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Lean Manufacturing Practices in Tanzania: Exploring Awareness, Training and Capital Investment

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ABSTRACT

With the growing competition among industries in the world, manufacturing industries are now forced to adopt the Lean Manufacturing philosophy to improve their competitive abilities. The adoption of the philosophy is very low in developing countries such as Tanzania, as is demonstrated with 1% of publications and the lack of knowledge and capital for Lean Manufacturing implementation causes this. Furthermore, the contribution of the sector to the Gross Domestic Product in Tanzania is low and stands at 8.4%. The study wants to bridge the gap in training, capital and awareness of Lean Manufacturing in Tanzania. Survey and purposive sampling techniques were adopted in the study. A structured questionnaire was used to collect responses from 243 manufacturing industries of all sizes. Descriptive and inferential statistics were analysed with SPSS version 27.0.1. The results demonstrated that there is inadequate training for micro and small industries as more than 80% have not received any training, have inadequate funds whereby more than 95% have not allocated funds and low awareness with a mean score of below 3 out of 5. The status is contrary in medium and large industries, with more than 75% training provision. It was also revealed that 90% of large industries have allocated funds while for medium ones it is more than 39% and the awareness for Lean Manufacturing is high as they have a mean score of above 3. The Lean practices with high levels of awareness to all manufacturing industries are 5s, concurrent engineering and visual management. The low level of awareness, training and insufficient capital for Lean Manufacturing affect the adoptions of the philosophy in Tanzania. Therefore, the study will assist practitioners and policymakers in setting strategies for bridging the gap in the adoption of Lean Manufacturing in developing countries such as Tanzania.

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INTRODUCTION

With an increase in the importation of cheap Asian goods in developing countries such as Tanzania, manufactured goods from internal industries are facing heavy competition with imported goods (Lugina *et al.*, 2022). To cope with the competition, industries are now forced to adopt Lean Manufacturing to survive in this turbulent business environment (Nawanir *et al.*,

2016). Lean Manufacturing is used to eliminate nine types of waste, which are defects, overprocessing, waiting time, non-utilised talent, transportation, inventory, unnecessary motion, excess production and environmental wastes (Patel *et al.*, 2022; Sinkamba *et al.*, 2023). Lean Manufacturing has several benefits to organisations, which include lowering inventories; improving quality; reducing lot size, waste, rework, manufacturing cost and lead times; increase in morale and motivation; flexibility, productivity increment; reduced delivery time; and reduced cycle time (Ainul *et al.*, 2017; Chaple *et al.*, 2021). Effective use of lean tools and practices will lead the implementing organisations to benefit economically and environmentally. Moreover, sustainable development can be achieved through the application of Lean Manufacturing in organisations (Kafuku, 2019).

Various studies have indicated that the adoption of Lean Manufacturing implementation in developing countries is low compared to developed countries. The adoption of Lean Manufacturing in Tanzania and Africa in general is low, demonstrated with one percent of publications for Lean Manufacturing in low-income developing countries (Sinkamba *et al.*, 2023). A study by Negrão *et al.* (2020) conducted in Brazil revealed that adopting lean practices in low economic and technological development countries is fragmented compared to developed countries. Moreover, a study by Panwar *et al.* (2016) conducted in India revealed that the adoption of Lean Manufacturing is hindered in developing countries due to unfamiliarity with the tools and philosophy, lack of expertise, education and support from top management. Another study conducted in India, a middle-income country, demonstrated that Lean Manufacturing dissemination is hampered by the lack of in-depth training (Sahoo and Yadav, 2018). Likewise, Ohiomah and Aigbavboa (2015) observed the challenges for Lean Manufacturing adoption in Nigeria, identifying lack of familiarity with lean tools, lack of awareness of the benefits of Lean Manufacturing and lack of knowledge as the main hindrances to the adoption of the philosophy. All these studies show that the adoption of lean manufacturing in developing countries is low. The lack of awareness of the tools, Lean Manufacturing training, and capital might influence this.

The low adoption of the philosophy in Tanzania has affected the performance of manufacturing industries in terms of the quality of products and production cost, impacting their market competitive position in the global market. As a result, customers opt to use cheap and quality imported goods from Asian countries such as China (Lugina *et al.*, 2022). The poor performance of the manufacturing sector is further reflected in its contribution to the country's economy. The contribution of the sector to the Gross Domestic Product (GDP) in Tanzania is low; it is currently estimated to be at 8.4 percent (Mwinuka and Mwangoka, 2023). Despite Lean Manufacturing being in place for decades now, most developing countries still struggle to adopt it due to insufficient understanding of the philosophy (Sinkamba *et al.*, 2023). To increase understanding of the philosophy, there is a need to create awareness of the tools and the philosophy. Likewise, training on Lean Manufacturing practices and tools is required. To date, limited studies have evaluated the readiness of manufacturing industries in Tanzania in terms of training provision, availability of capital and awareness of lean tools for all levels of manufacturing industries that is micro, small, medium and large industries.

The research intended to address the following three research questions (RQ): (i) What is the level of training provision for Lean Manufacturing for micro, small, medium and large industries in Tanzania? (ii) What is the budget allocated for Lean Manufacturing implementation for micro, small, medium and large industries in

Tanzania? (iii) What is the level of awareness of lean tools and practices for micro, small, medium and large industries in Tanzania?. The study is important as it highlights the availability of training, capital and awareness for Lean Manufacturing in Tanzania at all levels of manufacturing industries. The status obtained will assist in providing the strategy for increasing the implementation of Lean Manufacturing, which at last might assist in bridging the gap of adoption between developing and developed countries in terms of Lean Manufacturing adoption. Moreover, the study will be used by the policy makers in setting the strategies and policies for raising funds and awareness and organise training for the manufacturing industries in Tanzania.

LITERATURE REVIEW

Lean Manufacturing

Lean Manufacturing is a philosophy that tries to improve the organisation's competitive advantage in the market by increasing efficiency and reducing cost by eliminating non-value added activities and inefficient processes (Belekoukias *et al*., 2014). Nonvalue added activities do not add any value to the organisation, such as unnecessary movement and excess inventory (Kafuku, 2019). Lean originated in the shop floor of manufacturers in Japan, specifically innovations made at Toyota Motor Corporation in the early 1980s. Innovations raised due to scarce resources and strong domestic competition in Japanese market for automotive industries. Innovations include Just in Time (JIT), Kanban method of pull production, respect for employees and a high level of problem solving (Hines *et al.,* 2004). All these lean management operations focused on the elimination of waste and excess materials on the production floor at Toyota Motor Corporation and were introduced to improve the competitive advantage of the industries against their rivals in the domestic and international markets (Gonzalez *et al.,* 2019).

To date, Lean Manufacturing is very popular as it is estimated that 70% of the world organisations, whether manufacturing or non-manufacturing, have either implemented or to some extent applied lean tools in their production processes (Ainul *et al.,* 2017; Kafuku, 2019). The main focus of Lean Manufacturing is reducing waste in the process of responding to customer requirements (Brito *et al.,* 2020; Setianto and Haddud, 2016). Despite several benefits of Lean Manufacturing, its adoption in developing countries such as Tanzania is very low, as most manufacturing industries have not achieved the benefits of lean (Negrão *et al.,* 2020; Yadav *et al.,* 2020). This shows there is a need to explore various inputs in the Lean implementation, such as capital and training, to bridge the gap in the implementation of Lean Manufacturing in Tanzania's manufacturing industries.

Lean Manufacturing Tools and Practices

Lean Manufacturing tools and practices have multiple names, some overlapping with one another. The tools and practices are used to eliminate non-value-added activities in the operations of various organisations. Various studies have evaluated the application of Lean tools in various countries for various sectors such as manufacturing. The highly practised tools in manufacturing industries of Tanzania are pull production, set-up time reduction, production levelling (heijunka), product design simplicity, just in time (JIT), cross functional teams, employee involvement, training, daily schedule adherence, customer and supplier involvement in design, group involving in design, continuous flow, Total Preventive Maintenance (TPM), error proof equipment, kaizen, 5s, as well as customer and supplier involvement in quality control (Kafuku, 2019). Lean tools which are highly applied in processing industries of

India include 5s, TPM, visual control, work standardisation, statistical process control, quality management programme and cross-functional team (Panwar *et al.*, 2015). However, according to Jasti and Kodali (2016), the tools which are highly used by manufacturing industries in India are cross-functional teams, multi-skilled workforce, kanban system, pull production, one piece flow, mistake proofing, statistical process control (SPC), JIT, small lot production, Value Stream Mapping (VSM), Single Minute Exchange of Die (SMED), workload balancing, continuous improvement, work standardisation, TPM, visual control and production levelling.

This study used tools which are presented in Table 1 to evaluate the awareness of the lean tools for manufacturing industries in Tanzania. The tools were classified based on five main categories of lean tools which are customer, supplier, human resources, manufacturing planning and control, and process and equipment (Alefari *et al.*, 2017). The tools were selected since they are relevant and fit for the context of developing countries like Tanzania.

Table 1: Lean manufacturing practices and their categories

Lean Category	Lean Practices and Reference
Customer	Customer involvement in design, customer involvement in quality (Kafuku, 2019; Sahoo, 2020)
Supplier	Feedback of performance metrics, supplier in the design, JIT delivery by suppliers, Lean supplier development (Kafuku, 2019; Panwar *et al.*, 2015)
Human Resources	Workforce recognition and reward, empowerment, teamwork and leadership, quality circle, multifunctionality and problem solving (Jasti and Kodali, 2016; Sahoo, 2020)
Manufacturing Planning and Control	New product development, Levelled production, Total Quality Management, Visual management of quality control, Pull production, Concurrent engineering, Statistical Process Control, Design for manufacturability, Visibility and information exchange, Visual management of production control (Jasti and Kodali, 2016; Panwar *et al.*, 2015; Sahoo, 2020)
Process and Equipment	Layout size and shape, autonomation, continuous flow, cellular manufacturing, set up time reduction, Total Preventive Maintenance, work standardisation, 5s, Value Stream Mapping, Kaizen (Belekoukias *et al.*, 2014; Jasti and Kodali, 2016)

Questioning Lean Manufacturing: Awareness, Training and Capital

Awareness

Many small and medium enterprises (SMEs) in developing countries are unaware of the tools and benefits of lean manufacturing. Qureshi *et al.* (2022) conducted their study in India and revealed that most employees were not providing good cooperation on the adoption of the philosophy due to a lack of understanding of the benefits and the use of the tools; as a result there was low adoption on the philosophy. Minimum investment in the Lean Manufacturing training makes the transition to the new manufacturing philosophy slow in organisations as they lack supportive environment for the implementation such as understanding of the philosophy by all employees in the respective organisations. Lack of awareness and benefits regarding adopting Lean Manufacturing were among the barriers to implementing the philosophy in Brazil (Primo *et al.*, 2021). For industries to benefit from Lean Manufacturing, employees need to be aware of the philosophy. Awareness creation made to Ethiopian manufacturing industries led to the improvement in the adoption of lean tools such as kaizen, compared to when they were unaware of the advantages of kaizen (Berhe, 2022).

The performance of manufacturing industries in Tanzania is not good, as it is reflected in the contribution of the sector on

the country's GDP, which is very low (Mwinuka and Mwangoka, 2023). Based on that, this study aimed to evaluate the awareness of the Lean Manufacturing philosophy in Tanzania since few studies have been conducted on the subject matter in the context of Tanzania and other developing countries of sub-Saharan Africa. Moreover, few studies have evaluated awareness and application of Lean Manufacturing tools using the Awareness, Interest, Desire and Application (AIDA) model. The model has been widely used in marketing studies such as a study by Hassan *et al.* (2015), which evaluated social media's impact on marketing goods and services in small business organisations in Malaysia. This study looks at the influence of awareness, among others, on the application of lean practices.

Training

Training in manufacturing organisations is crucial for imparting knowledge to employees on various issues. As revealed by Qureshi *et al.* (2022) on the study conducted in India, employees resisted adopting Lean Manufacturing practices for SMEs because of lack of appropriate training on the lean tools and benefits expected by adopting the philosophy to both employees and organisations. Based on the lack of knowledge, employees were worried about adopting the philosophy to avoid mistakes and the probability of losing their jobs. Failure to adopt the Lean Manufacturing philosophy makes manufacturing industries such as SMEs miss benefits from the advantages of the philosophy (Qureshi *et al.,* 2022). Furthermore, lack of training has resulted in slow adoption of the philosophy in other developing countries such as Brazil. A study by Primo *et al.* (2021) conducted in Brazil revealed that with a lack of knowledge on the philosophy, there was a small pace for its adoption. Thus, manufacturing industries proceeded with using traditional manufacturing methods that do not benefit the organisations as they are characterised by a high rate of waste production, such as high inventory (Primo *et al.,* 2021). Lack of training has also been observed as one of the barriers to Lean Six Sigma in automobile industries in India. The adoption of the philosophy is hampered by the lack of the necessary understanding of the philosophy, for example which tools are needed for a certain kind of waste. As training is not provided, there is low adoption of the philosophy and thus manufacturing industries lack operational and financial benefits of the Lean Six Sigma implementation (Rathi *et al.,* 2021).

For effective implementation of Lean Manufacturing, there should be repetitive training of lean to employees and professional education for easily understanding of the technical terms. Continuous training eliminates hurdles that might appear during the implementation process. The same is not observed in developing countries such as India, where they do not have repetitive programmes for lean training and operators lack professional education. Lacking of professional education makes operators struggle to understand the philosophy especially when technical terms are used (Alkhoraif *et al.,* 2019). Based on the fact that training is important for the adoption of the philosophy, this study intends to evaluate the gaps in the provision of training related to Lean Manufacturing and manufacturing industries in Tanzania. To date, few studies have evaluated the status of lean training in developing countries of Sub-Saharan Africa, such as Tanzania.

Capital Investment

Most SMEs fail to adopt Lean Manufacturing successfully due to lack of funds for the implementation. As most SMEs are characterised by low investment in capital, they lack funds from either internal or external funding for the facilitation of Lean Manufacturing implementation in terms of training and

purchasing of necessary tools (Sinkamba *et al., 2023; Zhang et al., 2017).* For the successful implementation of Lean Manufacturing, investment in cost and funds is important as it will ensure that employees in organisations get the necessary training to implement the philosophy. SMEs struggle to find funds as they lack sponsors; they do not collaborate strongly with other financial organisations such as banks. As a result, a lack of funds becomes a barrier to adopting the philosophy (Chaple *et al.,* 2021). With the information above and the lack of enough literature on the status of capital investment for Lean Manufacturing in Tanzania and other developing countries of Africa, this study evaluates the status of capital investment in the context of Tanzania.

Conceptual Framework

The conceptual framework shows the relationship between the independent and dependent variables of the study. Independent variables in this study include awareness level, training level and fund allocation for Lean Manufacturing implementation, while the dependent variable is the application of lean practices. Figure 1 shows the conceptual framework of the study.

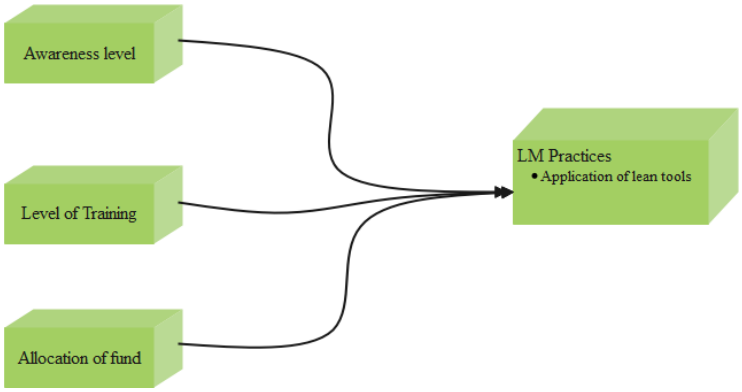

Figure 1: Conceptual framework of the Study.

The allocation of funds to facilitate training for Lean Manufacturing and other activities related to Lean Manufacturing is vital for the increase in the application of Lean Manufacturing practices. Likewise, training is essential for the effective implementation of Lean Manufacturing as it may enable employees in manufacturing organisations to understand and apply lean tools efficiently, as quoted in Bloom's taxonomy. Moreover, training will increase awareness of Lean Manufacturing tools and practices. With a high level of training and awareness of Lean Manufacturing tools, adoption of the philosophy will increase (Ramadas and Satish, 2018; Sahoo, 2020). In short, applying Lean Manufacturing practices depends on awareness, training and capital investment, as shown in equation (1).

$$LMP = f(A \times T \times C) \quad (1)$$

where: LMP represents lean manufacturing practices, A is the awareness index, T depicts Training while C stands for capital investment.

METHODS AND MATERIALS

Data Collection Approaches

A survey research design was used to collect data for this study. It was revealed that 30% of the Lean Manufacturing studies used survey research design as the method for data collection (Alkhoraif *et al.*, 2019). This study also used the same research design to collect data from respondents. Furthermore, the survey is preferably used to collect large data (Zhou, 2016). Data were collected from manufacturing industries located in three regions of

Tanzania: Dar es Salaam, Arusha and Mbeya, with the help of a structured questionnaire. The regions were selected since they have many industries; thus, they have a good presentation of all industries for various levels of manufacturing industries (URT, 2016).

The questionnaire consisted of two main sections. The first section comprised background information of respondents and the other comprised questions related to provision of training, availability of funds and awareness of Lean Manufacturing practices. Lean Manufacturing practices used in the questionnaires were adopted from various literature on Lean Manufacturing as presented in Table 1. The questionnaire comprised both open-ended and closed-ended questions. The 5-point Likert scale was used to evaluate the extent of awareness of lean tools and practices. The same approach was used by other studies, such as Ahmed *et al.* (2021) and Hyarat *et al.* (2024) in evaluating the awareness level based on the use of lean practices and tools for the construction industries in Bangladesh and Jordan respectively. Moreover, the 5 -point Likert scale was used to determine the extent of training provision and the availability of funds for Lean Manufacturing in Tanzania. The 5-point Likert scale was interpreted as follows: 1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, and 5 – Strongly agree. A structured questionnaire is the preferred data collection tool for studies of this kind, which was the basis for its use in this study (Jasti and Kodali, 2014; Psomas *et al.*, 2018; Belhadi *et al.*, 2019).

Reliability and Validity Testing

Before structured questionnaires were distributed to the respondents, the validity and reliability of the questionnaires were tested. Validity was tested with the help of content validity whereby the questionnaires were distributed to senior practitioners from manufacturing industries in the selected regions (Dar es Salaam, Mbeya and Arusha) and selected academicians with vast experience in Lean Manufacturing from the University of Dar es Salaam to remove ambiguities. The feedback from academics and practitioners was used to refine the questionnaire. Reliability was tested by using SPSS; it was found that all tested constructs had Cronbach's alpha of above 0.7, signifying that the constructs of the questionnaire were reliable.

Population and Sample Size

The population of this study included all manufacturing industries ranging from micro to large industries in three selected regions of Tanzania: Dar es Salaam, Mbeya and Arusha. The regions were selected since they have a good representation of all levels of industry, including micro, small, medium, and large. According to the 2013 industrial census, there are 12,331 industries in the selected regions (URT, 2016). The sample size of 388 manufacturing industries was obtained with the help of the Yamane formula, as shown in equation (2).Yamane was selected since it is a powerful method for calculating sample size in survey studies (Adam, 2020). Purposive sampling techniques were adopted in this study as they are commonly used in many Lean Manufacturing studies (Susanty *et al.,* 2021; Uday *et al.*, 2023). The study targeted respondents with an education level of diploma and above since the ones with low levels of education are not well versed in technical terms related to Lean Manufacturing. One respondent from each industry was used in this study because of the mixed-size sample from micro to large industries; in micro industries, it is impossible to get more than one respondent (Al-Hakimi *et al.,* 2023). Three hundred eighty-eight questionnaires were sent to the manufacturers through email and WhatsApp. As micro and small industries comprise more than 90% of all industries in Tanzania (URT, 2016), taking a sample based on the proportion could not bring a good picture of the results; therefore, the sample size was divided into

four equal sizes. A total of 97 questionnaires were distributed to each of micro, small, medium and large industries. A total of 256 responses were received from the respondents; upon data cleaning, 243 responses, equivalent to 66% of all respondents, were found to be useful for analysis. A response rate of 66% is appropriate because other studies related to Lean Manufacturing obtained a response rate of 41.38%, which was regarded as a fair response rate (Kale *et al.*, 2022).

$$n = \frac{N}{1+Ne^2} \quad (2)$$

where: N = population size, e = margin of error and n = sample size, with a 5% margin of error. Now, assuming the population size N of 12,331 the sample size should be 388.

Data Analysis

Data were analysed using SPSS version 27.0.1 and Excel to get descriptive and inferential statistics. Mean was used to determine the extent of awareness of lean practices and the availability of funds for lean manufacturing implementation at all levels of manufacturing industries in Tanzania. The extent of training provision was analysed by using frequencies for the provision of training. The mean score of 3 (60%) and above demonstrates that there is awareness of the tools and funds allocated for the implementation. ANOVA was calculated to check if there is a significant difference in the extent of awareness, provision of training and the allocation of funds for Lean Manufacturing implementation at various levels of manufacturing industries. A p-value was used to determine the significant difference. If a p-value is less than or equal to 0.05, it means that there is a significant difference in awareness of the lean tools, extent of provision of training and allocation of budget.

RESULTS AND DISCUSSION

Demographic Information

Education levels of the respondents were as follows: diploma was 35.4%, the degree was 58.8%, and postgraduate was 5.8%. This demonstrates that most of the respondents had attained a high level of education and were able to understand the concepts of Lean Manufacturing, as it is advised for those involved in the implementation of the philosophy (Robertsone *et al.*, 2022).

The working experiences of respondents were as follows: 0 to 5 years of experience were 19.8%, 5 to 10 years were 34.2%, 10 to 15 years were 16.5% and above 15 years were 29.6%. This demonstrates that most respondents had a working experience of 5 years or more. The long experience of workers shows that what was provided by the respondents represents the reality obtained from the long-serving in the industries.

The departments that led with a high number of respondents were production (74.9%), followed by marketing (9.5%), quality (6.2%), finance (5.8%), maintenance (1.6%), logistics (1.2%), as well as research and development (0.8%). This shows that most responses were from the production department, and the results reflect lean implementation based on production operations in manufacturing industries. Moreover, the results show that almost 78.6% of respondents were from SMEs, while only 21.4% were from large industries. The large number of respondents from SMEs might be due to the fact that the majority of the manufacturing organisations in the world are from SMEs; for instance, in India, more than 80% of manufacturing organisations are SMEs (Thanki and Thakkar, 2020), while in Africa, more than 90% of formal sectors are from SMEs (Mutalemwa, 2015). This might be attributed to the fact that SMEs are drivers of the economies in most of the countries in the world (Sajan and Shalij, 2020).

Categories of manufacturing industries used and participated in the study were food, beverages and tobacco; textiles, apparel and leather; wood products and furniture; paper, paper products and

printing; chemical products; non-metallic mineral products; basic metal industries and fabricated metal products as used in a study by Mgwatu (2019), evaluating the link between quality management practices and manufacturing industries performance in Tanzania. Participation of industries in this study were as follows: food, beverages and tobacco (30%), textiles, apparel and leather (22.6%), wood products and furniture (11.9%), paper, paper products and printing (5.8%), chemical products (6.6%), non-metallic mineral products (2.1%), basic metal industries (5.8), and fabricated metal products (15.2%) as shown in Table 2. The distribution of manufacturing categories and levels of manufacturing organisations are also shown in Table 2. As 80% of all respondents were from four categories of industries–which are food, beverages and tobacco; textiles, apparel and leather; fabricated metal products; and wood products and furniture–the results obtained in this study are highly reflecting the status of Lean Manufacturing implementation for the four categories of manufacturing industries in Tanzania.

Table 2: Manufacturing industry categories and levels of manufacturing organisations

	Level of Manufacturing Organisation					
Industry Category	**Micro**	**Small**	**Medium**	**Large**	**Total**	**Percent**
Food, Beverages and Tobacco	8	23	17	25	73	30.0
Textiles, Apparel and Leather	27	23	0	5	55	22.6
Wood products and Furniture	12	16	0	1	29	11.9
Paper, Paper Products and Printing	3	4	5	2	14	5.8
Chemical Products e.g Plastics	0	3	1	12	16	6.6
Non Metallic Mineral Products	0	0	1	4	5	2.1
Basic metal Industries	0	1	11	2	14	5.8
Fabricated Metal Products	10	23	3	1	37	15.2
Total	**60**	**93**	**38**	**52**	**243**	**100.0**

Extent of Training Provision

The availability of training for micro and small organisations was low, as demonstrated in Figure 2 which shows 90% of micro industries and 82% of small industries have never received any kind of training related to Lean Manufacturing. The rate of training provision for medium and large industries is somehow impressive as 79% of respondents from medium industries and 94% from large industries admitted that they had received training for Lean Manufacturing. Furthermore, medium and large industries are receiving repetitive training as it was demonstrated that 63% of medium industries receive often training and 3% receive always while for large industries, 67% of industries receive often training and 17% receive training always. Moreover, the ANOVA results as shown in Table 3 have a large F – test value of 302.997, which suggests that there is a significant difference in the provision of training for various levels of manufacturing industries in Tanzania, such as micro, small, medium and large industries. At the same time, the p-value of 0.000 which is less than 0.05 confirms there is a significant difference on the provision of training among levels of manufacturing industries, that is micro, small, medium and large industries.

The low level of training for micro and small industries might be causing the low adoption of Lean Manufacturing and challenges during implementation of the philosophy in Tanzania (Panwar *et al.*, 2015). This is because employees do not have the necessary knowledge of the implementation of the philosophy, which

leads them to resist its implementation (Martínez-Jurado and Moyano-Fuentes, 2014). Lack of training for Lean Manufacturing philosophy has made the adoption of Lean Manufacturing in most developing countries to be low (Sahoo, 2020). Furthermore, the literature shows that the low level of training for SMEs is caused by their reluctance to take training because of the higher investment required for Lean Manufacturing training (Ahmad *et al.*, 2021). The reluctance is accelerated by the fact that most SMEs in Tanzania have low capital. According to Tanzania's small and medium enterprise policy (URT, 2002), the capital invested by micro industries is less than five million Tanzanian shillings, and for small industries, it is less than 200 million Tanzanian shillings. Medium and large industries receive repetitive training to a large extent; this might be why these industries are performing well in case of adopting Lean Manufacturing compared to micro and small industries (Sahoo, 2020).

The results obtained in this study are supported by the studies such as Ramadas and Satish (2018) in India, Panwar *et al.* (2016) in processing industries of India, Jaiswal *et al.* (2021) in India, Sinkamba *et al*. (2023) in Tanzania, Negrão *et al*. (2020) in Brazil and Qureshi *et al.* (2022) in India. The studies indicated that there is a low level of training for SMEs in developing countries, causing obstacles to Lean Manufacturing implementation. The results are in line with the findings of the current study which has shown that there is a low level of training for micro and small industries; but they differ on the aspect of medium industries where this study has shown that in Tanzania there is a high level of training provision for Lean Manufacturing for medium industries.

Training gaps which have been observed in this study could be filled by manufacturing organisations to set appropriate strategies for providing Lean Manufacturing training to all members of the organisations–starting from operators to the higher levels of management–to have a common understanding on the benefits of the lean philosophy in the organisations before its actual implementation.

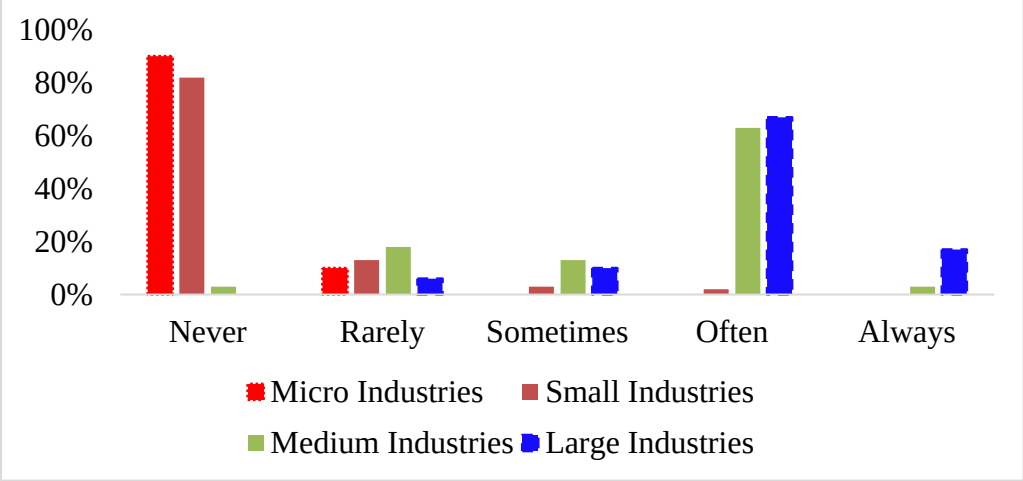

Figure 2: Extent of provision of training on lean manufacturing.

Table 3: **ANOVA results for the provision of training**

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	374.719	3	124.906	302.997	0.000
Within Groups	98.524	239	0.412		
Total	473.243	242			

Funds Allocation for Lean Manufacturing Implementation

Results show that 61% of medium, 98% of small and 95% of micro industries have not set aside funds for Lean Manufacturing, as shown in Figure 3. Moreover, 13% of medium and 5% of large industries have set aside funds ranging from five to 200 million Tanzanian shillings, and 6% of large industries have set aside capital ranging from 200 to 800 million Tanzanian shillings for Lean Manufacturing implementation. Moreover, the ANOVA results in Table 4 show a p-value of 0.000, indicating a significant difference in the funds allocation for Lean Manufacturing implementation based on various levels of manufacturing industries in Tanzania.

The results demonstrate that large industries have set aside funds for Lean Manufacturing implementation. Micro and small industries have set funds to an almost negligible amount, while medium industries have set capital to an average extent. The results further reveal that the allocation of funds for Lean Manufacturing implementation varies based on the level of manufacturing industries such as micro, small, medium and large as shown with a large F – test value of 126.587 in Table 4 which suggests there is a significant difference and confirmed with p-value of less than 0.05 that signifies that there is a significant difference in the allocation of funds for various levels of manufacturing industries. This might be the factor for the high adoption of Lean Manufacturing in medium and large industries since Lean Manufacturing implementation is regarded as a cost-intensive philosophy and needs some investment of funds (Sahoo and Yadav, 2018). The low adoption of Lean Manufacturing for small and micro industries is because they regard it as a costly philosophy, hence avoiding setting aside a budget for Lean Manufacturing implementation (Goshime *et al.,* 2019). Furthermore, the capital invested by micro and small industries as stipulated in the small and medium enterprises policy for small and medium enterprises in Tanzania shows that the capital invested for the business is low and is in the range of zero to 5 million for micro industries and a range of five to 200 million for small industries. Because of the lack of capital for Lean Manufacturing implementation in small and micro industries, manufacturing organisations in Tanzania tend to use basic lean tools that do not involve high costs.

The results in this study concur with other studies, such Qureshi *et al.* (2022) in India, Yuik and Puvanasvaran (2020) in India, as well as Panwar *et al.* (2016) in processing industries of India, indicating that industries in developing countries lack a capital for Lean Manufacturing implementation. The fund allocation gap observed in this study could be addressed by the positive actions that the stakeholders of the manufacturing industries could take to provide adequate training on the Lean Manufacturing philosophy which will assist in raising the commitments of the top management and understanding on the benefits of the philosophy. By doing so, the top management will see the importance of setting aside funds to implement the philosophy in their organisations. Allocation of funds will raise the philosophy's implementation level and further improve the organisations' operational performance.

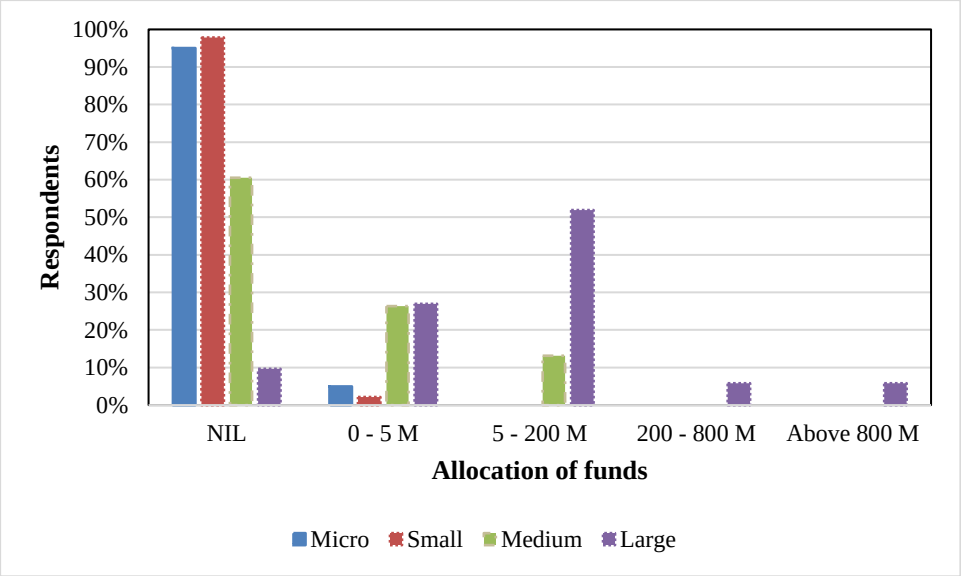

Figure 3: Fund Allocation for Lean Manufacturing.

Table 4: ANOVA Results for the Allocation of Capital

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	109.565	3	36.522	126.587	0.000
Within Groups	68.954	239	0.289		
Total	178.519	242			

Awareness of Lean Manufacturing Tools and Practices

Results demonstrate that awareness on Lean Manufacturing tools is low in micro and small industries as their mean score is below 3 out of 5 (which is the maximum mean score). The awareness is highly seen in medium and large industries where the average awareness is above 3. For medium industries, the level awareness is 3.3 and for large industries it is 3.7 as shown in Table 5. High awareness about Lean Manufacturing tools in large and medium industries demonstrates that they have utilised Lean Manufacturing tools in their operations. The low rate observed in micro and small industries shows that the adoption or utilisation of lean tools in their operations is low.

Moreover, the Lean Manufacturing tools and practices with high awareness level in micro industries include concurrent engineering, customer involvement in the design, 5s, visual management of quality control and visual management of production control; for small industries, they include concurrent engineering, 5s, customer involvement in design, visual management of quality control and work standardisation. Moreover, for medium industries, they include 5s, visual management of production control, levelled production, concurrent engineering and Total Preventive Maintenance; while for large industries, they include 5s, concurrent engineering, visual management of quality control, cellular manufacturing and set up time reduction. The results further reveal that the Lean Manufacturing tools and practices with high awareness and common to all manufacturing industries of all levels in Tanzania include 5s, concurrent engineering and visual management of production, as well as quality control. The tools with high awareness in Tanzania might be attributed to easiness of use and

cheapness in terms of their acquisition (Yadav *et al.*, 2019).

Low awareness of the tools and practices might lead to employees' resistance to change. The resistance might be caused by the fear of making mistakes during the implementation of the Lean Manufacturing philosophy (Ohiomah and Aigbavboa, 2015; Belhadi *et al.*, 2017). Also, the employees might create the assumption that the adoption of lean might increase their workloads. All these perceptions can be eliminated through a proper awareness creation among employees on the Lean Manufacturing tools and practices, hence increasing the application of the tools and improving the operational performance of the manufacturing industries in Tanzania.

The results obtained are in line with other studies, such as Sinkamba *et al.* (2023), showing low adoption of Lean Manufacturing in Tanzania, which might be caused by a lack of awareness of Lean Manufacturing; Thanki (2014) observed that the awareness of Lean Manufacturing is not encouraging in eastern and western part of India; Panwar *et al.*, (2016) noting that awareness about Lean Manufacturing in processing industries is low and should be increased for performance improvement on those industries; as well as Ramadas and Satish (2018) revealing that lack of awareness is among the barriers for the Lean Manufacturing implementation.

Moreover, the results are in line with findings obtained in the studies by Adzrie and Armi (2021) in Malaysia, Negrão *et al.* (2020) in Brazil, Belhadi *et al.* (2018) in Northern Africa and Ramadas and Satish (2018) in India. These studies indicated low awareness of Lean Manufacturing tools and practices affects the adoption of Lean Manufacturing. The low rate of adoption affects organisations in terms of operational performance. For tools with high awareness levels in Tanzania–that is 5s, concurrent engineering and visual management–5s has been observed in other studies as a practice with high awareness and a tool which is more applicable just as observed in this study. 5s was observed as a highly practised tool in studies by Panwar *et al.* (2015) in Indian process industries, Zahraee (2016) in Iran's manufacturing industries, Salem *et al.* (2016) in Qatar manufacturing industries and Khaba and Bhar (2018) in the Indian coal mining industry.

The awareness gap on Lean Manufacturing observed in this study could be addressed by industry stakeholders such as the ministry responsible for the industry development and owners through appropriate training to raise the awareness level of Lean Manufacturing philosophy. Furthermore, the responsible ministry might establish competition schemes for industries that apply lean manufacturing at all levels of manufacturing industries in Tanzania. Through the use of those strategies, the awareness gap can be addressed.

Table 5: Awareness of Lean Manufacturing Tools and Practices for Manufacturing Industries in Tanzania

Lean Manufacturing Practice	Mean Awareness							
	Micro	Rank	Small	Rank	Medium	Rank	Large	Rank
5s	3.5	**3**	3.6	**2**	4.5	**1**	4.7	**1**
Concurrent Engineering	3.9	**1**	4.1	**1**	4.2	**4**	4.6	**2**
Visual Management of Quality Control	3.3	**4**	3.2	**4**	3.5	**14**	4.4	**3**
Cellular Manufacturing (Group Technology)	2.1	**28**	3	**11**	4	**7**	4.3	**4**
Set Up Time Reduction	2.3	**18**	2.5	**21**	3.3	**18**	4.3	**5**

Lean Manufacturing Practice	Mean Awareness							
	Micro	**Rank**	**Small**	**Rank**	**Medium**	**Rank**	**Large**	**Rank**
Visual Management of Production Control	3	**5**	3.1	**6**	4.3	**2**	4.2	**6**
Total Productive Maintenance or Total Preventive Maintenance	2.7	**10**	3	**9**	4.2	**5**	4.2	**7**
Total Quality Management (TQM)	2.6	**12**	3	**10**	3.8	**8**	4.2	**8**
Layout Size and Shape (LSS)	2.4	**15**	2.7	**16**	3.6	**13**	4.2	**9**
Smoothed (Levelled) Production	2.2	**22**	2.4	**23**	4.3	**3**	4.1	**10**
Work Standardisation	3	**6**	3.2	**5**	4.1	**6**	4.1	**11**
Teamwork and Leadership	2.5	**13**	3.1	**8**	3.6	**11**	4.1	**12**
Continuous Improvement	3	**8**	3.1	**7**	3.6	**10**	3.9	**13**
Feedback to the supplier	2.2	**20**	2.1	**29**	3	**23**	3.9	**14**
Statistical Process Control (SPC)	2.2	**23**	2.4	**24**	2.6	**30**	3.9	**15**
Visibility and Information Exchange	2.3	**19**	2.6	**18**	3.2	**21**	3.8	**16**
Feedback on Performance Metrics	2.7	**11**	2.8	**14**	3.8	**9**	3.7	**17**
Workforce Recognition and Reward	1.9	**32**	2.3	**26**	3.3	**19**	3.7	**18**
JIT Delivery by Suppliers	2.1	**25**	2.1	**30**	2.7	**28**	3.7	**19**
Root Cause Analysis for Problem Solving	2.4	**14**	2.7	**15**	3.6	**12**	3.6	**20**
Workforce Autonomy (Empowerment)	3	**7**	2.9	**12**	3.3	**15**	3.6	**21**
Multifunctionality and Problem Solving	2.4	**16**	2.5	**20**	3.3	**17**	3.6	**22**
Pull Production (Kanban)	2	**30**	2.2	**28**	2.7	**27**	3.6	**23**
Design for Manufacturability	2.8	**9**	2.8	**13**	3.3	**16**	3.5	**24**
New Product Development	2.1	**26**	2.6	**19**	3	**22**	3.5	**25**
Workforce Involvement in Problem Solving (Quality circle)	1.9	**31**	2.3	**25**	2.8	**25**	3.5	**26**
One-piece flow (continuous flow)	2.2	**24**	2.7	**17**	3.2	**20**	3.4	**27**
Autonomation (Jidoka)	2.1	**27**	2.2	**27**	2.8	**26**	3.3	**28**
Lean Supplier Development	2.2	**21**	2	**31**	2.7	**29**	3.2	**29**
Customer Involvement in Design	3.7	**2**	3.5	**3**	2.9	**24**	3.1	**30**
Customer Involvement in Quality	2.1	**29**	2.5	**22**	2.3	**32**	2.8	**31**

Lean Manufacturing Practice	Mean Awareness							
	Micro	**Rank**	**Small**	**Rank**	**Medium**	**Rank**	**Large**	**Rank**
Supplier in the Design	2.3	**17**	1.9	**33**	1.9	**33**	2.8	**32**
Value Stream Mapping (VSM)	1.8	**33**	2	**32**	2.4	**31**	2.7	**33**
Average	2.51212		2.7		3.32727		3.76364	

Theoretical and Practical Implications

The study contributes to the understanding and knowledge of researchers and academics on Lean Manufacturing challenges for aspects of training gaps, capital limitations and awareness of Lean Manufacturing tools and practices in developing countries such as Tanzania. Manufacturing practitioners might use the findings to address the identified training and awareness gaps to raise the Lean Manufacturing implementation level in developing countries such as Tanzania. Policymakers may also use this study to set strategies for raising training levels and providing subsidies to organisations for implementing Lean Manufacturing. Raising training levels will benefit manufacturing organisations by improving their operational performance regarding the quality of products and reduction of production costs, number of defects, and lead time, among others. Performance improvement will raise the sector's contribution to the GDP.

CONCLUSION

The study aimed to determine the status of training provision, allocation of funds and awareness of Lean Manufacturing. Survey and purposive sampling were used to collect data from the selected manufacturing industries. Descriptive and inferential statistics were used to analyse the collected information from the respondents. Based on this study, the following conclusions were drawn.

1) The extent of provision for training in Lean Manufacturing is increasing progressively based on the level of manufacturing industries. It has been observed that 80% of micro and small industries never provide training, while more than 60% of medium and large industries provide training on Lean Manufacturing. Also, there is a significant difference in the provision of training among various levels of manufacturing industries, such as micro, small, medium and large industries, as they have a p – value of less than 0.05 and F test value of 302.997, signifying a statistical difference.
2) More than 95% of micro and small industries do not allocate any funds, less than 40% of medium industries allocate funds, and more than 80% of large industries allocate funds for the Lean Manufacturing implementation. It is further shown that there is a significant difference in the allocation of capital at various levels of manufacturing industries that is micro, small, medium and large, with a large value of F test of 126.587 and a p – p-value of less than 0.05.
3) The awareness of Lean Manufacturing tools and practices is low for micro and small industries as they have a mean score of less than 3 out of 5; the mean score is 2.5 and 2.7 for micro and small industries, respectively, while it is high for medium and large industries, having a mean score of above 3, which is 3.3 and 3.7 respectively.
4) The theoretical and practical contributions of the study to the field of Lean Manufacturing are on addition to the literature that hinders the implementation of Lean

Manufacturing in developing countries such as Tanzania. Moreover, the study will assist manufacturing industries to improve their operational and financial performance by providing training and allocating funds for the Lean Manufacturing implementation in Tanzania, increasing the sector's contribution to the country's GDP.

The research has been limited on the status of training, allocation of funds and awareness of Lean Manufacturing for manufacturing industries in developing countries such as Tanzania. Other studies can look at the same status for sectors such as service and construction. Moreover, this study just explored the application of Lean Manufacturing practices. Other studies can go beyond by examining the impact of training, awareness and capital investment on organisations' operational and financial performance.

To increase level of training and awareness, manufacturing industries should set a schedule for Lean Manufacturing training whereby all members of the industries should be encouraged to participate. Moreover, manufacturing industry stakeholders such as the ministry responsible for industry development should provide subsidies for Lean Manufacturing training to all levels of industries. Furthermore, other stakeholders such as the confederation of manufacturing industries in Tanzania (CTI) can establish a lean competition scheme to increase the country's awareness level of Lean Manufacturing.

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