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Article

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Review article

Competition and resilience: Lean manufacturing in the plastic industry in Lebanon



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ABSTRACT

In recent years, competition in the Lebanese plastic industry has significantly increased. At the same time, industry reports have shown that the sector is still resilient. A closer look at the sector shows that mounting competition incentivized many firms to adopt manufacturing systems that can provide better cost and quality. A large number of studies in the literature have focused on lean production and its efficiency gains. However, the challenges remain in the ability to implement the lean philosophy in manufacturing industries. This paper aims to explore the production system in the plastic manufacturing in Lebanon and shed the light on the implementation of the lean system and its related barriers. Based on the literature, a map of lean practices is drawn. A survey analysis using a sample of 20 factories is performed to explore the status of lean implementation in these organizations. The results indicate the existence of several barriers and challenges that prevent the Lebanese plastic manufacturing firms to implement lean practices. Firms suffer from a wide misconception of the lean system. Moreover, the results reveal that several firms use some aspects of lean manufacturing without realizing it.

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1. Introduction

Challenges and global competition have forced manufacturing firms all over the world to search for manufacturing strategies to increase their level of efficiency in order to be more competitive both locally or internationally. Firms from different industries producing various types of products and services do not face the same challenges and the same level of competition. In this environment, firms aim to become more competitive by improving the quality of their products without causing disruption to their cost. Several approaches are available to improve the quality of manufacturing. However, these approaches are not all suitable for all types of organizations and industries but tend to depend on the resources they have and the effect they have on cost and quality. A popular approach to improve quality and increase efficiency at the same time is known as the lean manufacturing system. Lean manufacturing can be understood as an integrated manufacturing system that aims to maximize the capacity of industry utilization and minimize the level of inventory that can become overloaded. Using lean manufacturing can minimize the system process including processing time of production as well as costs and wastes (De Treville & Antonakis, 2006). Over that last decade, the lean concept has become well-known in the operation management of industries. According to previous studies, industries that implemented the lean manufacturing system witnessed production performance that is better and superior comparison to competitors in terms of quality and cost (Cua, McKone, & Schroeder, 2001; De Menezes, Wood, & Gelade, 2010). However, adopting the lean concept is challenging for manufacturing industries especially in countries that suffer from lacking resources, tools and techniques that are necessary to implement this concept. Lebanon is selected in this paper because it is one example of countries facing substantial barriers and challenges to implement the system. The Lebanese manufacturing industries have for a long time suffered from rising cost and rising competitive pressure from imports from other countries. Some unofficial reports state that over 288 manufacturing firms have shut down since 2011 due to increased competition, rising operating cost and lack of governmental incentives. However, Blominvest, in its 2016 report shows that manufacturing firms in the plastic industry have remained resilient. At the same time, the report explains that the strengths of the sector is mostly due to their large export markets, low oil prices, and the weak Euro (Blominvest, 2016). However, it is not clear as to whether this resilience is related to the operating efficiency of their manufacturing process which might be boosting those positive factors. As such, this paper aims to explore the existence of lean manufacturing process and its different aspects in the plastic industry in Lebanon, and identify the barriers and challenges of its implementation. For instance, the system or some of its aspects might be behind the resilience of the sector and could bring long term benefits when the current favorable conditions change. A survey analysis using a sample of 20 Lebanese factories in the plastic industry reveal that several firms use some aspects of lean manufacturing without realizing it. The results show that the existence of substantial barriers and challenges that prevent the Lebanese plastic manufacturing firms to implement lean practices. Among the most important barriers is the firm's wide misconception of the lean system. The next section of the paper provides a literature review followed by the methodology of the paper based on a survey of industrial plastic firms in Lebanon. Section four provides the results and findings while the last section concludes.

2. Literature review

The most popular definition of lean manufacturing system is provided by Toyota that defines it as a comprehensive set of practices and techniques which enhance the organizations benefit by eliminating wastes, cost and improving quality. The concept is well known and implemented in the Japanese manufacturing industry. In fact, these organizations implement the lean system to benefit from reducing cost by eliminating wastes (Green, 2000). Waste elimination and continuous improvement are therefore considered as the two basic elements of this concept. The system leads organizations to be leaner and characterized by flexibility and to be more responsive to waste reduction (Wilson, Araba, Chinwah, & Cheeseman, 2009).

Lean manufacturing is viewed as an alternative approach to the traditional manufacturing model (Hayes, 1981). This new paradigm can be used in a wide range of factories worldwide in their operations that it could influence and serve their strategies (Katayama & Bennett, 1996). There are many principles of lean manufacturing system and they all target the same goal of eliminating wastes and non-valuable activities (Womack, Jones, & Roos, 1990). Implementing the lean system generates value from organization activities starting from raw materials to the finished goods or services.

The lean system includes several practices that are all related to each other. Organizations must apply them all to reach an integrated lean system and for achieving the main objective of elimination waste, reducing cost, and improving performance

(Liker, 2004). Shah and Ward (2003) define about 15 practices of lean manufacturing such as six sigma, visual management, A3 thinking, Kanban, and Just in time. In a more restrictive way, there are five elements that together with flexibility can help achieve the concept of the lean manufacturing system. These factors include the elimination of zero and value activities, the reliance on multifunctional teams, the continuous improvements of the process, and the supplier integration.

The lean system is not only about reducing cost in terms of workforce reduction or cutting inventory but it is a long term growth strategy that merge several practices and as such must be adopted by the top management. Moreover, the difficulty of competing with local and international companies leads firms to shift from traditional manufacturing system to a lean system but this change requires to get over some barriers and challenges in order to get this shift successfully. As such, the successful implementation of the lean manufacturing system, depends on some crucial factors such as leadership, good management, finance, skills and expertise, as well as a strong corporate culture directed toward efficiency in the organization (Balle, 2005; Chaisorn & Lila, 2011; Nordin, Deros, & Wahab, 2010).

For instance, a recent research done by Dora and Kumar (2016) find that there are barriers and challenges that small and medium enterprises (SMEs) should avoid in order to implement the lean system. These barriers and challenges were examined by Boyer and Sovilla (2003) in his research about the lean system implementation. These two studies focused on the list of barriers and highlight the culture and financial aspects. The barriers of the lean system implementation were also examined by Bednarek and Luna (2008). The results shed the light on the tools, principles, practice, and application of the lean system. The paper explains how focusing on individual tasks instead of focusing development the whole enterprise can become a serious barrier to the lean system implementation. Another important barrier in the paper is the lack of the needed resource that are essential for the lean system and the lack of training that aims to develop the skills of the employees. The underlying argument is that with training the level of resistance to apply the lean system decreases.

In another paper, Pingyu and Yu (2010) runs a survey about the lean system implementation in some Chinese industries. The survey shows that the lack of understanding of the lean system and its benefits are considered as major barriers. In addition, as mentioned by Bednarek and Luna (2008), Pingyu and Yu (2010) argue that the resistance of the firms' employees to the lean system is again an important barrier. For instance, employees resist the system due to their fear of losing their jobs and of being replaced by a smoother system that in their view is aimed at downsizing and reducing the workforce in the organization. The resistance of change is a common phenomenon as it raises fear of failure and companies fear from failure because failure needs money and efforts to overcome. Another important barrier highlighted in Pingyu and Yu (2010) is the perception of managers of the time frame benefits of the lean system. Managers tend to be believe that the rewards to achieve from the lean system are uncertain and its return on investment is long to be achieved. As such, they tend to avoid implementing the system due the lack of support from the top management. The lack of employee skills related to the lean system is also among the barriers of implementation as explained by Bednarek and Luna (2008). In that sense, organizations need to find ways to motivate their employees to get trained and learn new skills that add value not only to the organization, but also to themselves.

Another paper by Radnor, Walley, Stephens, and Bucci (2006) explores the barriers of the lean system implementation. The results of his paper show that there are three main critical issues related to the barriers and challenges of applying the lean system. All the barriers and challenges come under these three main issues namely human capital, operation and sustainability. These were confirmed thereafter by Bollbach (2012) which gives special attention to the issues related to human resources that tend to be affected by the external environment.

The barriers and challenges that SMEs face when implementing the lean system in China as explained above, are also re-affirmed in Sahwan, Ab Rahman, and Deros (2012) in the context of Malaysia. According to Sahwan et al. (2012), the most important barriers of the lean system implementation in Malaysian industries lie in the lack of awareness as well as the lack of systematic way in implementing the lean system during the transitional phase of implementation. These barriers are intensified in Malaysia by the existing technological and financial gaps that prevent successful implementation. Garg et al. (2014) reveal a list of barriers re-affirming the above barriers in the context of SMEs and show that the lean system implementation is far from easy to achieve. His research is applied in a context similar to the Lebanese one, where firms are mostly small and medium, and where large enterprises tend to be almost inexistent.

Most studies which relate to the lean system implementation barriers focused on defining the main changes associated with the system, and on adopting the lean thinking though better understanding of the system. Hansen and Doolen (2008) define the increasing competition and the changes occurring to the customers' requirements as two of the main barriers and challenges. These changes limit the time for companies to set plans and strategies to implement the system. Furthermore, their results explain how the lean thinking should be reflected through effective communication in the vision, mission, and company values. This was a major challenge in the context of the US and Germany.

The resistance to change and changing customers' requirements have been also highlighted in Bhasin (2012) when applied to Third World countries. Moreover, his results show that the lack of support from the top management and the lack of commitment are additional barriers preventing implementation. These last two barriers are re-affirmed in Darabi, Moradi, and Toomari (2012). In Europe, Axelson (2007) explain that SMEs face three main barriers when implementing the lean system namely resources, management, and organization barriers. Resource limitations can be related to human capital, skills, finance, and materials. The management limitations refer to as mentioned previously to top management lack of support, to the lack of vision, and the lack of holistic view to the firm's performance. The organization limitations are reflected in the firm's hierarchy, its structure, and its lack of flexibility.

Plastic producers in developing countries are presently confronting a concentrated worldwide rivalry. A large number of firms have a small scale and face among others inherent issues such as inefficiency, high employees' turnover, high levels of waste, poor

flexibility, and long production time. Implementing the lean system provides with no doubt a great opportunity to deal with these issues and to improve the performance of the firms' operations as a whole. Implementing the process can with no doubt serve the organization competitiveness (Sanchez & Perez, 2001). The lean process allows the firm to be more flexible and more responsive to market changes (Wilson, 2010). In addition, the lean system, brings more market share and helps firms enter new markets (Smith, 2013). However, as the literature review shows, the implementation of the lean system must be carefully designed to overcome substantial barriers and challenges.

Today, both developed and developing countries are highly motivated in implementing the lean system in order to gain from the abovementioned benefits which have been evident in a wide range of factories worldwide (Pavnaskar, Gershenson, & Jambekar, 2003). As such, there is no doubt that implementing it in the Lebanese context could bring similar benefits if the barriers and challenges of its implementation are identified and addressed. Moreover, the resilience of the Lebanese plastic industry might be due to better operational and production practices in relation to the above issues.

3. Methodology of the study

To explore the implementation of lean production in the Lebanese plastic industry, this paper adopts a descriptive research design based on the collection of primary data from a survey analysis that describe the current manufacturing systems used, the barriers and the challenges for implementing the lean production system. For instance, the current methodology reveals the perceptions, knowledge, and awareness of these industries when it comes to lean manufacturing. The methodology targets manufacturing practitioners such as operation and production managers and rely on their experience to collect the data needed. This methodology is designed to investigate the barriers and challenges that each industry faces, by distributing a questionnaire to each factory in the sample. The questionnaire includes 26 questions divided into two sub-sections and is available upon request, the questionnaire aims to identify the current production practices and in its first sub-section highlight the barriers faced to implement best practices of the lean system, and its second sub-section the challenges of such implementation. The questionnaire is inspired from Akugizibwe and Clegg (2014) that have similar objectives of the current paper.

We select the plastic manufacturing industry in Lebanon because it is one of the few sectors that have remained strongly resilient since 2011 when the economy started to decline. As such, we would like to explore through that industry if aspects of the lean system exist and the barriers and challenges of the implementation of the system in Lebanon.

When it comes to sampling, the Association of Lebanese Industrialists (ALI) lists 51 manufacturing firms in the plastic industry in Lebanon. Of the 51 questionnaires sent, 26 questionnaires were received, and 20 of them were usable.

4. Results and findings

4.1. Overview of the sample

In Lebanon, there are different thresholds to categorize a firm between micro, small, medium, and large enterprises. The definition in Lebanon based on Ministry of Economy of Trade assumes that an enterprise must meet both a turnover and an employee thresholds in order to be considered in a particular category. For instance, to be considered as a micro enterprise, a firm should simultaneously have less than 10 employees and 500 million LBP, a small enterprise should have between 10 and 50 employees and a turnover less than 5 billion LBP, a medium enterprise should have between 50 and 100 employees and an annual turnover between 5 and 25 billion LBP. Finally, a large enterprise has more 100 employees and turnover of more than 25 billion LBP. Exceeding either of these thresholds would lead to recognizing enterprises in the next category (Ministry of Economy and Trade, 2014).

Due to the small number of respondents, we have categorized enterprises in two categories. Those that have 10-50 employees and those with more than 50 employees. In relation to the Lebanese definition context, the firms are categorized as small firms as a first category, and medium and large firms as a second category.

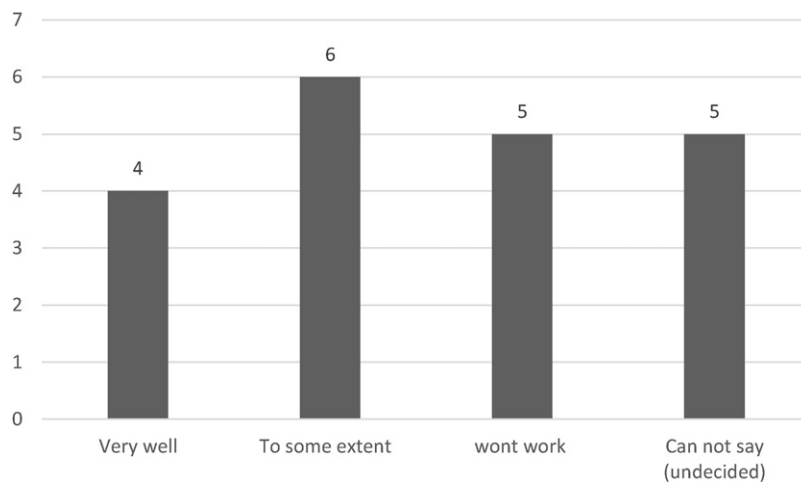
Table 1 provides a background of the Lebanese plastic firms that have responded to the questionnaire. The table shows that more than half of the surveyed plastic firms have more than 50 employees (55%), whereas 45% have less than 50 but more than 10 employees. Moreover, the results show that all surveyed firms are Lebanese.

4.2. Current practices

The results of the question about the extent that top managers think that Total Quality Management (TQM), may work in their organizations are provided in Fig. 1. The results show that four firms (20%) claimed that TQM will work very well if they implement it. Six firms (30%) of the total of Lebanese plastic industries expect that TQM will to some extent work. There are four organizations (25%) that consider that TQM will not work due to considerable challenges. The remaining four organizations (25%) were not decided whether TQM will work or not if they implement this system in their operations. The percentage of the respondents in favor of the system (50%) gives an indication that the involvement of Lebanese plastic industries toward lean manufacturing system is still moderate.

Table 1 – Plastics industries characteristics.

Plastic industries characteristics	Frequency	Percent
<i>Number of employees</i>		
Less than 10	0	0
More than 10 but less than 50	9	45
More than 50 but less than 300	11	55
300 or more	0	0
Total	20	100
<i>Nationality of the industries</i>		
Lebanese industries	20	100
Foreign industries	0	0
Total	20	100

**Fig. 1 – The extent TQM work in Lebanese plastic industries.**

When it comes to the perception of top managers toward the importance and relevance of their organizations to become lean, Fig. 2 shows that the majority of respondents (17 firms) agreed that it is indeed important to become a lean organization. The results reveal a high level of awareness toward the practices of the lean manufacturing system among practitioners in the plastic industry in Lebanon. It is important to note that most respondents were unfamiliar with the formal terminology of the lean system but have implemented some its aspects based on their experience. The aspects of the lean system were explained to respondents in order to identify if they are being used in their manufacturing process.

After explaining to respondents the aspects of the lean system, the majority of the surveyed firms have revealed that they are considering the implementation of the lean manufacturing system in their production line as shown in Figs. 3 and 4. However, their intent is not based on prior knowledge of the lean system. This result reinforces the previous results concerning the awareness toward the system. Moreover, the results reveal that a greater number among large firms are considering the system in comparison to small firms. This might be due to the fact that large firms have more resources, more employees, more machines, and are more concerned about their level of inventory and wastes.

In addition to current practices of some of the aspects of lean system, Figs. 4 and 5 show that most of the surveyed firms have only thought of the implementation of more sophisticated aspects of the system but have yet taken concrete steps in that direction. For instance, these firms are considering the implementation of the aspects of the lean without previous background about the system. Firms are in the planning phase of the implementation at most. Of the surveyed firms, 13 or about 65% are in the planning phase whereas three or just 15% have only discussed the idea. The remaining firms or about 20% have only heard of the concept.

Fig. 5 shows that nine of the 20 surveyed managers are planning in a way or another to use more sophisticated aspects of the lean system in their production, whereas six managers have thought about using it and the remaining five managers have only heard about it. As such, 15 of the 20 surveyed managers seem to have the willingness to implement the system and it is interesting to understand the reasons why the system has not been formally implemented yet.

The next question is more specific about the tools and aspects of the lean system that are currently in use. After defining and explaining each of the tools used in the lean system to respondents, interviews with the managers reveal that some aspects and tools that are similar to the lean system that is actually being used, but without necessarily being aware that it is a practice of the lean manufacturing system. Fig. 5 shows the aspects of lean manufacturing being used and the number of firms using it. For

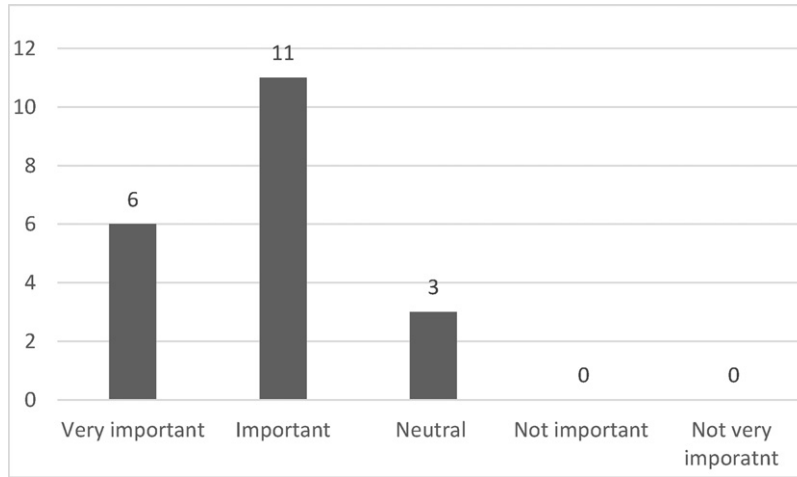


Fig. 2 – The importance to become lean.

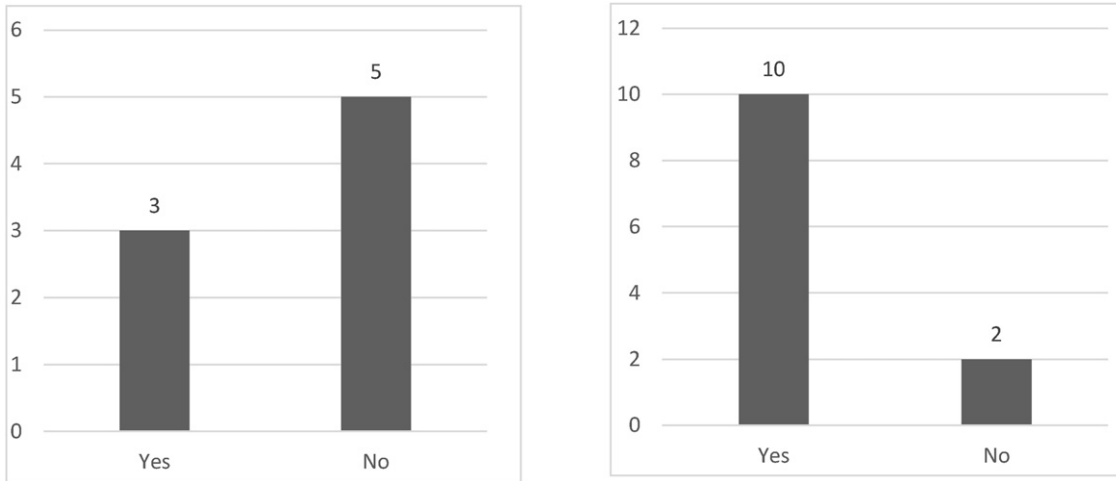


Fig. 3 – Thought to apply lean manufacturing system – (a) small size; (b) medium and large size.

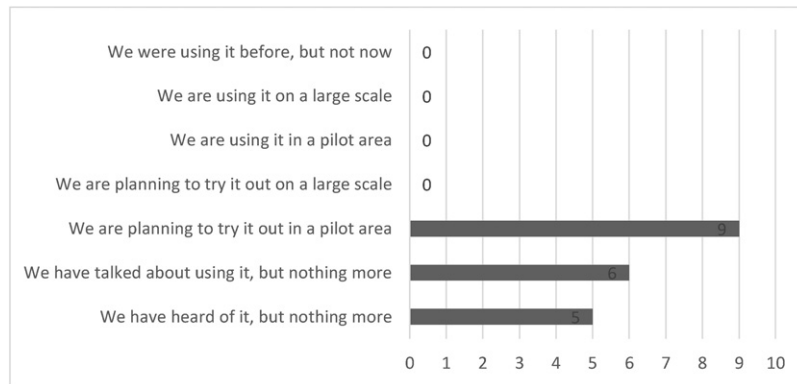


Fig. 4 – Organizations toward lean system.

example, 14 of the surveyed managers explained that they are actually using aspects of the Toyota Production System (TPS) practice without being aware that this practice is actually part of the lean system. TPS is a preliminary phase of the more sophisticated lean system and relies essentially on enhancing integration between suppliers and customers. The TPS tool seems to be the one that is mostly being used by plastic producers in Lebanon (Fig. 6).

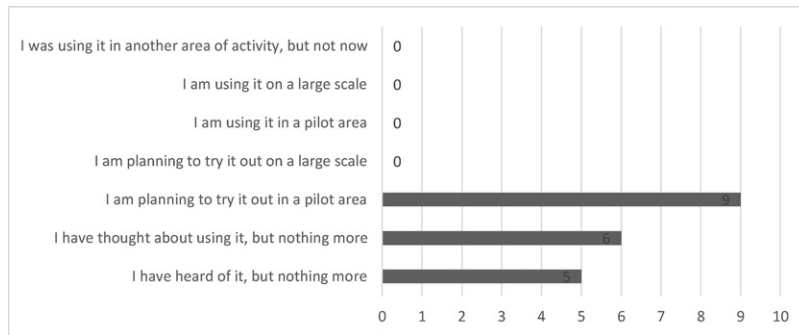


Fig. 5 – Managers experience toward lean system.

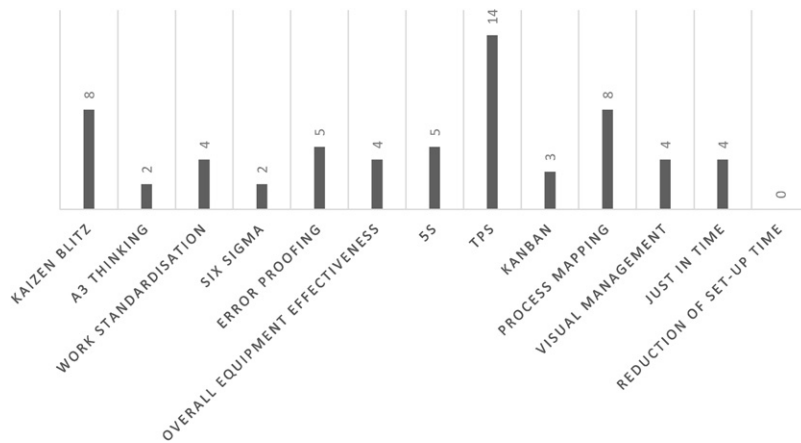


Fig. 6 – Tools of lean system.

4.3. Barriers

Respondents provide a list of barriers preventing them from implementing the system. The initial list of barriers emanate mostly from the above literature review. Despite those barriers some firms apply their similar own tools to survive in the market. [Table 2](#) shows the list of barriers according to the surveyed managers. In order to rank the barriers, the mean of each barrier as per the managers' perceptions are used.

Widening customer requirements appear to be ranked as number one barrier to the implementation of the lean system and this might actually be due to the pressure that customers impose on firms. In addition, when the level of demand is high, organizations sees it as an opportunity to make profits so they focus on covering this demand and increase their sales. The lack of methodology is also an important barrier that reflects the lack of knowledge that practitioners have about the lean manufacturing system as revealed earlier. These results are reinforced by revealing the lack of learning and the lack of strategic perspectives as potential barriers. Technological advancement seems to play a major role. Most of the surveyed industries do not have the technology including machines and equipment needed to implement the system.

The misunderstanding of lean production as a barrier shows that respondents believe that lean implementation needs a large investment and is only suitable for large industries. These misconceptions lead organizations to apply some of the lean tools instead of applying the wide system. The high cost of advanced technology ranked in the fifth position and this is due to the lack of funding that allows firms to invest in the new technology. Another interesting result is that respondents believe that with the current technology it is difficult to reduce the whole production process and that this could actually harm the quality of the product. As such, a new technology is needed and this would actually require funds that are scarce as explained above. Finally, most managers seem to believe that the method is suitable to their firms and that competition does not seem to be a barrier to the implementation.

The list of barriers listed above are for all firms, and were calculated regardless of the size, and the number of employees in each company. A closer look at those barriers across firms' size reveal a different ranking.

As [Table 3](#) shows, firms with 10-50 employees have different scores than firms more than 50 employees. For instance, small firms see widening customer requirements as a major barrier to the implementation of the lean system, while the lack of methodology is a major barrier for the medium and large firms. These differences are due many reasons such as the amount of

Table 2 – The ranking of barriers.

List of barriers	Mean	Standard deviation	Mean ranking
Widening customer requirements	17.20	2.59	1
This kind of changes need too long to become profitable	17.00	2.66	2
Social factor (environmental pressures, workforce/workplace)	16.30	2.70	3
Technological advancements	15.95	3.15	4
High cost of advance technology	15.90	3.74	5
Integration and pro-activity	15.45	3.94	6
Lack of collaboration between different functions	15.15	3.19	7
We do not believe that these methods suits us	14.55	3.24	8
Reduced manufacturing lead time	13.80	3.87	9
Lack of technological infrastructure	12.40	5.02	10
Personal training	10.05	5.21	11
Lack of skilled employees	9.55	4.82	12
Lack of strategic perspective	8.80	3.07	13
Competition	8.75	5.99	14
Finance problem	8.60	5.60	15
Resistance to change	6.75	4.34	16
Misunderstanding of lean production	6.10	3.24	17
Unwillingness to learn and see	5.25	3.02	18
Lack of planning	5.20	2.46	19
Lack of methodology	4.30	2.70	20
Lack of top management commitment	4.20	3.19	21

available resources, the number of employees, funds, level of inventory, position in the market, the quality of their products, and the capital of the company.

4.4. Challenges

Table 4 shows that there are 14 challenges. The list of challenges reveal the knowledge and information transfer as a major challenge for the implementation, followed by the lack of a common vision and the lack of pressure from customers. It can be concluded that the ranking of challenges is somehow similar to the ranking of barriers. For example pressure from the top management is similar to the lack of support and commitment from the management, and the pressure of the customers is similar to the barrier of the widening customer requirements.

Table 3 – The difference between two sizes of companies in ranking barriers.

List of barriers	Company size between 10 and 50 employees (small)		Company size more than 50 (medium and large)	
	Mean	Mean ranking	Mean	Mean ranking
Competition	8.22	13	9.18	8
Finance problem	7.89	15	9.18	8
High cost of advance technology	15.78	6	16.00	18
Integration and pro-activity	17.67	2	13.64	13
Lack of collaboration between different functions	15.56	7	14.82	15
Lack of methodology	4.89	20	3.82	1
Lack of planning	5.67	17	4.82	3
Lack of skilled employees	8.22	13	10.64	11
Lack of strategic perspective	9.56	11	8.18	6
Lack of technological infrastructure	14.89	8	10.36	10
Lack of top management commitment	4.00	21	4.36	2
Misunderstanding of lean production	6.78	16	5.55	5
Personal training	8.33	12	11.45	12
Reduced manufacturing lead time	13.00	10	14.45	14
Resistance to change	5.00	18	8.18	6
Social factor (environmental pressures, workforce/workplace)	16.33	4	16.27	19
Technological advancements	16.33	4	15.64	17
This kind of changes need too long to become profitable	16.89	3	17.09	21
Unwillingness to learn and see	5.00	18	5.45	4
We do not believe that these methods suits us	13.22	9	15.09	16
Widening customer requirements	17.78	1	16.73	20

Table 4 – Challenges to implement lean system in Lebanese plastics industries.

List of challenges	Mean	Standard deviation	Ranking
Knowledge and information transfer (effective communication)	10.65	3.08	1
To reduce work in process between operations	10.6	2.91	2
Time spends on working and capability, which are the “physics” of process improvement	10.05	3.46	3
Non-effective method (e.g., inventory management)	10	2.81	4
Non-lean behavior (increase flow time, increase waste)	10	2.77	4
Projects implementation	9.8	3.27	6
Cooperation with suppliers to establish a lean supply chain	9.2	3.22	7
Technological issue	7.55	3.58	8
Training	5.8	3.17	9
Adequate information	5.45	3.73	10
Lack of common vision	4.6	2.14	11
Uncertainties in demand	4.55	3.19	12
Pressure from customer	3.8	2.61	13
Pressure from top management	2.95	1.93	14

Table 5 shows that there are differences between the rankings of the challenges across the size of firms. For example, small firms rank pressure from top management as number one challenge whereas medium and large ones ranked it as number two, and the lack of common vision as the major challenge.

Table 6 shows the strategies that firms that cannot implement the lean system follow alternatively. Respondents in the plastic firms seem to rely primarily on employee’s engagement and improved flexibility.

The above strategies bring benefits as shown in Table 7. When asked about the benefits they believe are achieved through the strategies above, the Lebanese plastic firms seem to adopt strategies aiming to reach outcomes that are the same as those that can bring benefits from implementing the lean system as shown in Table 7. The scale used goes from 1 to 5 (1=not achieved; 2=very limited achievement; 3=only partially achieved; 4=largely achieved; 5=fully achieved).

It can be noticed that those aims are similar to the potential benefits mentioned in the literature review about the lean system. However, the strategies cannot be used in the long term because the changes in the environment and the high level of competition leads some of them not to give the organization the expected outcomes.

Table 5 – The difference between two sizes of companies in ranking the challenges.

List of challenges	Company size between 10 and 50 employees		Company size between 50 and 300 employees	
	Mean	Mean ranking	Mean	Mean ranking
Adequate information	5.67	5	5.27	5
Cooperation with suppliers to establish a lean supply chain	9.67	10	8.82	8
Knowledge and information transfer (effective communication)	10.78	14	10.55	12
Lack of common vision	5.44	4	3.91	2
Non-effective method (e.g., inventory management)	9.44	9	10.45	11
Non-lean behavior (increase flow time, increase waste)	9.11	8	10.73	13
Pressure from customer	3.56	2	4.00	3
Pressure from top management	2.78	1	3.09	1
Projects implementation	10.00	11	9.64	9
Technological issue	7.78	7	7.36	7
Time spends on working and capability, which are the “physics” of process improvement	10.44	12	9.73	10
To reduce work in process between operations	10.44	12	10.73	13
Training	5.67	5	5.91	6
Uncertainties in demand	4.22	3	4.82	4

Table 6 – Strategies used to implement the lean system according to respondents.

Strategies	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Employee engagement in identifying solutions	5	12	3	0	0
Employee empowerment	3	10	3	0	0
Incentives	3	3	13	2	0
Emphasis on training and skill building	3	11	8	0	0
Employee ownership	5	9	5	1	0
Improved flexibility	5	11	5	0	0

Table 7 – Aims being achieved.

Aims	(1)	(2)	(3)	(4)	(5)
Cost reduction	0	1	5	6	9
Customer satisfaction improvement	0	0	3	10	7
Improvement in flexibility	0	1	5	8	6
Increase staff motivation	0	0	4	11	7
Increase staff contribution to decision making	0	0	5	7	7
Reduction in lead time	0	0	3	7	9
Reduction in the workforce	0	0	4	8	8
Quality improvement	0	0	3	5	11

5. Conclusion and recommendations

Facing rising competitive pressures, manufacturing firms seek to improve their production line in terms of quality and cost using the lean manufacturing system. Today, the uncertainty of changes in the environment surrounding organizations of different size and industry pushed them to implement practices of the lean manufacturing system. This could help them overcome their competitors including a high level of controlling and monitoring of their activities and help them survive in different environments and economic situations.

In this paper, the barriers and challenges of implementing the lean manufacturing system have been explored using a survey analysis of 20 manufacturing firms in the plastic industry in Lebanon. The lack of planning and the widening customer requirements have been identified among the major barriers. The key message is conveyed to plastic firms but also to other manufacturing firms producing different types of products. For instance, lean is not limited for a specific type of industry despite the fact that each industry and firm has its own process of production which is somewhat different from other companies.

The plastic industry has been selected among other industries due to its high degree of resilience during the economic downturn and due to the number of firms operating in the industry. Moreover, the plastic industry is considered as big producer of waste comparing to other industries which makes lean thinking very relevant to them. This paper has contributed to the body of knowledge of studying lean system tools and identifying the barriers and the challenges within Lebanese plastic industries and help them solve these challenges and barriers and increase their chance of implementing the lean system. The paper surveyed two types of organizations of different sizes of employees. The paper reveals the gap needed to overcome to reach a successful implementation of the lean system based on interviews with managers of plastic industries. A misconception of lean seems to create the biggest problem for the lean implementation.

The plastic industry in Lebanon have good features to be a thriving sector comparing to other sectors if they end up implementing the lean production system successfully. This can be done if the organization provides the right training and education programs to the right employees to increase the awareness toward the system and to have a fully understanding of lean and its benefits, remove the lack of vision they face, and get the right support and commitment from the top management. Managers must have a strategy to support their lean implementation efforts. Training will lead to have a situation of integration and proactivity to implement the lean system. Moreover, the important role of the top management to support and motivate their employees to work in efficient and effective way is crucial. Managers needs also to have a full understanding of lean practices including 5S, A3 thinking, Kanban, just-in-time, and visual management.

Defining the barriers and the challenges of implementing the lean system can help them eliminate these barriers and challenges. Our findings show that 90% of the barriers are under control by the company. Implementing the lean system requires efforts from external (government) and internal (workforce) players. This includes the role of the government in offering to firms the suitable infrastructure and funding facilities to implement the system. Long term loans with zero interest can be offered to buy new technological equipment and can have a critical role in implementing the system in the Lebanese plastic industry.

Although the methodology applied used in this paper was carefully selected and designed to fit the objectives of this study some limitations apply. The response rate is low and it was difficult to convince managers to be part of it. The results and findings reflect the current state of manufacturing in some of the Lebanese plastic firms. Despite that, it was possible to go deeply in understanding these barriers and challenges for the implementation of the lean system in those firms. Future work can focus on several industries in Lebanon such as the agro-food industry in order to highlight the major challenges and barriers of implementation of advanced production techniques that help the Lebanese manufacturing sector to become more competitive at the local and international levels.

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