian firms.

These and other studies clearly point towards a positive impact of Lean on the performance of the firms adopting these methodologies and in turn on the economy of the region/country. As Pakistan matures into a developing economy, its industries will have to adopt these modern concepts. It is imperative for the competitive position of Pakistani industries to learn from firms that have begun to adopt modern management techniques such as Lean, and that will enhance their position in the global business environment. This research is designed to help fill this gap.

As Pakistan moves away from being an agricultural and rural based economy, the industrial sectors are gradually becoming a vital and ever growing part of the overall economy. This research looks at Manufacturing-Steel, Meat processing, Textile, Leather-Shoe and Pharma-Chem industries. Together these industries account for around 62% of the industrial output and approximately 65% of the industrial labour force. Manufacturing industry (along with Mining) accounts for 13.5% of industrial output of Pakistan and 14.1%[2] of total employed labour workforce. Textile and Apparel industry is the most important manufacturing sector of Pakistan and contributes nearly 31.2% of industrial output of Pakistan, employing 40% of the industrial labour force; Pharma-Chemical accounts for 12.89%; Auto and other vehicles accounts for 5.33%; and leather products 0.91%.[3] Table 1 provides a summary look at the industry profiles.

Insert Table 1 Here

While much research in Lean has used anecdotal or based on small case studies, for example, Portioli–Staudacher and Tantardini (2012); Vinodh et al., (2015); Bhamu, (2013); and Thirunavukkarasu et al., (2013), only a few studies such as Bhutta et al. (2013) have used empirical

[2]http://finance.gov.pk/survey/chapters_14/03_Manufacturing_and_Mining.pdf
[3]http://www.pbs.gov.pk/sites/default/files/industry_mining_and_energy/publications/cmi2005-06/Executive_Summary.pdf

data. This research aims to fill this gap of empirical research in the Pakistan. A survey instrument was used to collect data and categorize Lean practices into impact areas. The exploratory analysis of data from five industries helps recognize the need for more aggressive implementation of Lean practices. Furthermore, the categorization of the impact areas provide for a detailed analysis of the data and helps derive inferences about the extent of Lean practices in the Pakistani industrial sector.

The paper is organized as follows, an overview of literature is provided in Section 2; Section 3 lays out the methodology; Section 4 presents the findings and discussions of the results, and Section 5 enumerates the summary of the paper and lays out avenues of further research.

2 Background and Literature Review

Several researchers in their efforts to extend the body of literature in Lean have written extensively on its origins for example Panizzolo (1998), Hines et al. (2004), Bhutta et al. (2013) and Parkes (2015). Researchers have also worked to codify Lean practices, categorizing them into "impact areas" that once implemented lead to a leaner organization. Among these, Doolen and Hacker (1998) and Shah and Ward (2007) stand out. More recently Pakdil and Leonard (2014) have developed a Lean Assessment Tool (LAT) with the objective of measuring the impact of Lean on the efficiency and effectiveness of an organization.

This research is based on the impact areas as identified by Doolen and Hacker (1998). Bhutta et al. (2013) compared the categorization of Doolen and Hacker (1998) and Shah and Ward (2007). Table 2 provides a summary of the "impact areas" of Lean. Both of these are quite similar in structure, however The Doolen and Hacker categorization is more granular and in a developing country such as Pakistan it is easier to implement.

Insert Table 2 here

Much work has been conducted in the field of Lean and its implementation in the developed world including studies such as Doolen and Hacker (2005), who studied Lean practices in electronics firms in the U.S.A. They focused on the need to understand what factors encouraged Lean adoption and found that though most electronics manufacturers had adopted Lean but the degree of implementation varied according to economic, operational and organizational factors. Bhasin and Burcher (2006) studied the factors in adoption of Lean in UK firms and delineates the intricacies of why Lean adoption rates depend on culture and contextual factors. Nordin et al. (2012) studied the impact adoption of Lean has on organizations and they too argue that the organizational context and the manner or implementation has an impact on its adoption rates. Lampón et al. (2015) studied

the Spanish automobile components industry and looked at Lean supply and technological requirements, they argued that these logistic and technological determinants must be considered in adoption as well. Chick et al. (2014) argued that European and North American companies have moved so far down the Lean road that they are now having to come up with even more unique approaches to Lean such as Lean in Supply Chains and other cooperative models.

Scholars have also studied Lean implementation/adoption in the Asian context, for example Taj (2007) identified implementation of Lean in Chinese automotive plants began as early as 1977. Another study by the same author, (Taj and Morosan; 2011) studied the impact of Lean adoption on Chinese firm's performance. The study looked at 65 facilities in various industries including chemical, food and beverage, garment, electronics, and argued that there is a positive impact of Lean on the performance of the firms. Wickramasinghe and Wickramasinghe (2012) studied Lean and the link between organizational support and job satisfaction in a Lean production environment in Sri Lanka. They posited that the benefits of Lean extend far beyond just the physical (lower inventories, faster flow times etc.) and have an impact on employees and their attitudes to their work. Another Sri Lankan study by Perrara and Kulasooriya (2011) provide a case study of a food processing company that links the "leanness" of the business processes with improvement to lead time reduction (41%), process cycle efficiency improvement (94%) and the financial gains of the firm.

Another south Asian country that has received significant attention in Lean research is India. Ghosh (2013) in Indian manufacturing plants looked at the implementation of Lean. The author studied 79 firms and found that around 80% of the respondents had implemented Lean to varying degrees with positive impact on their performance. Ghosh based the study on the survey developed by Shah and Ward (2007) with some modifications for the Indian context. His results in Indian manufacturing plants provide an insightful look at the degree of implementation. In addition to this research, Bhamu et al. (2013) present an excellent case of an automated production facility in India and listed several positive gains by Lean implementation. Vinodh et al. (2015) studied Lean in the automotive remanufacturing industry and identified what areas of the facility had shown improvement and what areas still needed work. The achieved this by creating a checklist of remanufacturing attributes and by asking relatively simple questions ascertain the extent of implementation. While Ravikumar et al. (2015) studied MSMEs and the role that Lean adoption has played in their success and. These and other studies demonstrate the vigor of research in Lean adoption in India.

Nawanir et al. (2013) looked at the impact of Lean on the operational and business performance of Indonesian firms. Using statistical techniques they develop relationship between Lean implementation and operational and business performance. They argued that adoption of Lean results in enhancement of a firm's performance.

Researchers have also recently started focusing on Lean implementation in Pakistan, for example Hashmi et al. (2015) in their recent research have studied the role of Lean on organizational

operational performance, linking the improvement to daily scheduling, layout design and repetitive production. They develop a conceptual model linking these three aspects to the operational performance and empirically test their model in the Pakistani context. However they restrict their study to only these 3 factors. Another study is by Bhutta et. al. (2013) where they looked at the level of adoption in the Pakistani textile industry. The research was a case study of 8 textile firms and the results indicated partial adoption of Lean.

From the above review, we see that much work has been done around the world on Lean; the extent of adoption, the role that culture, traditions, work conditions, and economic factors play in Lean's adoption and its impact on the operational and organizational performance of a firm. However scant work exists in the Pakistani context. This research is the first step to exploring the extent of adoption of Lean in Pakistan and will form the basis of further studies in this area, in addition it provides a benchmark to gauge future implementation and growth of this crucial management technique.

3 Methodology

Data for this study was collected using a survey instrument that was externally and internally validated by Doolen and Hacker (2005). The collection was facilitated by conducting face to face structured interviews, based on the well published research methodology, (for more details please see Hoinville and Jowell, 1978 and Bryman and Bell, 2011) with supervisors/managers who had firsthand knowledge of operations within their organizations. The interviews were prearranged and were scheduled by appointment to ensure sufficient time with the respondents. The survey was carried out with the purpose of identifying the extent to which Lean practices were being applied in the firm.

The interviewer was a MBA student taking an Operations Management course with knowledge of the survey methodology. The interview was conducted on the premises of the firm and was complemented by a tour of the facility, enabling the interviewer to observe the operation first-hand. The surveys were carried out between January and August 2014. This research looked at Lean management as a set of 6 "impact areas"; namely Manufacturing Equipment and Processes, Shop-Floor Management, New Product Development, Supplier Relationships, Customer Relationships, and Workforce Management. (For more details please see Doolen and Hacker, 2005.) For the most part descriptive statistics from the survey data was used for developing the insights presented in this paper.

3.1 Data

Appendix 1 provides a summary of the survey along with the type of measurement method used to assess each question. A total of 100 companies were surveyed across these 5 industries. The 5 industries and number of respondents within each industry were, the Manufacturing-Steel (29), Meat processing (5), Textile (43), Leather-Shoe (6) and Pharma-Chem (17). The number of respondents are generally in proportion to the strength of each industry. The survey was designed using a 5 point Likert scale.

4 Findings and Discussion

This section presents a detailed account of the findings across the industries and highlights comparisons. The conceptual framework of this study is simple. The study uses data collected in the survey and categorizes it into 6 impact areas rank ordering it from best to worst. The results show that all the industries have begun to implement Lean practices to varying extent. This is a positive indication for Pakistani industries that with their relatively modest investments (especially when compared to their western counterparts) and despite their lack of an educated labour force, have begun to adopt advanced management practices. The analysis used Q1-Q35 (Appendix 1) to investigate Lean practices with responses providing quantitative results. The scores range between 0 (Never use) to 5 (Always Use). The mean scores provide insights into the level of adoption of the impact area within an industry. The impact scores were calculated by averaging the responses across the respondents. Based on the responses, the industry profile on each of the 6 impact areas is presented in Figure 1.

Insert Figure 1 here

The Leather-Shoe industry ranks highest among the 6 impact areas. From a conceptual perspective, due to the resource constraints in the Pakistani industrial sector, the efficiency of the implementation of Lean practices can be improved by reducing waste, pollution and the cost of production. Lean practices are a must for the Pakistani industrial sector to be competitive with the other countries in the region. As is evident from the analysis of the survey data, some of the industries in Pakistan are far ahead of the others in their adoption of Lean principles. It is an indication from the results of the survey that the other industries that are lagging need to benchmark best practices to the Leather-Shoe industry.

The grand average of all areas combined for the 100 surveys was 3.495; Leather-Shoe Industry 3.86; Pharma-Chem 3.712; Manufacturing & Steel 3.611; followed by Textiles 3.376 and Meat industry at 2.453 respectively. Table 2 shows details of the average responses. In terms of customer relationships, the average scores of industries ranged between 2.25 and 4, Leather-Shoe manufacturing had the highest score of 3.993. Leather-Shoe manufacturing is ranked highest with

the average scores in other categories, such as manufacturing & processes (3.875), new product development (3.819), and shop floor management (3.752). Pharma-Chem industry was found to have the highest score of 4.072 in work force management category. Given that we used a five point Likert scale and the most that was scored was a 4 with the average falling below 4 for all six categories, the indication is that even with self-reporting the Pakistani industrial sector is falling behind in its Lean practices. The results/averages for the 6 impact areas are proxy for the indicator of the level of Lean practices. As we further drill down into the data in our analysis, one can gain a deeper insight into the reasons and justifications for these narrow ranges and performances.

Insert Table 3 Here

The average response rate helps us understand the extent of Lean practices in Pakistani industrial sector as a whole and by specific industries. They help us identify which industries may be further along in their adoption of Lean and which perhaps are lagging and in which impact areas. The highlighted impact scores show that the Leather-Shoe industry score highest in every impact area except workforce management which is claimed by Pharma-Chem. This can be attributed to the regulatory constraints on the industry. Pharma-Chem are regulated to international standards and requires a comparatively well-educated/skilled workforce. Figure 2 presents the average scores by main focus areas.

Noticeably, Meat processing industry scores the lowest in all areas. This can be explained by the fact that it is largely an informal sector (88% of the livestock is owned by small farmers or individuals) with low level of regulatory mechanisms in place leading to lax adherence or adoption of modern management techniques. The labour forces is also among the least educated usually relying on an informal training structure.

Insert Figure 2 Here

In the following sections we will discuss each *impact area* in detail.

4.1 Customer Relationships

Customer relationship management is a grouping of 5 specific lean practices namely; delivery performance improvement; demand stabilization; service to enhance value; customer requirements analysis; and product customization. The results of the survey depict that the Leather-Shoe industry ranks highest on average scores; with a standard deviation of 0.466; followed by Manufacturing-Steel, Pharma-Chem, Textiles and Meat processing industries respectively. A low

standard deviation indicates that there are fewer outliers and the application of standards are uniform across the entire industry. This focus on customer relationships by the Leather-Shoe industry can be attributed to the nature of the industry itself. Most if not all Leather-Shoe manufacturers in Pakistan supply directly to retails stores (in many cases the retail store is owned/operated by immediate family or relatives) or exports them; in a sense forcing them to practice good relationship management techniques. Also in a high context culture, it follows that customer relationship management would be critical to the profitability of the firm. Over all for all industries combined the standard deviation was 0.090, indicating a relatively low variation in the responses.

Table 4 provides the average adoption of Lean practices by specific Focus Area in each of the industries.

Insert Table 4 here

In terms of working to improve delivery performance, we find that the Leather-Shoe industry superior in its adoption of techniques that help it improve delivery performance, (18.99% above the average), followed by the Pharma-Chem and Manufacturing-Steel industries respectively. In fact we see the same pattern in virtually all the specific focus areas, with the Leather-Shoe industry leading the pack followed by Pharma-Chem and Manufacturing-Steel Industries respectively, with the exception in Product customization where the Textile industry seems to have a greater adoption than the Pharma-Chem industry.

In the Leather-Shoe industry, the delivery performance is very important since a large percentage of the revenue comes from exports and given the terms of the contracts for client companies abroad the Pakistani Leather-Shoe manufacturers are compelled to find better ways of meeting delivery deadlines through better managing delivery schedules.

4.2 Manufacturing Equipment and Processes

A critical area in Lean practices is manufacturing equipment and process improvement. There are 10 specific areas for improvement as noted by Doolen and Hacker (2005). Table 5 depicts the specific focus area scores for the 5 industrial sectors.

Insert Table 5 Here

Table 5 depicts that all industries have implemented procedures to adopt these focus areas, however the Meat industry (with the exception of setup time reduction methods, work standardization and poke yoke - mistake proofing methods) is lagging behind in virtually all the

specific focus areas. All three of these areas are critical to processing meat (being a highly deregulated industry) standardization has to be the norm for prevention of meat borne diseases. There is significant room for improvement in this focus area for the Meat industry. This deficit also raises policy and regulatory issues. To further improve the Meat industry and bring it to par with global standards, the government of Pakistan should establish and enforce meat processing standards similar to those established in more mature economies such as the USA, where there are standards set by organizations such as USDA and OSHA. These type of standards would encourage this sector to run on a more modern footing and ensure that the products meet health and safety standards. This would also encourage training on a more systematic manner for those engaged in this sector.

4.3 Shop Floor Management

Table 6 lists the specific areas and scores for the industries in shop floor management.

Insert Table 6 here

Virtually all respondents practice good shop floor organization practices. This was also verified during the walk through of the facility. General housekeeping practices were being enforced. The personal were seen to show ownership of their tools and materials. Visual controls and signs were evident in the facilities (perhaps more so due to the relatively high illiteracy rate). Use of Kanban bins was in evidence to keep lots sizes small. However the use of integrated flow in operations was not responded to positively by any of the respondents except those in the Textile industry. Either the question was not understood correctly or they indeed do not practice this. The authors of this manuscript intend to investigate this anomaly in future research.

4.4 New Product Development

Table 7 shows that all industries except Meat practice new product development initiatives. This bodes well for the industries. Although the variance is large it is observed that the distribution is skewed to the right indicative of firms implementing product development initiatives.

Insert Table 7 here

The Meat industry, as it matures and enters export markets should be encouraged to develop new products. For example, pet food industry is lagging in Pakistan, new products can help this industry create new markets both domestically as well as globally, especially in the GCC countries where there is already some trade linkage.

4.5 Supplier Relationships

Table 8 shows that all industries except the Meat processing industry, practice supplier evaluation and maintain relationships with their suppliers. The Meat industry typically buys livestock (cows/goats/sheep etc.) from farmers. Many of these farmers bring their livestock to Friday or Sunday mandies/bazaars and the transactions are usually spot transactions. Few farms currently operate specifically to breed livestock specifically for slaughter on modern breeding principles. One area where this is changing in the poultry industry, where commercial farms are in evidence. Establishing and maintaining supplier relationships will become critical as Pakistan becomes more urbanized and livestock farmers are forced to move further and further away from urban areas and the logistical issues in the transactions will become increasing difficult.

Insert Table 8 Here

Also from (Table 8) we see that the companies in the Leather-Shoe industry evaluate their suppliers most often and maintain long term relationships. As a major proportion of the Textile industry (especially apparel and weaving) is export oriented with global brands dictating quality standards, suppliers have to be developed and the investment in this dictates maintaining long term relationships. In addition in the Leather-Shoe industry, the demand chain has high impact on the this industry's practices and hence it is more focused on supplier selection and long-term relationships. The obvious relationship between the Meat industry and Leather-Shoe industries should enable these industries to form linkages and maintain positive information flows.

4.6 Work Force Management

Table 9 depicts all industries except the Meat industry have work force management practices in place. The Meat industry again, perhaps by virtue of its nature (in Pakistan) has not adopted many of the Lean work force management initiatives. A standout is implementation of formal employee evaluation system. Typically the Meat processing operation is carried out individually with more or less a master-apprentice type structure. In the Meat processing industry, the workers' skill-set are their most valuable asset. Butchering is a skill that is developed through practice and close supervision under the tutelage of the master. This is typical in high context cultures similar to the Japanese approach in developing skills in the sword making or fish processing industries, where skills are developed under the tutelage of a master craftsman. In this male dominated industry when the master craftsman leaves a firm, he typically takes his apprentice with him. There seems to be less loyalty and a greater entrepreneurial spirit in this industry, where apprentices after honing their skills will setup their own businesses. In other, perhaps more technical industries there is a

need for formal education/technical skills, we see that the implementation of formal work force practices is significantly higher.

Insert Table 9 here

4.7 Analysis of Industry by Specific Focus Area

In this section we present insights in these five industries by looking at the specific focus areas. We divided the responses into 2 broad categories; those who responded positively to adoption of the individual focus areas (100-50%) as high implementers, and others who were lagging in the adoption (49.9% and below), as low implementers. The intent of this analysis was to identify the areas where there is need for improvement in the adoption of Lean practices. Figure 3 depicts the average response scores by focus area.

Insert Figure 3 here

Table 10 provides the scores in each area. It is evident from this data that certain focus areas need improvement in adoption, however this is not universal and close attention needs to be payed to identifying these areas and developing strategies to overcome these deficiencies. In this section we focus on these deficit areas.

Things change very slowly in high context (traditional) societies like Pakistan. More modern techniques such as cellular manufacturing, automation, nagara, concurrent engineering, design for manufacturing, and delegating decision making power to the lowest possible levels find acceptance ever so slowly in Pakistan. However this can be explained when we consider that Pakistan is a high context culture. As argued by Bhasin and Burcher (2006) culture plays a significant role in the adoption of impact areas, this is certainly true in the case of Pakistan.

Insert Table 10 here

In the next sections we comment on each of the areas that require improvement in adoption.

4.7.1 Cellular Manufacturing

In cellular manufacturing, companies try to identify part families and take advantage of machine groupings in producing these part families. This is done by creating machine groups that can produce these parts. The idea being that wastes such as transportation, setup time, and labour inefficiencies can be eliminated or minimized. Based on the responses (Table 10–Q3), we see that the adoption of this principle is only at 46%, indicating low implementation. This can be attributed to the fact that in many cases the facilities in Pakistan are relatively small, producing low volumes/varieties of products, and usually employing a master-apprentice model. As labour is relatively inexpensive, firms tend to be labour intensive, and hence have not as yet felt the need to set up manufacturing cells. However in the Manu-Steel industries that the adoption is higher (59%), that indicates that when there is an advantage to be gained due to the product characteristics, Pakistani industry are adopting this principle.

4.7.2 Autonomation (Jidoka)

Jidoka refers to the concept of self-detecting defects and fixing them so that number of defective items are minimized and value is not added to defective products. Table 10–Q10, depicts that only about 50% of the respondents responded positively. This can be attributed to the fact that in a labour intensive production environment (such as in Pakistan), labour incentives are usually based on quantity not on quality. However here too, in the more mature and mechanized industries such as Manu-Steel (55%); Textile (53%) and Pharma-Chem (53%), firms are implementing Jidoka and employees are empowered to detect and rectify defects before letting the product move on to the next stage.

4.7.3 Nagara System

Nagara refers to smooth flow of products through the production line. This typically involves production leveling and balancing techniques. Table 10–Q14 depicts, on the average only a 48% implementation response. This again is due to the nature of "production" in these industries. Meat processing and Textile (especially stitching) are typically fragmented, labour intensive, product diverse, and piece-meal production facilities and do not entail a smooth flow in product making. However, other industries do show higher levels of implementation of Nagara, namely the Pharma-Chem (65%) and Leather-Shoe (67%), and have again we see the product itself dictates the necessity and advantages of adopting this principle.

4.7.3 Integrated Flow Operations

As stated earlier, integrated flow of operations has the lowest implementation rate, a meager 7% on the average (Table 10–Q15). Only the respondents from the Textile industry admitted to

adopting this principle. It is not evident from the responses if in fact this principle is not being adopted at all or if the question was not understood by the respondents. The authors of this study intend to look into this more closely in further research.

4.7.4 Concurrent Engineering

Concurrent engineering involves trying to accomplish tasks simultaneously as opposed to sequentially. Designing and manufacturing functions are integrated with the aim to reduce time to manufacture. In majority of the industries (Table 10–Q18), the implementation is modest except for the Leather-Shoe industry (83%). This can be attributed to the fact that majority of these industries are production oriented and design is usually handed to them by clients others. For example in the Textile industry, clothing design is done by fashion designers (in Pakistan or the west) and weaving/stitching manufacturers only implement these designs. However this is changing, as more and more facilities have begun to design their own products or at the very least try to modify existing designs.

4.7.5 Design for Manufacturability (DFM) Principles

Design for manufacturability refers to the ability to produce products in an eas(ier) way. Table 10–Q19, depicts a low implementation response for DFM, which is not surprising given that most companies do not design the products that they make, as discussed above.

4.7.6 Delegating Decisions to Lowest Level Possible

Most firms in Pakistan are family or sole proprietor owned firms and in many cases run by the eldest member of the family (grandfather or father). Most decisions are made by this individual(s) and other family members generally implement the decisions. Responses (Table 10–Q30), depicts this quite aptly. However in those industries that are mature, or where there is less of a family orientation (professionally run), this is changing. Almost all the Leather-Shoe responded positively to this question and other industries have varying level of adoption rates. It is expected that as the industries mature and become more professionally run, delegated decision making will increase.

In summary it can be seen that Pakistan presented a very interesting case, certain focus areas are quite well adopted yet work remains to be done in other areas. It is particularly interesting to gauge the adoption of Lean as industrial sectors mature and as they compete internationally, the authors plan to conduct a longitudinal study in the future to gauge these changes.

5 Conclusions

The adoption of Lean practices also seems to be varying with the following contextual variables of the industry, we will briefly discuss our observations on this below.

Maturity of industry – The adoption of Lean principles can also be attributed to the maturity of the industry in Pakistan. We see that generally speaking Textile and Leather-Shoe industries, which have a long history in Pakistan (many of these pre-date independence), the adoption and implementation of modern management principles is quite advanced. Other industries that are perhaps in their growth phase, for example the Manufacturing-Steel and Pharma-Chem are gradually adopting these principles. And the informal (mostly family owned) are quite lacking in the adoption of these principles. However, Textiles industry presents a surprising case. Besides the maturity of this industry, and the fact that this industry constitutes a majority share of Pakistan's export, relatively lesser focus on the adoption of Lean management practices is a matter of concern.

Complexity of industry – the complexity of industry (described as a number of industrial sub-sectors / processes in the value chain) also influences the adoption of Lean practices across sub-sectors and also the measurement of those practices. One can perceive that higher the industry complexity, the harder it would be to adopt Lean practices owing to the confusion in a uniform set of industry best practices. In the current study, the Textile industry is the most complex, and it collects data from apparel, formal wear and weaving sub-sectors. Thus, relatively lower scores in the adoption of Lean practices should not be surprising. The other industrial sectors in our study such as Leather-Shoe, Pharma-Chem, and Manu-Steel are relatively less complex, have certain standards to follow and thus present higher adoption of Lean practices.

Technology sophistication / content in the industry – it seems as the sophistication or content of technology deployed by the industry increases, the focus on Lean manufacturing practices also increases. For example, the Pharma-Chem as well as Manu-Steel industries contain higher technology content or sophistication and showing higher adoption of Lean practices. The pharmaceutical industry mostly deploys batch production processes. Batch production processes are typically used to produce mostly standard product types Product development is quite rare and firms either reproduce already tested (elsewhere) products and/or make minor changes in the formulation to adapt existing recipes.. Besides, legal requirements of adopting clean-room and ISO standards result into better manufacturing practices. On the other hand, high technological content in the Manu-Steel industry makes it inevitable to deploy waste reduction processes, energy conservation, and safe working practices.

Export Orientation – higher the export orientation, higher the adoption of Lean practices. The export oriented Leather-Shoe firms in Pakistan has to deploy Lean management practices in order to stay competitive in the international markets. Pakistani firms are mostly engaged in Leather-Shoe manufacturing which is considered a fashion item. Thus, adoption of Lean practices is

important both for reducing costs and improving new product introductions. Similarly, the Textile sector being predominantly export-oriented focuses on new product developments.

Domestic competition – with improving wages and standards of living within the Pakistani society the need of better and more sophisticated products is increasing. Consumers want more value for money from any purchase they make. A significant increase in brands and retails store, in the last 5-8 years, belonging to textiles and shoe sectors manifests this trend. This trend is dictating the way the firms have set up their internal operations. Where there is relatively less competition and industry is monopolistic, firms have not adopted Lean practices, e.g. the meat sector.

Thus, based on these contextual variables the state of each sector can be explained as follows:

Textile sector – mature and high complexity industry; high export and domestic competition; and low to medium technology sophistication / content. Resultantly, there is a need for the industry to focus more on Lean practices. Especially, the supplier relationship management and productivity enhancement techniques for manufacturing processes. The sector has laid significant focus on new product development and shop floor management. It should be noted that this sector has come out of the quota regime in 2005 and it is only after that the firms started paying attention to the need for reducing their costs. One caution while interpreting results for this sector is that the study focused predominantly on weaving and apparel sectors.

Leather Shoe sector – mature and relatively less complex industry; high export and domestic competition; and low to medium technology sophistication / content. Given this context, the industry has focused on adopting Lean practices, as needed. The industry did not suffer from quota regime and focused on manufacturing excellence since early days. Efforts should be made to transfer learnings made in this sector to other industrial sectors.

Manufacturing Steel sector – relatively less mature and less complex industry; no export and medium to high domestic competition; and high technology content. In Pakistan, there is only one state-owned large steel mill followed by numerous small to medium sized steel mills owned by the private sector. The data is collected from these private sector medium sized firms. Given that criterion of competition is predominantly product-cost and quality, firms need to deploy Lean practices. To date, this sector's highest focus is on shop floor management and supplier management, the least focused area in the sector is manufacturing processes.

Pharma-Chem sector – relatively more mature and less complex industry; low exports and high domestic competition; and relatively high technology sophistication. In the past, the sector has mostly focused on me-too kind of products where the competition was based on cost. Owing to the low buying capability of public in general, doctors favored products that were relatively low priced and effective. Coupled with legal requirements of using clean-room technologies the firms laid high on workforce management as well as manufacturing processes. Firms laid lesser focus on R&D and new product development in the past. However, with growing export potential of

basic pharmaceuticals especially herbal products, firms have started to shift focus on new product development.

Meat sector – nascent and less complex industry; little/no exports and low domestic competition; and relatively low to medium technology sophistication. Being in the nascent stage of evolution, this sector requires improvements in all impact areas of Lean.

In summary the relatively lower adoption of Lean practices in the Textile sector that contributes the largest in the export portfolio of Pakistan is notable, the Textile sector needs to focus on areas where it is lagging so that it can continue to compete on the world stage. In the Leather-Shoe sector, a higher adoption of Lean practices signifies that the sector is developing and the learning thus gained need to be extrapolated onto the higher value added products sector within the leather industry. The Pharma-Chem sector has shown a higher degree of adoption of Lean practices in line with the maturity and growth of this sector as well as its potential for exports. The Manufacturing-Steel sector has largely been inward looking. In this sector Lean practices can enhance productivity and hence the competitiveness of the sector especially since a majority of the firms produce only commodity products. The Meat industry though in its nascent stage of modernization, needs to focus on Lean practices from the outset in order to create a competitive image in international markets.

These findings are useful for practitioners and academics alike. The detailed findings on each impact area of Lean management are useful for practitioners working in each sector. They can learn from better performing firms within and across industry sectors in order to improve their state. Thus, there is a significant room available for cross-industry learnings. Besides, industry-academia linkages can be developed for identification and implementation of best practices for specific industrial sectors. Similarly, government organizations such as Small to Medium Enterprise Development Authority (SMEDA) or National Productivity Organization (NPO) can be mobilized to develop industry specific programs of Lean implementation.

Academicians can follow a number of avenues for further research:

a. One stream of research for future could be to identify Lean management practices that can be cross-pollinated among sectors.
b. The second piece of research could focus on looking at the variances between sectors and identifying specific focus areas in the Pakistani context that have a greater impact on the performance of the firms in each sector.
c. Another avenue of research is to conduct a longitudinal study that would garner more in-depth information as to the rate of adoption of Lean practices and link them to the performance of firms.
d. Cross country studies (among developing countries) can be carried out in order to determine the factors that lead to greater and faster adoption of Lean practices.

This research is a snapshot on Lean implementation in the various industrial sectors in Pakistan. Leather-shoe and Pharma-Chem sectors are found to have adopted Lean practices more than Textiles, Manufacturing Steel, and Meat sectors. It is envisaged that a better understanding can be developed through a longitudinal study that would perhaps garner more in-depth information as to the rate of adoption of Lean practices and link them to the performance of firms. Similarly, there is a need to gather more in-depth information regarding sub-sectors within large industrial sectors such as textiles and leather manufacturing. Future research studies need to take these factors into consideration.

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Table 1 Industry Profiles[4][5][6][7][8][9][10][11][12]

Industry Type	% of GDP	% of Export	% of Industrial Labour Force Employed	% Of Foreign Direct Investment	Export Vs. Domestic Orientation
Textile and Apparel	8	55	40	0.67	Export and Domestic
Pharmaceuticals-Chemicals*	2.59	4.85	0.4	4.03	Predominantly Domestic
Auto and automotive (Manu-Steel)+	2.8	0.14	6.5	1.89	Predominantly Domestic
Leather and Shoe	4	5.03	0.37	0.13	Export and Domestic
Livestock (Meat)^	11.8	2.22	16.41	-	Predominantly Domestic

* Data for GDP and employment is only of pharmaceutical industry which is a part of chemical industry

^ The data is for the whole livestock sector that comprises dairy, meat and poultry

+ includes Manu-Steel sector

[4] http://www.sbp.org.pk/Ecodata/NIFP_Arch/index.asp

[5] https://www.kpmg.com/PK/en/IssuesAndInsights/ArticlesPublications/Documents/Investment-in-Pakistan2013.pdf

[6] http://www.tdap.gov.pk/tdap-statistics.php

[7] Total workforce data http://www.finance.gov.pk/survey/chapters_13/12-Population.pdf

[8] http://www.pitad.org.pk/Publications/28-Pakistan%20Trade%20Liberalization%20Sectoral%20Study%20on%20Leather%20Sector%20in%20Pakistan.pdf

[9] http://www.finance.gov.pk/survey/chapters_13/HGHLIGHTS%202013.pdf

[11] http://www.veterinaryhub.com/economic-survey-of-pakistan-livestock-sector-2013-2014/

[12] Economic Survey of Pakistan 2014-15

Table 2 Six impact areas in Lean Management*

Impact Areas	Lean manufacturing Principles and Practices	
	Doolen and Hacker (2005)	**Shah and Ward (2007)**
Manufacturing Equipment and Processes		Internally related
	Setup time Reduction Practices	
	Work Standardization	
	Cellular manufacturing	
	Mistake or error proofing	
	Value identification	
	Total productive maintenance	
	Shop floor organization	
	Total quality management	
	Cycle time reduction	
Shop-Floor Management		Internally related
	Production scheduling	
	Lot size reduction	
	Pull flow control	
New Product Development		
	Parts standardization	
	Concurrent engineering	
	Design for manufacturability	
Supplier Relationships		Supplier Related
	Supplier evaluation	
	Total cost evaluation	
	Information exchange	
	Long-term relationships	
Customer Relationships		Customer Related
	Delivery performance improvement	
	Demand stabilization	
	Service to enhance value	
	Customer requirements analysis	
	Product customization	
Workforce Management		Internally related
	Multifunctional workforce	
	Work delegation	
	Employee evaluation	
	Pay for performance	
	Formal reward system	

*Bhutta et al. (2013), *International Journal of Services and Operations Management, Vol. 15, No. 3. pp 338-357.*

Table 3 Average Scores of Industries in Impact Areas

Impact Areas	Textile	Leather-Shoe	Manu-Steel	Pharma-Chem	Meat	Overall Average
Customer Relationships	3.372	3.993	3.584	3.475	2.250	3.439
Manufacturing & Processes	3.358	3.875	3.575	3.857	2.350	3.486
New Product Development	3.450	3.819	3.585	3.404	1.583	3.433
Shop-floor Management	3.450	3.752	3.747	3.626	3.395	3.560
Supplier Relationships	3.225	3.685	3.615	3.628	2.354	3.409
Work Force Management	3.416	3.993	3.588	4.072	2.778	3.621
Grand Average	**3.376**	**3.859**	**3.612**	**3.712**	**2.454**	**3.495**

Table 4 Customer Relationships – Specific Focus Area Scores

Specific Focus Area	Textile	Leather-Shoe	Manu-Steel	Pharma-Chem	Meat	Overall Average	Overall StDev
Improve Delivery Performance	3.706	4.467	3.799	3.875	2.313	3.754	1.183
Stabilize Demand	3.058	4.000	3.549	3.267	2.867	3.234	1.302
Enhance Product Value	2.993	3.250	3.229	3.109	2.188	3.069	1.426
Collecting Customer Requirements	3.295	3.958	3.516	3.801	1.583	3.433	1.258
Product Customization	3.805	4.292	3.825	3.321	2.300	3.706	1.251

Table 5 Manufacturing Equipment and Processes – Specific Focus Area Scores

Specific Focus Area	Textile	Leather-Shoe	Manu-Steel	Pharma-Chem	Meat	Grand Average	Grand StDev
Setup Time Reduction	3.082	3.907	3.365	3.759	3.350	3.329	1.306
Work Standardization	3.740	4.389	4.155	4.692	5.000	4.112	0.994
Cellular Mfg. Implementation	3.266	3.667	3.787	3.770	1.833	3.292	1.365
Poke Yoke Implementation	3.852	4.250	3.984	4.288	3.200	3.939	1.017
V/NV Added Activity Analysis	3.003	3.419	3.122	3.323	1.333	3.047	1.306
TPM Implementation	3.331	4.142	3.220	3.783	2.000	3.366	1.275
TQM Implementation	3.041	3.500	2.920	3.428	2.036	3.053	1.323
5S Implementation	3.160	4.556	3.729	3.517	2.083	3.456	1.318
Cycle Time Reduction	3.655	3.917	4.029	3.896	1.667	3.757	1.123
Autonomation (Jidoka) Implementation	3.450	3.000	3.438	4.111	1.000	3.508	1.250

Table 6 Shop Floor Management – Specific Focus Area Scores

Specific Focus Area	Textile	Leather-Shoe	Manu-Steel	Pharma-Chem	Meat	Overall Average	Overall StDev
Production Scheduling Improvement	3.578	4.533	3.797	3.815	3.280	3.720	1.236
Use of Visual Controls (Andon)	3.754	3.667	3.794	3.603	4.300	3.828	1.272
Use of Smaller Lot Sizes	3.450	3.725	3.958	3.250	N.I.	3.548	1.180
Imp. of Nagara System	3.333	3.000	3.489	3.879	1.000	3.429	1.124
Use of Integrated Flow Operations	3.125	Data N/A	Data N/A	Data N/A	Data N/A	3.125	0.927
Pull Flow Control Imp.	3.459	3.833	3.694	3.585	5.000	3.710	1.239

Table 7 New Product Development – Specific Focus Area Scores

Specific Focus Area	Textile	Leather-Shoe	Manu-Steel	Pharma-Chem	Meat	Overall Average	Overall StDev
Imp. of Parts Standardization	3.232	3.733	3.843	3.400	1.500	3.404	1.253
Imp. of Concurrent Engineering	3.884	4.500	3.565	3.700	2.250	3.746	1.073
Use of Design for Manufacturability (DFM) Principles	3.233	3.222	3.346	3.111	1.000	3.150	1.215

Table 8 Supplier Relationships – Specific Focus Area Scores

Specific Focus Area	Textile	Leather-Shoe	Manu-Steel	Pharma-Chem	Meat	Overall Average	Overall StDev
Supplier Evaluation	3.181	4.144	3.881	4.313	2.200	3.619	1.278
Use of total cost analysis in supplier evaluation	3.606	3.417	3.777	3.594	3.000	3.611	1.246
Exchanging information with suppliers	3.179	3.722	3.794	3.419	2.800	3.416	1.370
Establishing Long Term Partnerships with Suppliers	2.933	3.458	3.009	3.188	1.417	2.987	1.312

Table 9 Work Force Management– Specific Focus Area Scores

Specific Focus Area	Textile	Leather-Shoe	Manu-Steel	Pharma-Chem	Meat	Overall Average	Overall StDev
Imp. of Worker Cross Training	3.060	3.875	3.240	4.141	1.917	3.358	1.261
Delegating Decisions to Lowest Level Possible	3.399	3.889	3.511	3.619	2.444	3.506	1.139
Imp. of a Formal Employee Evaluation System	4.370	4.500	4.583	4.706	5.000	4.533	0.502
Use of a Formal Performance Related Pay System	2.835	3.708	3.019	3.824	1.750	3.088	1.247

Table 10 Implementation Percentages of the Lean Principles by Industry

ID	Specific Focus Area	Overall Percent	Textile	Leather-Shoe	Manu-Steel	Pharma-Chem	Meat
Q1	Setup Time Reduction	94%	95%	100%	93%	94%	80%
Q2	Work Standardization	96%	98%	100%	90%	100%	100%
Q3	Cellular Mfg. Implementation	46%	40%	50%	59%	41%	40%
Q4	Poke Yoke Implementation	69%	74%	67%	55%	71%	100%
Q5	V/NV Added Activity Analysis	74%	58%	100%	79%	94%	80%
Q6	Total Preventive Maintenance Implementation	90%	93%	100%	86%	88%	80%
Q7	Total Quality Management Implementation	78%	77%	100%	72%	76%	100%
Q8	5S Implementation	66%	56%	100%	69%	71%	80%
Q9	Cycle Time Reduction	75%	67%	67%	79%	94%	60%
Q10	Autonomation (Jidoka) Implementation	50%	53%	17%	55%	53%	20%
Q11	Production Scheduling Improvement Efforts	98%	100%	100%	93%	100%	100%
Q12	Use of Visual Controls (Andon)	67%	60%	67%	69%	71%	100%
Q13	Use of Smaller Lot Sizes	54%	58%	83%	45%	65%	0%
Q14	Implementation of Nagara System	48%	42%	67%	48%	65%	20%
Q15	Use of Integrated Flow Operations	7%	16%	0%	0%	0%	0%
Q16	Pull Flow Control Implementation	57%	56%	100%	41%	59%	100%
Q17	Implementation of Parts Standardization	65%	72%	83%	59%	59%	40%
Q18	Implementation of Concurrent Engineering	56%	51%	83%	59%	59%	40%
Q19	Use of Design for Manufacturability (DFM) Principles	45%	47%	50%	48%	35%	40%
Q20	Supplier Evaluation	87%	77%	100%	93%	94%	100%
Q21	Use of total cost analysis in supplier evaluation	87%	74%	100%	97%	94%	100%
Q22	Exchanging information with suppliers	88%	88%	100%	79%	94%	100%
Q23	Establishing Long Term Partnerships with Suppliers	92%	91%	100%	97%	94%	60%
Q24	Striving to Improve Delivery Performance	92%	88%	100%	97%	94%	80%
Q25	Strive to Stabilize Demand	77%	60%	50%	97%	88%	100%
Q26	Strive to Enhance Product Value	87%	77%	100%	97%	94%	80%

Q27	Collecting Customer Requirements	86%	86%	100%	83%	94%	60%
Q28	Product Customization	77%	91%	100%	69%	41%	100%
Q29	Implementation of Worker Cross Training	78%	67%	100%	83%	94%	60%
Q30	Delegating Decisions to Lowest Level Possible	54%	53%	100%	52%	41%	60%
Q31	Implementation of a Formal Employee Evaluation System	82%	81%	100%	79%	100%	20%
Q32	Use of a Formal Performance Related Pay System	71%	63%	100%	72%	94%	20%
Q33	Use of a Formal Reward System	70%	63%	100%	72%	88%	20%
Q34	Strive to Improve the Culture for Acceptance of Lean Principles	94%	95%	100%	90%	100%	80%

Figure 1 Average Impact Area Scores by Industry

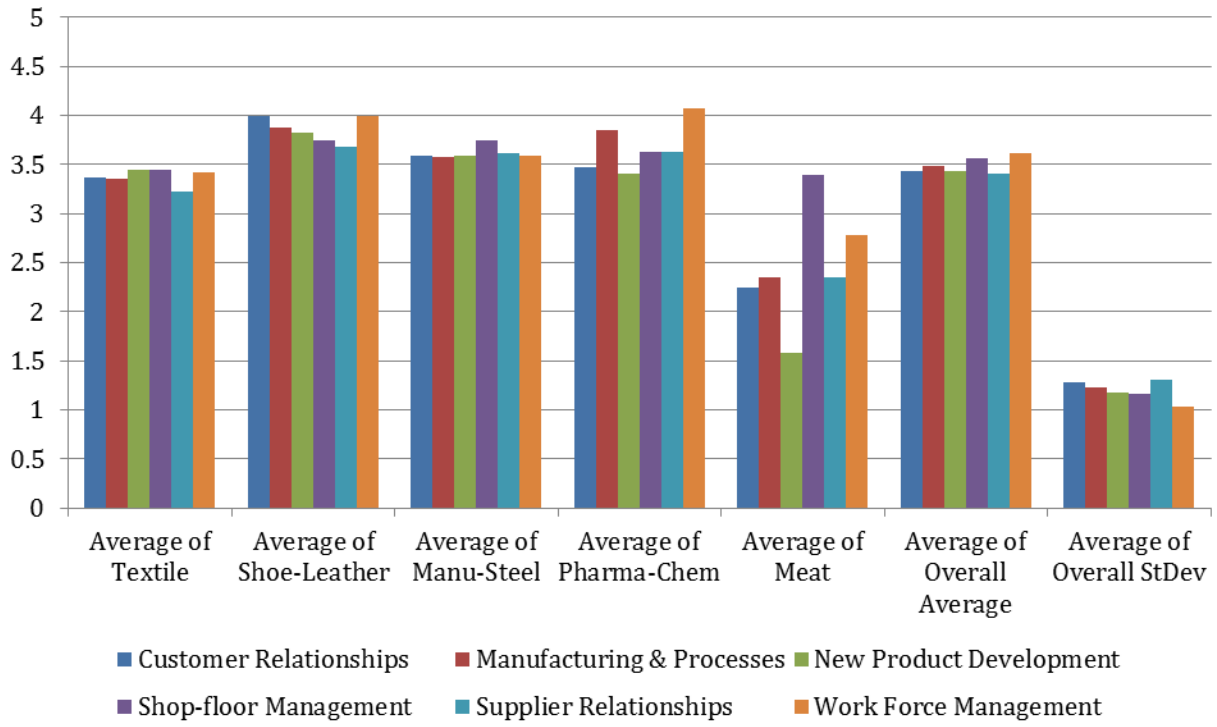


Figure 2 Average Scores of Industries by Main Focus Areas

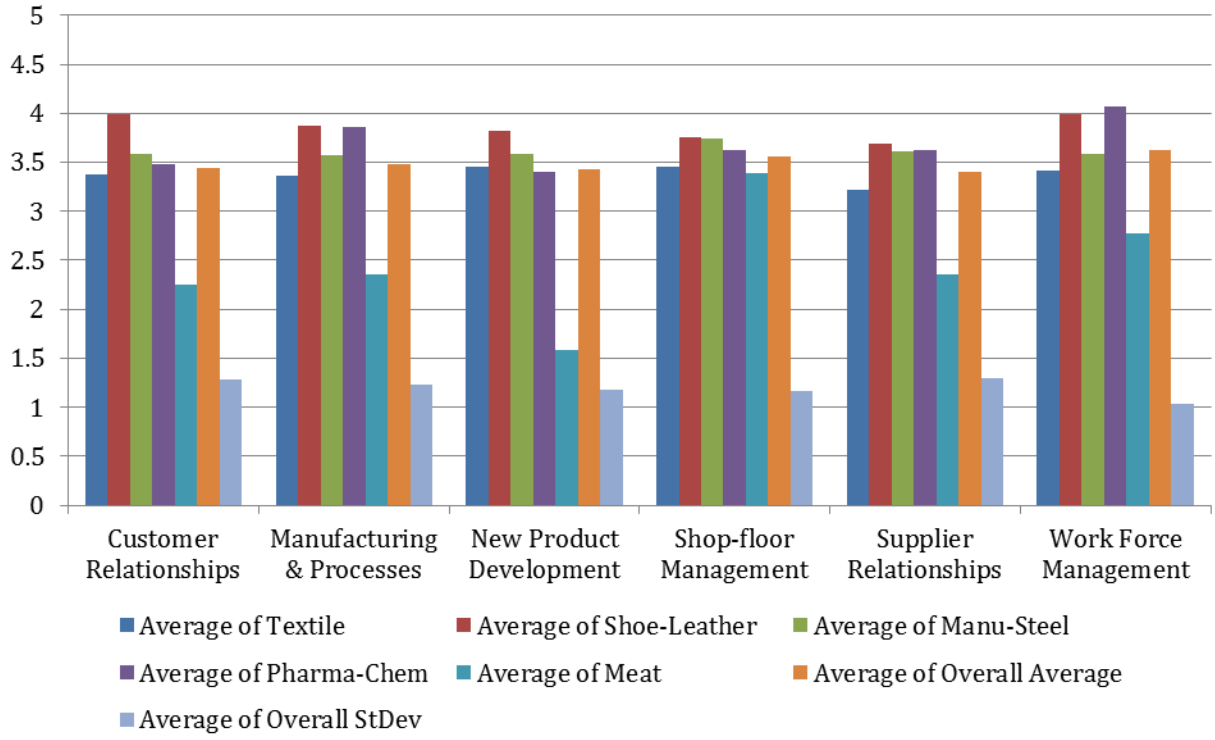
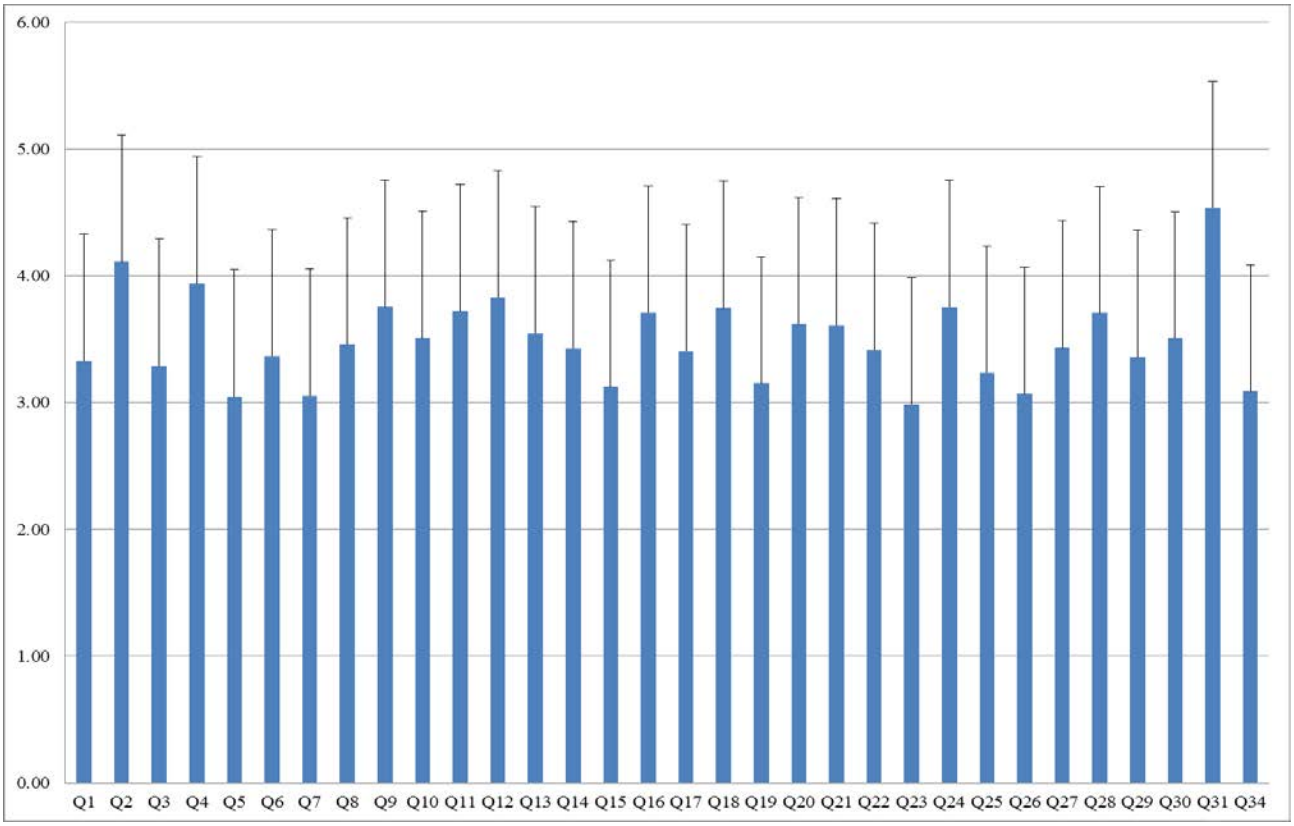


Figure 3 Averages by Focus Area



Appendix: Survey Questions and Measurement Scales

ID	Main Focus Area	Specific Focus Area	Measurement Method
1	Manufacturing & Processes	Setup Time Reduction	Likert Scale
2	Manufacturing & Processes	Work Standardization	Likert Scale
3	Manufacturing & Processes	Cellular Mfg. Implementation	Likert Scale
4	Manufacturing & Processes	Poke Yoke Implementation	Likert Scale
5	Manufacturing & Processes	V/NV Added Activity Analysis	Likert Scale
6	Manufacturing & Processes	Total Preventive Maintenance Implementation	Likert Scale
7	Manufacturing & Processes	Total Quality Management Implementation	Likert Scale
8	Manufacturing & Processes	5S Implementation	Likert Scale
9	Manufacturing & Processes	Cycle Time Reduction	Likert Scale
10	Manufacturing & Processes	Autonomation (Jidoka) Implementation	Likert Scale
11	Shop-floor Management	Production Scheduling Improvement Efforts	Likert Scale
12	Shop-floor Management	Use of Visual Controls (Andon)	Likert Scale
13	Shop-floor Management	Use of Smaller Lot Sizes	Likert Scale
14	Shop-floor Management	Implementation of Nagara System	Likert Scale
15	Shop-floor Management	Use of Integrated Flow Operations	Likert Scale
16	Shop-floor Management	Pull Flow Control Implementation	Likert Scale
17	New Product Development	Implementation of Parts Standardization	Likert Scale
18	New Product Development	Implementation of Concurrent Engineering	Likert Scale
19	New Product Development	Use of Design for Manufacturability (DFM) Principles	Likert Scale
20	Supplier Relationships	Supplier Evaluation	Likert Scale
21	Supplier Relationships	Use of total cost analysis in supplier evaluation	Likert Scale
22	Supplier Relationships	Exchanging information with suppliers	Likert Scale
23	Supplier Relationships	Establishing Long Term Partnerships with Suppliers	Likert Scale
24	Customer Relationships	Striving to Improve Delivery Performance	Likert Scale
25	Customer Relationships	Strive to Stabilize Demand	Likert Scale
26	Customer Relationships	Strive to Enhance Product Value	Likert Scale
27	Customer Relationships	Collecting Customer Requirements	Likert Scale
28	Customer Relationships	Product Customization	Likert Scale
29	Work Force Management	Implementation of Worker Cross Training	Likert Scale

30	Work Force Management	Delegating Decisions to Lowest Level Possible	Likert Scale
31	Work Force Management	Implementation of a Formal Employee Evaluation System	Yes/No Question
32	Work Force Management	Use of a Formal Performance Related Pay System	Yes/No Question
33	Work Force Management	Use of a Formal Reward System	Yes/No Question
34	Work Force Management	Strive to Improve the Culture for Acceptance of Lean Principles	Likert Scale
35	Work Force Management	The Number of Employees (<10, 10 to 49, 50-99, >99)	Categorical Selection
36	Work Force Management	The Drivers of Starting Lean Implementation	Open-ended question
37	Work Force Management	Challenges Faced During the Lean Implementation	Open-ended question
38	Work Force Management	The Annual Sales (in Rupees)	Quantitative Question
39	Work Force Management	Having plan to make expansion in facilities in the next 3 yrs	Yes/No Question
40	Work Force Management	Have sales been increasing over the past year	Yes/No Question
41	Work Force Management	Description of the end product or service	Open-ended question
42	Work Force Management	Title of the Participant	Open-ended question
43	Work Force Management	Experience of the Participant in the Organization (yrs)	Quantitative Question
44	Work Force Management	Functional Area(s) of the Participant at Work	Categorical Selection
45	Work Force Management	The Industrial Sector of the Organization	Categorical Selection