Evaluation of Manufacturing Wastes and Their Impact on Operational Performances: The Case of a Bottled Water Manufacturing Company

Tadele Kumie, St. Mary's University

Abstract

Lean is a system that deals with all about the reduction of wastes which are significantly contributing to the ineffectiveness and inefficiency of the business entities. Companies that have not previously been exposed to lean manufacturing tend to have a lot of wastes in their manufacturing processes. The case company, which this research focuses on, is a bottled water manufacturing firm which was not an exception. This research was conducted to identify the significance of the eight manufacturing wastes (such as, quality, delivery time, and costs) and their impact on the operational performances of the case company. To validate data through cross verifications, triangulated measurement systems including survey questionnaire, archival data collection, and focus group discussions, were employed. To investigate the magnitude of wastes in the processes, the research was conducted in two categories. Category 1 represented the manufacturing and those processes intensively interact with it, and category 2, the support process. A total of ninety five (95) responses were collected and the analysis of the data demonstrated that wastes were significantly present both in category 1 and category 2. Analysis made on the archival data collected in a period of twelve months has also revealed that significant amount of wastes existed in the case company in different forms. The third instrument used was focus group discussion. It was designed to identify the root causes of manufacturing wastes and determine their significance to be risks to the case company. The data analysis and conclusions made on these triangulated methods showed consistency in that wastes were significantly present in both manufacturing and support processes and these wastes were also significantly impacting negatively the operational performances of the case company.

Keywords: Lean, Lean waste, Lean manufacturing, and Operational performance.

1. Introduction

Lean production system was first introduced in Japan by Taichi Ohno, an engineer in Toyota, after he had studied the concept of Ford Production System (FPS). However, the term “lean” was first coined and used by John Krafcik, Nordin N. et al. (2016), to describe the Toyota Production System (TPS) established by Ohno. After the Second World War, Toyota realized that they could not afford to invest much due to lack of resources and thus contributed to the birth of TPS. Toyota Production System (TPS) was developed in order to survive in an environment with limited resources; therefore, its main objective was to reduce wastes in every section and step across the production timeline (Wahaba N. et al. (2013). A lean manufacturer typically uses as less of everything (half the inventory, half the defects, half the manpower, time to market, and manufacturing space) to become more responsive to customer demand while producing quality products in the most efficient and economical manner (Womack .P.J et al. 1990).

Waste is any activity that does not contribute value to operations. On the other hand, value adding activities add value to operations and transform inputs to desirable outputs (Keitany, P. and Riwo-Abudho M. (2014). Wastes can add value and directly impact the operational performance of organizations where the operational performances, in turn, impact on the business performances, which is their ultimate purpose of customers' satisfactions and profit, for example. However, in companies where no systematic study was carried out to uncover the sources and the impacts of the eight manufacturing wastes and appropriate actions were not taken, these wastes remain to be abundant and manifest themselves in different forms, such as, low product quality, late delivery time, high operation costs, customers' dissatisfaction, and low profit margins.

In Ethiopia, though the bottled water business has started recently, many companies have invested on it, and consequently the competition has become fierce. Initially, competitive advantages were taken from increased production volume, price reduction and proximity to large markets. Nowadays, those enablers seem to be no longer a competitive advantage as they have been realized by many of them. However, the most important enabler has never been thought about - waste reduction. The concept is not well known by the sector as their immediate target is the implementation of ISO 9001 quality management and ISO 22000 food safety management standards. Those international standards are essential; however, their effectiveness is questionable without integrating the concepts and practices of the reduction of manufacturing wastes.

The case company was established in Addis Ababa in 2015 to produce purified bottled and jar water. It has six bottled water and two jar water production lines with a total capacity of producing 120, 000 bottles per hour, which makes it one of the top 3 competitors in the sector. The company has implemented the requisite regulations, and, thus achieved international certification on quality and food safety management systems based on the requirements of ISO 9001:2015 and FSSC 22000, Version 5.1, respectively. However, manufacturing wastes were not adequately taken into consideration, where poor factory layout is creating excessive transportation of materials, and excessive motion to people in their efforts to complete their routine jobs. Holding of excessive inventories for in case, and due to the push production system finished products were excessively produced and exposed to deterioration in quality as they were staying longer time in storage. Some of the reasons were the manufacturing waste categories, such as, motion wastes, waiting wastes, and overprocessing wastes are not easily perceivable by individuals unless uncovered by research results of this kind. For other waste categories, the management holds wrong perceptions, such as, holding large volume of input materials in order to be a guarantee for ensuring the continuity of the business, and overproduction is a measurement criterion for rewarding people.

Based on the background information and the problems discussed earlier the following research questions were formulated:

a) What are the sources of the eight manufacturing wastes?
b) What are the impacts of the eight manufacturing wastes on operational performances?
c) What can be done to mitigate the impacts of the eight wastes in order to improve the operational performances of the case company?

2. Research Design and Methodology

The research methodology was a mixed type where both qualitative and quantitative data were used. It was an investigative case of a single company where in-depth data collection and analysis were undertaken to identify and determine the magnitude and the impacts of the eight manufacturing wastes on operational performances. To ensure cross-verification of the effectiveness of data collection instruments, method of triangulation was used. Survey questionnaires and focus group discussions were employed to collect data from primary sources and the archival data collection instrument was used to collect secondary data from archives of the case company.

2.1 Data Collection Instruments

a) **Survey questionnaire:** A separate five-point Likert scale questionnaires were developed for two categories of respondents. Category 1 included production, maintenance, quality and food safety assurance, and top management. Category 2 encompassed marketing and sales, procurement, warehouse management, general service and human resource management. The reason for forming categories was to understand the magnitude and impacts of wastes in different functions of the case company and indicate priority areas for planning of actions. The questionnaires in both categories were prepared in Amharic and English languages in order to eliminate communication barriers and ensure the quality of data to be collected.

b) **The Focus group discussion:** The focus group discussion was designed to identify the root causes for each category of wastes. Members of the focus group discussion were meticulously selected to ensure the quality of data to be collected. To extract and organize data, tools such as, fishbone diagram, 5 WHY, and likelihood of occurrence and consequence were used to identify the most significant root causes for each category of waste.

c) **Archival data:** Sources of archival data were identified in advance and appropriate forms were designed to collect data in the archives of the case company retained for a period of one year.

2.2 Sampling Strategy

a) The Target population

The case company has a total of 406 employees working in three shifts. If random samples had been taken the required number of samples would have been 196. However, to ensure the quality of data, random sampling was not the choice of this research.

b) Sampling procedure

Non-probability, purposive sampling techniques were selected to ensure the quality of data, and a criterion was also established to select respondents in each function.

To ensure the accuracy of data collected, respondents were selected based on their understanding of the concepts of manufacturing wastes, as proposed by Yeasmin S. and Rahman K.F. (2012) and Rasi R. et al. (2015). Therefore, the purposive sampling technique was adopted, where educational levels of the respondents were a minimum of Diploma, 10+3, and Level 4 and above.

3. Data Analysis and Key Findings

3.1 The Significance of Occurrence of Manufacturing Wastes

3.1.1 Survey Data Analysis

Questionnaire was used to collect data on people's perceptions on the significance of the occurrence of the eight manufacturing wastes in the processes of the case company. As the name implies, the manufacturing wastes were initially attached to the production processes as they were easily perceivable and their impacts were apparent. However, nowadays, it is well known that wastes are associated with each and every process, though their type and magnitude is different. That is why this research has considered studying of wastes in two categories. Before full scale data collection commenced, reliability and validity of the questionnaire were tested and assessed to verify their consistency and accuracy to measure what was intended to be measured.

Reliability Test: Samples were collected from category 1 respondents and tested for reliability using Cronbatch Alpha (α) and the result was 0.835 which indicated that the questionnaires used were found to be reliable (consistent) as the acceptable limit is $\alpha \geq 0.7$. The same test was conducted on samples collected from Category 2 and the reliability test result was 0.801, which was acceptable to proceed with the full-scale data collection.

Validity Check: The questionnaires were presented to three experts in the field to provide their opinion on appropriateness, clarity, and comprehensiveness (composition). Prous et. al. (2009) indicated that experts' opinion as a method of validity check on research instruments is vital. The experts suggested feedbacks to eliminate confusion and divergence of responses from the intents of the study.

Data collection: Seventy four (74) questionnaires were distributed to category 1 respondents, and sixty (60) responses (81%) were received, which was acceptable. At the same time, forty (40) questionnaires were distributed to category 2 respondents and thirty five (35) responses (87.5%) were collected, which is also adequate to proceed with the data analysis process.

3.1.2 Data Analysis Findings and Discussions

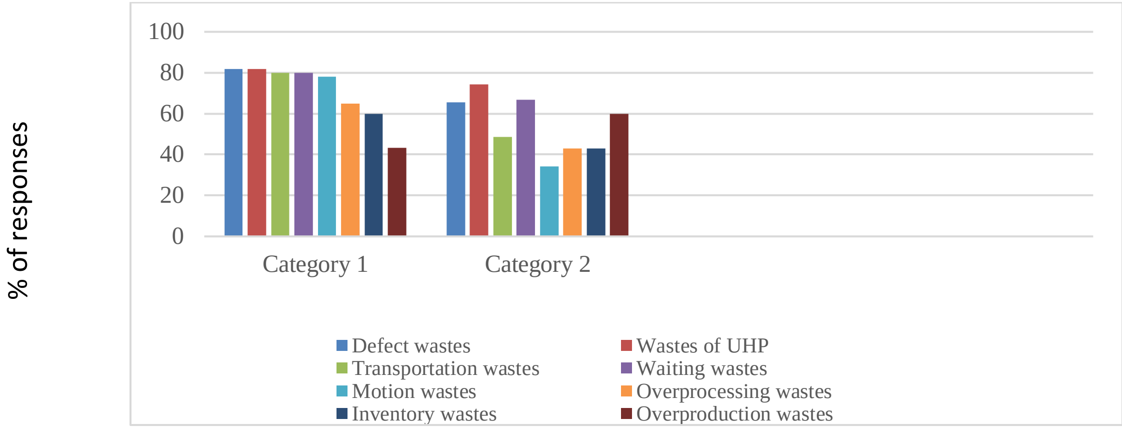


Fig1: Survey data analysis – The Significant Occurrence of Manufacturing Wastes in Category 1 &Category 2

3.1.2.1 The Significance of Occurrence of Manufacturing Wastes in the Case Company

The survey questionnaires and the archival data collection and analysis were designed to identify the presence of the eight manufacturing wastes and determine their significance. The data analysis results in this regard have shown that the eight manufacturing wastes were significantly present in the case company and determine as follows:

a) Defect Wastes: The survey results showed that (Fig. 1) defects were significantly present in both manufacturing and support processes, with a response rate of 81.7% and 65.7% respectively. These findings were also supported by the archival data analysis results of the case company's "Process Sigma Level". The company was operating at 3.25 Process Sigma Level where Defect Per Million Opportunities (DPMO) was 40,398.6190. To corroborate the significant existence of defect wastes in the case company, the focus group discussions identified the followings as the most significant root causes:

- Poor internal communication,
- The wrong attitude of "fix it when it is broken",
- Lack of skills to operate processes,

- Inadequate early stages monitoring system,
- Excessive stacking height of products in storage,
- Unavailability of spare parts,
- Using defective packaging materials, and
- Inadequate storage space.

As stated by Nawanir G. (2016), it is important to warrant that products being passed to the subsequent work station are high in quality, have no defect, not rejected, and conform to the required specification. *Nawanir G. (2016) further explained that:*

> *"In terms of quality, we strive to ensure that each process does not receive a process and dispatch any defect to the subsequent process. So, there is an imperative role of quality control starting from suppliers up to vanning process. In every single process, from receiving up to vanning, quality must be strictly controlled. Each process should ensure that no defective items are processed and delivered to subsequent processes."*

In light of this, this research has identified that defects were occurring significantly in the manufacturing and support process. Thus, by implementing lean system, it is appropriate to reduce the magnitude of wastes in the processes of the case company and ensure improvement of operational performances.

b) Inventory Wastes: The response rate for inventory wastes by category 1 respondents (Fig. 1) was significant (60 %), however, the response rate for category 2 respondents was comparatively less significant with a response rate of 42.9%. The results indicated that a significant number of inventories were in hold in category 1 than in category 2 (the support processes). As demonstrated by focus group discussions, the perception held by people in category 2 on holding excessive inventories was not considering the consequences. They believed that holding large quantity of input materials was considered as a guarantee for business continuity and overproduction. The cause of holding excessive inventory is considered as one of the most acceptable practices, where people are rewarded when they managed to achieve it. In upholding the significant existence of inventory wastes in the case company, the focus group discussions identified "poor sales performance and poor sales forecasting" as the most significant root causes for excessive inventories.

According to Nawanir G. (2016), producing only based on customer orders, no more and no less, may encourage to have inventory in a very minimum level, even zero inventory. It is certainly different from a push system, which requires holding a certain amount of stock. However, this research revealed that the case company was experiencing problems of excessive inventory both in input materials and finished products due to the prevalent misconceptions that excessive inventories guarantee uninterrupted business transactions.

c) Overprocessing Wastes: The data analysis results have shown that overprocessing was a significant waste in the manufacturing processes of the case company, with a response rate of 65% (Fig. 1). This finding was supported by the archival data analysis results where 30 % of the water pumped to the factory was wasted (drained back to the environment) due to overprocessing of reverse osmosis to unnecessarily remove total dissolved solids (TDS) to 50 mg/l or less, while the national compulsory standard requires TDS to be a maximum of 1000 mg/l,. Supporting the significant existence of over processing wastes in the case company, the focus group discussions attributed it to the misconceptions of “customers” on product quality of “bottled water” as the most significant root cause for over processing wastes. The misconception was that customers preferred tasteless and flat bottled water. However, according to WHO document number WHO/SDE/WSH/03.04/16, water with extremely low concentrations of TDS may also be unacceptable because of its flat, insipid taste. In this document, acceptability was defined as follows: excellent, less than 300 mg/litre; good, between 300 and 600 mg/litre; fair, between 600 and 900 mg/litre; poor, between 900 and 1200 mg/litre; and unacceptable, greater than 1200 mg/litre. However, the TDS content of the case company was 210 mg/l on average.

According to Arunagiria P. and Gnanavelbabu A. (2014), every process in the manufacturing operation is often assumed to be value adding. This leads individuals to overlook processes as a source of waste. In reality, many processes are unnecessary. The authors further explained that streamlining or eliminating processing steps that add no value can dramatically speed up an operation and reduce costs. In line with this finding, Chahal. V and Narwal (2017) stated that when an extra work happens on work piece or machine to avoid rejection or for perfect working, it is inappropriate/overprocessing, which is sometimes very costly. It is also time and money consuming, which may influence workers’ behaviors. In line with the findings of those researchers, this research also identified overprocessing wastes, such as, excessive removal of TDS, excessive monitoring and inspection of stable processes and reliable machines, excessive review and approval steps for suppliers - which may retard the speed of processes and add operational costs. As proposed by Arunagiria and Gnanavelbabu (2014), the solution is to eliminate those wastes and enhance the efficiency of processes.

d) Transportation Wastes: Transportation wastes due to poor factory layout were found to be significant with a response rate of 80% (Fig. 1). The response rate for transportation wastes obtained from support process was also significant (48.6%). This finding is supported by archival data analysis where forklifts (expensive to purchase, maintain and operate) unnecessarily travelled a total of 7,604 kilometer per year from production site to the warehouses and the vice versa. Nine people were assigned permanently to perform the unnecessary transportation of finished products. In addition, packaging materials (preforms and caps) production facility was 8 km away from the water manufacturing facility and a vehicle transports packaging materials on average 3 times a day and 7 days a week. The vehicle covered 336 km round trip per week and approximately 13, 056 km per year. Confirming the significant existence of transportation wastes in the case company, the focus group discussions identified “poor factory layout” as the most significant root cause for excessive transportation wastes.

Soliman H. (2017) explained that transportation waste involves all material movements from the supplier to the customer. It adds more cost on the product and could affect external customers directly, causing a delay in the delivery of orders. Most of transportation problems in plant facilities are subjected to the layout of the plant and production style. This involves the distance between the process steps, the distance between the machines inside each workstation, how close the workstations and machines are to the tools, how far the inventory warehouses are from the production facilities, and how far the other service departments, such as, the maintenance workshops, are from the production lines. Soliman H. (2017) further explained that this usually involves the cost of the transportation equipment like forklifts, cost of operators driving these equipment, safety risks due to using forklifts in the working areas, labor wages, cost of resources, the risk of product deterioration during the handling process, and the effect of delays on the customer. In agreement with those findings, this research has identified significant wastes associated with transportations, such as, unnecessary transportation of products from production site to warehouses, transportation of maintenance technicians from remote locations for emergency maintenance, and transportation of packaging materials from own facility located 8km away.

e) Motion Wastes: Though motion is one of the hidden wastes, it was effectively perceived by the respondents in category 1 (Fig. 1) and their response rate was significant (78.3%). However, comparatively, motion wastes were found to be less significant in support processes, with a response rate of 34.3%. Supporting the significant existence of motion wastes in the case company, the focus group discussions identified “poor factory layout and poor machines setup” as the most significant root causes for excessive motion wastes.

According to Okpala C.C. (2014) the waste of movement or motion is the unnecessary movement of persons in the shop floor without the addition of any value on the products or services, thereby leading to wastes of time and efforts. These avoidable movements occur because of badly organized layout, low standard processes, poorly trained workforce and bad process design. Motion is associated with ergonomics as it is observed in all cases of running, walking, jumping, bending, lifting, stretching and kneeling. All these motions are wastages as they don’t only cost money but also stress and wear-out to the equipment, machine and persons. In line with these findings, the current study identified significant motion wastes due to poor ergonomics, shared resources, poorly organized materials and tools in storage, and poor alignment of workstations to employees’ facilities, such as, rest rooms, canteen, and lockers.

f) Waiting Wastes: The response rate for waiting wastes was significant in both manufacturing and support processes, with response rate of 80 % and 66.7%, respectively (Fig. 1). The findings were also supported by archival data analysis results, where machine downtime and idle time was 3,172.1 hours and 2,495.2 hours per year, respectively. Stressing the significant existence of waiting wastes in the case company, the focus group discussions has identified the following as the most significant root causes for waiting wastes:

- Poor understanding of the consequences of excessive waiting,
- Lack of work standards,
- Long steps of purchasing processes,
- Production changeover took too long time (due to lack of work standard),
- Increased corrective maintenance due to the absence of preventive

maintenance,
- Poorly established supply chain, and
- Poor quality of materials halts production process until the problem is fixed.

In the research findings of Okpala C.C. (2014), it was explained that the waste of waiting is the idle time that occurs when co-dependent events are not synchronized. This is because the process of manufacturing is reliant on the procedures that occur downstream and upstream. Lantech (2013) has also identified that the wastes of waiting in manufacturing process are bottlenecks in time. These usually are broken machinery, lack of trained staff, shortage of materials, inefficient planning, or as a result of the other six manufacturing wastes. The findings of the current research matched with Lantech (2013) and Okpala, C.C. (2014) in that waiting wastes were significant and were manifested in different forms, such as, delayed materials supply, waiting for decisions to stop production machines for scheduled preventive maintenance, waiting until faulty equipment is fixed, delayed foreign purchases due to unavailability of foreign currency, and customers' waiting because of manual loading of products onto their trucks.

g) Overproduction Wastes: Overproduction wastes were found to be significant (Fig. 1), both in category1 and category 2 where the response rates were 43.3% and 60%, respectively. Acknowledging the significant existence of overproduction wastes in the case company, the focus group discussions identified the following as the most significant root causes:
- Poor understanding of the consequences of overproduction,
- Push production system, and
- Poor forecasting (creating false demand).

As stated by Okpala C.C (2014), overproduction is at a variance with the basic principles of waste reduction as the excess product ties money down and increases the cost of maintenance and storage. Soliman H. (2017) asserted that making more products than is actually needed or over the capacity of the selling department is a waste of money in enormous rates. The losses are the costs that have been spent to make these products plus all the inventory losses. Even if these products are going to be sold later, there is still a problem with the return on investment of the used raw materials and the other resources that have been expended to make this product. These research findings are also in line with Okpala, C.C. (2014) and Soliman

H.(2017) in such that overproduction wastes were manifested in the actual production processes due to push production system and poor market forecasting. Overproduction was also the sources of other wastes in the case company, such as, excess inventory, defects on products due to excessive staking height, and transportation waste due to lack of storage space.

h) Wastes of Untapped Human Potential: Wastes associated with failure to use the human potential were also fund to be significant in both categories, category 1, 81.7% and category 2, 71.4% (Fig. 1). Supporting the significant existence of wastes associated with failure to use the human potential in the case company, the focus group discussions revealed that "forcing people to use inappropriate input materials" was the most significant root cause for failure to use the human potential (knowledge and skill).

Brito M. et al. (2020) conducted a study to answer a research question: "Why do workers do not use their full talent?". The respondents (production workers, managers and executives), responded that the eighth waste is related to the lack of one or more than one of the following components: rewards, recognition, justice, evaluation, motivation, goals, self-esteem, knowledge, and resources. In line with these findings, this research has identified that the case company failed to exploit the human potential due to failure to include the employees in the decision of strategic issues, resignation of knowledgeable and experienced people, and failure to improve workers' motivation.

3.1.2.2 The Significance of the Impact of Manufacturing Wastes on the Operational Performances of the Case Company

The results of the data analysis showed that the eight manufacturing wastes significantly impacted negatively the operational performance indicators, such as, quality, delivery time and costs. The negative impact of the eight manufacturing wastes on quality was significant with a response rate of 80% in category 1 and 71.2% in category 2. For delivery time, the response rate was 80% in category 1 and 65.7% in category 2. The response rate for cost was 83.3% in category 1, and 65.7 % in category 2.

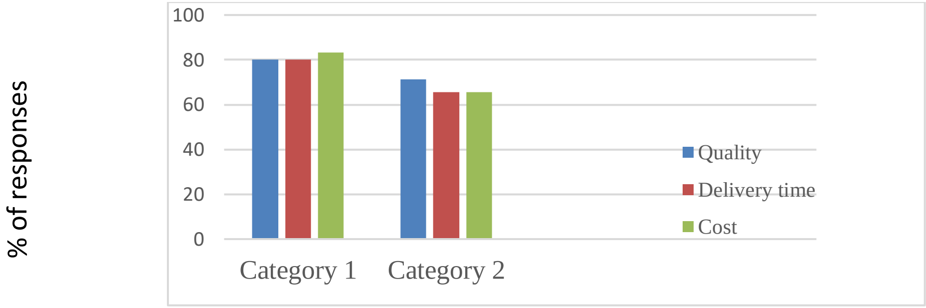


Fig 2: The Impacts of the Eight Manufacturing wastes on Operational Performances

Fig. 2 indicated the significant imapct of the eight manufacturing wastes on operational performances of the case company was significant in all the three operational performance measures.

In general, the analyses of the data findings (Fig. 2) in both categories are summarized as follows:

a) The data analysis results clearly demonstrated that the eight manufacturing wastes significantly impacted the operational performance of the case company.
b) The impact of the eight manufacturing wastes was significant both in the main and support processes, however, the magnitude was more intense in manufacturing and associated processes than in support processes.
c) The impact of the eight manufacturing wastes was more intense in cost than quality. This was due to the fact that all wastes were associated with cost but not all wastes were associated with quality.

4. Conclusions

This research analyzed an understanding regarding the potential effects of manufacturing wastes on operational performances, which will, in, turn, impact the business performances of the case company. It was indicated that wastes were significantly present in different forms, consuming the organization's benefits with a potential to negatively impact its ability to compete in the market places due to failures to achieve quality and delivery time and, of course, being unable to reduce unnecessary costs. The research identified significant results, such as, "failure to exploit the human potential". This suggests that the case company needs to adjust its leadership style and install appropriate system to dig out the human wisdom from within and use it for reducing and eliminating the rest of the seven manufacturing wastes. In addition, “overprocessing of the reverse osmosis” was unnecessarily removing total dissolved solids (TDS) to 50 mg/l or less, where this value was far below the regulatory limit, 1000 mg/l. Excessive removal of TDS was the cause for wasting 30% of the raw water pumped to the production lines. It was a huge wastage for the company and for the country as well, suffering from water stress. The research also identified that the case company was operating at a defect level of 4.04%, where significant number of products (40,399 bottles of water) were rejected in every one million opportunities.

The eight wastes were found to negatively affecting the operational performance of the case company, such as, quality, delivery time and costs. The operational performances, in turn, would negatively affect the business performances, such as, customers’ satisfaction, and profit. For Example, when the organization fails to meet product conformity with agreed specifications, defect becomes apparent (in this case 4.04%). If the defective products pass all the control processes and reach the customers, they become the causes for customers’ complaints, product return and liability for business damages. On the other hand, to fix the causes of defects, the production process is halted and a significant amount of time elapses until it begins again. More frequent stoppage of the production process affect productivity, delay deliver time, and escalate operation costs. As no waste manifests itself without a cost, it is, therefore, very essential for the case company to take appropriate solutions to improve the existing situations. However, this can never happen without the commitment of the top management and active involvement of people at all levels.

5. Recommendations

Based on the research findings and the conclusions made, it is appropriate to systematically address the identified problems so that wastes are reduced or eliminated to an acceptable level. Therefore, the following short-term and long-term solutions were suggested to the case company.

5.1 Short-Term Solutions

Immediate solutions should be taken on root causes of wastes where no excessive investment is required, such as:

a) To stop overprocessing of reverse osmosis (excessive removal of Total Dissolved Solids (TDS):

- Discussions at Bottled Water Manufacturing Association level on the need to stop overprocessing of TDS;
- Initiating revision of national standard (CES 99:2019), such as, revision of the lower limit for TDS; and
- Educating consumers that bottled water with taste is also acceptable and safe.

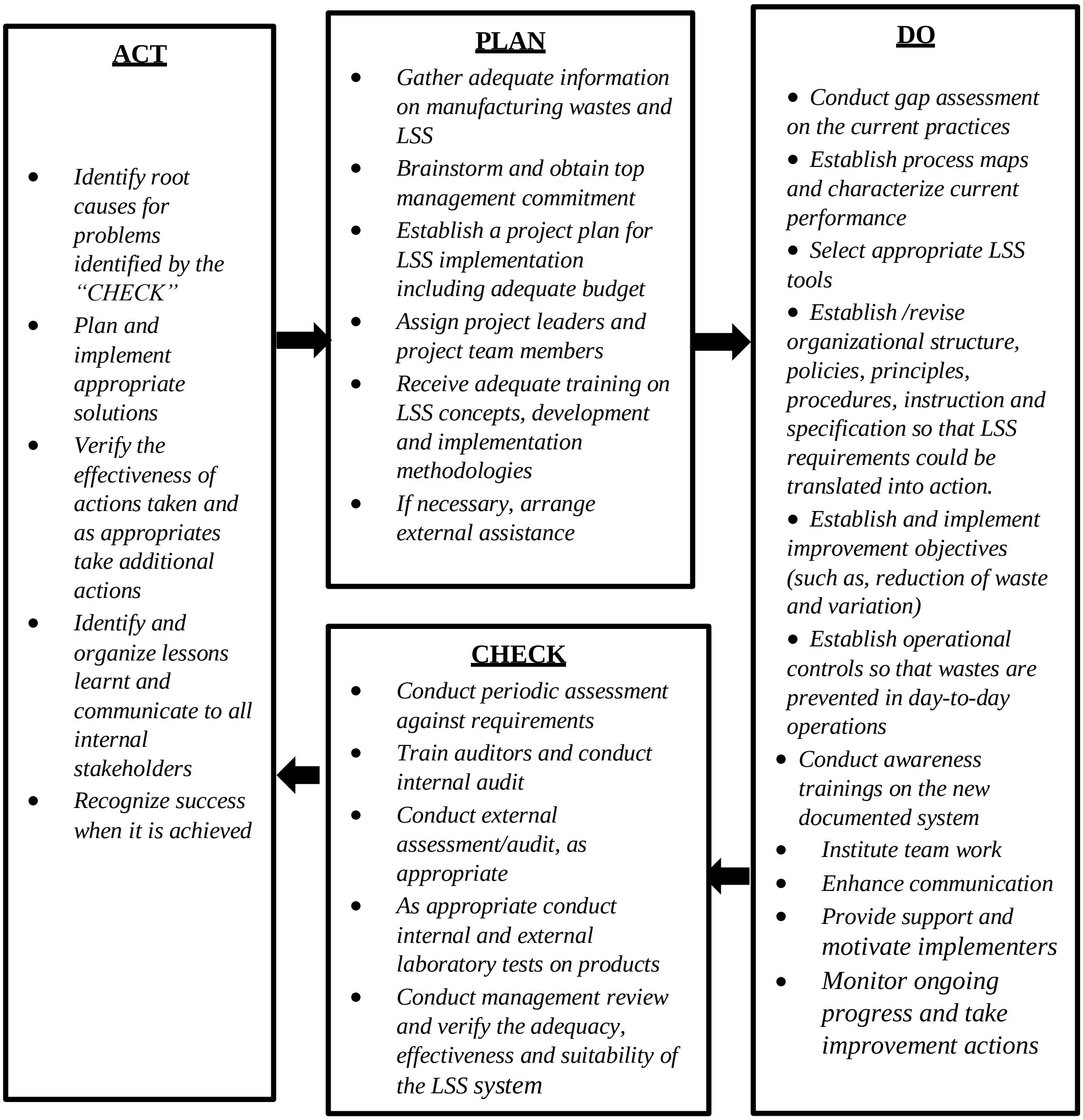
b) Internal transportation of input materials and finished products by forklifts could be minimized by using conveyor belts and re-arranging the company's layout.

c) Establish and implement a comprehensive preventive maintenance as it is the cause of multiple wastes, such as, waiting wastes, defects and motion wastes.

5.2 Long-Term Solutions

The long-term solutions for reducing or eliminating wastes is possible through the application of Lean Six Sigma (LSS) integrated with the existing quality and food safety management systems. The researcher has synthesized the following model organized around the Deming's PDCA Cycle (Fig. 3).

Fig. 3: Proposed Lean Six Sigma Implementation Model



Limitations

The archival data collection instrument was designed to include all the eight manufacturing wastes, however, when data collection started data were not available for overproduction wastes, motion wastes, wastes related to untapped human potential, and inventory wastes as the case company did not capture them at all. However, it should be noted that studies on those waste categories were adequately covered by perceptual data analysis (survey and focus group discussions) made and the conclusion derived were adequate and justifiable.

References

Khalil A. et al (2013). "Implementation of Lean in Continuous Process-based Industries", International Journal of Scientific & Engineering Research, Volume 4, Issue 10.

Womack .P.J et. al (1990). "The Machine that Changed the World"; ISBN, 0-89256-350-8.

Nawanir G. et. al. (2013). "Impact of Lean Practices on Operations Performance and Business Performance: Some Evidence from Indonesian Manufacturing Companies", Journal of Manufacturing Technology Management.

Keitany, P. and Riwo-Abudho, M. (2014). "Effects of Lean Production on Organizational Performance: A Case Study of Flour Producing Company In Kenya", European Journal of Logistics Purchasing and Supply Chain Management Vol.2, No.2.

Soliman H. (2017). "A Comprehensive Review of Manufacturing Wastes, Toyota Production System Lean Principles", Emirates Journal for Engineering Research.

Nawanir G. (2016). "The Effect of Lean Manufacturing on Operations Performance and Business Performance in Manufacturing Companies in Indonesia".

Uz-Zaman A. (2013)."A Methodology for Effective Implementation of Lean Strategies and Its Performance Evaluation in Manufacturing Organizations", Business Process Management Journal, Vol. 19.

Nordin N. et. al (2016). "A Review on Lean Assessment Models and Performance Measures", Journal of Advanced Review on Scientific Research ISSN (online): 2289-7887 | Vol. 21, No.1. Pages 1-26.

Rasi R. et al. (2015). "Relationship between Lean Production and Operational Performance in the Manufacturing Industry", IOP Conf. Series: Materials Science and Engineering.

Rahman S. et al. (2010). “Impact of Lean Strategy on Operational Performance: A Study of Thai Manufacturing Companies”, Journal of Manufacturing Technology Management, Vol. 21 No. 7.

Suketu Y. et al. (2016). “Review of Lean Manufacturing Practices – Critical Success Factors and Performance Measures for SMEs”, Int. J. Quality and Innovation, Vol. 3, No. 1.

Susilawati A. et al. (2013). “Develop a Framework of Performance Measurement and Improvement System for Lean Manufacturing Activity”, International Journal of Lean Thinking, Volume 4, Issue 1.

Pal S. (2019).”Toyota Production System (TPS) – Applications and Benefits for Indian Pump and Motor Manufacturing Industry: A Case Study”, International Journal of Research in Engineering, Science and Management Volume-2, Issue-9.

Marta K. et al. (2015). “Eliminating Waste in the Production Process Using tools and Methods of Industrial Engineering”, Production Engineering Archives, Vol. 9, No.4, pp 30-34.

Chahal V. et al. (2017). “Impact of Lean Strategies on Different Industrial Lean Wastes”, International Journal of Theoretical and Applied Mechanics. ISSN 0973-6085 Volume 12, Number 2.

Leksic et al. (2020). “The Impact of Using Different Lean Manufacturing Tools on Waste Reduction”, University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture.

Hassan M.K., (2013). “Applying Lean Six Sigma for Waste Reduction in a Manufacturing Environment”, American Journal of Industrial Engineering, Vol. 1, No. 2,

Brito M. et al. (2020). “The Eighth Waste: Non-Utilized Talent”, CIDEM5.

Mani M. and Gill P. (2019). “Indian Automotive Sector: Recognizing its Chief Lean Production Waste”, Recent Trends in Decision Sciences and Their Implications for Business, Department of Management, CBLU, Bhiwani Assistant.

Wahab et al (2013). “A Conceptual Model of Lean Manufacturing Dimensions”, The 4th International Conference on Electrical Engineering and Informatics (ICEEI).

Pramadona and Adhiutama A. (2013). ”The Application of Lean Manufacturing for Operation Improvement: A Case Study of Black Cough Medicine Production in Indonesia”, The Asian Journal of Technology Management Vol. 6 No. 1.

Okpala, C.C. (2014). “Tackling Muda – The Inherent Wastes in Manufacturing Processes” International Journal of Advanced Engineering Technology E-ISSN 0976-3945.

Lewis P. and Cooke G. (2013). “Developing a lean measurement system to enhance process improvement”, Int. J. Metrol. Qual. Eng. 4, 145–151.

Alefari M. et al. (2017). “The Role of Leadership in Implementing Lean Manufacturing”, The 50th CIRP Conference on Manufacturing Systems doi: 10.1016/j.procir.2017.03.169.

Pakdil F. et al. (2014).”Criteria for a Lean Organization: Development of a Lean Assessment Tool”, International Journal of Production Research, Vol. 52, No. 15, 4587–4607.

Arunagiria P. and Gnanavelbabu A. (2014). “Identification of Major Lean Production Waste in Automobile Industries using Weighted Average Method”, 12th Global Congress on Manufacturing and Management, GCMM.

Rathore A. et al. (2015)."Lean Implementation in Indian Process Industries – some Empirical evidence", Journal of Manufacturing Technology Management, Vol. 26 Iss 1 pp. 131 – 160.

Yeasmin S. and Rahman K.F. (2012).“Triangulation' Research Method as the Tool of Social Science Research” BUP JOURNAL, Volume 1, Issue 1, ISSN: 2219-4851.

Prous, et al. (2009). “Validation of Questionnaires”, M.J. García de Yébenes Prous et al / Reumatol Clin. 2009;5(4):171–177.

Jimenez G. et al. (2019). Improvement of Productivity and Quality in the Value Chain through Lean Manufacturing – a case study, 8th Manufacturing Engineering Society International Conference.

Belekoukias I. et al (2014). “The Impact of Lean Methods and Tools on the Operational Performance of Manufacturing Organizations” International Journal of Production Research, 52 (18):5346.

Sharma V. et al. (2015). “Impact of Lean Practices on Performance Measures in Context to Indian Machine tool Industry”, Journal of Manufacturing Technology Management.

ILO; (2017). “Lean Manufacturing Techniques For Ready Made Garments Industry”; ISBN: 978-92-2-130768-6.

Deming E. (1986). “Out of the Crisis”;ISBN-13 978-0262-54115-2.

Philip B. Crosby; (1979); “Quality is Free”; ISBN O-07-014512-1.

International Organization for Standardization (ISO);(2015). “Quality management systems — Requirements”.

Ethiopian Standards Agency (ESA); (2019). “CES 99: Packed Drinking Water (other than packed mineral water) – Specification”.

Kenya Bureau of Standards (KEBS); (2014). “KS EAS 153: Packaged Drinking Water — Specification”.

International Bottled Water Association (IBWA); (2016). “IBWA Code of Practice Monitoring Requirements”.

Garfí, M. et al. (2016). “Life Cycle Assessment of Drinking Water: Comparing Conventional Water Treatment, Reverse Osmosis and Mineral Water in Glass and Plastic Bottles”, Journal of Cleaner Production 137 (997- 1003).

Mohammed M.M. et. al. (2015). “Measuring the Validity and Reliability of Research Instruments”, Faculty of Technical and Vocational Education, University Tun Hussien Onn Malaysia.