Lean Manufacturing: A Collaborative Tool for Optimizing Organizational Efficiency

Rabia AZZEMOU[1], Khedidja Soumeya BENHADDOU[2],
[1]University of Sciences and Technology of Oran-Mohamed Boudiaf (Algeria),*rabea.azemou@univ-usto.dz*
[2]University Mohamed Ben Ahmed – Oran2 (Algeria),*benhaddou05@yahoo.fr*

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Abstract:
This article presents a methodology utilizing Lean Manufacturing tools to optimize internal organization and flow management in SMEs. Through analysis, dysfunction identification, and collaborative solutions, the approach aims to enhance efficiency and competitiveness. The methodology was validated in an Algerian SME, resulting in a redesigned workshop layout for improved space utilization and employee working environment. Emphasizing material and informational flow control, waste reduction, and collaborative practices like the "water spider" method, this methodology enables swift problem resolution and implementation of corrective actions, ensuring sustained competitiveness in a dynamic economic landscape.

Keywords: Flow management; Algerian SME; Optimization; Lean manufacturing.
JelClassificationCodes: L23, L25, M11

1. INTRODUCTION

Effective organizational structures are critical for companies to remain competitive and ensure longevity in today's fast-paced economic environment. However, there is no one-size-fits-all model that can be imposed by management, as each company has its unique cultural and civilizational characteristics, financial and human resources, and other specificities. While effective organization can help companies anticipate and address problems through prompt corrective action, it is not a guarantee of success. Organizational dysfunctions can be counterproductive and lead to a negative spiral that weakens the organization.

Problem research: Organizational dysfunctions can be counterproductive and lead to a negative spiral that weakens the organization, so how can organisations deal with these problems and achieve their objectives efficiently and effectively?

Hypotheses:
In order to give an answer to the problem research, we suppose these hypotheses:
H1: Efficient management and control of flows are critical in achieving improved company performance and reflecting a new economic vision.
H2: Managing processes, service structuring, and employee management are important for an organization's success, given their contribution to daily mission fulfilment in an efficient and effective manner.

Objectives: The optimization process includes global reorganization or service merger, aiming to reduce costs and process lead times, increase performance, respond better to contingencies, and achieve certification. Lean Manufacturing is an optimization method that offers a detailed analysis of each step and function of a company's processes, allowing for the elimination of waste throughout the process, reducing production effort and lead times, and adding value to products/services through value-added activities.
In recent years, the use of lean manufacturing tools has become increasingly popular among organizations seeking to improve their production processes and achieve operational excellence. Ahuja discusses the key lean manufacturing tools, such as 5S, the Ishikawa diagram, and collaborative improvement using lean tools (Ahuja& Khamba, 2016).
Studies have shown that the implementation of 5S methodology can result in significant improvements in product quality, employee productivity, and workplace safety. Pannu and Singh found that 5S implementation resulted in enhanced product quality, employee productivity, and workplace safety(Pannu & Singh, 2020).. Guo et al. found that the implementation of 5S led to a reduction in lead times, improved inventory accuracy, and increased workplace organization (Guo et al., 2020)
The Ishikawa diagram is an effective tool for identifying the root cause of production defects and quality problems in manufacturing organizations. Studies by De Souza and Gupta, Li and Bai both found the Ishikawa diagram to be an effective tool in these areas (DeSouza &Gupta, 2011).

Collaborative improvement using lean tools has also gained popularity among manufacturing organizations. Studies by Zhan et al. (Zhan et al., 2016)and Ahi and Searcy (Ahi & Searcy, 2013)found that this approach led to significant improvements in production efficiency, quality, employee engagement, and motivation.

While the literature suggests that lean manufacturing tools can result in significant improvements in production processes and overall organizational performance, the effectiveness of these tools depends on specific contexts and implementation strategies. As mentioned by several authors, further research isneeded to fully understand the factors that contribute to the successful implementation of lean manufacturing tools in various organizational contexts. In addition, emerging tools such as the "water spider" have shown promising results in enhancing production efficiency and reducing waste. For example, a study by Hines and Rich investigated the role of the water spider in lean manufacturing systems and found that this position was crucial in facilitating material and information flow (Hines& Rich, 1997). This highlights the importance of ongoing research and exploration of new tools and techniques to continuously improve organizational performance.

In this article, we propose a collaborative approach to organizational optimization based on Lean Manufacturing and its tools (Lashari et al., 2019). The second section explores organizational optimization, while the third outlines the steps of our approach, which follows a general model incorporating several stages. Finally, we present the validation of our approach in the fourth section, through its implementation in an Algerian SME specializing in the production of stainless steel products. The result is a new workshop organization that optimizes space, creates a functional and enjoyable working environment for personnel, and ultimately contributes to the company's success.

2. Organizational Optimization

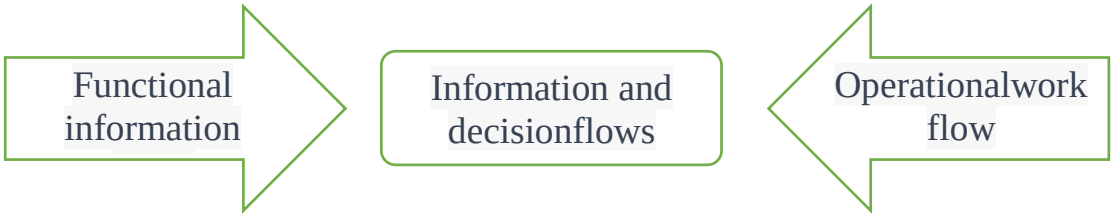
2.1. The Mintzberg Model: Five Key Elements of Organizational Structure

The organization's structure refers to the methods used to divide work into separate tasks and establish coordination between these tasks (Mintzberg, 1989). Any organization of a certain size consists of five basic elements:

- The operating core: Its mission is to produce and distribute goods and services;
- The strategic summit: Its main mission is to make the organization efficient and effective. The strategic summit controls, disseminates information, and manages both the company's relationships with its environment and any internal conflicts. It is responsible for strategic decisions;
- The middle line: Its role is to effectively implement decisions made at the top. It consists of intermediate managers between the operating core and the strategic summit;
- The technostructure: Its role is to design, analyze and adapt the structure. Human relations departments standardize skills and qualifications. Planning and control services standardize results. Methods services standardize tasks;
- The logistical functional units: They have a particular role to play, such as research and development services, legal services, etc.

These five elements (Figure 1) are interconnected by standardized flows that operate seamlessly within the organization.

Fig.1. Standardized flows



Source: By authors

Within an organization, there are several types of flows, including the operational flow of work, which involves the movement of materials (input or reception, transformation, output or shipment) and information (work orders, production standards, manufacturing schedules), as well as the flow of information and control decisions represented by a vertical circulation of information. The upward control is achieved through the collection of information on job execution, while the downward control involves the dissemination of decisions (orders and instructions). Additionally, there is a horizontal flow of functional information, which characterizes the relationships between operational and functional units such as production support, exchange of advice, and transmission of assistance for production.

2.2. Optimizing Manufacturing Processes and Space

Optimizing processes is a major challenge in the socio-economic context. In order to do this effectively, processes must first be well identified so that they can be controlled and optimized. The optimization process is a series of steps, the first of which is to analyze the current situation and then define what needs to be improved. The final step is to find the means that will be used to optimize. Optimization allows for greater efficiency and effectiveness, in other words, to spend fewer resources (human, financial, technical).

How can space be optimized while also optimizing the manufacturing process? It is necessary to redesign the factory using tools, reduce the lead time by optimizing the process, control the inventory level of raw materials, work-in-progress and finished products, reduce work-in-progress inventory by reducing the batch size to be produced. How can production costs be reduced without increasing the workload of employees while improving the environment in which they work? It is necessary to eliminate waste in the factory, maximize the utilization rate of machines, redesign workstations to be as effective as possible, reduce machine setup time, reduce batch size, and bring workstations closer together.

Lean Manufacturing (Mintzberg, H. (1989)(Drew et al., 2004); (Womack & Jones, 2007) is an excellent way to analyze malfunctions and search for the best solutions for the company (Leksic et al. , 2020).

3.A Model for Optimizing Organizational Performance in the Factory Context

3.1. Optimization Approach

Optimizing organizations is part of a progressive approach whose objective is to produce strategies and implementation plans that are feasible on the ground. Organizational questions are essential in improving the understanding of human relationships among individuals within a work organization. This is because the organization serves as a medium to achieve strategy and enhance effectiveness (Azzemou & Noureddine, 2009). Before embarking on an optimization approach, it is important to clearly define the organization in order to improve its performance. It is important to focus on malfunctions and its future evolution. In this context, we propose an approach based on a model that integrates the following sequential steps:

1. Analyzing the structute of the factory
2. Identifying inefficiencies
3. Implementing solutions
4. Proposing an improved organization

Our methodology adopts the principles of Lean Manufacturing, leveraging supporting tools to carry out an organizational analysis. The analysis is aimed at designing and implementing optimized physical organization and flow. This, in turn, results in a reduction in physical flow distances, maximization of volumes and available space, reduction in material handling, and minimization of waiting times and inventory levels. The outcome of this approach is a structural analysis that highlights dysfunctions using the Ishikawa diagram, which is a visually intuitive tool used for group reflection. The insights gained from the analysis help us propose solutions for each cause by applying the 5S management technique.

3.2. Overview of Supporting Tools

The Ishikawa diagram, also known as the Fishbone diagram (Ishikawa, 1990); (Ishikawa, 2007), is one of the most popular and widely used quality tools. It is a graphical tool used to understand the causes of a quality defect and analyze the relationship between a problem and all possible causes. Causes that may be responsible for a problem are classified into five categories: Manpower, Environment, Method, Materials, and Machinery. Each cause family is then further divided based on its level of importance or detail. It is an excellent communication tool to explain a phenomenon. The 5S (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke) is the first tool to be implemented in a Lean Manufacturing approach. The 5S (Jaca et al. , 2014)aims to eliminate what is unnecessary, define a place for everything, clean up, define necessary procedures, and finally audit and measure the improvement. It allows for better control of the environment on the ground (Imai, 1997). It also serves as a means to establish participatory management by empowering operators in organizing the company (Mehta et al. , 2020). This basic Lean tool

primarily aims to change mindsets and initiate a policy of continuous improvement. The application of the 5S enables the establishment of strong foundations for a Lean Manufacturing approach (Gupta& Jain, 2013).

4. Implementation of the approach in a Small and Medium-Sized Enterprise (SME)

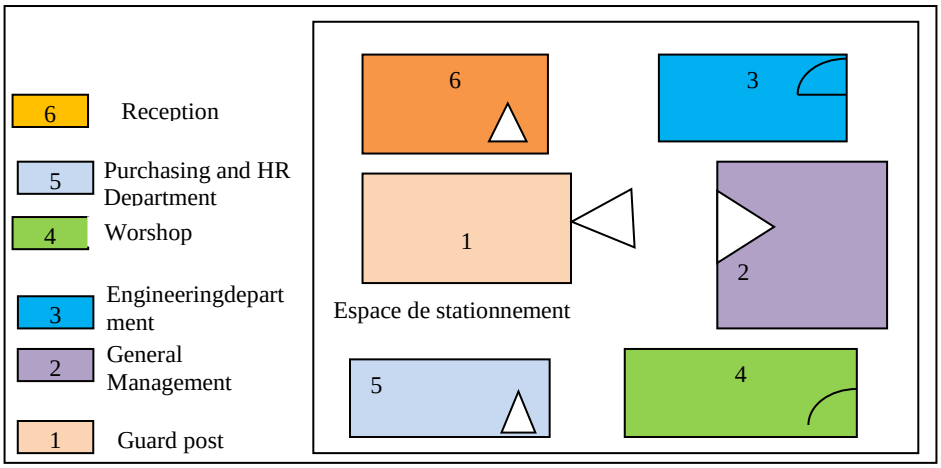
4.1. Company Presentation and Specifications

The approach was applied to an Algerian SME, which is an LLC with around sixty employees. The company specializes in manufacturing and selling stainless steel products, such as cutlery, kitchen utensils, stainless steel and aluminum worktables, bakery shelves, butcher shop counters and sinks, stainless steel insulated chests, carts, robotics and bakery equipment, equipment for communities and restaurants, etc. Its customers are mainly collectives, businesses, hospitals, army, etc. throughout all regions of Algeria.

The company produces two types of products: standard products that are uniformly and continuously produced and available (entirely or partially) in the store and specific products that are not available at the factory and require product prototyping based on design and feasibility study activities.

The main structures that make up the company include the general management, purchasing and human resources department, engineering department, reception office, guard post, and workshop (Figure 3).

Fig.2. Organisation of SME



Source: By authors

In this work, we focus on the production workshop to identify and characterize the various flows that circulate within it. The main stages of the manufacturing process of this SME's products are as follows:

- Cutting: This is the action of cutting the sheet metal using a cutting machine according to the desired quantities.
- Punching: This is the action of tracing the shapes on the sheets according to the programming of the punching machine.
- Bending: This is the action of bending the sheet metal.

- Welding: This is the action of connecting the pieces together.
- Cutting: This is the action of cutting the tubes.
- Assembly: This is the action of assembling the finished products.

This SME is looking to expand and commit to ISO 9001 certification. However, it is facing organizational difficulties. How can work efficiency be improved in the workshop? Space management is the weak point in workshop management. Indeed, this increases the movement of workers and therefore has a negative effect on production. In this context, we propose the implementation of a "KAIZEN" site (Vo et al. , 2019)by adopting Lean Manufacturing tools at the workshop level. It will be necessary to rethink the layout of the space and work methods according to three axes: technical ("Arrange and Signal" to fluidize and regulate traffic), human ("see to be seen" and move around safely), and organizational ("organize and formalize" to optimize production and secure work).
The description of the production process by the diagram below will allow visualizing the sequences of operations. For the manufacture of a product, the successive stages show the sequence of operations representing the material flows and the movements of workers.

4.2 Applying the Chosen Methodology

The objective is to ensure productivity by optimizing the organization of the factory, while reducing production times and improving the quality of products of the SME. During the observation period, the problem to be addressed is the improvement of work efficiency. The malfunctions identified are grouped in the Ishikawa diagram by considering the 4 axis: Methods, Manpower, Environment, and Means. These identified causes generate poor space management, poor circulation of information, and waste of raw materials.
Juran states that organizational dysfunctions account for 80% of the problems encountered within a company, highlighting the critical importance of organization (Juran, 2004). As a result, companies arefaced with various issues related to their organization. In this context, our approach aims to propose solutions to these dysfunctions in the form of corrective actions. Therefore, after identifying the dysfunctions using the Ishikawa diagram, we apply the 5S method to these dysfunctions, by suggesting corrective actions that the company could implement to improve its organization.

In this case, corrective actions are:

- For Workforce axis: Improve working conditions Adapt internal communication Identify flows with arrows on the floor or on walls.
- For Environment axis: Improvement of working conditions Reorganization of the factory layout Perform a reorganization of the aisles, entrances, and exits.
- For Methods axis: Implementation of an information system; Procedures, Introduction of a versatile agent "Water spider".
- For Means axis: Maintenance.

The proposed corrective actions stem from the application of each of the 5S's to the identified dysfunctions. The first S (Seiri or Sort and Remove) which involves eliminating the unnecessary. The second S (Seiton or Set in Order) which advocates for the doctrine "A Place for Everything and Everything in its Place," and the third S (Seiso or Shine) which is a means of discovering anomalies and gaps will be applied to corresponding dysfunctions such as unnecessary movements, cluttered workstations, and poor organization of tool storage, etc. The solutions provided will therefore aim to improve working conditions, rearrange the factory, reorganize movements, etc. The fourth S (Seiketsu or Standardize) which involves sustaining the first 3 S's through systems and procedures will enable the implementation of an information system and procedures. Finally, the fifth S (Shitsuke or Sustain) consists of formalizing an action plan to maintain a stable working environment.

4.3. Optimizing the Organization: Proposed Solutions

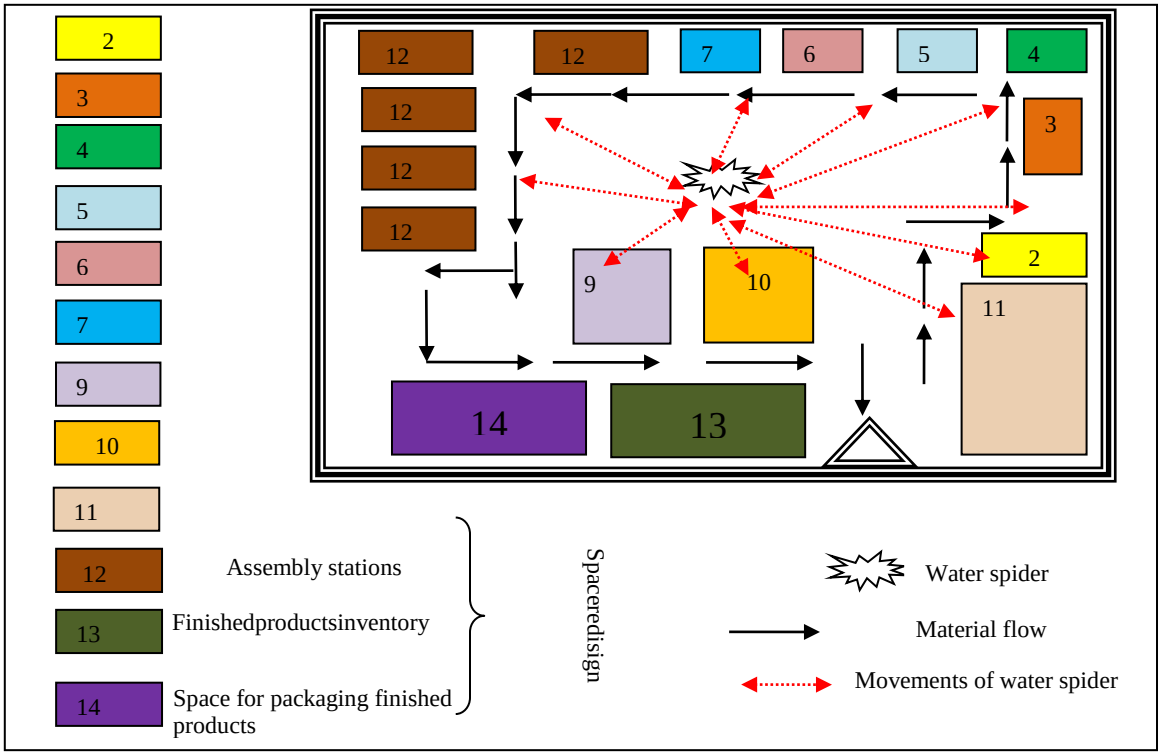
The layout of the company reflects its space organization as well as its functioning and rules. Our proposal consists of introducing an optimization solution to the organization, focused both on the physical redesign of the factory and a new vision of collaboration among workshop members, thus joining the corrective actions given in the previous table.

- The redesign of the factory aims to enhance internal circulation and provide workers with more space. This will create a more efficient and comfortable working environment. (Figure 3). Individual workers operated at their own pace without synchronization. The following employee at the next workstation used the accumulated products after finishing their own batch. This helped in optimizing the production process. Work-in-progress could accumulate between two workstations for several days. The overcrowding of the space shrinks the available space and limits the workers' movements. The application of the 5S, which is a simple and effective tool, will contribute to improving working conditions. Indeed, the priority is to eliminate everything that is unnecessary, such as broken machines. We proceeded with the reorganization of the workshop, firstly by removing unused space regarding machines and products (spaces 1 and 8) and secondly by adding others regarding workstations, finished stocks, and their packaging (spaces 12, 13, and 14). The new organizational structure favors the circulation of material, organizational, and informational flows. Thus, all flows converge in the same direction, avoiding any disruption of processes. The reorganization of work aims to establish an uninterrupted flow from the first to the last stage of the production process. This mode of organization will generate a new conception of workstations and the installation of tools nearby, in order to reduce employee movements and increase production.

- To enhance the efficiency and effectiveness of the SME's organization, we suggest introducing a "Water Spider", a versatile agent that can facilitate tasks for the entire workshop team (Westcott, 2002). The role of the Water Spider is to retrieve necessary

parts for each order, thus eliminating the need for individual team members to travel, and ultimately saving time. This introduction will optimize material and informational flows, reduce waste, and improve collaboration and teamwork within the production team. There will be fewer movements, less fatigue, and stress. By facilitating handling, the productivity is enhanced and the overall yield is improved. This will make it possible to optimize organizational, material, and informational flows (Figure 3). Thus, each member of the team will concentrate on value-added tasks. In addition to reducing employee movements, this new mode of organization significantly reduces the number of adjustments and sub-assemblies to be carried out since, in the new organization, there is a control before each stage of the production process. This new organization of the workshop will allow for more space and create a pleasant environment for workers. Material and informational flows all go in one direction, allowing for fewer worker movements. The cleared spaces will allow for better circulation inside the factory and thus design a visual organization and control system.

Fig.3. New workshop organization



Source: By authors

4. CONCLUSION

This article presents an approach to enhance the efficiency of a company's internal structure and operations. By analysing the company's internal workings and external environment, potential issues can be identified, their root causes traced, and solutions promptly found. The approach comprises two iterative steps: identifying issues using the Ishikawa diagram and

implementing Lean Manufacturing to propose solutions. The identified issues were also addressed through the 5S method. The approach was applied to a local SME specializing in stainless steel products, and corrective measures were proposed using the 5S method to eliminate waste, improve work pace, and optimize the organization. The "water spider" concept was introduced to regulate workshop flows and foster collaboration among the production team members. This will optimize material, informational, and organizational flows, reduce waste, and identify non-value-added processes to increase competitiveness. The new organization will encourage flexible working hours and collaborative work within the production team. The effectiveness of the proposed measures will be evaluated by calculating the ratio of value-added time before and after their implementation.

5. Bibliography List:

[1] Ahuja, I. P. S., & Khamba, J. S. (2016). Lean manufacturing: literature review and research issues. International Journal of Quality & Reliability Management, 33(6), 704-750. doi: 10.1108/IJQRM-09-2013-0136.

[2] Pannu, C. S., & Singh, P. (2020). A systematic review of 5S implementation practices in industries. International Journal of Production Research, 58(16), 4846-4870. doi: 10.1080/00207543.2020.1727058.

[3] Guo, C., Yang, W., Wang, Y., & Zhang, X. (2020). The implementation of 5S management in small and medium-sized enterprises: A literature review. Sustainability, 12(11), 4426.

[4] DeSouza, R., & Gupta, M. (2011). Ishikawa diagram as a quality control tool in manufacturing industry. International Journal of Engineering Science and Technology, 3(5), 4485-4490.

[5] Zhan, L., Zhang, Y., & Fang, Y. (2016). Effects of 5S implementation on workplace organization: empirical evidence from the electronics manufacturing industry. International Journal of Production Research, 54(3), 676-686.

[6]Ahi, P., & Searcy, C. (2013). Lean and green: The role of lean management in environmental sustainability. Journal of Cleaner Production, 40, 93-100.

[7] Hines, P., & Rich, N. (1997). The seven value stream mapping tools. International Journal of Operations & Production Management, 17(1), 46-64.

[8] Lashari, S. K., Arain, G. A., Hameed, I., & Memon, N. A. (2019). Collaborative lean approach for improving production performance. Business Process Management Journal, 25(6), 1236-1262. doi: 10.1108/BPMJ-08-2018-0239.

[9] Mintzberg, H. (1989). Mintzberg on management: Inside our strange world of organizations. Simon and Schuster.

[10] Drew, J., McCallum, B., & Roggenhofer, S. (2004). Objectif Lean. Réussir au plus juste : enjeux techniques et culturels. Les éditions d'Organisation.

[11] Womack, J., & Jones, D. (2007). Système Lean : penser l’entreprise au plus juste. Pearson Education.

[12] Leksic, I., Stefanic, N., & Veza, I. (2020). The impact of using different lean manufacturing tools on waste reduction. Advances in Production Engineering & Management, 15(1).
[13] Azzemou, R., & Noureddine, M. (2009). Quel modèle de gestion pour l'entreprise algérienne ? Actes de la 6ème Conférence Internationale Conception et Production Intégrées CPI 2009, Fès, Maroc.
[14] Ishikawa, K. (1990). Introduction to quality control. Chapman & Hall.
[15] Ishikawa, K. (2007). La gestion de la qualité : Outils et applications pratiques. Dunod.
[16] Jaca, C., Viles, E., Paipa-Galeano, L., Santos, J., & Mateo, R. (2014). Learning 5S principles from Japanese best practitioners: case studies of five manufacturing companies. International Journal of Production Research, 52(15), 4574-4586.
[17] Imai, M. (1997). Gemba Kaizen: A commonsense Low-Cost Approach to Management. Mac Graw-Hill.
[18] Mehta, V. B., & Dave, P. Y. (2020). Impact of 5S and lean manufacturing techniques in various organisations to enhance productivity. International Journal of Advances in Engineering and Management, 2(1), 421-436.
[19] Gupta, S., & Jain, S. K. (2013). A literature review of lean manufacturing. International Journal of Management Science and Engineering Management, 8(4), 241-249.
[20] Vo, B., Kongar, E., & Suárez Barraza, M. F. (2019). Kaizen event approach: a case study in the packaging industry. International Journal of Productivity and Performance Management, 68(7), 1343-1372.
[21] Juran, J. (2004). Architect of quality. Mac Graw Hill.
[22] Westcott, R. (2002).Creating Continuous Flow. Quality Progress, 35(8), 110.