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A Review of Awareness and Implementation of Lean Manufacturing within Nigerian Small-Scale Manufacturing Companies

Taiwo E. Abioye[1, 2] and Emmanuel I. Bello[1]

1. Department of Mechanical Engineering, Federal University of Technology, Akure, Ondo-State, Nigeria

2. Manufacturing Division, Faculty of Engineering, University of Nottingham, Nottingham, NG7 2RD, United Kingdom

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Abstract: With the world trade agreements and the resulting of global competitions among the manufacturers through massive exchange of goods across the national borders, many sectors of Nigerian manufacturing industries particularly, small scale companies have virtually collapsed. In view of the fact that Lean Manufacturing (LM) thinking enables manufacturers to combine the good features of mass and craft production by mass producing goods at low cost and quickly reconfigure to accommodate a variation in product mix and design could be a way out for the ailing small-scale manufacturing companies. This paper presents the level of awareness and implementation of some selected LM tools/practices within the Nigerian Small-Scale Manufacturers (NSSMs). A field survey with a structured questionnaire, interviews and site visits were conducted to get necessary information from the respondents. One hundred small-scale companies were selected purposely to represent the best scenario of LM practices within Nigerian small-scale manufacturing companies. The findings revealed that the awareness and implementation levels of 5S, Kaizen, Kaban pull system and value stream mapping are very low whereas team work, staff training and visual management are extremely known therefore their implementation levels are high. Lack of full understanding of lean principles, high logistic problem in Nigeria, cost of implementation and large communication gap between the manufacturers and their suppliers and customers are identified as main barriers to full implementation of the LM tools within NSSMs.

Key words: Lean manufacturing, small-scale manufacturers, implementation, awareness, survey, tools.

1. Introduction

The increasing customers' demands for increased speed of delivery or service, higher quality and more flexibility all at lower cost have generated a new trend in the global manufacturing industries [1]. Therefore, securing a competitive edge in the current global competition is becoming increasingly difficult for the manufacturers. Consequently, many firms, particularly, small-scale companies are gradually folding up as it is becoming tough for them to catch up with the current challenges. As revealed by Ferdousi and Ahmed [2], the key to competing in the current international market is to simultaneously improve both quality and productivity on continual basis. Abdulmalek and Rajgopal [3] reported that Lean Manufacturing (LM) is one of the initiatives that many businesses in the United States have been trying to adopt to remain competitive in an increasingly intensive global market.

Lean manufacturing, a Japanese concept, is a production philosophy which shortens the time line between the customer's order and shipment through the elimination of waste and adoption of continuous improvement in the production system. The time line between the customer's order and shipment is often called Production Lead Time (PLT) which is now a

Emmanuel I. Bello, Ph.D., research fields: biofuel technology, operation management.

Corresponding author: Taiwo E. Abioye, Ph.D. in view, research fields: surface engineering and operation management. E-mail: tennyjoy2003@yahoo.com.

very important performance objective for the manufacturers in a fully competitive market. According to Womack and Jones [4], LM implementation is grounded in five principles. The principles are: specifying value from the customers' perspectives, identifying the value stream, creating the flow, introducing pull system and working towards perfection. The chief benefits of LM implementation include the use of fewer resources, rapid and efficient product development cycle, lower work in process inventories, smaller floor space requirement, higher throughput and greater flexibility [1, 5].

Due to the gains of LM implementation, manufacturers in many different business sectors and in many countries across the world have invested in the implementation of lean manufacturing practices [6]. For example, Royce Rolls, Jaguar and Toyota have secured strong competitive advantages in their respective competitive industries through the adoption of LM principles. To date, most Nigerian indigenous companies particularly, the small-scale manufacturing companies are yet to embrace fully the lean concept thus retarding in transforming themselves to world-class organizations. According to Rose et al. [7], there are more than hundred LM practices available and being practiced by industries. Due to their incapability to implement all practices at once, seventeen LM practices were considered feasible for the small-scale manufacturing enterprises at the beginning [7]. The feasible LM tools include Value Stream Mapping (VSM), Total Quality Management (TQM), Total Production Maintenance (TPM), 5S, Just In Time (JIT) practice, Visual Management (VM), Staff Training (ST), Team Work (TW), Supplier Management (SM), Kaizen or quality circles, Small Lot Size Production (SLSP), Daily Schedule Adherence (DSA), Single Minute Exchange of Die (SMED) or reduced set-up time, Cellular Manufacturing (CM), Equipment Layout (EL), Standard Operation Procedure (SOP) and Kaban pull system. Since LM implementation is a continuous process, small-scale manufacturers can sequentially run the feasible practices starting from the easiest or cheapest lean practice [8].

To understand the impact of LM principles on the survival of manufacturers in both global and local market competition, the level of awareness and implementation of LM must be conducted. In the past, review of the level of LM implementation has been carried out in different manufacturing sectors of some countries including China [9], UK [10], Malaysia [11] and United States [12]. However, no single literature is found reporting the level of awareness and implementation of LM within Nigerian manufacturers. The aim of this work is to ascertain the current levels of awareness and implementation of lean manufacturing within the Nigerian small-scale manufacturing companies. Furthermore, the barriers to LM implementation in Nigerian small scale manufacturing companies were investigated. Section 2 of the article reports the research methodology employed in the collection and analysis of data. Section 3 presents the results and discussion while section 4 gives the concluding remarks.

2. Research Methodology

A questionnaire was designed and structured to collect data for this study. According to Nachmias and Nachmias [13], all formal processes of questionnaire design, administration and validation were observed. The questionnaire was principally designed to assess the level awareness of lean manufacturing tools and implementation of lean practice among the selected companies. 100 small-scale manufacturing companies were selected across the country. The questionnaire consists of two parts. The first section surveyed the awareness of lean manufacturing tools while the second section investigates the level of implementation of the tools in Nigerian small-scale manufacturing companies. The Likert Scale 1-5 was used to rank the impact factors in the various areas. The most important factor being 5 and the least 1 where 1 = very low, 2 =

low, 3 = average, 4 = high and 5 = very high. The mean values of the total responses for each LM tool in sections A and B was taken as its level of awareness and implementation respectively.

One hundred copies of questionnaire were administered by personal visit to avoid postal problems and delay. Only 58 useful questionnaires were returned and this was considered a fair response rate. The respondent companies are in the wires and cables, food and drinks, pharmaceuticals and agro-allied. It was difficult in some cases to get across to the top managers of the companies visited hence lower cadre staff members with useful information on their companies were approached to fill the questionnaires. Attempts were made to explain very vividly the questions and the terms used in the questionnaire. The respondents were requested to ask for information they do not have from the relevant departments. Questionnaire with doubtful information were invalidated and in few cases, where doubts exists, repeat questionnaire and telephone confirmations were made.

3. Results and Discussions

3.1 Awareness of Lean Manufacturing Tools

Implementation of LM in any organization usually starts with lean training/education. Through lean education, the manufacturers get equipped with lean thinking, get familiar with lean tools and get to know about the overall benefits of LM practices. A study of the level of awareness of lean tools within Nigerian Small Scale Manufacturers (NSSMs) was first carried out. The lean tools investigated were the first seventeen feasible lean practices recommended for small-scale Manufacturing Enterprises (SMEs) [7]. The first section (A) of the questionnaire was designed primarily to ascertain the levels of awareness of these tools within the NSSMs. Data collected from the survey are presented in Fig. 1.

A value of 2.9 was found as the total average of the levels of awareness of the investigated lean tools. This simply implies that the overall awareness level of LM

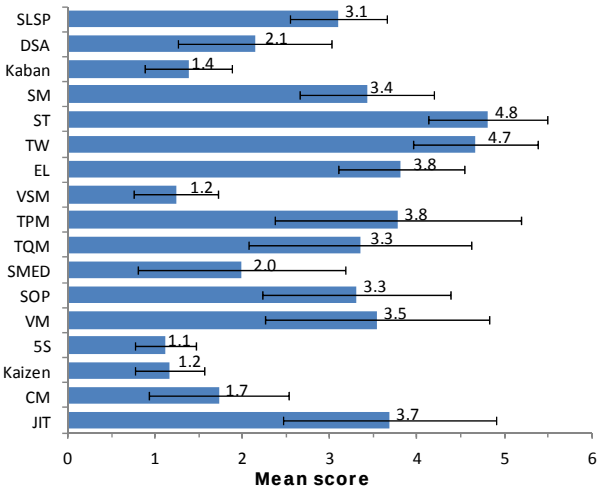

Fig. 1 The awareness levels of LM tools.

thinking within the NSSMs is fair. Team work and staff training have mean score of 4.7 and 4.8 respectively. This shows that the two tools/practices are most known by NSSMs thus their level of awareness is rated very high. However, the survey revealed 5S (mean score = 1.2) followed by Kaizen (mean score = 1.2) and Kaban (mean score = 1.4) as the three least popular LM tools among the NSSMs. Therefore their awareness level is classified very low. Among the remaining tools, the level of awareness of equipment layout, total production maintenance, visual management and Just-in-time system among the manufacturers is high. The mean scores of small lot size production, total quality management and standard operation procedure range between 2.5 and 3.4 therefore their awareness levels are rated average. Finally, the tools with low awareness level are daily schedule adherence, single minute exchange of die and cellular manufacturing all having mean scores of 2.1, 2.0 and 1.7 respectively.

3.2 Lean Manufacturing Implementation

According to Nordin et al. [11], LM practice can be broadly classified into five categories namely: process and equipment, manufacturing planning and control, human resources, suppliers' relationships and customers' relationship. In this study, the last two categories (i.e., suppliers' and customers' relationship) are jointly replaced with supply chain management.

The list of lean practices that comprises each category is presented in Table 1. Section B of the questionnaire was designed to determine the level of implementation of the lean tools/practices listed in Table 1 among the NSSMs.

3.2.1 Process and Equipment

The lean tools in this category are mainly practiced by the people at the Gemba aiming at shortening the production lead time by ensuring a functional process layout and eliminating all forms of non-value added time such as equipment breakdown time, long set-up time, time spent in searching for right tools, material travelling time, etc in the production system. In manufacturing companies, Gemba, i.e., an actual place where values are added to the product, is the factory floor. Non-value added time is a waste and it is the time spent on activities that do not add values to the product or process.

Of all the tools in this category, the survey, as shown in Fig. 2, shows that the implementation levels of TPM and EL both with mean scores of 3.3 and 2.8 respectively are fair within the Nigerian small scale manufacturers. SMED scores 2.3 therefore has low implementation within the manufacturers. Average scores of 1.2 and 1.4 are found for 5S and CM meaning that their implementations are very low within Nigerian small-scale manufacturing companies.

3.2.2 Manufacturing Planning and Control

Manufacturing planning and control focus on achieving day-to-day operational goals of an organisation. When approved by the top managers, lean tools in this category are anchored by the shop floor manager who gives daily instruction on what to produce, when to produce, how to produce and quantity to produce to the shop floor workers. In summary, LM tools in this category primarily focus on effective and efficient flow of information and materials along the production line thus removing production wastes such as work-in-process inventory, finished goods inventory, raw material inventory, re-work, production bottlenecks and all forms of waste that may originate from an unbalanced production system.

Table 1 Categories of lean manufacturing practices.

Category	Lean manufacturing tools
Process and equipment	5S, equipment layout, total production maintenance, cellular manufacturing, reduced set-up time (single minute exchange of die, value stream mapping, standard operation procedure, etc.
Manufacturing planning and control	Kaban pull production system, daily schedule adherence, small lot size production, visual management, etc.
Human resources	Team work, staff training, Kaizen, etc.
Supply chain management	Just-in-time delivery from suppliers, Just-in-time supply to customers, suppliers quality level, suppliers' and customers' involvements in product development programs, etc.

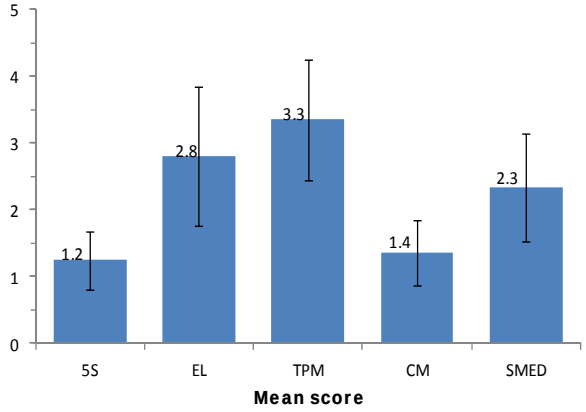

Fig. 2 Implementation levels of LM practices under process & equipment category.

As shown in Fig. 3, VM (mean score = 4.1) is extensively practiced whereas Kaban pull system implementation (mean score =1.0) is very low within the NSSMs. The result can be traced to the level of awareness of these lean tools within Nigerian manufacturers. Also, VM is relatively simple to implement when compared with Kaban pull system which requires some advanced technicalities and logics such as smoothening of production capacity and work force, and determination of takt time.

Takt time is the maximum time (expressed in seconds) allowed to producing a product in order to meet the customer demand. Additionally, the survey revealed that SLSP with mean score of 3.0 is averagely practiced but the implementation of DSA with mean score of 1.7 is low.

3.2.3 Human Resources

Staff development and involvement at all level of

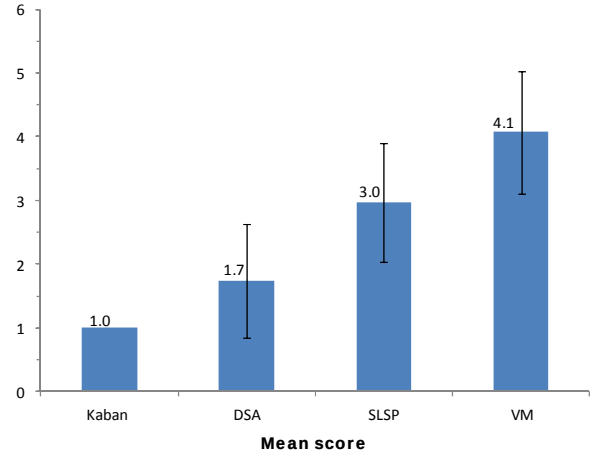

Fig. 3 Implementation levels of LM practices under manufacturing practice & control category.

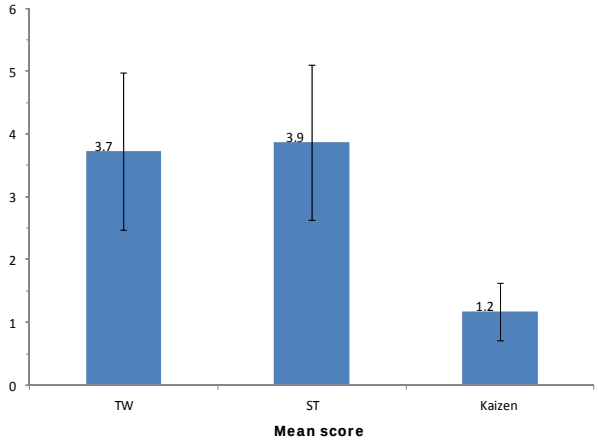

Fig. 4 Implementation levels of LM practices classified under human resources.

organization structure is a key to gaining staff commitment thus making them more efficient in an organization.

Taking ideas from shop-floor workers during decision making, regular staff training, etc. result in increased employee morale and skills which often boost production efficiency. Team work and Kaizen event are two important lean tools aimed at boosting staff involvement whereas employee are empowered through regular training. As shown in Fig. 4, implementations of team work and staff training within NSSMs are high. Both have mean scores of 3.7 and 3.9 respectively. A mean score of 1.2 recorded for Kaizen shows that the quality event is not known by the manufacturers. Therefore, its implementation is significantly low within Nigerian small-scale manufacturing companies.

3.2.4 Supply Chain Management

Maintaining an efficient and effective supply chain is a key part of Toyota production system. An effective supply chain management involves regulating the delivery of raw materials and supplies of finished goods in the right-small-amount, JIT, establishing a stable partnership with the suppliers and customers, information sharing and acquisition among the suppliers, manufacturers and customers, suppliers' and customers' involvements in product design and quality programme. The main benefits of this system are huge decrease in inventories, building long-term relationship of loyalty and trust with the two parties which will improve product quality, reduction in process and/or product variability. In general, a reduction in the cost of production is achieved.

As shown in Fig. 5, responses from the interviewed staff of the respondent companies revealed that the level of implementation of JIT delivery of raw materials to the Manufacturers (JIT-M) is low whereas JIT supply of finished products to the Customers (JIT-C) has been fairly implemented. In fact, further questioning made us to believe that full implementation of JIT-C is hindered by erratic supply of electricity, bad road and poor road network constituting high logistic problem in Nigeria. Low implementation of JIT-M was agreed to be caused by remoteness of suppliers to the manufacturers, long protocol that characterises Nigerian border system which delays supplies from foreign companies (suppliers). Consequently, manufacturers do order in bulk believing that cost is being saved and production will not be delayed. The implementation levels of Suppliers' Involvement in Quality Investment Programs (SIQIP), Suppliers' Involvement in Product Development Programs (SIPDP), Customers' Involvement in Quality Investment Programs (CIQIP) and Customers' Involvement in Product Development Programs (CIPDP) are found to be low. The result can be traced to low information sharing between the manufacturers and their customers and suppliers.

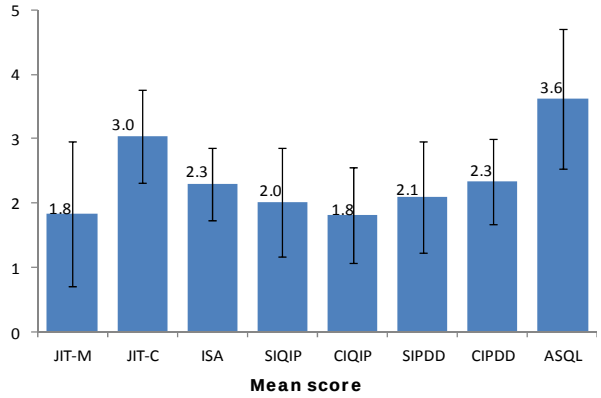

Fig. 5 Implementation levels of LM practices classified under supply chain management.

Out of the LM practices in this category which their implementation were reviewed, Appraisal of Suppliers' Quality level (ASQL) is rated high (mean score = 3.6). Reports from the returned questionnaires show that 73% of the respondent companies require for quality test certificates from their suppliers on each batch of supplied materials. The mean score for Information Sharing and Acquisition (ISA) among the three parties is 2.3 meaning that the NSSMs only share little information with their suppliers and customers.

3.3 Barriers of Lean Manufacturing in Nigeria

Following the results of the survey, it is evident that the major barrier to lean implementation among the NSSMs is lack of full understanding of lean concept. Since the overall average level of LM awareness is middling, the management and the entire staff therefore cannot fully and clearly picture the rewards of its implementation. Consequently, full implementations of these tools are hindered by the fear of unknown. The implementation levels of nearly all the tools are lower than their awareness levels. For example, awareness level of JIT and TPM are high but their implementations are average. Also, TW and ST have very high awareness level however their practices within NSSMs are high. The common cause of lower implementation level is found to be the cost involved.

Lower level of implementation of TPM is found to be primarily caused by the cost involved in equipping each workstation and regular training of the staff. Information gathered from the interviewers show that the companies shared only few information such as product quantity required from suppliers, item quantity delivered to customers and expected delivery time, change in product price, time to launch a new product, etc, with their suppliers and customers. Quality- and product development-related information are secretly kept within the middle and top managers. Accordingly, lack of proper and effective communication between the companies and their suppliers and customers constitute a great barrier to implementing efficient supply-chain by NSSMs.

4. Conclusions

The levels of awareness and implementation of lean manufacturing tools within Nigerian small-scale manufacturing companies have been successfully investigated. The overall average awareness level of lean manufacturing tools within the NSSMs is middling. The awareness level is found to be responsible for their low implementation within the NSSMs.

Out of the seventeen reviewed LM tools, 5S, Kaizen, Kaban pull system, and VSM have extremely low awareness hence very low implementation levels. The awareness levels of team work and staff training are extremely high whereas their implementation levels are high. The awareness and implementation levels of visual management within Nigerian small-scale manufacturing companies are both high.

Lack of full understanding and awareness of lean concept and its benefits have been identified as the major barrier to LM implementation within NSSMs. Other barriers include high logistic problem and long protocol required in moving raw materials across the Nigerian borders which hinder full practice of JIT system. Also, lack of proper and effective communication results in inefficient supply chain within the NSSMs.

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