

Identification of the Barriers in Implementation of Lean Principles in Iranian SMEs: Case Study Approach

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Abstract

The manufacturing sector is considered to be a cornerstone in the global economy through its influence on areas such as mining and construction in upstream and warehousing and transportation in downstream. Despite having a rich literature concerning the application of lean principles in the large companies, the number of studies related to SMEs is relatively limited and a lot of essential problems and areas are largely untouched in academic research. This paper aims to identify the main barriers in implementation of lean manufacturing principles in Iranian SMEs. In order to do so, case study approach was selected and 9 in-depth interviews were conducted in various industrial sectors such as electrical equipment, industrial machinery and automotive part supplier. As a result the main barriers were classified into four categories namely, lack of top management support, financial capability, lack of employee's skill and expertise and organizational culture. Accordingly a guideline was developed that can be adopted to address the aforementioned barriers and reduce their costs by adopting the lean principles.

Index terms— Lean manufacturing, lean thinking, Iranian SMEs.

1 I. Introduction

The manufacturing sector has been playing a critical role in developing and advancing the world. This is evident as the developed countries such as USA, Germany and the UK, are planning to win back their manufacturing sectors from low cost countries (Moradlou and Backhouse 2016a; Moradlou et al. 2017). It is considered to be a cornerstone in the global economy through its influence on areas such as mining and construction in upstream and warehousing and transportation in downstream. This has resulted in various challenges to develop new approaches to maximize the production efficiency in terms of cost, quality of the products, required resources, environmental impacts and many others described by Liker (2004). The emphasis for perfection in manufacturing operations has been evolving throughout history. As the time passes, with the aid of advanced technologies, the lean manufacturing techniques have gained considerable popularity among the Iranian industries to boost productivity, effectiveness, responsiveness and the quality of the product. This is further emphasized as the Iranian industries are trying to attract foreign investment in manufacturing sector after the economic sanctions being removed in 2015 (Dyer and Bozorgmehr 2016).

It is concluded from the available literature that the lean and techniques are theoretically applicable in all industries and has proven their success in practice specifically in large organizations (Rose et al., 2011). Despite having a rich literature about the applicability of the lean tools in large companies and the importance of these production philosophies in SMEs, it is evident that there is still a gap existing in the current knowledge to provide a classification of tools that enables the SMEs to adopt these two approaches. Due to the dearth in the available literature and the lack of emphasis within the industries, lean manufacturing concepts have not been widely introduced to the Iranian SMEs, hence the advantages of such production philosophies are not fully appreciated within the Iran's business environment. Consequently it can be seen that the number of manufacturing SMEs

44 are gradually decreasing in the Iran's manufacturing sector regardless of their substantial influence in the overall
45 economy of the country and being shifted to the countries that offer lower production costs similar to the off
46 shoring trend in developed countries (Moradlou and Backhouse 2014; Moradlou and Backhouse 2016b).

47 One of the reasons behind this is that the SMEs are considered to be relatively vulnerable to the new entrants
48 in the market therefore their market share can be easily replaced by other competitors. In addition the lean
49 manufacturers at the head of supply chain tend to start the business with the suppliers who are capable of
50 aligning their processes to comply with lean manufacturing. This is due to the lack of production strategies such
51 as lean systems in the case of facing a turbulent business environment and inadequate knowledge about the lean
52 principles for the cost reduction and effective production (Achanga et al., 2006).

53 2 II. Literature Review

54 The challenge for cost reduction in manufacturing sectors have prompted the majority of the companies regardless
55 of the business size, to adopt the lean manufacturing system to boost their competitiveness in the intensified global
56 market. According to Hogg (2008), lean is "a mindset, or way of thinking, with a commitment to achieve a totally
57 wastefree operation that's focused on your customer's success. It is achieved by simplifying and continuously
58 improving all processes and relationships in an environment of trust, respect and full employee involvement.
59 It is about people, simplicity, flow, visibility, partnerships and true value as perceived by the customer". A
60 comprehensive definition for the non-value added processes "wastes" was given by Russell & Taylor (1999) as
61 follow: "anything other than the minimum amount of equipment materials, parts, space, and time that are
62 essential to add value to the product".

63 According to Womack et al., (1990), the main objective in the implementation of lean techniques is to design
64 a system with a smooth process, which enables the companies to manufacture world-class quality products and
65 services to satisfy the customer demand while eliminating wastes. In order to achieve that, it is important for the
66 companies to recognize the wastes associated with their manufacturing systems. To simplify this task, Shingo
67 (1992) established the concept of seven deadly wastes. This identifies seven different categories of manufacturing
68 wastes as follow: overproduction, over-processing, transportation, inventory, motion, defects and waiting time.
69 Further indication was given by Ohno about the overproduction to be the most important waste among the other
70 nonvalue added activities since it ultimately leads to excessive inventory in the operations downstream (Liker,
71 2004). Womack et al., (1990) claimed that it is the employees that determine the level of leanness within the
72 companies and they can be considered to be the heart of the lean organization. This emphasizes the importance of
73 sharing the lean knowledge among the employees of all levels which results in their participation and contribution.
74 This can ultimately result in lean culture within the organization, which is considered to be a crucial challenge
75 for management (Worley & Doolen, 2006).

76 Despite having a rich literature concerning the application of lean principles in the large companies, the
77 number of studies related to Iranian SMEs is relatively limited and a lot of essential problems and areas are
78 largely untouched in academic research. Zhou (2012) has stated that the failure in implementation of the lean
79 programs are due to the style of the management or people related factors as well as the key knowledge and
80 know-how. Correspondingly Achanga et al., (2006) believes that there is a connection between management
81 styles and the company outputs such as the lead-time, number of employees and the return on investments
82 (ROIs). He argued that the main lean barriers are not tools and technologies, but the lack of appreciation
83 and provisions from middle and senior management. This can be also found in the study done by Moradlou and
84 Asadi (2015) where top management is one of the key reasons behind the management of SMEs in a fluctuating
85 environment. This is while Salaheldin (2005) claims that the lack of skilled resources for implementing the lean
86 practices is the main obstacle for SMEs to be lean. However Shah and Ward (2003) believe that the main obstacle
87 in implementation of lean tools, is considered to be the size of the organization. This was further emphasized
88 through particular suggestion that not all Just In Time (JIT) practices can be a suitable solution to be applied
89 in SMEs (Shah & Ward, 2003). Cusumano (1994) also studied the feasibility of the lean implementation in
90 SMEs but in his studies, he concluded that the product variety could be the major consideration that leads to
91 an unsuccessful lean implementation for any company (Cusumano, 1994)

92 3 III. Methodology

93 For the purpose of this investigation, qualitative data collection method was nominated since this technique
94 offers a range of benefits in this instance (Klein & Myers, 1999). These types of research enable to gather in
95 depth information about the human behavior and their justifications. It also determines the reason behind any
96 decision-making (why and how) as well as the time and location of each decision. Therefore one of the advantages
97 of qualitative research is that it allows discovering the reason for any failure or success in implementation of lean
98 programs. Another advantage of this technique is its flexibility according to the types of the industries being
99 studied (Patton, 1990). It should be noted that according to Akhoondi & Morshedi (2012) the companies having
100 less than 100 employees fall into the SME category in Iran whereas this number is different in other countries.

101 In order to undertake the interviews, an openended questionnaire was used in 9 different companies in Iran.
102 Table 1 provides the demographic information of the companies that were visited and interviewed. This approach
103 has been recommended by various authors such as Ribeiro & Fernandes (2009) and Powella et al., (2013) who have

104 carried out similar studies to this investigation. Planning an exploratory interview questions can only be achieved
105 after obtaining a good understanding of the recent literature about the lean techniques and the relevant tools that
106 supports their objectives. It is also essential to discover their functionalities within different industries (electronic,
107 food, etc.), meanwhile to gather adequate knowledge about the Small and Medium Enterprises in Iran. For the
108 purpose of this investigation the interview questions contains only basic terms. It was found that the SMEs tend
109 to have limited knowledge about the technical terms used in the lean manufacturing principles. Therefore to
110 minimize the misinterpretations the generalized questions were asked to cover wider areas and the results were
111 then extracted from the recorded or written documents during the interviews. The data gathering addresses the
112 questions about the lean techniques and how the companies approach the design changes and respond to the
113 demand fluctuation. It also questions to what extent the companies manufacture customized product and the
114 possible barriers in implementation of lean manufacturing.

115 4 IV. Findings

116 After performing a qualitative data analysis based on interviews and visiting 9 different organizations in Iran,
117 the following observations were drawn to provide an in-depth understanding of the barriers in implementation
118 of lean programs in Iranian SMEs and to facilitate the identification of a general solution for companies to
119 adopt lean principles. Hence, in order to analyze the interviews it is essential to assess the company's level
120 of understanding about the lean principles. One way to do this is to question the number of years that these
121 companies have employed lean practices within their systems. As a result, the targeted companies were divided
122 into two categories. The first category was the companies that had no previous knowledge about the lean
123 techniques therefore did not have any desire on implementation of lean programs. These companies appeared to
124 have a limited understanding of any tangible and intangible advantages gained by lean production. The results
125 show that only four companies out of the nine companies could be allocated in this category. The second category
126 was the organizations that have established a clear understanding of the lean concept or have already attempted
127 on adopting the principles to reduce their production cost and improve their line efficiency. This category consists
128 of mainly the medium sized enterprises due to the size of the organization and the importance of maintaining a
129 low cost production. Consequently the remaining five companies were included in the second classification, which
130 represent the majority of the companies selected for the purpose of this investigation. The result shows that the
131 medium size companies visited, have all taken the first steps towards development of leanness however they have
132 experienced a range of barriers in different aspects.

133 According to the results obtained, the second categories of companies described above, adopt lean principles
134 due to variety of reasons. The most important factor, which was shared by almost all of the companies, was
135 the reduction in cost to improve the profit margin. Other factors such as improvement in space utilization in
136 the factory, improvement in the product quality, reduction in lead-time, reduction in the manpower required,
137 improvement in the competitive position within the market, reduction in the inventory and improvement of the
138 collaboration with their suppliers were also taken into account.

139 After accomplishing nine interviews from different industries, the reasons for the failure in implementation of
140 the lean practices in Iran were classified into four fundamental categories which appear to be consistent with
141 the research available in the literature suggested by the researchers such as Achanga et. al., (2006) and Zhou
142 (2012). Figure 1 highlights these four reasons which are the lack of top management support for implementing lean
143 programs, financial capabilities of the organisation, skills and expertise of the employees and finally the culture of
144 the organisations that plan to implement the lean practice. Management contribution and provision is considered
145 to be one of the biggest challenges in successful implementation of lean practises. A large number of SMEs fail to
146 achieve lean objectives due to the lack of providing appropriate support and foundation for lean programs. One
147 of the major tasks that the managers do not perceive as one of their core responsibilities, is the encouragement for
148 employee participation. In other words, members of the organisation were not involved in the improvement of the
149 processes. This was observed as one of the managers stated: "In our company the decision making processes are
150 carried out among the top managers and then are introduced to the line personnel" (Manufacturer 3) According
151 to the interviews, seven companies experienced the fact that their production managers did not establish a clear
152 communication with the employees to introduce the vision and the strategy of their production. Therefore there
153 was a lack of commitment on training other members of the organisation to enhance the skills and experties
154 among the workforce. Due to the nature of lean principles, continues improvement in production processes is
155 required to be achieved by the managers in order to prevent backsliding to the old ways of operation.

156 5 b) Financial capabilities

157 Another critical obstacle in the implementation of lean principles is found to be the financial and resource
158 constraints that SMEs face when investing in lean programs. This ultimately prohibits the companies to hire
159 their ideal management team and consultant for the training required for lean practices and leads to a poor system
160 implementation. This is due to the nature of the small and medium size companies (number of employees and
161 annual turnover). It should be noted that the lean manufacturing tools require company's financial capabilities.
162 In order to support the system and its activities, every company is required to dedicate the implementation cost.
163 Moreover there is a substantial variation in capital required according to the purpose of each tool. In addition

7 E) GUIDELINE FOR IMPLEMENTING LEAN PRINCIPLES

164 to the capital required for each tool, there is a cost for the consultancy and training. The reason behind this
165 is that the majority of small companies are incapable of transforming their organization towards leanness and
166 require external consultants who can provide the necessary knowledge about different techniques and educate
167 their employees.

168 Another factor related to the finance was discovered to be the resistance of the companies towards dedicating
169 extra capital on process improvement. This was observed when six interviewees stated that they could not afford
170 the cost of implementing lean tools in specific occasions such as long-term strategies and they would prefer to focus
171 on cost saving activities rather than any other additional costs on processes. In addition to this, three companies
172 believed that any cost dedicated to training and consultancy is considered to be loss of resources and can be used
173 for alternative purposes such as purchase of raw material. The following quotation is from a managing director:
174 "We already have high demand for our products and we don't see the necessity for further training, so any
175 extra capital we get are spent on buying the material required for our production" (Manufacturer 7) Due to the
176 financial incapability, it was found that all the targeted companies in this investigation have a tendency to employ
177 highly skilled yet cost efficient personnel. Consequently these employees do not have sufficient background about
178 lean principles. Therefore this is considered to be a hindrance to the implementation of competitive technologies
179 for improving productivity and flexibility. This appeared as the small companies intend to carry on with the
180 traditional production method as long as they can sustain their businesses.

181 It was also observed that one of the most critical triggers in unsuccessful lean programs is the lack of training,
182 education and technical knowledge. In other words being unable to provide the appropriate form of training for
183 each and every one in order for them to be able to do their job properly (Shibani et al., 2012). This fact would
184 create obstacles, which prevents the development of lean programs. It was found that these barriers emerge in
185 different formats. The first problem can appear in terms of inadequate knowledge about the lean in employees
186 resulting in confusion on the program and not fully acknowledging the benefits. This ultimately contributes
187 to the employee resistance since they are not directly involved in the planning and implementation phases of
188 leanness (Haupt & Whiteman, 2004). Therefore lack of training has a substantial influence on the participation
189 of the employees in decision-making.

190 "According to my experience as a line manager in this company, the new employees come with limited
191 background about lean tools therefore it requires a substantial effort to teach them what lean actually means
192 and what its benefits are" (Manufacturer 1) Another issue caused by inadequate training was observed in terms
193 of absence of work discipline. This is due to the inappropriate division of the tasks in the organization, which
194 determines the contribution of the employees to the lean program. Since the implementation of the lean principles
195 should be carried out in a team, it is important to keep the team members motivated by introducing the benefits
196 of the program and clearly defining the aims and objectives of the lean methodology. So the employees are
197 familiarized with the lean concept, which leads to further collaboration of team members.

198 6 d) Organisation culture

199 The establishment of an appropriate organizational culture is another crucial element in lean implementation.
200 This provides a suitable platform for a better collaboration in a diverse environment. This enhances the
201 importance of the management roles in overcoming the conflicts in organizations. The responses from the
202 interviews emphasize that it is important to understand people growing up in different environment and
203 background would ultimately have different cultures. This is also considered to be another potential factor
204 caused by insufficient training, which leads to the failure in lean implementation since it determines the way
205 people deal with the conflicts. The resistance to changes would be substantial if there is particularly deep-seated
206 culture (Ngowi, 2000). The provision of insufficient training and uncertainty about the lean benefits can have a
207 demotivating outcome on the members of the organizations. This is also supported by other researchers such as
208 Achanga et al., (2006) who have also suggested that the absence of an appropriate organizational culture have
209 negative effects such as employee resistance to changes and lack of focus on their long-term roles.

210 7 e) Guideline for implementing lean principles

211 In order to promote the lean thinking within an organization and fully employ the lean techniques, companies
212 are required to undergo significant cultural transformation which can be achieved over the years. But there are
213 number of critical success factors that should be adopted to facilitate the lean implementations in short term. This
214 study attempts to address the main reasons that the SMEs in Iran fail to adopt lean manufacturing techniques and
215 emphasizes on the key criteria to establish a suitable platform for leanness. In this section of the paper, a series of
216 recommendations are included as a guideline for the industries to remain competitive and healthy in the business
217 by applying lean tools. According to the literature, the SMEs are incapable of applying all the techniques at the
218 same time therefore they are recommended to approach sequentially in order to avoid any difficulties in terms of
219 finance and employee's commitments (Rose et al., 2011). As a result of this investigation, the outcome can be
220 classified into two categories. The first category emphasizes on providing a suitable environment to accelerate the
221 productivity, efficiency and the quality improvement in products and services while the second category includes
222 a set of tools that are the most feasible to be applied in SMEs.

223 8 f) Creating a lean environment

224 As it was mentioned before, despite the fact that the top management plays an important role in implementation
225 of the lean principles, the entire population of the organization should undertake the responsibility of participation
226 and commitment to their tasks. These responsibilities are for all the members of the organization from the line
227 personnel such as the technicians, operators and shop floor workers to the vice presidents and senior manager.
228 Hence the lean culture is a vital element of leanness and is considered to be the most challenging task in initial
229 phases of lean implementation (Zhou, 2012).

230 Cultural changes take time; it cannot be accomplished overnight or in a few weeks. In order to prevent the
231 risk of the failures in the lean implementation, two approaches are suggested to provide the essential background
232 about the program and its applications in the organization and train the team for the continues improvement.
233 The first method is the formal training. This can be achieved by commissioning a leading consulting group that
234 can educate the managing directors and teach them the key elements in execution of the lean programs. Their
235 knowledge can ultimately be used to provide the sufficient technical material for the rest of the organization. This
236 method tends to be an easy solution in the small organizations since it has fewer layers of management and staff
237 (Ghobadian & Gallear 2001). However this can be a great disadvantage for the small companies in term of the
238 significant requirement for financial support. An alternative approach for training is the informal guidance. One
239 way to achieve this is to display information about lean tools on the company's bulletin board. This information
240 can be gradually observed by the members of organisations since it is always available and can be easily updated
241 every month. The training provided by the organisations can take two forms. In the first method the principle
242 of the lean manufacturing and training are delivered. This can familiarise the team members with the concept
243 of leanness. Then further training can be subjected in terms of preparation exercise for the members to face and
244 address the problems by adopting lean tools and techniques. To do so, examples from real life problems can be
245 introduced (Kassieh & Yourstone, 1998; Amar & Zain , 2002).

246 As a result of the training methodologies mentioned above, the organisation members would be encouraged to
247 undertake more responsibilities, develop their creativity skills, be innovative, improve their communication skills
248 and work effective. According to Tenner and DeToro (1992) "Education and training provides the knowledge
249 needed on the mission, vision, direction, and strategy of the organization as well as the skill need to secure quality
250 improvement and resolve problems".

251 As part of the management responsibilities and cultural platform, it is important to ensure a no-blame
252 environment within the company. In such an environment the mistakes are approached as an opportunity to learn
253 more about the elimination of the potential causes. This is achieved by establishing a close relationship between
254 the managers and the workers. It is important to have in mind that the mistake can frequently occur and are
255 part of the facts in all employees work life. Hence in the case of any failure in the processes, pointing at people
256 should be avoided. Managers should also ensure a regular conversation with the employees involving questioning,
257 listening, observing and judging, to boost their self-esteem. This is done by arranging regular meetings to allow
258 people to share their assignments and achievements. In order to ensure an effective participation in every meeting,
259 firstly the aims and objectives of that meeting should be clearly communicated and then the time frame and
260 agenda should be mutually agreed with other members of the organization. Moreover after every meeting a
261 summary of activities that are required to be carried out until the next meeting can be obtained highlighting
262 critical tasks.

263 Another key element that needs to be considered is to provide a clear vision when starting any process
264 improvement program. According to Covey (1989), to establish an understandable vision, the following
265 characteristics should be taken into account. It should After adopting a suitable management style and
266 organizational culture, the next task is to select the feasible tools and techniques that can be applied in SMEs
267 regardless of their size and financial capabilities, which is included in the following section.

268 9 g) Applicable lean tools in SMEs

269 Due to the limited budget available within SMEs, these companies are cautious in the investments regarding
270 the productivity, efficacy and quality improvement programs. This has reduced the range of tools available
271 for the SMEs. In this section of the paper some tools are recommended as feasible examples to be applied in
272 Iranian SMEs that are already in operation. This can encompass the factory layout design process. Layout
273 design process for a production line involves determination of the physical relationship between workstations or
274 equipment and identification of the tasks, which need to be allocated in each of them (Arostegui et al., 2006).
275 Thus it is an essential task to define a close relationship between product design, process design, schedule design
276 and layout design while designing a factory plant. Therefore this allows obtaining the optimum design, which
277 would minimize the material handling cost and time. At present different types of layout designs can be adopted
278 in production lines according to nature of the production. In other words these layouts are selected or combined
279 as a hybrid layouts based on system characteristics such as production volume and product mix. These layouts
280 are fixed position layout, functional layout (job shop and process layout), cell layout (group technology) and
281 product layout, which is also called flow shop layout (Askin & Standridge, 1993). Note that by this stage, some
282 of the most essential lean tools should be applied

283 ? Be instigated by the managers ? Be inspiring and positive to motivate the team members ? Include adequate
284 level of details and be easy to understand ? Be shared among the group members ? Be concise and easy to

remember as part of factory layout design. For instance, tools such as cell layout pull system, Kanban systems, one-piece flow and poka-yoke can be taken into account from the early stages of designs. Once the mentioned considerations are taken into account the following recommendations can be applied in an already operating organization to increase the production efficiencies, productivity and quality.

As a suggestion for initial step towards leanness, one would recommend the lean consideration during the product design stage. According to the National Research Council Canada (2004), the consideration of lean principles at product design stage can reduce the problems caused during the production up to 92%. In order to do so, firstly the designers should attempt to minimize the complexity of the product in order to reduce the waste created in manufacturing stage. Another important step towards leanness is to standardize the components used in the products to ensure the reusability of the parts in different products. This strategy can be also employed in system architecture and factory layout design to allow mass customization downstream of the production. It is also important to build the quality in products during the design phase. One method used for this is six-sigma methodology.

After applying the lean principles in the design phase, various lean tools can be recommended according to their purpose. Note that these recommendations are based on the existing literature and data collected during the interviews. It appears that some of these tools have already been applied within the case studies selected in this investigation (medium size companies) and have proven to be successful such as work place organization 5S systems and process mapping. It was found that the 5S system is the most suitable tool to be applied in SMEs as a starting point in lean programs. However according to the literature, mapping the value stream is considered to be the primary tool to be used (National Research Council Canada, 2004). The reason for employing the 5S prior to the value stream mapping is due to the simplicity and the low investment required for its application. This ultimately provides a clean and standardized environment within the company in which the non-value adding activities can be easily identified and eliminated. After applying 5S systems to a satisfactory level, value stream mapping can be initiated. This tool allows the company to develop a clear image of the value stream and identifies the potential bottlenecks that are likely to occur within the processes. This can be achieved using various methods such as the process activity mapping, supply chain response matrix, production variety funnel, quality filter mapping, demand amplification mapping, decision point analysis, and physical structure volume and value (Taylor & Brunt, 2001).

Consequently the non-value adding activities are identified. This can also be achieved using quality circle, which is a group of employees that work together under the supervision of their leader to identify and solve the issues related to the manufacturing processes and report them to the organisation management to overcome and improve the production performance. One of the non-value adding activities, which were found to be the most common among the visited companies, was the excessive material handling and the set up time. In order to reduce such inefficiencies, it is important to list every set up required during the production and measure the times spent on each of them. Moreover the external and internal setup times should be identified. After doing so, the internal setups can be converted to external ones. The overall reduction can be illustrated using the setup reduction graph, which compares the result before and after applying the setup time reduction tool.

Another critical aspect in lean manufacturing is the ergonomic and the health and safety of the workplace. The principal aim of the ergonomic is to provide a suitable condition for the staff in their working environment. This would depend on the characteristics of the employees and the area that they work in. Therefore in any of workstation within the production line, it is important to ensure that any unnecessary movements are prevented by keeping the handling range as short as possible. This would result in increase in productivity of the employees since it avoids fatigue in the work place (ITEM, 2010).

10 V. Conclusion

This investigation was undertaken to assess the applicability of the lean manufacturing techniques within Iranian SMEs and identify the potential barriers for implementation of these tools. The findings suggest that in general, the lean manufacturing tools are not fully developed within SMEs in Iran. Hence there were number of obstacles identified towards leanness of the organisations. The following conclusions can be drawn from the present study.

This study shows that the barriers to implementation of lean program can be classified into four categories. These categories are lack of top management support, financial capabilities, employee skills and expertise and organisational culture. After identifying these barriers, a reasonable approach was then developed to address these obstacles. The finding of this research suggests that the lean implementation can be achieved in two stages. The first set of recommendations is to provide an appropriate lean environment in the organization. In order to do so the managers are responsible to educate every members of the organization about the concept of lean manufacturing by providing formal and informal training.

In addition as part of the management responsibilities and cultural platform, it is important to ensure a no-blame environment in which the mistakes are approached as an opportunity to learn more about the elimination of the potential causes. Another step towards a lean environment is to arrange regular meetings to discuss the new ideas and provide a clear vision. In the second set of recommendations, a range of feasible tools were suggested. The first step was to integrate lean principles in product design phase eliminating potential wastes. This was followed by the consideration of cell manufacturing, pull system, Kanban systems, one-piece flow and poka-yoke methodologies in factory layout design stage. Subsequently, tools such as 5S, value stream mapping,

347 quality circle, work place ergonomic and health and safety can be applied once the company is about to start the production. ^{1 2 3}

1

Sector	Firm	Number of employees	Informant position
Electrical Equipment	Manufacturer 1	105	Supply Chain Manager
	Manufacturer 2	90	Supply Chain Manager
	Manufacturer 3	56	Managing Director
Industrial Machinery	Manufacturer 4	80	Supply Chain Manager
	Manufacturer 5	50	Managing Director
	Manufacturer 6	35	Managing Director
	Manufacturer 7	42	Managing Director
Automotive Part Supplier	Manufacturer 8	70	Sales and Marketing Manager
	Manufacturer 9	25	Managing Director

Figure 1: Table 1 :

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