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The Role of Continuous Improvement Process in Optimizing the Warehouse Operations: A Case study on a German Automotive Company

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Abstract. Organizations are doing a huge effort to have great visibility on the real time status of their supply chain network, eliminating waste, reducing response time, simplifying the structure of both products and processes, and improving performance quality, thus, giving them the ability not only to fulfil the demand but adapting to new activities and eliminating those which add little or no value. Therefore, this study aims to improve the warehouse operations and optimize its performance through Continuous Improvement Process (CIP). To fulfil the purpose of this study, first the qualitative approach has been adopted through conducting interviews and observation in order to collect the study's data. Second, a systematic literature review (SLR) was carried out to help in constructing a framework. Third, a case study was conducted on a manufacturing company in Germany to enhance the implementation of lean production and warehouse operations through CIP. The findings indicated that applying these techniques reduce the overall production cycle time and lead time, decrease errors, and lead to better performance in warehouses. The paper contributes to theory through adopting systematic literature review to identify the frame of knowledge of the study and fill the gap in the literature related to implementation and of lean methodology and CIP. Practically, organizations will find benefits, such as reducing the inventory levels, waste elimination, lead time reduction, and cycle reduction, thereby improving the warehouse operations.

Keywords: Continuous Improvement Process, Lean warehouse, Systematic Literature Review (SLR), Case study, Thematic analysis

1. Introduction

Warehouses remain a crucial link in today's Supply Chain; operating within very different supply chains are no longer seen as static storage units, disregarding the confined commercial thought of a warehouse as a storage and retrieval purpose into a more treasured potential of its significant role, which needs to be addressed in order to optimize the material flow throughout the whole supply chain of an industry. Terminologies, for example consolidation and cross docking, have become essential, with the ultimate goal of increased throughput, stock reduction, transparency and reduced delivery time. This is where the lean techniques can be handled within a warehouse (Braglia, Castellano, Gallo, & Romagnoli, 2019; Hughes, 2015; Kiani Mavi et al., 2020).

Continuous Improvement Process is the main part of the implementation of lean warehousing, gaining importance in the industries ever since the end of the Second World War. The main theme of the process is the reconstruction of the industry without any financial investment, and the idea is to present the activities in warehouses that consume resources but do not make an extra value (Martins, Pereira, Ferreira, Sá, & Silva, 2020).

Lately, Continuous Improvement has received a considerable attention due to some important factors, such as companies suffering to decrease inventory within the supply chain and ongoing use of offshore management, competition among the markets, customer services and avoiding product recalls (Y. J. Kim & Ha, 2022; Rogers, Kahraman, & Dessureault, 2019; Salhieh & Alswaer, 2021).

After a systematic review of the literature on lean warehousing and lean thinking, the tools of continuous improvement, such as Plan-Do-Check-Act (PDCA) technique, which is adapted to the business streamlining methodology includes Value Stream Mapping (VSM), 1*1 Flow method, Supermarket pull system, Kanban and Kaizen bursts were utilized. The research will fill the gap in the literature related to the previous discussion, which is the implementation of lean methodology in warehouse management through using different techniques (Adeodu, Kanakana-Katumba, & Maladzhi, 2022; Seman, Setiaji, & Nor, 2022). Therefore, this paper aims to apply lean methodology in warehouse management through adopting CIP. In addition, a systematic literature review will be conducted in order to determine the key lean principles in warehousing to work as a guide for the paper's case study. This will help in achieving a challenging target to manufacturing companies to apply lean principles in the warehouses of industries.

2. Literature Review

A systematic literature review is done to expand and identify the frame of knowledge addressing variables related to the implementation and sustainability of Lean Methodology (LM) and Continuous Improvement Process (CIP). The study aims at finding an inclusive framework of best practices vital to a strategic and successful lean management (LM) implementation. It will support the scholars and practitioners with a group of important success factors, revealing their interrelationships and understanding the relevance towards the achievement of Continuous Improvement (CI) culture successfully.

The research study is being carried out in a SLR way because it is a constructive and repeatable process for identifying, analysing, evaluating and deriving the information as the works of the researchers, scholars who pave the path as a guide towards the credible source and validation. The focus is directed on the variables that foster the implementation and reliability of Lean and CI, which might be considered significant to improve of the company's efficiency, capacity and performance. This can be further structured into five categories (Okoli & Schabram, 2010).

2.1. Planning for literature review and searching

The literature review was done through the check of the famously mentioned scholarly sources, books, articles, newsletters, conference proceedings and reports. The most feasible method for searching the literature is through electronic databases (Levy & Ellis, 2006); therefore, it relied on search engines, such as Emerald, Clarivate, Elsevier, Science Direct, and Google Scholar,. The search was collected using the following keywords: Warehouse Management, Lean, Lean Production, Continuous Improvement Process, Continuous Improvement, Kaizen, Kanban, KPIs and Lean Philosophy. Keywords were used to make dissimilar search patterns and search strings using Boolean connectors, such as AND, OR and NOT.

2.2. Screening

The next step in SLR was screening, which included deleting all the duplicates according to author and title. This study was carried by including and excluding criteria to confirm reliability and comprehensiveness. This is necessary for the quality assessment of the papers, and the criteria is critical in selection of the topic (Andrew Booth, 2012). Examination of research articles is done by title, abstract and keywords; the papers that achieved the criteria have been selected.

Using secondary keywords to concentrate on the research aim and so on the implementation and validation through well-known tools and practices, the first group of secondary keyword includes the following connectors: lean activities, enablers, barriers and tools, whereas secondary keywords' second group includes Implementation, Validation, Failure, Optimization. Searching the online databases by stating the primary keywords and secondly addressing the secondary keywords is being carried out, reading the abstracts and reviewing the full papers is done. Concentrating on the activities influencing Lean and CI Implementations demonstrated by 40 papers.

Showing the papers shaped by the SLR strategy, 10 variables have been able to be identified, which are mentioned to as activities affecting Lean and CIP implementation and reliability. Variables and related citations are being mentioned in Table 2.

Table 2: Critical success factors identified from SLR

Variable	Resources	Total
1. Employee engagement	(Oliver, Delbridge, & Lowe, 1996);(Flumerfelt & Kahlen, 2012);(Trochim, 2000);(Jönsson & Schölin, 2014);(Jadhav & Rane, 2014) ; (Jadhav & Rane, 2014);(Longoni, Pagell, Johnston, & Veltri, 2012);(Jayamaha, Wagner, & & Warwick, 2014);(Dombrowski & Mielke, 2014);(Sobanski, 2009);(Piercy & Rich, 2015) (Antony, 2012);(Psychogios, Atanasovski, & Tsironis, 2012);(Stewart & Garrahan, 1995);(Jadhav & Rane, 2014);(Longoni et al., 2012) ; (Skhmot, 2017,);(C., Shantz, Soane, Alfes, & Delbridge, 2013);(Stewart & Garrahan, 1995) ; (Adler, Goldoftas, & Levine, 1999);(D.S. & Antonakis, 2006);(Flumerfelt & Kahlen, 2012) ;(Welsh, 2016);(Chakravorty & Hales, 2017);(Staudacher & Tantardini, 2012) ; (R. Shah & Ward, 2007);(Marksberry, Badurdeen, Gregory, & Kreafle, 2010);(C. et al., 2013);(Glover, Farris, & Van, 2015);(Kumar, Dhingra, & Singh, 2018; Netland, 2016);(Yin, 2009);(Meiling, Backlund, & Johnsson, 2012);(Doolen, Farris, A.E.M., V., & Worley, 2008) ;(Reis, Stender, & Maruyama, 2017) (Jadhav & Rane, 2014);(Gu, Goetschalckx, & & McGinnis, 2010); (Abushaikha, 2018; B. Shah & Khanzode, 2017) ; (G. & P., 2009); (Letmathe, Schweitzer, & Zielinski, 2011);(M Saunders, Lewis, & Thornhill, 2003); (Prasetyawan & Ibrahim, 2020) ; (Kaur & Awasthi, 2018)	5
2. Training for employees		6
3. Top management commitment		5
4. Leadership		3
5. Teamwork		3
6. Performance measurement system		3
7. Bottom-up vs Top-Down approach		5
8. Kaizen Events		4
9. Lean warehousing		4
10. Dedicated Lean implementation teams		3

2.3. Thematic analysis

The most important steps of thematic analysis are coding, analysing and organizing the variables to be categorized. This study in particular was able to identify commonalities and managerial variables, as shown in Table 2. Furthermore, the SLR constructed a set of 10 variables, representing a complexity with high level to be integrated in the study. Therefore, the principle of reductionism (M. Saunders, Lewis, & Thornhill, 2008) was considered in order to build a framework of critical success factors, involving the lowest possible number of variables. This lets transparency to raise simplicity of understanding, as well as the goodness of the research work. Utilizing the categorization shown in Table 1 & 2, it has been possible to combine the variables within each category and to achieve a final categorization, including critical success factors used to achieve further analysis. The result of the process of rationalization derived as lean practices from the literature is shown in Table 3 and has been used for further analysis.

Table 3. Lean practices derived from literature

Lean practices	Sources
1. Kanban/pull **2. Continuous improvement programs** **3. Single piece flow** **4. Employee involvement** **5. 5S/ Safety improvement program** **6. Kaikaku/ Process redesign/Heijunka** **7. Cycle time reduction** **8. VSM**	(Schacht, Mansir, & Nicholas, 1989);(Bhsain & Burcher, 2006);(R. Shah & Ward, 2007);(Karlsson & Åhlström, 1996);(Arnheiter & Maleyeff, 2005);(Moore & Gibson, 1997);(Green, Lee, & Kozman, 2010);(Visser, 2014) (Schacht et al., 1989);(Bhsain & Burcher, 2006);(R. Shah & Ward, 2007);(Karlsson & Åhlström, 1996);(Arnheiter & Maleyeff, 2005);(Visser, 2014) (Schacht et al., 1989);(Bhsain & Burcher, 2006);(R. Shah & Ward, 2007);(Karlsson & Åhlström, 1996);(Martin & Osterling, 2014);(Yin, 2009) (Schacht et al., 1989);(Bhsain & Burcher, 2006);(R. Shah & Ward, 2007);(Karlsson & Åhlström, 1996);(Netland, 2016);(Yin, 2009) (Schacht et al., 1989);(Bhsain & Burcher, 2006);(Green et al., 2010) (Bhsain & Burcher, 2006);(R. Shah & Ward, 2007);(Arnheiter & Maleyeff, 2005);(Visser, 2014) (Schacht et al., 1989);(Arnheiter & Maleyeff, 2005) (Bhsain & Burcher, 2006);(Mittal & Verma, 2016) ; (Green et al., 2010) ; (Oláh, Lakner, & Popp, 2020)

Source: This research.

As observed, definitions used in research literature are mostly followed by the key terms, such as Kanban/pull, Continuous Improvement/ process kaizen, single piece flow and employee involvement. Cycle time reduction, Heijunka, Kaikaku/ process redesign and value stream mapping (VSM) are the least used practices in literature. This is due to the lack of individuality and interdependency of these tools, along with the other practices. For example, the process of redesign often involves pull based production and single piece flow. VSM is most commonly used as a tool to support continuous improvement process and therefore not often referred and cited in the definitions of lean production. As there is a progress in development of lean production, recent studies are involving a wide variety of practices in a rampant pace (Ongus & Nyamboga, 2019), utilizing the growing technologies (Rother, 2009; Song & Lee, 2020).

This approach suggests that lean production should be viewed as alignment of the practices and tools put together, rather than an individual and independent set of techniques and practices. To select the appropriate lean practices, the company has to be certain and critical instead of implementing all the lean practices(Wan & Chen, 2008).

2.4. Analysing the Systematic Literature Review and previous studies on Lean Warehousing

As per Jones et al. (1997), reduction of bin size, storage of products, speed stocking, standardized routing, institutionalized work, facility harmonization, manpower scheduling, paced routing and route cause analysis and critical thinking methods are for the most part Lean ideas exclusive to warehousing (Jones, Hines, & Rich, 1997). In accordance with the abovementioned, the principle ideas inside Lean warehousing are association/organization buy in, Kaizen events, order accuracy and on-time shipment (Bradley, 2006). Sobanski (2009) built up an extensive Lean execution assessment tool to quantify Lean standards being applied in warehousing (Faydy & Abbadi, 2022). The researcher recognized certain key Lean standards and strategies to help with the advancement of his Lean execution and assessment tool (Sobanski, 2009).

Bozer (2012) highlighted that warehousing assumes a critical job in the inventory network. He states that there is a very small amount of data on Lean warehousing with regard to associating with the cumulative collection of data and learning accessible on Lean coordination, Lean assembling and Lean inventory network. Furthermore, it clarifies that there are, to a great extent, no investigated and archived inquiries about regarding the matter of Lean warehousing in the scholarly network, making a void of information around there (Bozer, 2012).

To clarify the impact of Lean warehousing on performance, many research studies were conducted. For instance, one of the examinations demonstrates that the British vehicle industry has expanded stock turnover to “177.4 percent in the period from 1992 to 1994” (Oliver et al., 1996). It appears as though the lean warehousing is turning into an alluring exploration field. Nevertheless, studies on lean warehousing need to have more investigation. Certain studies have been done, of which the results show that, beside production, warehousing can be a good part for applying lean strategy and accomplishing a good result, which can be seen as an example in Table 4.

Table 4: The impact of implementing Lean philosophy in the warehouse system

Study	Area	Effect
(Swank, 2003)	Warehousing and services	60% reduction in response time, 28% reduction in labour costs and, 40% reduction of reissues due to errors.
(R. Shah & Ward, 2003)	Manufacturing	Positive influence on scrap costs, cycle time, lead-time, labour productivity and manufacturing costs
(Cook, Gibson, & MacCurdy, 2005)	Warehousing	71% decrease in inbound cycle time, 76% decrease in inventory levels, required storage space decreased by 51%
(Demeter & Matyusz, 2011)	Manufacturing	35,8% reduction of inventory days of raw materials, 33,8% reduction of inventory days of work in progress, 46,9% reduction of inventory days of finished goods
(Jaca, Santos, Errasti, & Viles, 2012)	Warehousing	9,34% improvement in overall warehouse productivity
(Dehdari, 2013)	Warehousing	An increase in warehouse productivity by at least 5%
(Dotoli, Epicoco, Falagario, Costantino, & Turchiano, 2015)	Warehousing	Increasing the profitability and quality and reducing errors.
(Makaci, Reaidy, Evrard-Samuel, Botta-Genoulaz, & Monteiro, 2017)	Warehousing	Defining pooled warehouse concept and bringing practitioners a better understanding of how it can be managed
(Valchkov & Valchkova, 2018)	Warehousing	Increase of the warehouse delivery reliability from 75% to 99.97%.
(Prasetyawan & Ibrahim, 2020)	Warehousing	Reaching a tool to make lower implementation cost and higher time reduction
(Raghuram & Arjunan, 2021)	Warehousing	Presented a framework that will make the work easier under lean warehouse and also applying step-by-step processes to achieve the company's goal.

Source: (Visser, 2014) till (Dehdari, 2013) and authors.

Lean in the warehouse means to measure lean maturity and performance within a warehouse.

There is a lot of sources of costs related to warehouse and warehouse operations, but it is also a source of competitive advantage. Because of this fact, acceptance of the lean policies in the warehouse will have a great role in value and reducing costs.

Increasing responsiveness and reducing the total cost are the main objectives of lean warehousing (Visser, 2014).

2.5. Concluding Literature Review

After thoroughly reviewing the literature, based on the SLR and journal articles as quoted in section D, and evaluating data according to the Table 3 and the effects of implementing Lean philosophy in the warehouse system, the authors found a gap between the application of Continuous Improvement tool of Lean methodology. There is no extensive consideration of CIP application in warehouse as it is in production; either study uses VSM to find the current state or evaluate the Key Performance Indicators (KPI) of the warehouse. When mapping as it is achieved, the information flow is included as well. According to the authors' knowledge, the capability of continuous improvement tool and its effects when applied in warehouse activities were not discussed before. Therefore, this research seeks to make an investigation of how the framework could be expanded to include the CIP to optimize the material flow and warehouse operations, as the small increments in process improvements (Kaizen) of performing a job will have a great influence on overall performance of the warehouse. This area could contribute to more valuable and interesting findings, since the information flows and the way of performing a particular activity plays a significant role in warehouse performance and efficiency.
Although the evaluation and applying of all mentioned Lean principles and concepts within warehousing do not form part of this research, using these principles should be beneficial for the employees to understand Lean (Sobanski, 2009). The following elements outline the standards of Lean warehousing as distinguished by Bozer, (2012). These standards will be utilized to decide the key Lean standards in warehousing. They are as follows:

- Kaizen and critical thinking.
- Status boards/orders showing progress
- Standardized warehouse work and equipment.
- One-piece flow in receiving, put-away, picking and dispatch.
- The flow level throughout the facility.
- Pull systems based on order due dates.
- Reduced organizing areas in receiving and dispatch.
- Eliminate double-handling between processes.
- Inbound and outbound shipments scheduled by time window.
- Reduction of all extra inventories.
- Measure and improve storage facility and travel times in material handling.
- Pick directly to shipping container (eliminating the need of handovers).

- Continuous improvement promotion.

The above factors will support the study in defining the key Lean principles in warehousing. An attempt has been made in this research study to fill the gap through a methodology emphasizing on CIP application in warehouse operations, which will help the study to progress further in developing a model to incorporate the Lean tools in process activities to achieve a continuously improving state of warehouse operations, thereby optimizing performance.

3. Methodology

In order to evaluate the CIP application in warehouse processes, the study develops a methodology that is based on qualitative research strategy. The qualitative research strategy focuses on the understanding and analysis of words, rather than numerical data. The results of this tool from analysing human behaviour (Rubin & Babbie, (2010)). Therefore, qualitative research is called as flexible when reaching the data collection phase.

Semi-structured interviews and observations have been conducted in order to collect the research data. The qualitative approach has been used through a case study in Germany. A quality of research strategy provides realizing of the phenomenon and filling the gaps related to the topic discussed. The research strategy in this paper has been applied using a qualitative data collection method. The range of analysis in this study is organizational level as the structure covers almost all the internal departments of the warehouse. The framework is adapted to a German automotive company, based on the organizational structure and its needs while focusing on the investigation and analysis depending on the framework (Bryman.A & Emma.B, 2007).

3.1. Case Study

The important aspects of this study involve participation in the research subject personally to understand how it operates. The question is a significant aspect when determining research strategy to work on. It implicates to who, what, where how and why. A case study is mostly a preferred research strategy tool to apply when the researcher goals is to answer questions of how and why (Yin, 2009). The case study will give a huge background of the processes at the German automotive company, which is required for data collection, and many methods can be utilized. With a case study, existing theories can be explored and challenged, which is applicable to this study. It can provide the researcher with new assumptions; based on this illustration, a case study is a feasible way of performing research strategy (M Saunders et al., 2003).

3.2. Interviews

The crucial method for data collection in this study is through personal interviews, which follow “Qualitative interview”(Bryman.A & Emma.B, 2007). Depending on the situation and purpose, there are different types of interviews: unstructured interviews, semi-structured interviews and Focus groups. Structured interviews are managed by the interviewer. The flexibility and causality of interviewee is less (Stuckey, 2013). The second type of interview is planned discussions that come towards the researcher's interests. This type has huge flexibility compared with the previous type (Gubrium & Holstein, 2001). Finally, the focus group contains usually six to twelve interviewees (Dornyei, 2007). The strategy of the groups will be based on the standards of questions, number of focus groups and number of contributors per group; moreover, these groups are normally led by a group leader (Adhabi & Anozie, 2017). The semi-structured interview has been selected as it has no strict obligations when compared to other forms of interview and helps the researcher to ask questions in a simple way, providing the researcher with the data needed (Yin, 2009).

3.3. Observation

It implies that the researcher observes e.g., while performing 'Go and See' protocol in 'Gemba' and while a job is achieved. The purpose of it is to receive real-life experience, how something works in reality and reciprocates to the given input. Observation can be direct or a participant one, where there is necessity for the researcher to participate in the activities rather than just observing. For this study, initial observations, along with the participant observations, were important to understand how warehouse at a manufacturing company in Germany functions. In order to give the study a depth, literature study was performed, and the research aim was formulated (Yin, 2009).

3.4. Secondary Data

In order to answer research questions, it is the data collected before for the other purpose but still can be reanalysed for the main aim of study. While performing this step, large data sets, forecasts, and newsletters were demanded from different persons at the company. Secondary data were also helpful to map the current state in VSM (M Saunders et al., 2003).

Table 5. Three data collection methods used in this study

Data collection methods used		
Interviews	**Observations**	**Secondary data**
interviews held during workshops and VSMs	Direct observations while performing Go and see protocol in Gemba	Mainly used for implementing lean techniques

Source: This research

Based on the above discussion that explained the different possible tools and methods to collect the study's data, this research conducted interviews with different positions in the company in Germany. The main aim of these interview is to grab as much as information related to the overall processes within the company's warehouse. Moreover, the researchers used observations through visiting the company and write down the overall processes and operations within the warehouses. Therefore, the next section will use this data in order to implement lean concept of continuous improvement process in the company's warehouse.

4. Reference Framework

In this research study, a framework implementing lean concept of continuous improvement process (CIP) is emphasized and with the alignment of the other lean tools, such as Value Stream Mapping (VSM), 1*1 flow method, supermarket pull system and e-kanban into the Plan-Do-Check-Act (PDCA) model is developed. The basis for the framework can be illustrated in Figure1. The goal of the framework is to create a sustainable continuous improvement model for warehouse operations, which can investigate and evaluate the current state of the value stream map and achieve a continuously improving future state mapping (Rother, 2009).

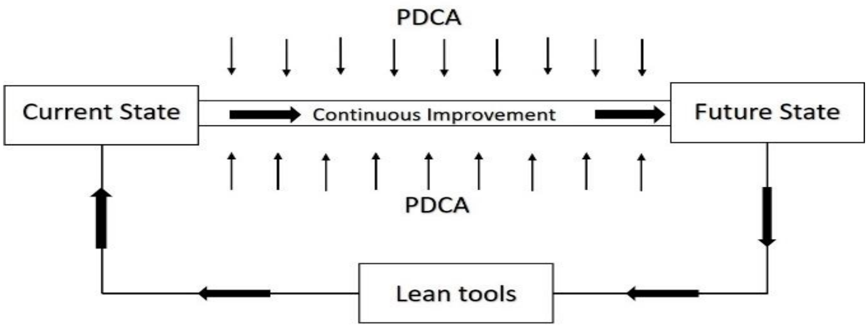


Fig. 1: Visionary pursuit of CIP
Source:(Smith, 1998)

The model provides information about how the warehouse operations perform and exposes the potential improvement areas to be worked on. There should be interdependence between the activities performed with a knowledge and understanding of how warehouse operations work and to be able to improve the state of the warehouse.

The visionary pursuit of CIP shows the way of lean application to achieve the target phase of the warehouse. It is cyclic process as seen in Figure 1, where the current state map of the warehouse is evaluated using one of the lean tools, called VSM, as it determines the current variables in warehouse operations. Later, PDCA cycle of improving the way of operation structures followed in performing the work determining the future state map, which is optimized. The cycle continues with applying the lean tools taking the optimized future state map as now the current state map. Again, it is evaluated with lean tools in process steps, such as:

Step 1. VSM

Step 2. 1*1 flow method

Step 3. Supermarket pull systems

Step 4. Kanban flow chart

Step 5. Pacemaker process

These five steps are continuously repeated in PDCA cycle as process improvement activities in performing warehouse operations; the operations that show improvement value are documented and standardized, and the ones that do not show any improvement value are abandoned considering the alternative process improvement. In this manner of step, wise process increments progressively lead to Continuous Improvement state of the warehouse.

This is as per a significant factor to build up when picking a suitable research strategy. Since individuals have various perspectives upon subjects, their recognition on what is significant additionally portrays various diverse research ways of thinking (M Saunders et al., 2003).

5. Case Study

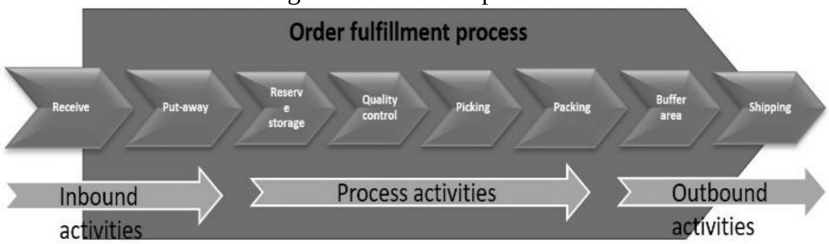
In this research, the studied warehouse is known as the efficient supplier of fasteners to the automotive industries. The orders met on daily basis range from 100 to 120 tons of material shipped throughout Germany. During the visit to the plant, the authors had the opportunity to conduct personal interviews with the logistics manager, warehouses manager, continuous improvement manager and other employees in the warehouse of the company. The interview went on about the general warehouse activities and was particularly concentrated on each and every step of the warehouse operations, such as Inventory, Inbound handling, Outbound handling, Value added services provided by the company on customer demands, damage and trade return area and the type of warehouse management system used in the company.

The plant visits, as an extension part of case study, helped authors to gain deeper insights into observing and analysing the functionality of the warehouse. The authors were able to relate the information gathered in the personal interview and collaborate with the functional form of the implementation of strategies and various process steps in the material flow.

The authors were not able to conduct face to face interviews with all the workers in the warehouse, but zoom application has been used to collect data related to material handling perspective of the process steps. With the help and guidance of continuous improvement manager, the researchers were able to understand the possibilities of lean implementation areas in the warehouse. These interviews had the pivotal role in this research study to build my work to practically analyse the potentials of lean tools, such as continuous improvement process and suggesting improvement in the warehouse performance of the company.

The secondary data on which this research study relies are the information collected from the sources that have been published. The authors considered using such secondary data from articles, books, journals and online source materials pertaining specifically to my topic. The other source of information was from the company's primitive information system in the form of reports, statistics, presentation materials, national summits and newsletters.

Fig. 2: Warehouse operations



Source:(Kłodawski, Lewczuk, Jacyna-Gołda, & Żak, 2017)

The warehouse operations are termed to achieve the order fulfilment process, which can be divided into the three value activities, namely Inbound activities, process activities and outbound activities (Hughes, 2015). The company can accommodate 1700 stock keeping units (SKUs) in high bay racks and equipped with lean lift for about 800 small units of material storage. The day targets for order processing are prepared to pick for 30 pages of order receipts, which would be later packed and stored ready to dispatch by the end of the day. The material flow incoming in inbound and outgoing outbound constitutes nearly 8-10 trucks per day, which measures as 8-10 trucks are shipped to all parts of Germany on a daily basis.

Each truck loaded with nearly 30-40 SKUs is delivered to the inbound entry at once, and 8-10 trucks constitute the material in flow per day. The high bay racks are specifically built to accommodate the SKUs as single units constituting 1700 SKUs capacity of storage and retrieval purposes. Nearly 80% of the order completion is done through SKUs, which constitutes the bulk orders and 20% of the order completion is done through manual dispatching on the Euro pallets. Since the SKU is constant in every shipment, the receiving process can be easily formulated as:

Time for truck to unload at receiving = 60 mins

Time per SKU = 60/30 = 2mins

Analysing the customer order profile, 15 to 22 SKUs per order, on an average 4800 SKUs, are in rotation per month, which gives approximately:

4800SKUs/(20 workdays)= 240 SKUs/day

240SKUs/(30SKUs per shipment)= 8 trucks per day

Metal containers capacity: 40000-50000/pieces per SKU and Small boxes capacity: 300-400 pieces per box

For the purpose of evaluation and determination of the typical metrics, VSM ise primarily examined through calculation of order processing time, order lead time and takt time. The current state map of value stream is plotted in Figure 3 with the calculations as follows:

Shift times: 07.30-17.30, 10hrs-1hr(30mins+30mins) break, Total work hours: 9hrs/day

$$Oder\ processing\ time = Sum\ of\ all\ cycle\ times\ \sum(C/T)$$

$$= 2mins + 10mins + 2mins + 1min + 2mins$$

$$= 17mins$$

$$Takt\ time =$$

$$Avaialble\ working\ hours\ per\ day \Big/ Customer\ demand\ rate\ per\ day$$

$$= (9 * 60mins * 60secs) \Big/ 240$$

$$= 135\ secs \sim 2.25\ mins$$

$$Order\ Lead\ time = 30mins + 5days + 2hrs + 2days$$

$$= 7.25\ days$$

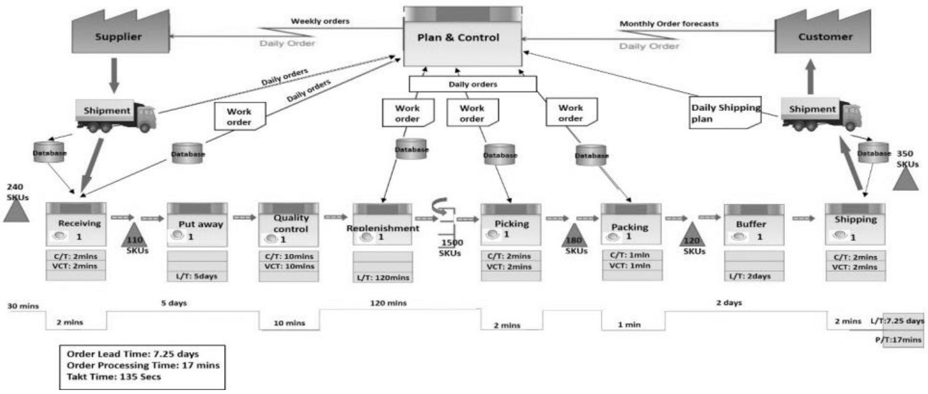


Fig. 3: Current State Map of VSM
Source: This research.

6. Results and Analysis

As the structure proceeds, it shows how PDCA methodology is applied as a CIP tool that contains the process steps following through, like VSM is performed in determining the wastes in warehouse operations through the current state map. Using

the results from case study in current state map, other process steps, including 1*1 flow method, supermarket pull systems, E-kanban and pacemaker processes, are utilized into the PDCA technique. And finally, how the methodology fosters in achieving the continuous process improvements is implicated, which are further applied in analysing the prediction of the optimized future state map also interpreted as continuously improving state of the warehouse.
The four phases of PDCA cycle as in Figure 4:

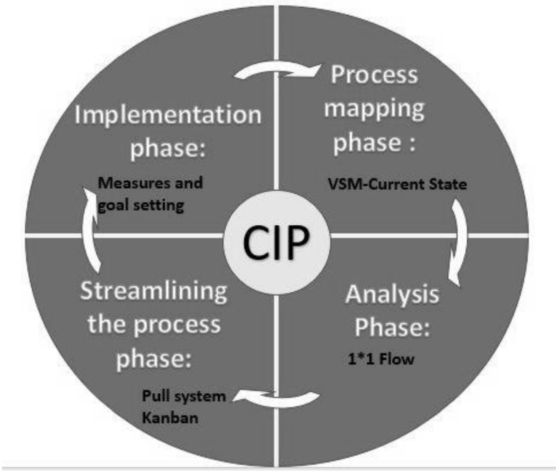


Fig. 4: Four Phases of adapted PDCA cycle
Source: (Christoff, 2018)

6.1. Process mapping phase: VSM

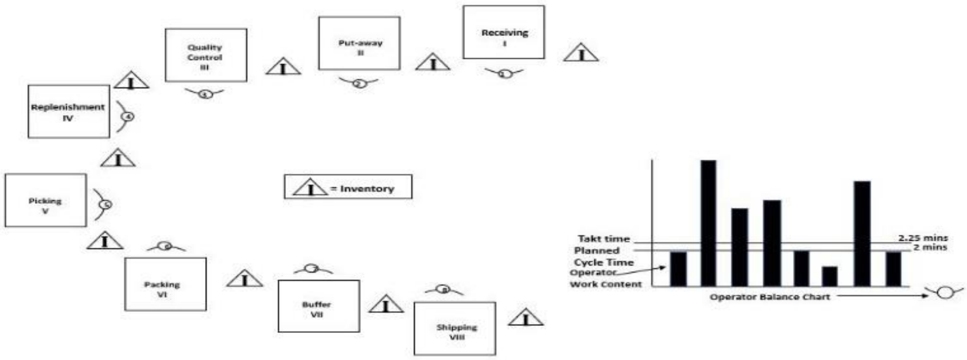
Mapping starts with shipping orders of customer requirements with a bottom-up approach and works along through the other warehouse operations ending at the supplier order requirements. This mapping helps in determining the value- and non-value- added areas, thereby making it desirable to apply CIP tools to cut down the wastes, and it also serves as a foundation for analysing the improved future state map. However, a “current state map” and the effort involved in creating it are considered to be pure muda until or unless it uses the map to quickly generate and apply a “future state map,” that removes sources of waste and thereby increasing value for the end customer(Mahoney & Goertz, 2006).

6.2. Analysis phase: 1*1 Flow Method

This research begins by looking and analysing the two process conditions: one without 1*1 flow and one with 1*1 flow. This process enables minimizing the number of operators needed by the whole process with the critical task of redistribution work elements among the operators making the amount of work equally distributed.

6.2.1. Condition: Without 1*1 flow

After applying this method, it seems that the process is flexible despite small process lags and stoppages as it can meet the required demand with the already available inventory level along with the incoming shipments per day of the warehouse. With



the availability of extra operators at the job, the process has the "flexibility" to work around problems and distribute the work and still reach the target output as seen in Figure 5.

Fig. 5: Operator balance chart-Without 1*1
Source:(Rother, 2009)

6.2.2. Condition: With 1*1 flow

By reducing wait times of operators with a better-balanced line, WIP inventory between operations, from several units to handling one at a time, is reduced. As far as finished goods inventory is known, most of these units are made to order. By reducing the compounded wait time, it clearly reduced the waste of inventory.

With company Toyota's philosophy of fostering the continuously improving warehouse, the second condition of 1*1 flow is preferable in spite of having necessary inventory buffers because both that striving and the 1*1 flow itself reveal factors and obstacles and make it clear what to focus our attention on. It always helps in reaching the ideal target state of the warehouse (Rother, 2009).

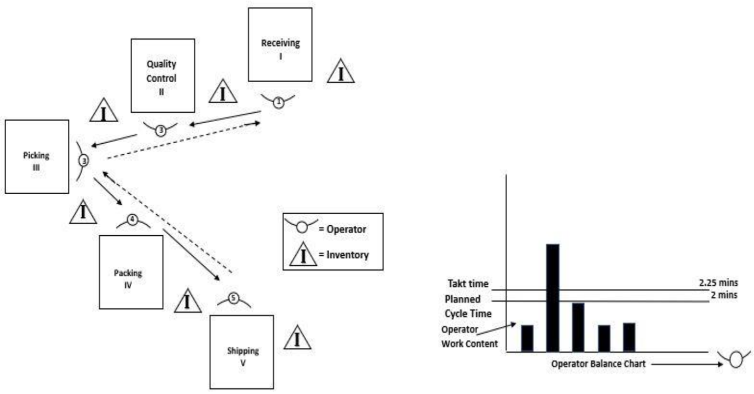


Fig. 6: Operator Balance Chart- With 1*1 Flow
Source: (Rother, 2009)

6.3. Streamlining the process: Supermarket Pull system

In order to make it adaptable to lean, "Supermarket pull system" is introduced, in which downstream process withdrawal rates from customer requirements control the upstream process as how much inventories should be maintained in order to fulfil the customer orders, getting rid of the MRP/ERP that try to schedule the different areas in the warehouse.

Consistent increment of work termed pitch, calculated on pack out container quantity. Considering a small order containing 350 items per small box.

Takt time = 135 secs

Pack size= 350 pieces/box

*pitch = (takt time * pack size) / 60 secs = 135 secs * 1 pack / 60 = 2.25 mins*

For every 2.25 mins pacemaker orders one pack quantity and takes away one finished pitch quantity.

On an average 210 orders/day

(210*2.25)/60 mins= 7.85 hrs.

By a simple calculation, it takes nearly 8hrs to fulfil the orders per day, taking 1hour buffer with removal rate of every 2.25th minute, an order is generated. This has become the basic unit of inventory removal and replenishment rate in the upstream process. However, if you are scheduling and checking inventory every pitch, then the response to problems and errors is quick, thereby achieving quality reducing errors and maintaining low inventory levels, which is an ultimate gain.

6.4. Implementation Phase

As this research is striving for continuous improvement, it should repeat the lean process steps to find the additional opportunities for improvement, introducing supermarket pull system into flow, thereby detaching the warehouse from upstream flow and allowing the downstream customer order to take over the flow, which is in turn makes the flow continuous. The order processing is replaced by electronic-Kanban cards, which helps schedule the whole value stream from shipping department to the receiving. Hence, by application of 1*1 flow, supermarket pull strategy, the process steps are deduced to 5 stages. The main 5 processes after deduction of the non-value-added activities are receiving, quality control, automated picking, packing station and shipping dock.

7. Discussion

7.1. Achieving the Future state map

Upon implementing all the lean tools into the flow, paving path for the real functional target realization state of the warehouse is reached. The duplicate activities are merged together to form a single process controlled by single operator for all the concerned activities for e.g. the quality control/replenishment. Kaizen bursts, such as time reduction applied at the receiving dock, processing 1*1 flow, which increases the quality improvement in the work, followed by the order levelling, which thereby eliminates batch processing orders, while holding very little finished goods inventory followed by picking and packing of the orders. Processing predetermined quantities, which are feasible to implement FIFO lane system, represent sequenced pull to plot future state as shown in Figure 7.

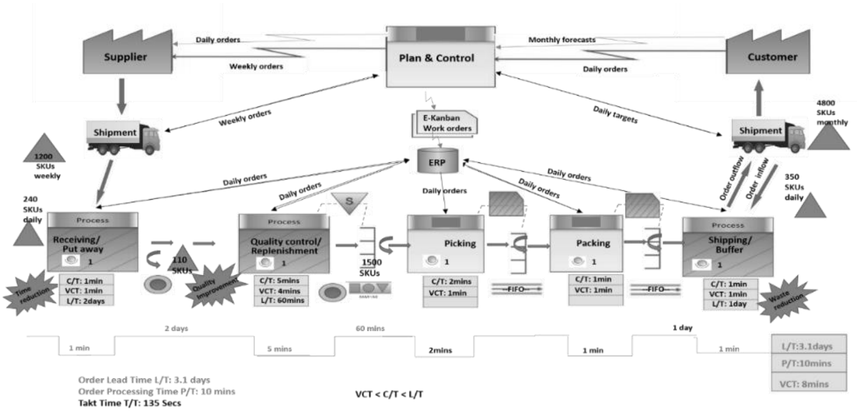


Fig. 7: Future State Map
Source: This research

7.2. Comparison of Current State Map and CIP Integrated Future State Map

The main essence of VSM is to act as an application tool to support the planning and performance improvement, as the current state map looks essentially at what happens now, and the future state map looks at how things should be carried out in order to progress into the future. When the current state value map is complete, there will be areas where improvements can be carried out, which are integral parts of the future state value stream map, building a basis for planning performance improvements. The implications for performance of this future state are shown in the expanded box score contrasting the current state and future state, see Table 6.

Table 6: Comparison Between CSM vs FSM

Items	Current State Map	Future State Map
Total Lead Time	7.25 days	3 days
Cycle Time	17 mins	10 mins
Value Creating Time	15 mins	8 mins
Pitch Time/order	Undetermined	2.25 mins
Takt Time	135 secs	135 secs

Source: this research

In this study, a wide examination has been done in order to evaluate whether a framework based on the lean concepts of continuous improvement process is appropriate to show the current condition in a warehouse and to present areas of improvement. The main significance is to investigate how these concepts interconnected and how they integrated to each other. This was tested through the practical application in the German automotive company. The impact of continuous improvement process on warehouse operations was discussed in this research. The main contributions of this study is that lean tool in achieving the process improvements in warehouse was given based on the VSM of current and future states.

This approach illustrated the difference of value-adding, non-value-adding activities, wastes that intervene in the warehousing functionality preventing it to achieve its full potential. This approach aims to find out the personified uncertainty in the value chain, including variations in supply, like shipment size, travel distances between the process's steps and order size and type for customer. It is clearly noticeable that the suggested approach in this study can be applied, such as CIP methodology containing variable process indicators, and it is not only limited to warehousing context but also to all the cross functional platforms where the performance measure is surely required.

8. Conclusion

This research conducted a different methodology in order to achieve the study goal, a systematic literature review (SLR) was carried out to help in constructing a framework. Second, a case study was conducted on a manufacturing company in Germany to enhance the implementation of lean production and warehouse operations through CIP. The research findings indicate that using CIP will enhance the warehouse operations and will achieve a better performance. It also addressed the benefits that were found with using PDCA methodology in a warehouse, since the continuous improvement concepts are not commonly used in a warehouse.

8.1. Theoretical Implications

The impact of continuous improvement process on warehouse operations was studied in this paper. As one of the main theoretical contributions of this study, the wide classification of lean tools in achieving the process improvements in warehouse was given based on the VSM of current and future states. This classification allows the explanation of warehousing roles based on their process activities. This approach demonstrates the distinction of value-adding, non-value-adding activities, wastes which are intervened in the warehousing functionality avoiding it to achieve its full potential. This new approach helps to overcome the personified uncertainty in an entire value stream including difference in supply, such as shipment size, difference in restrictions, such as travel distances in between the process steps and size and type of customer order. In addition, this approach will help the researchers and the academies to take step forward to apply such a technique. It is clearly noticeable that the suggested approach in this study can be applied, such as CIP methodology in any process chain comprising variable process parameters, and it is not only limited to warehousing framework but also to all the cross functional platforms where the performance measure is surely required.

The research also fills the literature gap as it provides a holistic approach through presenting a systematic literature review to identify the frame of knowledge addressing variables related to the implementation of lean methodology and CIP. This research also answers the call of Costa et al. (2019), Pinto, Mendonça, Babo, Silva, and Fernandes (2022), and Rossini, Kassem, and Portioli-Staudacher (2021) to use the lean methodology and CIP to better operations and performance in warehouses.

8.2. Practical Implications

The research findings confirmed the vital role of lean management and CIP. This will help organisations achieve many goals in supply chain in many different areas, such as achieving promising outputs through lean application at every process step of the operations (Filali, Lahmer, & Filali, 2022; Shou, Wang, Wu, & Wang, 2021), reducing the overall production cycle time and lead time (Balaji, Dinesh, Raja, Subbiah, & Kumar, 2022) and changing the work culture, which benefits employee and organizational relations for the mutual performance and growth (Tortorella, Fettermann, Cauchick Miguel, & Sawhney, 2020). This study also confirmed that continuous improvement process helps in cutting down the wastes in warehouses, increasing the work efficiency, cost cutting and waste elimination as agreed with many studies, like Medne and Lapina (2019), Martins et al. (2020), Yankson (2021), Knol, Lauche, Schouteten, and Slomp (2022), and Ghahramani, Yazdanmehr, Chen, and Wang (2022). Moreover, the environment gets increasingly unbalanced as supply chain competition heats up. Therefore, managers should use different techniques in different stages within supply chain to increase the quality of customer value creation with the maintenance of low inventories and high process rate of the overall warehouse functioning (Changarampat, 2022; Wang, Luo, Lee, & Benitez, 2022), and achieve a high level of customer satisfaction (E. J. Kim, 2022) while considering the digitalization in supply chain (Park & Kim, 2022). This study also supported companies by presenting different tools to measure their performance, release tied up space within warehouses, using electronic Kanban signals into the warehouse management system to solve problems and sharing information.

9. Results and Limitations

In the present work, it was concluded that VSM can be used successfully to expose areas of improvement potentials. The research area has been limited to the warehouse and the boundaries of the warehouse. The framework of this research is applicable to the entire supply chain to examine the areas of value-added and non-value-added as the field on interest in this research, thereby distinguishing where wastes occur and where value is added.

As it can be seen from the case study, the automated high bay warehouse is equipped with AS/RS system, and there is no possibility at instance to improve the cycle time of the machine as it is unchanged and follows the standard operating format. Only the direct material handling activities, such as put-away process and inventory buffers, are being acted upon. The applied lean methodologies, such as kaizen bursts and e-kanban cards, can be elaborated more in terms of the WMS and its applicability.

As this research is limited by both time and nature of the research questions and the accessibility of the data, there are other possible additional areas that could be investigated further in the name of academia, the first one related to the methodology. This research used an interview and observations to collect the study data; however, other tolls could be used like questionnaire. Other limitations are related to the paper; the study is applied in one of the developed countries (Germany). The study could be applied in different countries, especially in the developing countries. The sector was one of the study limitations, as the study is applied in automotive industry; however, more sectors could be included in the future research.

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