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THE CURRENT STATUS OF LEAN MANUFACTURING IN SMALL, MEDIUM AND LARGE SCALE MANUFACTURING COMPANIES OF KARACHI, PAKISTAN

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The major purpose of this study was to examine the current status of lean manufacturing in small, medium and large scale manufacturing companies situated in Karachi, Pakistan.The status of lean awareness, implementation, barriers and benefits in manufacturing companies were investigated through the questionnaire survey. The questionnaire was sent to 320 manufacturing companies and a response rate of 40.6% was received. SPSS 22.0 software was used to determine the average mean score for each factor and certain statistical analyses were performed to evaluate the results. It was observed that large organizations and SMEs both are fairly aware of the basic lean concepts but there is a sufficient difference in understanding of lean tools and techniques. Large organizations have a greater understanding and implementation of lean tools and techniques than SMEs. Some tools like 5S, Poka-yoke and TPM were found to have a similar status of implementation in various manufacturing companies irrespective of their size.The results of this study are applicable in Pakistani context, but could vary for other regions of the world, considering the awareness and challenges manufacturing enterprises are facing. To date there has been no research carried out in the context of large, small and medium manufacturing enterprises together in Pakistan, specifically in the Karachi region which investigate the status of lean awareness, implementation, benefits and barriers.Therefore, this study would serve as a foundation for conducting further in-depth studies on lean manufacturing in Pakistani manufacturing companies.

Keywords: lean manufacturing, lean awareness, lean barriers, lean implementation smes, large scale companies

1 INTRODUCTION

Manufacturers these days need to be efficient and flexible to meet dynamic situations by quickly responding to market needs to achieve customer's satisfaction [1]. Those companies which have adopted or working on modern methodologies like lean, six sigma and TQM have survived and competing in market [2]. Among different improvement approaches, lean has been well accepted approach throughout the world. One manner by which organizations have reacted to the increasingly competitive environment is by adopting lean tools and techniques [3]. Moreover, lean helps to achieve continuous improvement by reducing process wastes [4]. These wastes have become progressively evident, particularly with the COVID flare-up that has tested manufacturer's capacity to support their production activities [5]. Lean has been accepted worldwide and has admired position throughout the world. Effects of lean implementation show that it has enormous impacts [6]. As lean manufacturing is using fewer facilities, less manpower, time and effort, thus it is considered as modern method that manufacturers should adopt. In this consistent mission for achieving smooth production activities, firms must address inner and outer wastes that in the end lead to production closures, unstable business markets [7]. According to Bhamu and Sangwan lean philosophy is a business technique that improves productivity by eliminating waste and focuses on customer needs [8]. Lean is an efficient way to deal with wastes through consistent improvement by producing the product in the interest of the customers [9]. "Lean is doing more with less"[3]. "Lean is a systematic approach to identifying and eliminating waste through continuous improvement by flowing the product at the demand of the customer" [9]. Lean assembling apparently been the most prominent strategy for working on the functional presentation in assembling organizations [10]. According to [11] lean adoption will be the standard production method of the 21st century. The benefits of lean implementation in a non-process industry are lower lead time, lower inventories, improved knowledge and more robust processes and has also mentioned key tools and techniques inside the 'lean' framework which includes, 5S a visual procedure that provides a rule to the shop [12].

Some of the most commonly used lean tools and techniques are discussed here like, 5S was at first presented in the mid 1980's by Takashi Osada, it was felt that execution of the 5s practice would raise the execution for the production lines fundamentally and furthermore safety, wellbeing, housekeeping and considerably more.[13]. Recently, Industry 4.0 idea is being marked as the enabler of performance improvement. The fast advances in information technology (IT), identified with both hardware and software, have empowered an expected upset in the producing industry, normally known as Industry 4.0 [14]. Numerous fantastic tools can be used in a variety of situations. Value stream mapping, Judoka, 5S, Kanban, and other tools will aid firms in their lean manufacturing

and Industry 4.0 transition. Rather than using lean tools in isolation, it is recommended that they be used together [15]. In a lean assembling framework, any issues ought to be taken care, ideally by dealing with the root cause of the issue [16]. Poka-Yoke can be portrayed as a gadget or indeed, even a framework that can distinguish also as prevent dissentions and irregularities that adversely sway the quality of an item [17]. Single minute exchange of dies is a changeover activity time reduction method, it makes the machine to take less time to set up and reach ideal running conditions when properly implemented [18]. Kanban is a lean tool that controls production, inventory levels and supply components and is characterized as a controlling component, which controls the right amount of items required [19]. The goal of Kaizen is to enhance the method [20]. Through Kaizen occasions, employees gain the capacity to participate in tackling on-going issues that plague the work environment by distinguishing quality worries, process holes and waste arise during production operations. This key interaction requires active involvement of all members at all levels of an organization [21].

SMEs are urged to begin with the simple and attainable lean manufacturing methods such as 5S, continuous improvement, and a decrease in set up time [22]. Implementation of lean at large companies was not that much difficult, they don't face many difficulties in adopting lean, unlike SMEs who face greater and complex issues while adopting lean [23]. In an existing review of researches, [3] concludes that the execution of Lean in SMEs conveys with it various opportunities and difficulties than in bigger large-scale organizations. This proposes that it would be of worth to lead more research on Lean execution especially in a SME setting, where competition is expanding, and client focus and waste reduction turn out to be more significant. Implementation of lean can help Pakistani manufacturing enterprises to enhance their productivity by reducing wastes and by making effective use of resources. Most of the country's revenue is generated from Karachi's manufacturing sector, among which the textile sector is said to be the backbone of Pakistan's economy. Small and medium industries are also contributing in Pakistan's economy and most of them are providing the services as vendors to the large industries. There has been no research carried out in the context of large, small and medium manufacturing enterprises in Pakistan specifically in the Karachi region which investigates the status of lean awareness, implementation, benefits and barriers.

The next section contains the research methodology, which covers the entire process of conducting research. The results of the survey, as well as the results of various statistical analyses, are reported in the section of results and discussion. The research findings are summarized in the concluding part along with recommendations for future work.

2 METHODOLOGY

To carry out this research, an exploratory research method was used. The list of manufacturing companies was obtained from the Karachi chamber of commerce (KCCI). The provided list was filtered to select the specific type of manufacturing companies. From the given list, 320 manufacturers were chosen and the questionnaire was sent to them via e-mail or by meeting them personally. The manufacturing industries that were considered to fill the survey belonged to Textile, Steel manufacturing, pharmaceutical and automotive industries. The respondents were Assistant Managers, Senior Managers, Executives and Engineers from the Departments of Quality, Operation, Production, Warehouse and inventory control. Respondents' employment experience ranged from 5 to 20 years. Various tactics were used to boost the response rate like making phone calls, sending follow-up letters and sending messages via emails. A total of 146 responses were received out of which 130 responses were legitimate for the analysis resulting in a 40.6% response rate. According to a survey-based study on lean adoption in Pakistan, this response rate is deemed to be reasonable [24].

The survey instrument was primarily split into two components, the first segment inquired about the demographics and awareness of lean manufacturing. The demographics contained the respondent's education, working experience, designation, size of the organization and company's ownership. To know awareness, questions associated with the lean wastes, tools and techniques were asked. The second segment was created to determine the current status of lean implementation, its barriers and its benefits to companies.

The reliability tests were conducted for the major segments of the instrument by using SPSS 22.0 as shown in Table.1 to ensure that data was reliable. Cronbach's alpha is commonly considered to be reliable if its value is 0.7 or above [25]. Industry and academic experts familiar with lean ideas determined the questionnaire's face and content validity.

Table.1: Reliability test

	No. of items	Cronbach's alpha
Lean awareness	20	.883
Lean implementation	8	.820

3 HYPOTHESIS DEVELOPMENT

The hypotheses were developed as mentioned below for conducting this study considering the Pakistani scenario. The purpose was to identify the level of awareness and implementation of lean in SMEs and large-scale enterprises.

H_1: *On the Lean awareness mean score, there is a significant difference between SMEs and large manufacturing industries.*

H_o: *On the Lean awareness mean score, there is no significant difference between SMEs and large manufacturing industries.*

H_2: *In terms of the lean implementation mean score, there is a significant difference between SMEs and large manufacturing industries.*

H_o: *In terms of the lean implementation mean score, there is no significant difference between SMEs and large manufacturing industries.*

4 RESULTS AND DISCUSSIONS

The descriptive statistics of respondent companies, including industry size and type of ownership are shown in Table 2. Small and Medium Enterprises (SMEs) accounted for 45.4% of the total respondents and the rest were large manufacturing companies. The size of companies was classified using the definition provided by [26]. Large corporations rather than SMEs appear to have implemented lean manufacturing [27] and have more intentions towards lean adaption than small and medium-sized industries. The number of years that the respondent's organizations carried out lean manufacturing was likewise assessed to decide their development in the area. It was tracked down that 61.1% of industries were associated with lean manufacturing for under five years, while 38.8% were associated with it for over ten years.

Table 2.Profile of Respondents

Question	Elements	%
Size of Company	SMEs	45.4
	Large Enterprises	54.6
Company Ownership	Local company	64.8
	Foreign company	19.4
	Joint venture	15.7

4.1 Lean awareness

This section of the survey was designed to collect information regarding the basic knowledge of lean, familiarities with lean major wastes, tools and techniques in manufacturing companies. Multiple choices type questions were asked. In the multiple-choice format questions, one right answer could be selected and was assigned with a score of 1 and for the remaining unselected choice 0 score was assigned. In the situation, where more than one choices could be selected and all choices were equally important and correct, score 1 was assigned to each selected answer i-e total scores were added up based on the selected number of choices [28]. In this section, 20 questions were asked under three factors i-e basic knowledge of lean concepts, familiarity with major lean wastes and familiarity with lean tools and techniques as shown in Table.3. Before moving towards further analysis, a construct validity test of the questionnaire was conducted with a sample size of 130 manufacturing firms. It was found that the Pearson correlation value exceeds the critical value at 95 % confidence interval as shown in Table.3, it was found that all the factors had a significant correlation, hence the model was considered valid.

Table 3. Pearson r correlation.

Lean awareness	Mean	Std. deviation	Sample size(N)	Df (N-2)	Confidence interval	r Critical value	Pearson r correlation	P-value
Basic knowledge of lean	.56	.43	103	101	95%	0.2120	0.686	.000
Familiarity with lean major wastes	.51	.32	103	101	95%	0.2120	0.802	.000
Familiarity with Lean tools and techniques.	.46	.30	103	101	95%	0.2120	0.763	.000

To find out how well respondents have the understanding of basic lean concepts, some questions were asked like do they know about the term “lean manufacturing”? It was observed that the term lean manufacturing was heard by 79.2% of the respondents, while the remaining 20.8% were not familiar with the term lean manufacturing. For those who were aware, further questions were asked to collect more information about the general understanding of major lean wastes, tools and techniques.

It was seen that 60.4% of respondents had the right understanding of lean wastes. It was observed that the majority of the respondents were aware of the wastes due to defects followed by overproduction, waiting, transportation and inventory as shown in Figure.1.

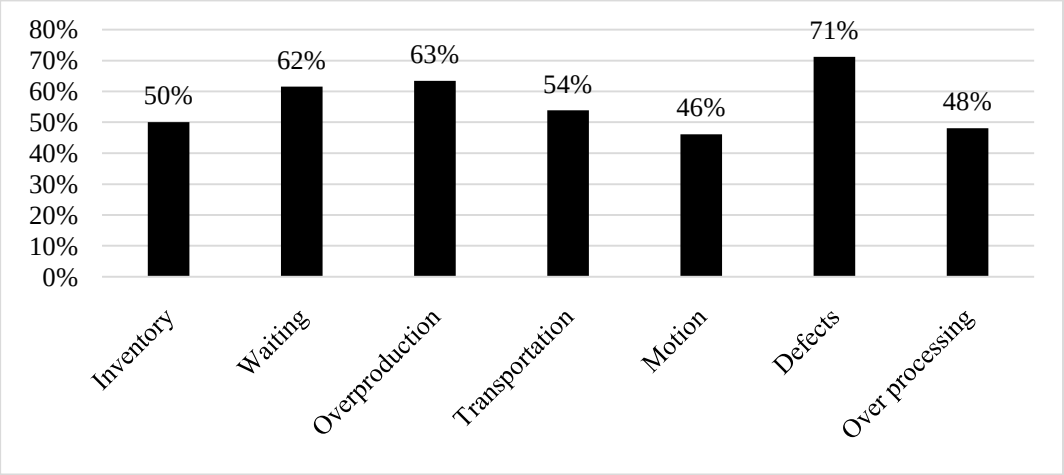

Fig. 1. Awareness of lean wastes.

Another set of questions were asked to collect data about major lean wastes occurring in respondent's companies. It was seen in Figure. 2 that defects, waiting and inventory were the most occurring waste in the respondent's companies that caused an increase in the overall production cost and affected the output rate and on-time delivery to the internal or external customers.

Afterward, the respondents were asked to name the lean tools and techniques that they are familiar with. The answers revealed that 5S, JIT, Kanban and VSM have more awareness than tools like SMED, production smoothing and cellular manufacturing as shown in Figure.3 and 90% of the respondents were sure that chosen tools would be relevant and successful in their plant.

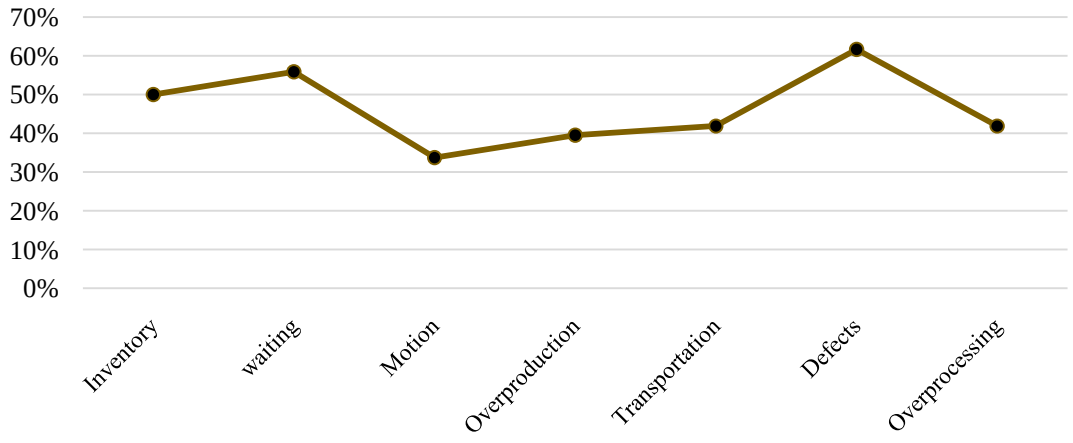

Fig. 2. Most occurring waste in respondent’s companies.

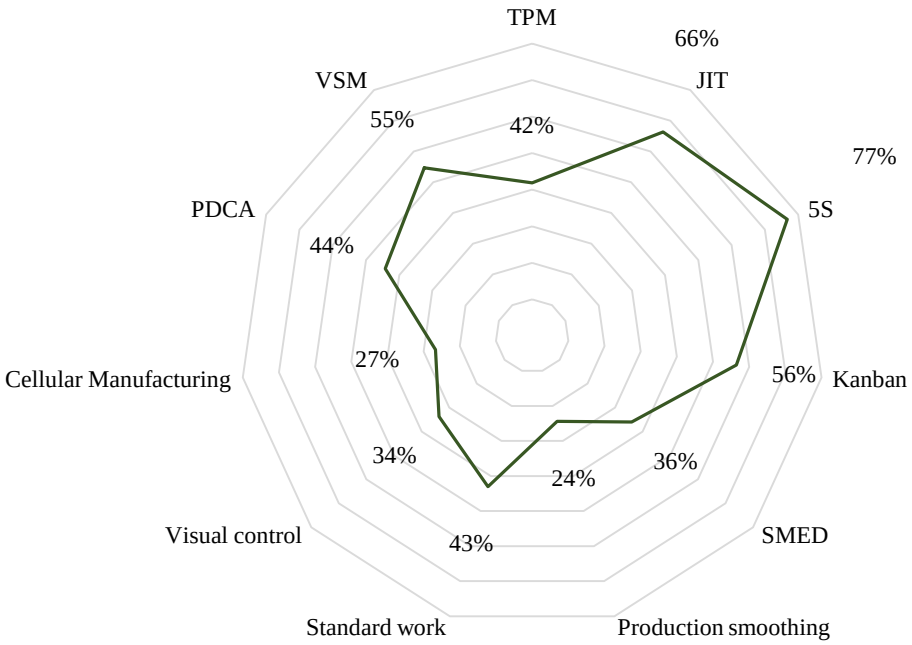

Fig. 3. Awareness of tools and techniques in SMEs and large-scale companies.

4.1.1 Hypothesis testing

HYPOTHESIS 1:

The first hypothesis was about the significant difference in the lean awareness mean score between SMEs and large enterprises. For this purpose, Mann-Whitney test was performed, as shown in Table.4, it was observed that both SMEs and large industries were aware of the basic knowledge of lean and major wastes but there was a significant difference in the awareness of lean manufacturing tools and techniques. The mean score showed that large companies are very much aware of lean manufacturing tools and techniques than SMEs, which resulted in a lack of successful implementation of lean in SMEs.

Table 4. Lean Awareness

	Mean score		**Mann-Whitney test**	
	Large Enterprise	**SMEs**	**P-value**	**Result**
Basic Knowledge of lean	.583	4.500	.392	Ho accepted
Familiarity with Lean major wastes	.552	.423	.118	Ho accepted
Familiarity with Lean tools and techniques	.521	.313	.002	H1 accepted

4.2 Lean Implementation

This section of the survey was conducted with the expectations to discover the endeavors that the small, medium and large scale companies are making to implement lean manufacturing and to investigate the associated benefits and barriers. The questionnaire consisted of 10 items as discussed in [29]. A 7-point Likert scale was utilized with a maximum score of 7 and a minimum of 1 with an interval of 1, 1=Never used, 2=very rarely used, 3 = rarely used, 4 = often used, 5 = Most often used, 6 = frequently used and 7 = regularly used. To check the construct validity, principal component analysis was conducted as shown in Table. 5, all the items were loaded into a single factor and the Eigen value of each factor surpasses the least threshold of 1.0 and the explained variance of each factor is larger than 50% and factor loadings are larger than 0.5 which are considered acceptable. Moreover, the Kaiser–

Meyer–Olkin (KMO) values for adequacy of sampling were satisfying and exceed the minimum score of 0.5. It was concluded that all the factors were valid and reliable, thus, could be used for hypothesis testing [30].

Table 5. Principal component analysis.

	Mean	Std. Deviation	Cronbach's alpha	No. of items	No. of items deleted	Eigen values	% Of variance explained	KMO	Sig.	Items Loading Range
Lean implementation	5.077	1.267	.859	10	0	5.361	53.614	0.898	.000	.520-.827

4.2.1 Hypothesis testing

HYPOTHESIS 2:

The second hypothesis was about the significant difference in the efforts taken to implement lean manufacturing by SMEs and large manufacturing industries. As the data is not following a normal distribution (non-parametric data), the Kruskal-Wallis test was used to check the hypothesis as shown in Table 6.

Table 6. Efforts to implement lean manufacturing.

Efforts to implement lean manufacturing	Mean score		Kruskal-Wallis test	
	Large Enterprises	SMEs	P-value	Results
The degree of time that the industry relied upon lean thinking specialists, advisors, or trained professionals, in the improvement of lean thiking.	5.07	4.87	.049	Sig.
The level of item families for which the value stream has been mapped.	5.13	4.79	.039	Sig.
The percent of the whole office (organization, deals, shop floor, dispatching/getting, and so forth) that have joined the 5S idea of sort, fix, clean, clear, and support.	5.48	5.30	.073	Not sig.
The level of all tasks the organization utilizes poka-yoke strategies (botch sealing, source assessment, agendas, machine measuring).	5.09	4.91	.224	Not sig.
The percentage of process equipment covered by a TPM (total productive maintenance program).	5.02	4.94	.574	Not sig.
At the workstations, the company has included visual controls (signs, graphics, procedures, and so on).	5.63	5.39	.022	Sig.
The organization has a systematic program of continuous improvement.	6.22	5.38	.000	Sig.
Continuous improvement (kaizen) events are held annually.	5.70	4.78	.001	Sig.
Decrease in throughput time during the previous year on the product(s).	5.09	4.73	.003	Sig.
Have these progressions expanded the organization's yield?	5.67	5.39	.017	Sig.

From the results obtained, it was found that there was a considerable difference between SMEs and large-scale companies in the context of lean implementation. The results revealed that the large companies more rely on lean consultants and the frequency of mapping VSM in the production line (when needed to reduce a cycle time) was also found more in large industries than SMEs, which results in more reduction in throughput time. It was also revealed from the results that a significant increase in the output was observed in large enterprises than SMEs. Large industries were more focused on continuous improvement programs like kaizen and have better visual controls than SMEs. Although, there was no significant difference was observed in focusing on 5S, poka-yoke, and Total productive maintenance. Both SMEs and large industries focused to have a well-standardized workstation, minimum defects and preventive maintenance to have a minimum breakdown, as seen in the lean awareness section, most of the respondents highlighted these wastes in their organization.

4.3 Benefits of Lean implementation

The respondents were asked about the benefits of lean implementation in their particular organizations. It was difficult to distinguish the advantages that the organizations achieved after the successful implementation of lean tools and techniques. It was obvious that practicing lean manufacturing provided them with numerous benefits. The results showed that the organizations achieved work advancement followed by organization restructuring,

productivity improvement, reduction in waste and quality of their products were also improved with successful adoption of lean as shown in Figure.4.

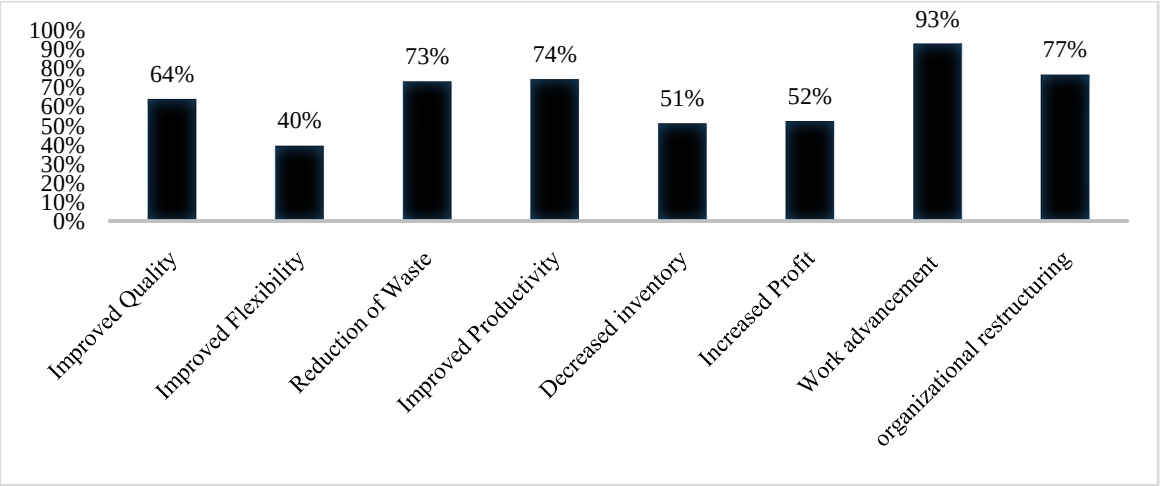

Fig. 4. Benefits of implementing lean tools and techniques

4.4 Barriers in Lean implementation

It was found that many companies have faced employee resistance in implementing lean manufacturing which showed that change management is a very crucial element in Pakistani industries. Another challenge faced by half of the respondents in adopting lean manufacturing was the lack of management support followed by the culture of the company, lack of know-how to implement and fear of success as shown in Figure.5. As [24] and [31] also investigated that management's unwillingness to commit to cultural transformation and employees' resistance to change are the most occurring barriers in Pakistani industries.

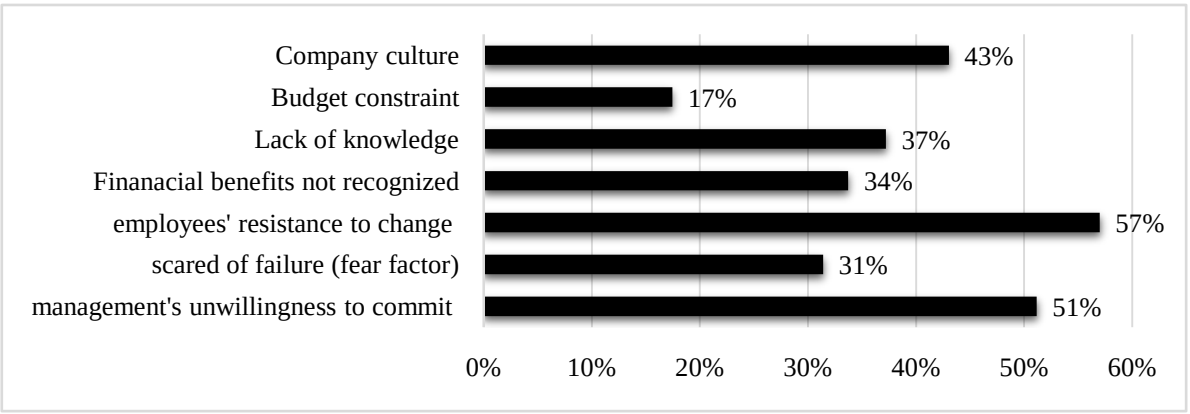

Fig. 5. Barriers in lean implementation

5 CONCLUSIONS

The status of lean awareness, implementation, barriers and benefits in manufacturing companies were investigated through a questionnaire survey. SPSS 22.0 software was used to determine the average mean score for each factor and certain statistical analyses were performed to evaluate the results. This study has given the better understanding of the current status of lean manufacturing implementation in the manufacturing enterprises situated in Karachi, Pakistan. The large industries are found to have a better understanding and familiarity with lean tools and techniques than SMEs, although they both have a good understanding of Lean major wastes. Moreover, defects, waiting and inventory were found the leading wastes in the manufacturing enterprises of Karachi Pakistan.

Large companies are more interested in implementing lean manufacturing in their organization than SMEs by adopting continuous improvement programs like, lean thinking and practicing various tools like VSM, Kaizen, and visual controls. While 5S, poka-yoke, and TPM have the same status of implementation in small, medium and large manufacturing industries. The benefits that the organizations have gained as a result of the successful lean implementation were improvements in the work, productivity, quality and flexibility in work, reduction in waste and inventory. The major barriers that the companies were facing in adopting lean were workers resistance, absence of management support, lack of knowledge and company culture. These challenges create many hurdles in the way to implement lean tools and techniques. To sum up the findings of this study, future researches should focus on in-depth inquiry using interviews, document review, observations, and qualitative methodologies.

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