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Efficiency Enhancement of Modern Manufacturing Industries through Lean Manufacturing System: An Overview

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ABSTRACT - Nowadays, the changing demand patters by the customers are increasing the pressure on the manufacturers. In this situation, manufacturers to sustain in the market are forced to do either toincrease the selling price of their product ortoreduce their internal costs of their organization. In this scenario, it is not possible to increase the selling price of the products. The only way is to reduce their experimental costs, internal costs and improve the quality of the products to survive in their field. This paper suggests a methodology to implement lean manufacturing system to enhance their efficiency significantly. As industries have a wide application of lean in their production activity. Realizing the potential for lean manufacturing system in their industrial environment, this paper is focused to cater future projected industrial needs. In this paper, the conceptual ideas and methodologies of lean manufacturing system are developed into tools and processes that help manufacturing organizations to improve their performances considerably.

Keywords -Economic crisis, lean manufacturing system, cost reduction, efficiency enhancement, economic growth.

1. INTRODUCTION

Nowadays, company leaders face the challenge of deciding which option to take when making critical decisions in regard to improving the product and marketing performance. Lean manufacturing represents a journey that should never end because it involves the identification and elimination of waste, and the continuous improvement of all operations involved in any form of work. As viewed by Karlsson and Ahlstrom (1996) [1], the ultimate goal of implementing lean production in an organization is to have the customer in focus when improving productivity, enhancing quality, shortening lead times, reducing costs etc.

As identified by Tempel, et al., (2001) [2], the top management presence and availability in the organization is one of the most critical points during the lean rollout. According to the AME (2004) [3], one of the most widely recognized challenges facing companies adopting a lean strategy is how to sustain initial momentum and develop a corporate culture with a built-in, ongoing commitment to that strategy. Claimed by Andreas (2005) [4], lean manufacturing is a philosophy for optimizing performance of the organizations in all functional areas, by utilizing the resources in a more efficient way and eliminate waste. Jorn (2009) [5] expressed that the numerous case studies have been published showing examples for the successful implementation of lean principles in different areas of corporate enterprises.

2. PROBLEM STATEMENT

Modern manufacturers are under intense, unrelenting pressure to find new ways to cut costs, improve productivity, and boost customer satisfaction. These parameters are usually achieved through developing creative and innovative approaches. The lean manufacturing system is a journey to becoming a world-class organization through continual improvements. This helps organizations to think more relevantly, clearly, creatively and innovatively pertaining to find solutions for the selected problems. Arrival of relevant, creative, innovative and optimal ideas for implementing lean manufacturing system in modern manufacturing industries pertaining to value creation, cost reduction, continual improvements, improve organizational performance and improve customer satisfaction are taken as research problem and conceptual solution methodologies are proposed.

3. LITERATURE REVIEW

According to Ritchie and Lewis (2003) [6], the wider literature about the role of existing theory, practice and research will shape future research. Kothari (2004) [7] expressed that the researcher should undertake extensive literature survey connected with the problem. Russell (2006) [10] stated that the contemporary practice of posing research in a wider literature is consistent with more recent articulations of grounded theory methodology and of the closely related case study methodology.

The literature review assesses the past and current status of research work in the area of lean production system, lean manufacturing system in quality improvements, lean manufacturing system in process improvements and lean manufacturing system in performance improvements. As expressed by Dankbaar (1997) [11], the lean production makes optimal use of the skills of the workforce by giving workers more than one task, by integrating direct and in direct work, and by encouraging continuous improvement activities.

Base on the statement given by Womack and Jones (2003) [12], the critical starting point for lean thinking is value. As per the statement given by Clare et al. (2005) [13], eliminating waste and zero-value added activity is one of the main goals of lean production. Jørgensen (2007)

[14]stated that anything that does not directly add to this value is regarded waste. As indicated by Marco (2009) [15], the need of manufacturing companies for a new model that goes beyond lean manufacturing to ensure the transformation of the enterprise into lean environment. Timothy and Mark (2010) [16] reported that the specific wastes are unacceptable, ideas can be sought to help minimize or even completely design the waste out of the process. Avoiding the wastes can drive even more efficiency into the solution.

4. BACKGROUND OF THE PAPER

Peter (1999) [17] expressed that the background concepts provides the research and researcher to make sense of the 'data' and the study to proceed in a systematic way. As described by Brian, et al., (2003) [18], the different backgrounds for the selective area of research has reducing the gap between the theoretical studies and practical analysis. In this paper the backgrounds of lean principles are presented.

Womack et al. (1990) [19] expressed that inspired by the waste elimination concepts developed by Henry Ford in the early 1900s.As expressed by Bergman and Klefsjo (2001) [20], lean manufacturing emphasis the importance of identifications of wastages and also to find out the root cause for the same. In the report of USEPA (2003) [21], rapid improvement events serve as a key tool for driving a waste elimination-focused culture change. Aberdeen Group (2005) [22] reports a 50% reduction in work-in-process inventory, a 50% reduction in manufacturing cycle time, and a 12% floor space savings in the original plant.

Noah et al. (2007) [23]through his work proved, applying lean principles to application development and maintenance can increase productivity by 20 to 40 % while improving the quality and speed of execution. As reported by Carlo (2009) [24], if the organization just had cut waste in their industry and public affairs by only 5% a year for the past 10 years there would be no crisis and no recession now.

5. RESEARCH APPROACH

As stated by Kothari (2004) [7], research approach is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. The various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them are to be taken. Martyn (2007) [8] stated that one of the strengths of the case study approach is that it allows the researcher to use a variety of sources, a variety of types of data and a variety of research methods as part of the investigation. Claimed by Yogesh (2009) [9] expressed that the research approach clearly establishes the nature of the problem and the logic underlying the investigation.The solution given in this paper has been carried out by using the research approach as shown in Figure.4.1.

As per the research work approach, the conceptual literature concerning the concepts and theories, and the empirical literature consisting of studies made earlier which are similar to the one proposed. After the conceptual stage, arrangements should be made for the selection of relevant manufacturing industry to carry out the case studies. The theories, rules and regulations of the lean manufacturing tools and techniques are studied thoroughly. The lean tool(s) should be finalized before conducting the lean manufacturing programme.

Necessary steps for conducting lean programme should be made simultaneously. Note down the outcomes clearly during the lean programme. Based on the outcomes achieved, an innovative model lean manufacturing system will be formulated, such that it could be widely applied for potential cost saving applications. The developed model can be applied to various industrial segments, which would enable to cater the current customer demanding needs.

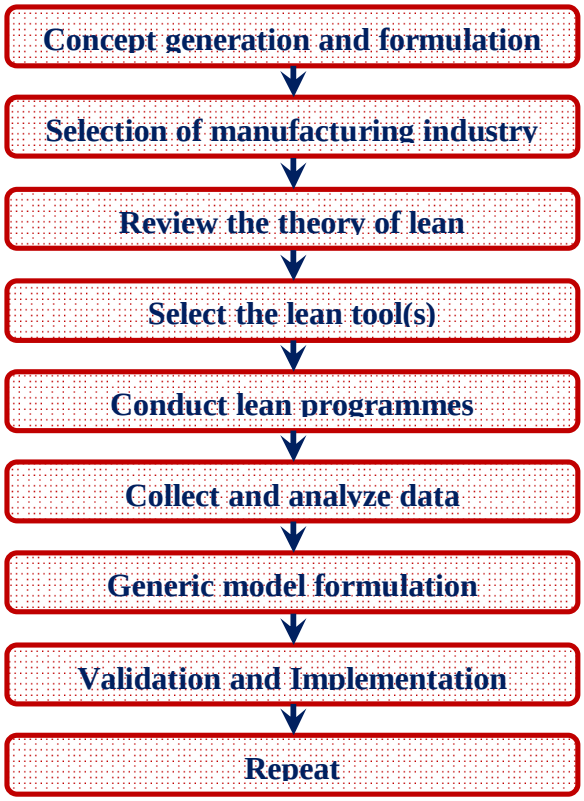

Figure 1 Research Approach

6. CASE STUDY

Bill and John (2001) [25] expressed that case study is a method / tool for research. Case study leads to very novel idea and no longer limited to the particular individual. Kothari (2004) [7] outlined that a case-study is an in-depth approach to reach the basic relationship between the theoretical and practical aspects. In order to examine the practical feasibility of integrating lean principles and software based mechatronics system in a traditional pump manufacturing industry had been chosen as a case study.

A. Industry initiation

As described by Rouhani (2006) [26], the initiative will significantly contribute to improve the level of research. Murray (2008) [27] explained that the successful of initiatives are based on the enterprise support, and funding. Further discussing on the same, Lucienne and Amaresh (2009) [28] described that the researcher has to take the initiative in finding a starting point and suggesting tentative solution areas. Getting permission for conducting brainstorming session in manufacturing industry and identification of existing wastages of a company / product / services will play a vital role during the process of analyzing data, decision making and to find optimal solutions.

B. Lean team formation

Auston (1997) [29] expressed that team embarking to design (or redesign) a process or an entire plant, it is necessary to take a broader scope of the system. As stated by Myles (1999) [30] as the team members mature, it slowly becomes increasingly autonomous, until it functions with minimal supervision. Peter and David (2000) [31]indicated that the team, consulting other process experts if necessary, must assess how much each of the goals is likely to contribute towards the key factor measures. Aberdeen Group (2005) [22] team formation for a specific goal enables the organizations to create and evaluate multiple line possibilities without disrupting current production. As described by AME (2009) [3], the selected team develops a set of critical success factors, with stretch goals that create gaps used to trigger improvement activities. Lonnie (2010) [32] explained that the team concept is very powerful and there is a real sense of assisting each other. Dantar (2010) [33] reported that the team set an aggressive target to cut development time in half for the new process.

C. Product selection

Andreas (2005) [4] stated that value can be created by the organization in terms of a specific product which meets the customers' needs. According to AME (2009) [3], employees perform a similar type of manufacturing operation on a wide variety of products assigned to their team to achieve more results. Claimed by AMTS (2009) [34], the real values of lean tools are their ability to capture and represent knowledge to make confident predictions to drive product and process design, and execution and management of the enterprise. The literatures for product life cycle, providing knowledge based environment to support value creation to the customers in term of innovation and customization, quality as well as sustainable and affordable products were studied thoroughly.

D.Time frame formulation

The product / process development cycle time is the most important factor that conditions the ability of the product to pay back benefits to the company. William (2001) [35] expressed that the time frame identifies major segments of the research, expected time for completion, and a sequence of events. As stated by Ritchie and Lewis (2003) [6] research involves decisions about the time frame for research - particularly the period of or point in time to which the research will relate, and the number of episodes of data collection required.

Lisa, et al., (2008) [36] indicated that completion of the research should be within the timeframe identified and within budget. As described by Lucienne and Amaresh (2009) [28] it becomes clear those criteria for product success, such as 'increase in profit', cannot be used as a measure given the timeframe. Murray (2008) [27] suggested that industry can maintain documents and records related to the research to estimate the manpower and time needed to execute the research project successfully.

E. Identification of product wastages

Frank and Brett (2003) [37] point of view; lean manufacturing provides a disciplined approach to the identification and reduction of wastages in all aspects. Andreas (2005) [4] stated that identification and elimination of waste makes it easier to focus on value adding activities and become more cost efficient. Heba (2007) [38] studies show that identification of critical problem(s) and generating of improvement suggestion(s) are performed in lean manufacturing approach. Claimed by Marcus (2008) [39], waste identification and waste elimination / reduction is a fundamental concern on the lean thinking philosophy. AME (2009) [3] reported that all employees are capable and responsible for problem identification and solving. As stated by Lonnie (2010) [32] lean emphasis the identification and elimination of waste, the improvement of quality and production time and cost reduction.

F. Departmental meetings

Andreas (2005) [4] expressed that all the team members have to work in the same way during departmental meetings pertaining to continual improvements. Brian (2008) [40] departmental meetings will be held the organizations for updates, reviews, and decisions to reach the desired goals. AME (2009) [3] team members attend many meetings to review research status and troubleshoot problems.

Based on the statement given by Jack and Derek (2010) [41], departmental meetings will require some discussion with the team members who will be doing their regular jobs while they are involved in collecting and analyzing data. Dantar (2010) [33] departmental meetings held with senior executives for a review of the progress, and requested approval to exit the current phase and enter the next phase. James (2010) [42] the purpose of departmental meetings is to review a team's activity backlogs and to find the root causes to overcome the backlogs.

G. Brainstorming session

According to Taylor et al. (1958) [43], the primary emphasis has been upon the effects of group participation during brainstorming. Maureen (1990) [44] point of view the brainstorming is a structured process for obtaining optimal ideas / solutions for the selected problem(s). CCI (1995) [45] reported that brainstorming is a term which was coined to describe a very powerful method for getting groups to develop creative ideas. As reported by Scott (1998) [46], brainstorming has been defined as a group tool designed as a supplement to individual ideation and usually followed by another session designed to evaluate and develop options.

Jeffrey (2005) [47] stressed that brainstorming can be a highly effective technique for maximizing a group's creative potential in order to generate ideas and determine which ideas are most likely to succeed. Centre for Excellence (2007) [48] ensured that brainstorm a fast, creative technique to generate bigger and better ideas…and explore whole new ways to solve problems and improve processes. David and Rusel (2009) [49] evaluated that one of the best ways to get great ideas in brainstorming sessions with whole staffs – marketing, research & developers, designers, purchasers, quality inspectors, production engineers, service engineers and so on.

H. Application of brainstorming technique in manufacturing industries

As stated by Alan (1997) [50], in any manufacturing industries, brainstorming helps them to think more clearly and creatively. Based on the statement given by David (2001) [51], brainstorming techniques have been introduced in any kind of industry to help develop creative thinking about projects and topics. Robert (2009) [52] stated that in manufacturing industries, the teamwork can be effectively utilized by simple procedures.

I. Consolidation of brainstorming session

Consolidation is the process of combining into an integral whole. All the points discussed during brainstorming sessions were reviewed along with the pump expert. Joan and James (2004) [53] indicated that consolidation needs assessment and evaluation wherever possible, which saves time and money and streamlines the process. As described by Lawrence (2005) [54] to scrutinize the proposed plan, prepare a consolidate list among the available points based on their nature before developing the action plan.

Jiju, et al., (2006) [55] reported that consolidation and centralization of data will place greater emphasis on lean continuity. Murray (2008) [27] expressed that many problems were identified through various methods and are needs to consolidate these problems into few based on their criticality. Wings (2009) [56] point of view, the lean tools are used by firms to further improve and develop a company's products and systems, via the consolidation of engineering, business and statistical data.

J. Voting, rating and ranking

According to Murray (2008) [27], for group decision making, the developers have created a voting interface for interactive ranking and classification options for groups and that can be moderated by a facilitator to survey and analyze submitted votes. Voting is a curious mix of intuitive and categorical selection; rating scores them against pre-selected criteria; ranking places ideas in order of preference.

Table 1. Voting, rating and ranking calculations

Sl. No	Description	Voting participants			Rating	Rank
		Disagree	Neutral	Agree		
		1	2	3		
1	Timely supply	73	68	45	344	10
2	Serviceability	74	71	41	339	11
3	Packing Quality	67	62	57	362	8
4	Aesthetic Look	83	68	35	324	13
5	Paint Finishing	88	84	14	298	15
6	Casting Finishing	69	66	51	354	9
7	Noise level	44	61	81	409	4
8	Low discharge	39	66	81	414	3
9	Seal leakage	81	71	34	325	12
10	Vibration level	35	62	89	426	2
11	Winding worn-out	63	52	71	380	7
12	Heat level	32	55	99	439	1
13	Overall efficiency	52	56	78	398	5
14	T.O.P Tripping	87	69	30	315	14
15	Bearing failure	55	57	74	391	6

The table 1 shows sample outcomes of a brainstorming session during the voting, rating and ranking analysis. thari (2004) [7] stated that categorical scales are also known as rating scales and

are used when a respondent scores some object without direct reference to other objects. Under comparative scales, which are also known as ranking scales, the respondent is asked to compare two or more objects. It is a powerful ritual suggesting participation, commitment and democracy. This approach scores highly with those who like to put numbers to their judgement.

Lucienne and Ameresh (2009) [28] stated that the ranking system is equivalent to a 'penalty' point system, where a '1' is the clearest type of interface and a '3' is the least clear. Qualitative data can be quantified, e.g., by classifying and ranking the data, but whether this is appropriate or not, depend entirely on the issue that is being addressed and the setup of the study.

K.Problem(s) selection

William (2001) [35] explained that when selecting a problem, it is important to keep in mind selection criteria and to have an understanding of what processes are required. As expressed by Ricky and Bruce (2004) [57] the selection of problems that account for the more significant reduction of labor, time, production lead time, cost and all other parameter in order to improve the product / processes / organizational performance. Lawrence (2005) [54] suggested that problems selection criteria must consider the risk of successful development, technical aspects (ability to deliver the functionality), cost, and schedule.

Josef (2005) [58] outlined that personal quality judgment will play a vital role, in the prioritization of the literature as well as the selection of the problems. As per the report given by Jiju, etal., (2006) [55] selection of problems is one of the most critical success factors influencing the outcome of the research. Dantar (2010) [33] outlined that the selection committee narrows the field based on pre-established criteria, then a team of judges representing both academia and industry visit during the problem selection.

7. VALIDATION

According to Janeri and Lewis (2003) [59], as a consequence, numerous suggestions are made about how to cross-check the validity of a finding or conclusion (validation) or to allow sufficient access to the research process for others to do so themselves (documentation). Checking accuracy of fit which involve deriving hypotheses from one part of the data and testing them on another by constant checking and comparison across different.Eric and Donna (2004) [60] stated that validation of a research would serve as a valuable decision support tool for future research.Martyn (2007) [8] suggested thatthe validation of the research findings are important tool for increasing their accuracy and authenticity.As per the report given byLisa (2008) [36] validation is further enhanced through co-researcher validation.Lucienne and Amaresh (2009) [28] explained thatvalidated and shared results are so essential for sustained progress in a research community.

8. RESULTS AND DISCUSSION

As stated by Murray (2008) [27], positive results helps create and maintain team spirit and commitment to the team objectives, most importantly, it may drive innovation within the team. Rouhani (2006) [26] insisted that the research results are significant, taking into account that traditional industry has to be changed into global competitive, innovative and technology developed industry. As expressed by Russell (2006) [10], the experimental results of an investigation can be conducive to further innovative work.Janeri and Lewis (2003) [59] reported that the discussions suggest a revision of the research objectives, or a radical change in the way in which the data are collected, and then there may be more reason to consider or not.

Mark and Peter (2001) [61] pointed out that the discussion aims to describe and explain some different options for qualitative research and to highlight the processes and issues involved in each.Lisa, et al., (2008) [36], discussion concerning a problem / solution often produces useful information. Various new ideas can be developed through such an exercise. The integration of lean technique and software based mechatronics systems very much successful for the prediction of product wastages. The various outcomes were discussed below.

A. Cost and time saving applications

The literatures suggest that there are large potential cost savings achieved through the implementation of lean manufacturing system in modern manufacturing industries. Womack et al. (1990) [19] studies show that Ford pursued partial implementation of lean system and could achieve substantial cost savings. As per the report given by Frank and Brett (2003) [37], the smaller companies had been achieved significant cost savings when implementing lean manufacturing system.

Hugh (2005) [62] expressed that when the organizations have desire to implement lean manufacturing system, roughly 50% improvement in the detailed engineering and drawing release cycle time, as well as cost savings. AME (2009) [3] reported that it had been discovered that a significant

cost savings achieved after the implementation of lean manufacturing system in manufacturing industries. As described by Dantar (2010) [33] the implementation of lean manufacturing system will bring immediate cost savings and long-term viability in the organizations. The expected cost and time savings after the implementation of lean in an organization is shown in figure.8.1.

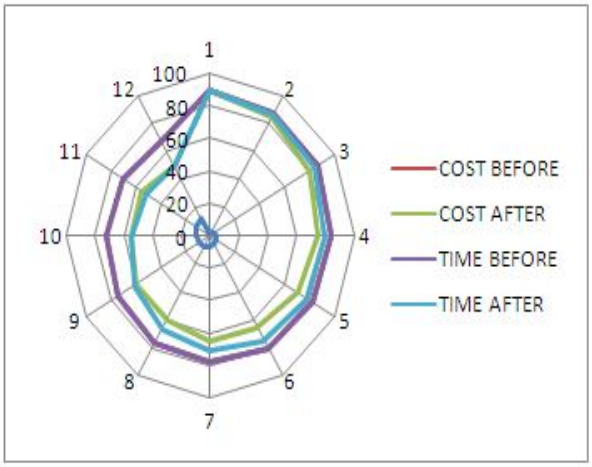

Figure 2 Cost and time saving applications

A. Benefits in industrial sectors

Auston (1997) [29] indicated that work in lean areas led to the conclusion that reducing the allowable customer lead time for post-payment production, would yield tremendous benefits both for individual factories as well as for entire linear distribution systems. Based on the statement given by Myles (1999) [30], at virtually every company, dramatic benefits are being achieved through implementation of lean practices includes new product introduction 30% down, producibility changes 75% down and production lead-time 65% down.

As per the report given by Clive (2004) [63] reported that when implementing lean, the company will be benefited 50% reduction in delivery time, 50% reduction in operation, maintenance and energy costs, 30% increase in productivity and comfort, 50% fewer occupant related illness and injuries, 50% less waste and pollution, 50% more durability and flexibility. Craig and Vodde (2009) [64] point of view, after the implementation of lean; the organization got the Indirect Benefits of Reducing Batch Size and Cycle Time. James (2010) [42] lean manufacturing benefits include indirect labor reductions of more than 60 %, material cost reductions exceeding 40 %, quality improvements in yield of more than 40 %, raw material reductions of greater than 30 %, and logistics cost reductions exceeding 30 %.

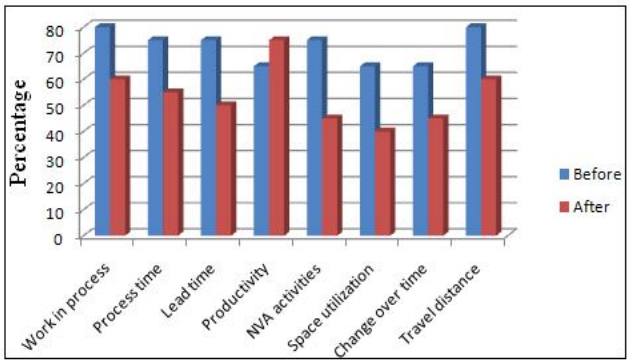

Figure. 3.. Expected benefits for industries

When the manufacturing techniques and software based mechatronics system are successfully integrated and implemented, the work-in-process, processing time, lead time, productivity, space utilization, change-over time, travel distance etc. as shown in figures 8.2.

B.Organizational performance improvements

Donald (1999) [65] stated that to improve overall operating performance, an expanding number of firms are adopting lean manufacturing system. Claimed by Jeffrey (2005) [47], when implementing lean, performance of the system will improve if the system is moving toward continuous flow by eliminating waste. Debbie (2004) [66] indicated that by understanding lean, it is easy to progress engineering, technical, and infrastructure dimensions are easy to achieve and sustain enterprise performance. Chris(2006) [67] expressed that the term lean refers broadly to a revolutionary approach to management that optimizes organizational performance.

As described by Jorn (2009) [5], lean have emphasized that methods and technologies supporting fast prototyping, simulation and testing of designs can significantly contribute to achieve high-performance. Dantar (2010) [33] explained that the beneficial achieved through lean system impact of innovation efforts goes far beyond corporate performance and actually drives the national economy. As per the report given by James (2010) [42] measuring and improving operational performance within an organization can be accelerated by effectively and efficiently deploying lean applications.

The above cited parameters have been demonstrated a considerable improvement in production environment; the lead time of each product will be reduced and the organizational performance is improved significantly as shown in figures 8.3. When the lead time and performances

are improved, then the customer satisfaction will improve automatically.

Figure 4. Performance improvements

9. CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH

This paper conclusion is based on the literature analysis during the conceptual design of lean manufacturing system. Auston (1997) [29] stated that lean manufacturing is processes constantly reduce the wastages through continuous improvement which eliminates the non-value added activities, and yields a manufacturing system. Claimed by Donald (1999) [65] lean emphasis channel-wide cooperation fostering, collaborative planning, forecasting, and replenishment which are growing ways to leverage cost-effective value for customers.

Jeffrey (2005) [47] expressed that the best way to understand lean manufacturing is to start with its roots in the importance of creating continuous material flow, standardizing processes, and eliminating waste. As stated by Debbie (2004) [66] lean manufacturing system had reliably and efficiently creating value and rapidly adapting to change. Chris (2008) [68] indicated that the lean production associate goes from value-added step to value-added step without interruption and without introducing non-value-added parameters.

Drew (2008) [69] explained that Lean identifies pure waste and must be eliminated wherever possible. As described by James (2010) [42] the goal of lean manufacturing is continual improvements, quick response manufacturing, reducing lead times, banishes waste and create wealth in organization. Dennis (2010) [70] reported that the intangible benefits of lean manufacturing system include the value of providing quicker response times than the competition, which aids in increasing market share, the reduction of workmanship quality issues, and the potential reduction in the number of operating shifts, management time, and the overhead costs resulting from productivity gains.

According to Brian, et al., (2003) [18], the results obtained in the present research will indicate the fresh opportunities and base for future research projects.Martin (2005) [71] pointed out that the validities of the present researches are to be confirmed and sustained by the future researches. As reported by AME (2009) [3], future research on how to create and maintain lean culture, including defining more specifically the artifacts and beliefs of the lean culture.Timothy and Mark (2010) [16] through his work proved that capturing and sharing knowledge helps the organization learn from past researches to solve problems and allows teams to accelerate discovery in the future research.

Future research of this development and application of lean manufacturing system in pump manufacturing industry will include: (1) full time lean team can be formed to achieve better results, (2) value stream mapping can be done for all activities, (3) System can be developed to record all activities, (4) new lean software can be developed and (5) research can be spread in to other manufacturing sectors. This will enable the pump and other manufacturers to observe relationships among the available sources. Also several methodologies will be developed in order to minimize the lead time and costs and maximize the profit, efficiency and customer satisfaction.

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