



Literature Paper Review: Improvement of Production Planning in Manufacturing Industry

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Abstract: This research paper delves into the intricacies of production planning within the manufacturing industry. By analyzing operational workflows, it identifies critical inefficiencies related to order processing, inventory management, and production scheduling. These inefficiencies result in prolonged lead times, excess stock levels, and material count imbalances, collectively impacting the industry's competitive edge. A systematic literature review of 40 publications in Lead time analysis and Inventory control and tracking was employed in this study, presented in this review with the bifurcation of 5 suitable papers for Lead time reduction and 7 suitable papers for the cause of inventory control and tracking. The study aims to address these challenges and enhance overall efficiency in heavy equipment production planning.

IndexTerms – Production Planning and Control, Value Stream Mapping, Make-to-Order, Work in Progress, ABC Inventory Analysis, Inventory, Lead Time Reduction

INTRODUCTION

This literature review aims to optimize production planning for heavy equipment components, addressing two critical challenges: prolonged order-to-payment lead times and significant inventory imbalances. The proposed methodology can be drawn from extensive research and industry standards, emphasizing the following key components. In Value Stream Mapping (VSM), the end-to-end production process is visualized to identify bottlenecks and streamline workflows. Material flows, information flows, and value-added activities are mapped to pinpoint areas for improvement, enhancing process visibility, and collaboration, and reducing cycle times. Rigorous inventory analysis and tracking systems are implemented to monitor stock levels, demand patterns, and lead times. Utilizing barcodes and other basic tracking methods provides real-time visibility into inventory movements, aiding in demand forecasting and order fulfillment. Effective inventory management reduces overstocking, stockouts, lowers carrying costs, and optimizes working capital utilization. The practical application of these insights in SMEs promises improved competitiveness and heightened customer satisfaction. By aligning production planning with lean principles, heavy equipment manufacturers can drive efficiency and reduce waste across the supply chain.

1. Existing Literature - review

The significance of addressing these two problems lies in their direct impact on operational efficiency and cost-effectiveness. Lengthy lead times can result in delayed customer deliveries, missed sales opportunities, and increased holding costs, all of which erode the company's competitive edge and profitability. Similarly, stock imbalances, particularly excess stocks, tie up valuable working capital, increase storage costs, and lead to potential obsolescence. By improving these areas, a manufacturing Industry can achieve a leaner operation, reduce waste, and enhance customer satisfaction, which are pivotal for maintaining a strong market position and ensuring long-term success. This literature review will guide the project by providing insights into successful strategies and techniques that can be adapted to the company's specific context.

1.1. Lead time reduction

Literature reveals that past researchers have examined various aspects of lead time reduction. In terms of Tailored VSM framework enhancing Make-to-Order efficiency (Christoph Koch's et al, 2014). Value stream mapping enhancing production efficiency, cutting waste and costs (M.D. Sarfaraz Choudhary et al, 2018) also (Jolanta B. Krolczyk1 et al, 2017). Delving into the Indian SME market and discovering that lean manufacturing reduces lead time and boosts productivity as (Neha Verma et al, 2017) have analysed. Research also uncovers digital transformation challenges in SMEs being a road bump in the advancement of SMEs as analyzed by (Arnesh Telukdarie et al, 2022)

1.1.1. Addressing Digitization Challenges in Medium Scale Industries

In a Medium Scale Industry, the absence of digitization and heavy reliance on manual processes pose significant challenges, particularly concerning Order to Process and Inventory tracking. Arnesh Telukdarie et al., [12] analyze the digital transformation lag in SMEs, identifying key obstacles such as limited digital expertise, inadequate infrastructure including slow internet, insufficient skills, low awareness of digital technologies, and distrust in online platforms. Employing a quantitative and agile co-generation methodology, the research utilizes surveys to identify essential digital systems for SMEs, leading to the development of an integrated, scalable, and customizable system using Django for functions such as invoicing and order management. The study highlights a substantial gap in digital technology awareness and its integration into business models and processes among SMEs.

1.1.2. Enhancing Competitiveness through Lean Manufacturing Implementation

In establishing a VSM, understanding Value-added time on projects in the firm becomes vital. Neha Verma et al., [8] underscore the sustainable competitive advantage achieved by implementing lean manufacturing in an Indian SME. The research meticulously examines inefficiencies in production processes, including waste generation, equipment malfunctions, and suboptimal inventory and rejection controls, resulting in increased waiting times and a surplus of non-value-adding activities. Their methodology incorporates Value Stream Mapping (VSM) to pinpoint waste and improvement opportunities, alongside the calculation of Takt time to enhance productivity by aligning production pace with customer demand. The proposed solutions, articulated through a future state value stream, showcase potential enhancements over the current operational model. The implementation of lean principles yields a remarkable reduction in lead time, from 5 days to just 2 days and 7 hours, signifying a substantial boost in productivity. These findings offer a profound understanding of how lean manufacturing can be leveraged to achieve sustainable competitive edge in the Indian SME sector.

1.1.3. Enhancing Production Efficiency Through Value Stream Mapping

Research conducted by Jolanta B. Krolczyk1 et al., [7], and M.D. Sarfaraz Choudhary et al., [9], highlights the effectiveness of Value Stream Mapping (VSM) in optimizing production processes. Krolczyk et al. explore the enhancement of production logistics through VSM, identifying and addressing issues such as waste, flow problems, and excessive process time. Their methodology includes a comprehensive analysis of the current state, graphical representation of activities, and mapping out the future state to pinpoint losses and propose waste elimination. The results indicate potential improvements in logistics, a better understanding of product flow, and a more consistent Lean Manufacturing process. Notably, the implementation plan led to a significant reduction in changeover time, saving 81 hours per month. Similarly, Choudhary et al. focus on the Optimization of Value Stream Mapping in the Production Line in an Automobile Industry. Their research aims to enhance quality and reduce costs by identifying and eliminating waste using VSM. The study outlines the process of data collection across departments, current and future state mapping, and the use of VSM symbols to pinpoint losses. The findings include reduced waste, shorter lead times, smaller batch transitions, and the introduction of lean flow, culminating in improved productivity and suggested process improvements. Despite not providing products to the automobile sector, Choudhary et al.'s study underscores the significance of employing VSM to understand and optimize production processes.

1.1.4. Enhancing Make-to-Order Efficiency Through Value Stream Mapping

In a Batch production setup, Christoph Koch's et al., [5], paper delves into the Requirements for Value Stream Mapping in Make-To-Order Environments. It critically examines the challenges posed by the application of Value Stream Mapping (VSM) in make-to-order (MTO) production systems, particularly due to the method's limitations and the complexity arising from a high variant mix. The study identifies the necessity for a tailored VSM adaptation to address the unique demands of MTO settings. Through a thorough analysis, the authors develop a set of requirements for an MTO-specific VSM, with a focus on logistics and manufacturing control. The results underscore the need for a comprehensive approach to manufacturing control tasks within the VSM guidelines for MTO environments. This paper fills a significant research gap by providing a tailored framework for effectively implementing VSM in MTO contexts, ensuring that the intricacies of such production systems are fully captured and managed.

1.2. Inventory Control and Tracking

Literature reveals that past researchers have examined various aspects of Inventory Control and Tracking as the following: Inventory management using ABC and Chi-square (A R Adams et al, 1993), optimizing inventory with ABC-VED analysis for

cost-criticality (Lt Col R Gupta et al, 2007). Studies done about using a multi-standard ABC analysis to enhance inventory management (Zhang Yongxia et al, 2013) and using XYZ analysis alongside ABC to synergize inventory optimization (Dinesh Dhoka et al, 2013). The study of FSN-XYZ analysis helping streamline the firms inventory (Divya Devarajan et al, 2016). There is study done on Bullwhip Effect and how it affects the supply chain costs (M. Zanddizari et al, 2019). The literature has an underlying trend of ensuring Lean and Agile methods to optimize MSME inventory (C. Hemalatha et al, 2021).

1.2.1. Minimizing Work-in-Progress Inventory for Enhanced Efficiency

In a MSME, the majority of inventory is typically classified as Work in Progress due to high manual involvement in production planning and scheduling. This manual approach increases the likelihood of mistakes due to human error, which can negatively impact inventory management and tracking. C. Hemalatha et al., [11], propose that Work-in-Process (WIP) Control can be achieved through the application of Lean and Agile Manufacturing methods. This approach aims to reduce cycle times, lower costs, and minimize inventory in manufacturing processes. The study critiques traditional manual methods for their inefficiency and advocates for lean and agile practices to enhance resource utilization and process flow. Strategies such as line balancing and Kanban are employed, with a case study on heat transfer coils used to optimize manufacturing capacity and WIP levels. The findings highlight the pivotal role of lean and agile manufacturing in achieving customer satisfaction, cost-effectiveness, and process optimization, ultimately minimizing WIP inventory and improving decision-making for quality maintenance.

1.2.2. Maximizing Efficiency Through Combined ABC and XYZ Analysis

The research paper titled “ABC Classification for Inventory Optimization,” authored by Dinesh Dhoka et al., [4], highlights the critical role of combining ABC and XYZ analyses to optimize inventory management. While ABC analysis prioritizes high-value items, XYZ analysis refines this by considering demand patterns, allowing for focused resource allocation and order schedule alignment to minimize stockouts and excess inventory. The study underscores the necessity of classifying items into distinct categories for streamlined monitoring systems, with Pareto Analysis being a prevalent method. Additionally, the paper introduces the Concept of Importance and Exception (CIE) for effective inventory management, advocating for tailored strategies to integrate inventory classification with policy selection. The findings suggest that ABC analysis, synonymous with Proportional Value Analysis (PVA), benefits from data-driven insights, as evidenced by the analysis of an OEM company specializing in automotive plastics. Moreover, the research identifies the ideal period for conducting ABC analysis to minimize deviation and prevent significant inventory management issues, emphasizing the importance of thorough pre-analysis to determine its necessity. This comprehensive assessment of ABC analysis provides valuable guidance for inventory optimization across various industries.

1.2.3. Enhancing Inventory Management Through Multi-Standard ABC Analysis

ABC analysis plays a crucial role in achieving inventory tracking goals by prioritizing high-value items for tighter control and tracking, thus optimizing resource allocation and minimizing stock issues. However, according to Zhang Yongxia et al., [3], traditional ABC analysis has limitations, as it relies on a singular classification system that overlooks factors such as market material accessibility and biases towards certain inventory categories. To address these shortcomings, the paper proposes a multi-standard ABC analysis method, incorporating criteria such as inventory time, risk degree, and cost value proportion to enhance inventory classification. This approach is further bolstered by fuzzy theory for comprehensive evaluation and entropy theory for weighting factors. The findings suggest that this method significantly reduces costs and improves inventory management by providing a more balanced resource allocation and time management strategy. Importantly, this study fills a research gap by introducing a novel direction for inventory management optimization, particularly in SMEs in China, through the implementation of multi-standard ABC analysis.

1.2.4. Optimizing Medical Inventory Control Through Combined ABC and VED Analysis

Combining ABC analysis, which prioritizes items by value, with VED analysis, focusing on criticality, provides a robust inventory management tool. This two-pronged approach ensures that not only high-cost items but also those essential for operations are prioritized. Lt Col R Gupta et al., [2], addresses the escalating costs of healthcare delivery, with drugs accounting for a significant portion of hospital budgets. To optimize resource utilization and control drug expenses, the study employed an ABC-VED matrix, categorizing drugs into vital, essential, and desirable based on consumption value and criticality. The analysis revealed that a small subset of drugs (14.6%) incurs 70% of the total drug expenditure. The study's findings suggest that stringent management of Category I drugs by top-level administration can lead to substantial cost savings. However, the research was limited to one hospital's PVMS (Price Vocabulary of the Medical Stores) section 01, indicating a need for broader studies to validate these results across multiple institutions. The key takeaways from this study examining medical inventory control through a combined VED (criticality) and ABC (cost) analysis framework offer valuable insights. The research revealed that a limited subset of high-cost, essential drugs constituted a significant portion of overall expenditure. Prioritizing Category I: Implementing more stringent management controls for these critical and expensive items. Risk-Based Management: Tailoring inventory management strategies based on the assigned VED-ABC category, with Category I warranting the most rigorous controls.³

1.2.5. Optimizing Inventory Management Through FSN and XYZ Analysis

In streamlining inventory management, FSN analysis emerges as a valuable tool, categorizing inventory based on consumption rate: Fast-moving (F), Slow-moving (S), and Non-moving (N) items. By implementing FSN analysis, stock levels can be optimized, storage costs reduced, and the availability of the right products ensured when customers need them. Divya Devarajan et al., [6], assessed the effectiveness of FSN and XYZ analysis in a chemical firm, addressing challenges of inventory accumulation and declining stock turnover ratios due to inadequate materials management techniques. The research employed a dual analytical approach, utilizing FSN analysis to categorize items based on turnover ratios and XYZ analysis to assess stock value. This methodological synergy, operationalized through the Power Builder software tailored for FSN analysis, revealed a substantial number of non-moving items. By applying the combined analysis, the study successfully identified and eliminated 33 items classified under the NX category, which were neither frequently issued nor of high value. This strategic discard is anticipated to curtail excessive inventory buildup, streamline spare management, and foster potential cost efficiencies. The paper's insights provide a concrete example of how integrated inventory analysis can lead to tangible improvements in stock control and financial savings, making it pivotal for literature review in major projects.

1.2.6. Enhancing Inventory Efficiency and Forecasting Accuracy

Inventory inefficiencies such as prolonged reviews and poor forecasting strategies can severely impact profitability by tying up valuable resources in excess stock and increasing storage costs. A R Adams et al., [1], highlights several issues including excessive review times, stagnant inventory, and ineffective reordering routines that result in arbitrary adjustments. Additionally, the study identifies the flawed assumption of using a normal distribution for all items, leading to inconsistent reorder points and safety stock levels, compounded by increasing lead times. To address these challenges, the research employs a robust methodology, utilizing ABC analysis for item classification and prioritizing critical items. It emphasizes the importance of maximizing management information and improving inventory models. Notably, the Chi-square goodness-of-fit test is utilized to determine the most suitable distribution for different items, while an exponential smoothing model is applied for demand forecasting. Furthermore, the study calculates the economic order quantity with constraints, ensuring efficient inventory management practices are implemented.

1.2.7. Unraveling the Bullwhip Effect: Quantifying Supply Chain Disruptions

The Bullwhip Effect, a well-known phenomenon where minor demand fluctuations escalate upstream through the supply chain, poses significant challenges to profitability. While its detrimental effects are acknowledged, accurately quantifying its impact on costs has remained elusive. M. Zanddizari et al., [10], address this recurring supply chain issue, highlighting its adverse effects on manufacturing and inventory costs, ultimately denting supply chain profits. The authors introduce a novel approach to quantify the Bullwhip Effect's impact, employing the KMV model alongside the classic newsvendor model to develop a Distance to Loss (DL) function. This function, integrating variables such as selling price, wholesale price, salvage value, and demand variability, adeptly captures both stock-out and overstocking losses attributable to the Bullwhip Effect. By utilizing concepts from both inventory management and credit risk assessment, the study fills a critical gap by distinctly categorizing these losses and presenting a method to quantify them, addressing a previous research limitation. The experimental results, analyzed using Minitab software, underscore the significance of demand parameters, selling prices, and wholesale prices in influencing the retailer's DL, providing valuable insights into optimal profit and purchasing decisions.

2. Conclusion

This research advocates for a multifaceted approach to enhance production planning within the heavy equipment component manufacturing industry. The proposed framework integrates Value Stream Mapping (VSM) for process streamlining, Lean and Agile Manufacturing principles to minimize waste and augment responsiveness, and a synergy of ABC/XYZ analysis with FSN analysis for advanced inventory management. These methodologies are further fortified by digital transformation initiatives aimed at automating and optimizing order processing and inventory tracking functionalities. The anticipated outcome of this comprehensive approach is a significant reduction in lead times, rationalization of inventory levels, and an overall enhancement of operational efficiency. Embracing these advancements is expected to enable the industry to achieve a more streamlined operation, leading to heightened customer satisfaction and a reinforced competitive advantage. The successful implementation of this framework would serve as an empirical validation of the efficacy of strategic planning and continuous improvement philosophies within the manufacturing domain.

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