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Modeling the Integration Process of Lean Production Techniques into Mass Catering Production

Yusuf GÜMÜŞ [1]
Kardelen Öykü TURHAN [2]

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Abstract

In this study, the integration process of lean production techniques into mass catering production has been investigated, and this integration process has been modeled based on the current conditions of a catering firm using traditional production methods. The study comprises literature review, data collection, model development, and comparative analysis phases. The model was developed based on data obtained from a catering company that has partially implemented lean production techniques, informed by the literature review. The model identified approximately 64 m^2 of idle space within the facility, reorganized workflow to improve labor efficiency, and recommended reducing high inventory levels. In the comparative analysis phase, the production costs, production volume, and labor capacity of two companies were proportionally compared.

Key words: Lean Production, Mass Catering Production, Cost Control

JEL Code: L66, M11, M41

1. Introduction

In contemporary industrial societies, mass catering production has emerged as a fundamental sector and continues to evolve into a rapidly growing industry. Institutions such as schools, hospitals, workplaces, and many others cater to the daily nutritional needs of thousands of individuals. In addition to meeting this substantial demand, these institutions must adhere to specific standards, such as food safety and occupational health and safety, while also ensuring customer satisfaction by delivering high-quality products and services in a competitive market environment. Therefore, businesses need to seek effective solutions to remain competitive and sustain their operations in this market.

[1] Prof.Dr, Dokuz Eylül University, Turkey, yusuf.gumus@deu.edu.tr, https://orcid.org/0000-0002-3791-1938
[2] Dokuz Eylül University, Turkey, turhankardelenoyku@gmail.com, https://orcid.org/0000-0002-0906-8824

This study primarily investigates the issues encountered in food and beverage production enterprises and the impacts of these issues. Common problems include improper workflow planning, technical issues and frequent breakdowns, lack of equipment, shortage of qualified personnel, disorganized workspaces, non-standardized production processes and recipes, non-standardized cleaning processes, unclear job descriptions, communication gaps between employees and upper management, production errors, improper storage conditions, and insufficient supervision. These problems lead to a decrease in labor capacity and efficiency, a reduction in production volume and speed, non-value-added labor, deterioration in product quality, increased occupational safety risks, employee dissatisfaction and high turnover rates, inefficient resource use, food waste, and consequently increased costs (Kaya and İlhan,2018; İlban and Karadut,2018; Dudbridge,2011; Türkay et al.,2020; Yıldırım and Akçadağ,2004)

Given these challenges, the study explores the potential benefits of applying lean production system techniques, which have been used in various sectors to address similar issues, to mass catering production. It is anticipated that implementing lean production in mass catering will enhance quality and efficiency, ensure cost control, and contribute to standards such as food safety and occupational health and safety.

Lean production is a manufacturing and management system aimed at increasing efficiency by minimizing non-value-added activities, optimizing processes, and eliminating waste. The foundation of lean production is largely based on the "Toyota Production System - TPS." TPS consists of a series of techniques for identifying and eliminating non-value-added activities and embraces the philosophy of "Continuous Improvement - Kaizen", which encourages employee initiative.

This study, which provides an understanding of how lean production principles can be applied to mass catering production, is expected to be a valuable resource for organizations, managers, chefs, and relevant stakeholders operating in the mass catering industry.

2. Lean Production

Lean production aims to reduce waste, improve flow, gain flexibility, reduce costs, increase competitiveness, and create value through a series of techniques developed over time (Ohno, 1996). These techniques are designed to minimize or eliminate activities that expend resources in production processes, defined as "muda" in lean production. The seven basic types of waste encountered in production processes are defined as defects requiring correction, overproduction, excess inventory, unnecessary processing steps, unnecessary movements, unnecessary transportation and maintenance operations, and idle times due to bottlenecks (Ohno, 1996). A commonly used lean technique for identifying these wastes is Value Stream Mapping (VSM), which portrays both value-added and non-value-added processes backward from the final state of the product reaching the customer to raw material procurement or from product introduction to product design within the existing organizational structure (Rother and Shook, 2003).

Various lean techniques are used to eliminate these wastes based on needs, current conditions, and organizational structure. For example, the "5S technique" can prevent waste of unnecessary movement and transportation within the production area by organizing and standardizing the production area (Gapp et al., 2008; Moya et al., 2016). The "Total Productive Maintenance - TPM" technique aims to prevent downtime due to breakdowns by initiating preventive maintenance processes and assigning simple maintenance tasks to employees (Marchwinski, 2016; Karaman, 2004). "Total Equipment Efficiency - TEE," often used in conjunction with TPM practices, is a lean tool that measures how effectively equipment and time are utilized through simple equations. "SMED - Single Minute Exchange of Die" is a lean technique that aims to reduce setup costs by shortening the setup process. (Marchwinski, 2016). Visual management elements are used to monitor production flow and performance in businesses, track unplanned stops and errors in the production line or station, and provide guidelines for production and workplace rules (Kaya, 2011). "Just-In-Time Production - JIT" aims to minimize overproduction and stocks by producing according to customer demands and reducing waste. In the JIT production approach, each production unit acts as both a customer and a server, not producing until an order is received before the final production stage, thus reducing stock, saving storage space, and improving business organization (Ünal, 2007). Kanban is a warning device that authorizes and instructs production and material flow (pulling-moving) in a JIT system (Sivaslı, 2006; Vacanti et al., 2022).

These techniques are developed to eliminate and minimize waste within the production system. Additionally, various techniques and methods supporting lean management understanding are also used to integrate lean discipline into the organizational culture.

3. Mass Catering Production

Mass catering production and service refer to the operations and processes carried out to meet the nutritional needs of individuals in places where they work, reside, or receive education collectively (Kaya and İlhan, 2018). Catering firms, also known as industrial food service systems, are organizations that plan, manage, prepare for service, and carry out logistical operations for food and beverage production for a specific group (Sezgin and Artık, 2015; Şen and Şimşek, 2020). These processes include standard recipe development, menu planning, procurement, storage, production, service, logistics, hygiene, sanitation, food safety, waste management, and organization (Kaya and İlhan, 2018). Additionally, personnel management and cost control constitute fundamental elements of this process (Şen and Şimşek, 2020). Organizations determine their menus and service styles considering the special needs and dietary habits of the groups they serve; for example, child-specific meal services prioritize the nutrition needs and safety of children (Karadut and İlban, 2018).

4. Literature Review

In the study conducted by Lopes et al. (2015), 5S and SMED techniques, along with kaizen activities, implemented in two different food companies. As a result of the implementation, both companies increased production flexibility, shortened delivery times, and introduced employees to a culture of continuous improvement.

In the research led by Kennedy et al. (2013), a frozen food production company identified waste points using VSM and implemented the "Kaikau" lean technique along with 5S, SMED, and TEE techniques to address these issues. Significant progress was made in hygiene, production speed, and flexibility, and approximately 53 tons of CO_2 emissions and around £45,000 in cost savings were achieved annually.

Moya et al. (2016) applied VSM, 5S, and JIT techniques in a food company to reduce costs without compromising quality and conducted kaizen activities. As a result of the implemented techniques, process efficiency, efficient use of resources, and on-time delivery time increased in the first three months, while excess inventory stock and employee absenteeism decreased within the process. A total saving of 24 minutes was achieved throughout the production process. While the cost of lean practices for the business was determined as $5,400, the financial benefit provided by lean practices was found to be $9,200.

The aim of the study conducted by Tanco et al. (2013) is to investigate the applicability of lean production techniques in food manufacturing. Accordingly, in a factory where seasonal nougat production is carried out, VSM, TEE, and Heijunka techniques were implemented. As a result of the improvements, the work efficiency cycle, i.e., value-adding processes, was calculated to be 1.12% at the beginning of the implementation and 6.23% at the end. Improvements in delivery times positively impact customer satisfaction, while improvements in work efficiency positively affect cost control. However, it is noted that some improvements create new bottlenecks due to the lack of a holistic view of lean practices. This study emphasizes the importance of a holistic perspective in lean production.

In the study conducted by Viles et al. (2021), multiple case studies were conducted to uncover water wastage in the food industry. It was found that water usage measured with digital measurement devices significantly differed from the estimated water consumption in companies' cost calculations. After identifying these differences, lean-green approaches were applied to reduce water wastage in businesses. Water heads were replaced with pressurized nozzles, and manual cleaning was standardized with the 5S technique, resulting in positive outcomes in water consumption and sustainability activities.

Aragon and Ros-McDonnel's study in 2015 examined a lean production practices project aimed at increasing the productivity of a food manufacturer. The project aimed to instill a lean production discipline and improvement understanding into the employee culture using TEE, 5S, SMED, and JIT techniques. As a result of the studies conducted, significant improvements were recorded in areas such as quality, machine reliability, cleanliness, production flexibility, visual management usage, and worker productivity.

Lethinen, U. and Torkko, M. (2005) utilized the VSM technique in their study to investigate how lean production concepts could be implemented in the supply chain of a company that acts as an outsourcing producer in the food industry, manufacturing ketchup-mayonnaise and various sauces. The VSM technique was used to identify waste points and high inventory levels in the supply process, and an imbalance between value-added and non-value-added activities was observed. As a result, the company transitioned to leveled production to reduce inventory levels and focused on frequent supply processes with small batch sizes.

In Cabrera et al.'s (2020) study, a fresh produce business found that 2.1% of its product returns were due to quality and food safety deficiencies. To address this issue, the company implemented the 5S technique, resulting in an 89.2% reduction in returns and a 35.6% increase in cash flow for the business.

Steur et al. (2016) investigated the impact of VSM on reducing food waste in food production and supply processes. The research showed that improvements targeting waste points identified by VSM could significantly prevent food waste.

In Huseynzade's (2020) study, processes in a restaurant business were examined using VSM technique, and improvement suggestions were provided. By implementing some of the recommendations, the business achieved a significant improvement of approximately 71% by reducing the unplanned downtime. With the completion of the suggested improvements on the future state map, a 50% increase in production flow time, a 21% increase in cycle time, and a 50% decrease in supermarket stocks are expected.

Dağdelen (2020) reported that the implementation of 5S, kaizen, SMED, jidoka, and heijunka techniques in a bakery resulted in various financial gains. These include an annual increase of 56,181 $ in oven capacity, 2.270 $ in scrap product prevention. These improvements led to increased productivity, workforce capacity, product quality, and customer satisfaction, while reducing unplanned downtime, the risk of accidents, and losses.

Şeremet's (2019) study demonstrates that the implementation of the 5S system in a confectionery manufacturer reduced losses, increased workplace safety, and enhanced productivity. Additionally, the 5S implementation minimized damage caused by malfunctions, positively impacting occupational health and safety, as well as cost control.

In Akça's (2016) research, the application of VSM in ice cream production resulted in radical improvements in production flow, with recommendations for preventive maintenance, adoption of a lean culture, and electronic information flow. As a result of these improvements, a 12-minute saving in planned downtime and an increase in production speed were achieved.

Aykül's (2018) study focused on a frozen meat production company and utilized the VSM technique. Process improvements led to the elimination of bottlenecks in the ice cream production process, a one-day time saving, and a reduction in product cycle time from 20 minutes to 15 minutes in the packaging department. Additionally, overall improvements increased production capacity by 900 kg.

Djekic's (2012) study examines the ability of large and small-scale food producers to implement lean techniques and the reasons for non-implementation. In the large-scale enterprise, lean tools such as JIT, OEE, and SMED were found to be effective, while autonomous maintenance and accelerated changeover times increased production volume by saving time. The Poka Yoke technique was noted to have a positive impact on hygiene in both enterprises. While the small-scale enterprise was successful in reducing inventory stocks in production flow, the OEE technique was reported to be ineffective for the large-scale enterprise.

Gladysz et al.'s (2020) study indicates that lean techniques are effective in reducing food waste and lowering costs in food and beverage establishments. The applied techniques also contribute to sustainable restaurant theory and support HACCP requirements. Additionally, this case study highlighted a 55% reduction in lead times and a 16% cost impact.

The research demonstrates that lean production techniques applied in the food and beverage sector have a positive impact on occupational health and safety, food safety, cost control, sustainability activities, production speed and volume, customer satisfaction, and product quality. In light of these studies, it is believed that lean production systems can provide positive contributions to businesses in sectors such as mass food production where demand is predictable.

5. Research Method

The research aims to establish and implement a lean production system in mass catering production by theoretically examining the lean production system and reviewing national and international literature. Additionally, data on the application and integration process of lean techniques were collected through semi-structured qualitative interviews conducted with a mass catering producer. The focus of the research is on how the lean production process is integrated into mass catering production and the observed changes resulting from these implementations.

In October 2022, an approximately one-hour interview was conducted with the food and beverage manager of a mass catering company that had integrated lean techniques into their production process. The interview aimed to gather information on the company's general background, the integration process of lean production applications, and the outcomes obtained post-integration. The interview was recorded with the consent of the participant. During the interview, general information about the company was collected initially. Subsequently, the discussion focused on which lean techniques were implemented, how these techniques were integrated into production processes, how employees were informed about lean techniques and the lean production philosophy, and the changes in production speed, costs, food safety, and customer satisfaction before and after the implementation of lean applications.

In March 2023, another interview was conducted with the owner of a traditional mass catering company to gather general information about the company and its production process. This interview was also recorded with the participant's consent. Information about the company's customer portfolio, production volume, costs, and production methods were collected during the interview.

As part of the study, a structured observation technique was employed to lay the groundwork for lean production integration in the traditional mass catering company. Observations were conducted over two separate time periods, each covering one full working day, within the production area. The employees were informed about the observation and the identity of the researcher. The researcher used a pre-prepared observation form to identify waste points defined in the lean production system. The observation focused on points classified as waste by lean production, and non-value-added activities in the production process were identified.

Based on the observations and interviews, the research aimed to develop a model defining the steps for integrating lean production into mass catering production. This model followed the lean principal steps outlined by Womack and Jones and was adapted for traditional companies, taking into account their specific characteristics.

5.1. Sample and Limitations of the Study

In the research, purposive sampling was used to select businesses that would serve the research purpose. In purposive sampling, the sample is determined by the researcher according to the objectives of the study. To gather information about lean production, a mass catering producer that applies lean techniques was chosen. Additionally, to provide a foundation for the model, another mass catering producer that uses traditional production methods was selected.

During the research period, it was not deemed appropriate to observe the production area due to pandemic restrictions and company policies in the enterprise implementing lean production techniques. Therefore, the data obtained are limited to the information provided by the company officials. Another catering firm implementing lean techniques could not be reached during the research period, thus limiting the scope of the study.

6. Model

In this section, general information about the interviewed businesses is provided initially, followed by data obtained from the enterprise implementing lean techniques and light of the literature, an attempt is made to present a roadmap and an exemplary lean model for the transition to lean production.

6.1. General Information About the Business Interviewed

The "L" company, which embraces the lean philosophy and integrates lean techniques into its production processes, has a daily food and beverage production capacity of 24,000 people while producing 22,000 people daily. The company manages its operations using fully automated systems and artificial intelligence technology. Starting its lean transformation process in 2017, the company built its new facility in 2020 with a focus on lean production principles. The company organizes kaizen workshops and training programs to embrace the lean production philosophy. Additionally, the company implements lean production techniques such as total productive maintenance, visual management elements, and 5S. It utilizes ERP and MRP systems for corporate resource and material planning. Striving to benefit from the opportunities of Industry 4.0, the company notes that half of its 175 employees are in general service roles, while the rest serve as operators in the production process.

The "T" company, utilizing traditional production methods, has a daily food and beverage production capacity of 15,000 people, but during the period under review, it produces 7,000 people daily. Its customer base mainly consists of schools, factories, government institutions, and state dormitories. Using approximately half of its production capacity for contracted institutions, the company also produces for private events and organizations. The company employs a total of 75 people, with one-third of them involved in service processes such as cleaning, serving, and dishwashing. The facility, covering an area of approximately 900 m^2, is owned by the company owners. Around 250 m^2 of the production area is utilized for storage purposes. For corporate resource planning, the company utilizes Microsoft Office programs.

6.2. Integration Process of Lean Production Techniques into Mass Catering Production

The lean production system focuses on optimizing production processes by addressing both production techniques and managerial processes. This situation has been depicted using the iceberg model in the study by Hines et al. (2008). The applied lean techniques represent the visible part of the iceberg, while concepts such as kaizen philosophy, lean leadership, organizational culture, strategy, etc., constitute the invisible part. Liker (2021) approached this situation under the mechanical and organic approach. While the techniques applied within the production system form the mechanical approach, other managerial activities are examined under the organic approach. Since the effects of managerial activities vary in each organization and require a situational approach, this modeling focuses on the mechanical approach.

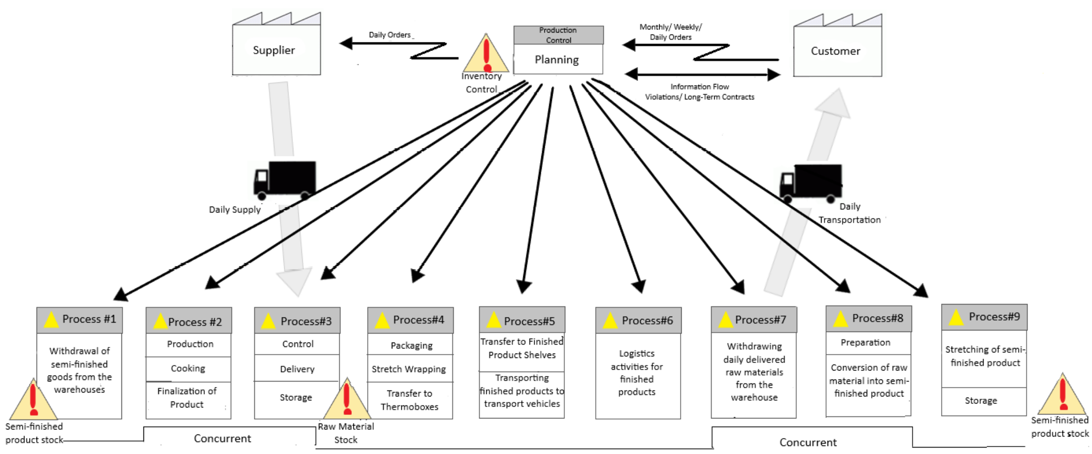
6.2.1. Mass Catering Production Value Definition

Mass meal production is a service provided by catering companies or within the facilities of large institutions or private organizations to meet their nutritional needs. The aim of mass meal production is to offer daily menus considering consumers' nutritional requirements and calorie needs. In establishments outsourcing mass catering services, the determining value is provided by the firms and organizations conducting the purchasing process. These establishments prioritize costs and aim to meet the daily meals needs of employees or service recipients at an affordable price. However, this situation leads to a balance issue between customer businesses expecting low costs and consumers expecting quality meal service. Mass catering producers strive to satisfy both the firms seeking low-cost purchases and consumers demanding quality service. Otherwise, continuous complaints can result in customer loss. In summary, from the perspective of customer businesses, the value definition of mass catering production is to provide healthy and delicious meals at the lowest possible costs and serve them to consumers on time, at appropriate temperatures, and in hygienic conditions compliant with food safety standards (Yanık and Yılmaz, 2011; Şen and Şimşek, 2020).

6.2.2. Value Stream Mapping in Mass Catering Production

Value stream mapping is a technique that visually represents a process to identify value-added and non-value-added steps, and it can be applied to both general and specific production processes (Akın, 2020). The current state VSM of Company T's production activities are as follows:

Figure-1: Current State Value Stream Mapping of Company "T"



Company "T" mostly carries out its daily production of 7,000 servings to meet the lunch needs of various organizations. Therefore, the preparation activities for the day's menus are conducted the previous day to meet the lunchtime deadline. However, various inefficiencies have been identified in the production process due to the timing of raw material procurement during production activities. In Company "T" production begins with the retrieval and distribution of semi-finished products stored in warehouses the previous evening after the preparation processes is completed. The bakery section completes preparation activities during the day, and

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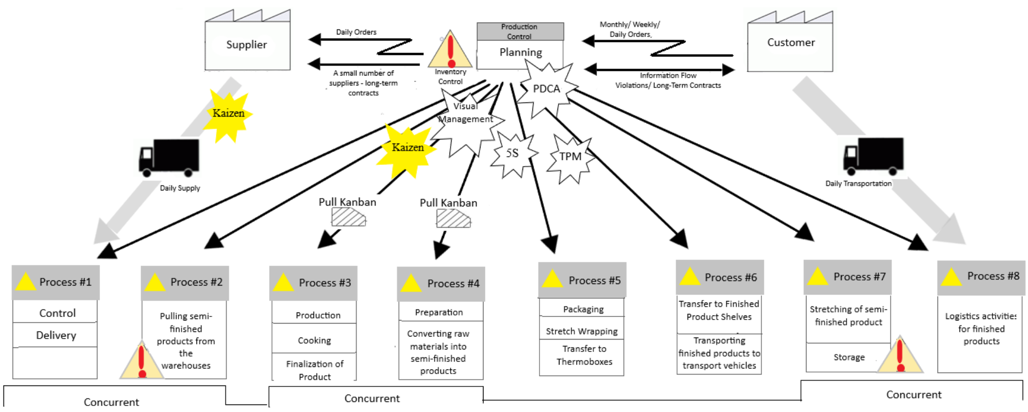
raw material procurement occurs simultaneously during production. Some products are moved to suitable storage areas during this process, while others are stacked within the facility. However, these activities complicate the production process, restrict the movement of employees, and negatively affect work efficiency. If Company "T" updates its agreements with suppliers and adjusts delivery times for raw materials, the processes of storing raw materials and withdrawing them from storage for conversion into semi-finished products will be eliminated. Additionally, reducing chaos and space occupation during production hours can accelerate production flow. In the future state VSM, process #3's location has been changed, and as a result, the storage step in process #3 and process #7 have been eliminated. Some lean technique recommendations are also provided in the future state VSM.

Figure-2: Future State Value Stream Map of Company "T"



Company "T" plans to move the raw material delivery to the beginning of the working hours in the future state VSM, aiming to process the daily incoming raw materials by the preparation unit before storage as semi-finished products. This approach aims to eliminate the storage and product withdrawal processes, reducing the complexity in the company's working environment. Additionally, the preparation unit can continue its activities during production, resulting in time and labor savings and increasing production speed.

Company "T" has a narrow and long layout for its production facility. The distance between the goods receipt entrance and the warehouses is long, and the raw material supply conducted during production activities adversely affects the production operations. The positioning of the stretch wrapping machine far from the production area and the finished product exit door leads to unnecessary movement of finished products. The distance of the warehouses from the production area and the narrow passageways makes the product retrieval process difficult. Moreover, the large areas allocated to warehouses increase high stock levels, raising the company's costs and causing inefficiency. From the perspective of personnel, it is observed that the area allocated for staff is limited and used as a warehouse at the same time. From a management perspective, it is observed that the office section shared by the head chef, food engineer, and marketing manager is disconnected from the production area, negatively affecting the flow of information between management and employees.

Other identified waste includes the irregularity of equipment in the production area and the presence of faulty and idle equipment in the production area. These types of waste adversely affect production speed and volume and lead to unnecessary efforts and movements by employees to find the necessary equipment in the production area. During the observation period, no defective product production or unnecessary process steps were encountered, but it was found that approximately 85 extra desserts were produced daily due to the lack of standard recipes. The management of the company has not provided an explanation on how to address the excess production. This situation leads the company to incur additional costs.

The largest storage area is allocated to dry foods, and these products are supplied in bulk on a monthly basis. Stock management is carried out in line with the "FIFO - First in First Out" principle. During the observation process, losses were reported in dairy and dairy products, especially in products such as cream used in soups and pasta, due to excess stock and storage errors. Additionally, losses due to excess stocking in dry foods were rarely reported. When the warehouse areas were examined, no guidelines or information regarding proper storage conditions were found.

During the observation period, the focus was on the seven types of waste defined by Taiichi Ohno, and it was determined that the most frequently observed waste type was the unnecessary movement of products and employees. Especially in the pastry department, the difficulty for employees to access the dry food storage and the limited space making production activities difficult lead to unnecessary movements. These unnecessary movements disrupt the production process. Throughout the observation period, it was mostly observed that pastry products were individually portioned and stretched. Due to the lack of a suitable stacking area near the stretch wrapping machine, it was found that the stretched products were stacked on the meat preparation table. This situation indicates a violation of food safety.

6.2.3. Flow in Mass Catering Production

In this section of the study, both the current state spaghetti diagram illustrates the movement of workers in the pastry department and both the flow of raw materials, semi-finished products, and finished products within the production area, and the future state spaghetti diagram.

In the future state production facility plan, in order to organize the flow, separate entrances and exits for raw material reception and finished product delivery have been designed. Warehouse areas have been reduced by half, targeting low inventory levels, resulting in savings in space and storage costs. Additionally, warehouse areas have been positioned close to the raw material reception entrance to minimize unnecessary movement of materials within the production area. The

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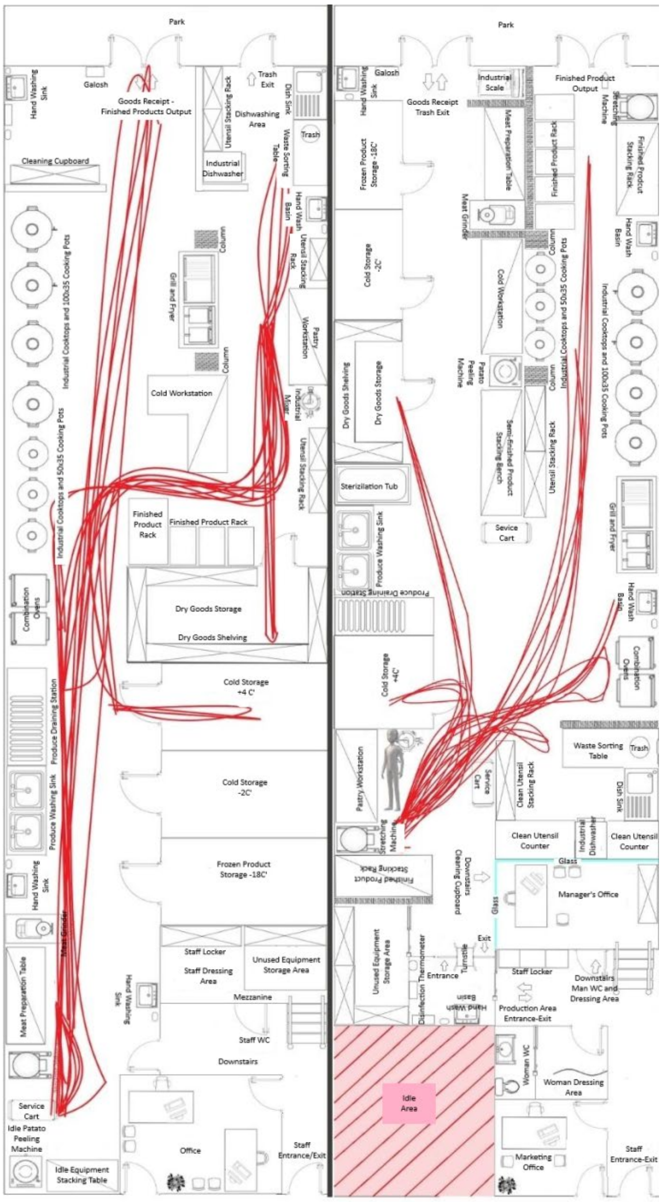
meat preparation counter has been placed opposite the -18°C cold storage room. The vegetable preparation section has been designed with a U-shaped flow arrangement, with a sterilization tub added to this section. The +4°C storage, frequently used by the bakery section, has been positioned between the vegetable preparation and bakery sections, with a cold counter located directly opposite. Both the hot section and the preparation section have been designed with a U-shaped flow arrangement. Gaps have been created between two production corridors to facilitate easy access to the hot section and enhance information sharing. A semi-finished product stacking table is available in this area to facilitate the flow of semi-finished products. Cookers in the hot section have been positioned opposite each other to enable workers to control cooked products with less movement and to facilitate their dominance over the area. This arrangement is also expected to reduce the number of workers in the hot section. In the new layout, the area where finished products are stretched and packaged has been placed close to the finished product exit door. The number of shelves for finished products in this area has increased, and the stretching machine has been positioned directly opposite this area. During observation, bottlenecks were identified during the portioning and stretching stages of pastry products. Therefore, an additional stretching machine has been added to the pastry department, and a finished product stacking table has been added to enable more efficient portioning processes.

In the following Figure-3, the diagram on the left illustrates the current state facility layout and the routine movement of employees in the pastry department, while the diagram on the right shows the future state production facility plan drawn according to lean manufacturing principles and the movement of the pastry department employees in the future state facility plan.

Upon examining the spaghetti diagrams, it is observed that in the new layout, the distance covered by bakery section employees has decreased, and except for the transportation of finished products, other sections can continue their workflow without hindrance. Another innovation aimed at preventing unnecessary movement is to position the ovens used by the bakery and hot sections closer to both sections. Additionally, in the newly created dishwashing area, a "U" type flow, also used within the production area, is implemented to facilitate the flow of dishes. Clean dish racks are designed to be suitable for bidirectional use, allowing staff to access clean utensils from the other side of the rack without entering the dishwashing area. Another notable aspect of the current state production facility plan is the insufficient number of handwashing sinks. This situation leads to unnecessary movement by employees, which does not add value. Therefore, the number of handwashing sinks within the production area has increased. Another change made in the new plan is to bring the management office closer to the kitchen. Additionally, personnel entry-exit points and hygiene spots have been organized. By reducing storage areas and implementing the new layout, an average of 64 m^2 of space has been saved in the production facility, which occupies approximately 900 m^2. The business owner, due to the current plan and high inventory levels, is unable to utilize investment opportunities from the idle space.

Figure-3: "T" Company Current State and Future State Facility Plans and Pastry Department Spaghetti Diagrams



6.2.4. Pull System in the Mass Catering Production

In mass catering production, demand is predictable and based on long-term contracts before production. This predictability provides advantages to mass caterers by allowing them to optimize the supply chain and enter into long-term business contracts. This situation allows for the establishment of a pull system, facilitating cost control and raw material procurement. Besides the pull system that

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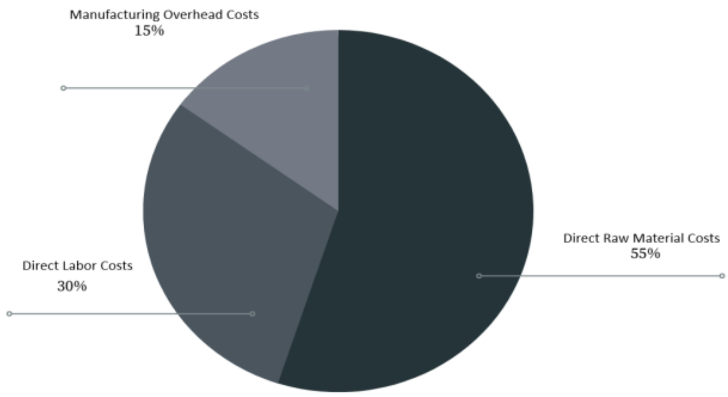
forms between customers, producers, and suppliers, the pull system established between production lines and/or cells is also crucial for feeding production and information flow. This pull system is managed using the kanban technique. In mass catering production, menu planning serves as the first kanban that initiates the production flow. Other kanbans facilitate information flow between production lines and cells, ensuring that semi-finished products are produced in the desired standards and quantities, thus preventing errors and overproduction.

7. Comparative Analysis

In this section of the study, "L" company, which benefits from lean production techniques in mass food production, and "T" company, which uses traditional production methods, are based on their production costs, production volumes, and workforce capacities. Production costs consist of "direct raw material costs (DRMC)", direct labor, and "Manufacturing Overhead Costs (MOH)". The comparison also considers the proportion of production costs stated in the study conducted by Gül, K. and Ergün, H. (2010) regarding industrial food production.

Figure-4: The Average Ratios of Production Cost Items in Total Production Cost in Mass Food Production (Gül and Ergün, 2010)



The table below shows the production costs of the mass catering producer company that uses traditional production methods.

Table-1: Production Costs of Company "T"

Direct Raw Materials Costs	70% of the monthly revenue
Direct Labor Costs (Monthly)	28 Personnel : Min. Wage - 308,063 \$ 22 Personnel: 431,28 \$ Average Cost Per Person: 362,28 \$ Total Direct Labor Costs: 18.113,92 \$
Manufacturing Overhead Costs	Energy expenses monthly average: 1.886,19 \$ Other expenses: 261,97 \$ Indirect Labor Costs: 7.701,575\$ Total MOH: 9.849,735 \$

In addition to this data, according to secondary data collected from local press about the company using traditional production methods, it is known that the table d'hôte menu offering four types of meals was $1.23 during the March 2023 period.

7.1. Comparison of Direct Raw Material Costs

In March 2023, T Company's daily direct material costs amount to $6,020, while the monthly direct material cost totals $156,520. As mentioned in the Comparative Analysis section, the average proportion of direct material costs to total production costs in mass catering is 55% (Gül and Ergün, 2010; Dudbridge, 2011). However, in T Company, this proportion is 70%. The 15% difference indicates faulty practices in managing G Company's direct material costs. The identified errors are as follows:

- Mistakes in menu planning and pricing
- Ineffective management of procurement and supply processes leading to the acquisition of low-quality products
- Procurement of high-priced raw materials and incorrect supplier selection
- Incorrect practices in cooking and food processing processes that may lead to food wastage, compounded by inexperienced employees
- Lack of standard recipes and failure to standardize production processes
- High levels of raw material procurement leading to spoilage of products in storage
- Short-term contracts with suppliers
- Failure to comply with proper storage rules

The T company operates with high stock levels, thereby incurring inventory holding costs (such as spoiled goods, warehouse heating-cooling expenses, etc.) and opportunity costs (missing investment opportunities due to tied-up capital in inventory).

The cost of one table d'hôte menu consisting of four types of meals for T company is $0.86. The daily direct raw material cost (DRMC) for the company, which produces 7000 meals per day, is $6,020, and the monthly DRMC is $156,520. When T company, as mentioned, has a DRMC ratio of 55% instead of 70%, the DRMC cost per table d'hôte menu decreases from $0.86 to $0.67. The daily DRMC decreases to $4,690, and the monthly DRMC decreases to $121,940. When the company can reduce its DRMC expenses to around 55%, it can save an average of $34,580 in monthly DRMC expenses.

7.2. Comparison of Direct Labor Costs

T company, which employs 75 people using traditional production methods, includes 50 individuals directly involved in the production process, while 25 individuals are engaged in supporting processes such as service, dishwashing, and cleaning. With its 50-person staff, T company produces 7,000 table d'hôte

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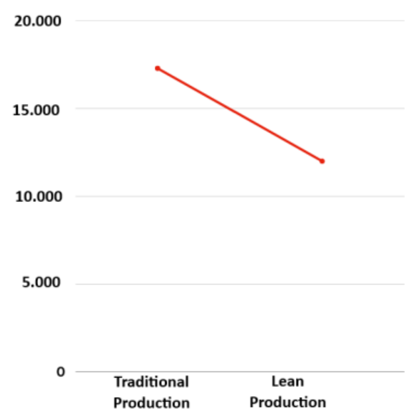
consisting of 4 types of dishes per day. Each worker contributes to the production of an average of 140 table d'hôte during their working hours.

On the other hand, L company, benefiting from lean production techniques, employs 100 personnel directly involved in production. L company produces 22,000 table d'hôte consisting of 4 types of dishes per day with its 100-person workforce. Each worker contributes to the production of an average of 220 table d'hôte per day.

If the business utilizing traditional production methods had adopted lean production techniques, it would have had the opportunity to accomplish its daily production of 7,000 meals with an average of 32 workers. In this case, it can be said that T company employs 18 more workers in direct production than necessary, and these employees have to bear the direct labor costs.

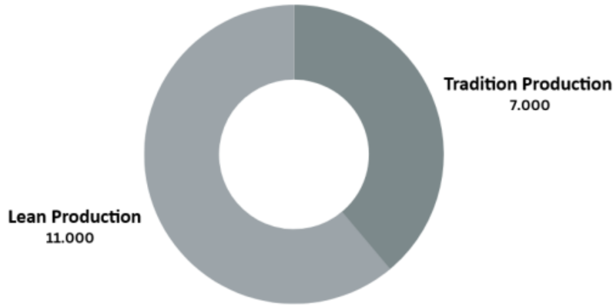
The average monthly direct labor cost per employee at T company is $362.28. The total monthly direct labor cost for T company amounts to $18,113.92. If T company had utilized lean techniques and employed 18 fewer workers, it could have saved an average of $6,521.04 in monthly direct labor costs.

Figure-5: "L" and "T" Enterprises' Direct Labor Costs Comparison Graph



From a different perspective, when "T" enterprise continues production with 50 employees and starts benefiting from lean production techniques, labor productivity and production capacity increase. In this case, each employee is able to produce an average of 220 portions per day instead of 140 portions previously. With increased labor productivity, the company can increase its daily production capacity from 7.000 to 11.000 portions without hiring additional workers, thus expanding its market share.

Figure-6: "L" and "T" Businesses Production Capacity Comparison Graph



Increasing the production capacity of the business also positively affects its profitability. The daily average turnover table of T company, depending on production capacity and production management system, is as follows:

Table-2: Daily Revenue Table Based on Production Capacity for T Business

	Daily Revenue
Traditional Production	7.000 Portion X 1,23$ =8.610$
Lean Production	11.000 Portion X 1,23$ = 13.530$
Difference	4.920$

When the business increases its daily production capacity from 7,000 portions to 11,000 portions, it can potentially increase its daily revenue by an average of $4,920.

A personnel in T enterprise works 6 days a week. The average daily direct labor cost for personnel during working hours; 362,28$/26=13,93$. During working hours, a worker produces 140 portions per day. The direct labor cost per portion is $13.93/140 portions = $0.099. If a worker had produced 220 portions per day instead of 140, the direct labor cost per portion would have been $13.93/220 = $0.063. The direct labor cost saving per portion after transitioning to lean practices is $0.036.

7.3. Comparison of Manufacturing Overhead Cost

"L" enterprise has chosen not to share information regarding its financial items, considering company privacy and security. T enterprise, for the same reasons, has opted to disclose only a portion of its general production expenses. The shared portion of MOH for a monthly period is $9,849.73. The proportion of this shared portion to total production costs is approximately 5.34%, significantly lower than the average manufacturing overhead costs in total production costs. This situation arises from the enterprise's insufficient investment in various technologies such as Industry 4.0 and automation systems. T enterprise's daily general production expense is $9,849.73/30 = $328.32. The MOH per portion is $0.046.

7.4. Comparison of Business Profitability

The current unit production costs and profitability ratio of T business are as follows:

Table-3: "T" Enterprise Current State Unit Production Costs

Direct Raw Material Cost	0,86$
Direct Labor Cost	0,099$
Manufacturing Overhead Cost	0,046$
Total Cost	1,005$

The average table d'hote price of the business is $1.23. The current unit gross profit of the business is $0.22. When the business benefits from lean techniques to reduce waste and expand production volume, the future state of unit production costs and profitability rate is expected to be as follows:

Table-4: "T" Enterprise Future State Unit Production Costs

Direct Raw Material Cost	0,67$
Direct Labor Cost	0,063$
Manufacturing Overhead Cost	0,046$
Total Cost	0.77$

The expected future unit gross profit of the enterprise is $0.46. These calculations were made based on the assumption MOH, average direct labor costs per person, and material costs are fixed. The calculations were performed by comparing the number of workers and the production quantity. The decrease in future production costs of T Enterprise is associated with lean production and low inventory levels. However, to achieve these savings, the following factors are necessary:

- L Enterprise's daily production capacity is higher compared to T Enterprise. This situation allows for advantages in bulk raw material purchases and reduces DRMC expenses.
- L Enterprise predominantly benefits from automation systems. While this reduces direct labor costs, it increases MOH with depreciation costs, maintenance costs, etc.

8.Conclusions

During the semi-structured qualitative interview conducted with the officials of Company L, who have incorporated lean techniques into their production process, the gathered data aligns with the findings obtained from the literature review mentioned. Company L has successfully implemented lean production techniques and achieved positive outcomes. In the business, while customer complaints were around 400 on average in 2017, they decreased to 100 in 2021, with a particularly significant 70% decrease in complaints related to foreign substances. Customer satisfaction has increased by 50%. Employee motivation and satisfaction have increased by 30%, and this increase has also been reflected in productivity. The lean process has had a positive impact on costs, although detailed cost data has not been shared. It has been stated that production processes have accelerated, and unnecessary movements have decreased.

One of the most noteworthy aspects highlighted by the business official, apart from the implemented lean techniques, is that the adoption of lean production and kaizen philosophy by the employees is crucial for the lean transformation process. It has been emphasized that the support of top management is crucial when transitioning to lean processes, and firstly, these philosophies should be known and embraced by top management, and efforts should be made to spread these understandings across hierarchical levels. During this process, the company provided 5S and TVB training to all employees, organized kaizen workshops, and continued these training sessions and kaizen workshops after transitioning to lean production. Additionally, it has been mentioned that an online academy has been established where employees can access via their phones, and the lean production system is explained through videos.

The business official also expressed that reducing waste, efficiently utilizing resources, and embracing a zero-waste approach contribute to sustainability efforts. They mentioned establishing a sustainability commission to improve these activities and engage in related initiatives.

This study was conducted with the aim of examining the integration of lean production in mass food production, using data obtained from Company L and information from the literature. Primarily, the main focus of this study is how lean production systems can be utilized in mass food production and the various advantages they can provide to businesses, along with the potential to increase operational efficiency.

In the study, data were collected using semi-structured qualitative interview techniques and semi-structured observation technique, which are qualitative research methods, and these data were combined with information obtained from literature research to create an exemplary model for the transition to lean production for mass food producers. The preferred businesses in the study were selected using purposive sampling method. Since lean practices in mass food production are still relatively new, businesses that have started implementing lean techniques and embraced the lean philosophy preferred using purposive sampling method.

Additionally, to model the lean integration process, another mass food production business that utilizes traditional production methods, where waste can be easily observed, was selected. The model presented in the study was developed based on the current conditions of the chosen traditional mass food production business. The aim of the study is to provide mass food production businesses with a general roadmap regarding the integration process of lean production by presenting an exemplary integration process model.

Literature research and the interviews conducted have confirmed the expected contributions of lean production in mass food production. However, implementing lean production systems in mass food production is still a relatively new practice, and the scope of the study is limited. Therefore, it is uncertain whether the same results will be achieved with the implementation of lean systems in every mass food production business. In such change engineering studies, taking a contextual approach to processes is crucial for mapping out a path tailored to the conditions of the business where lean production will be integrated.

For instance, establishing a just-in-time supply system for a mass food producer serving distant suppliers would entail additional logistics costs for the business. Specific conditions are unique operational and organizational characteristics of each business. It is important for businesses intending to implement lean production to adapt and customize lean techniques according to their own conditions. Each business should focus on and implement the lean transformation process according to its current situation and goals.

The successful implementation of lean production systems in mass food production can provide added value to the sector and support businesses in achieving a more competitive position in the market. The operational and organizational system changes presented in the study, along with internal factors of businesses, also underscore the importance of external conditions for the sustainability of the system. For example, the current inflationary environment can adversely affect businesses, leading to price volatility and increased costs. It is important for businesses intending to implement lean production to remain flexible in the face of inflation and economic fluctuations and efficiently manage their processes.

The SWOT analysis evaluating the integration of lean production techniques into mass catering production, considering the strong and weak points as well as potential opportunities and threats in a high inflation environment, is as follows:

Table-5: SWOT Analysis of Lean Production Integration into Mass Catering Production

Strengths	Weaknesses
The fundamental philosophy of lean production is to reduce waste and inefficiency. This situation provides an advantage in high inflationary environments by reducing raw material waste and costs. Focusing on continuous improvement and optimizing flow enables the effective and efficient utilization of resources. This situation speeds up business processes, reduces costs, minimizes food waste, and contributes to environmental sustainability. Lean production is a customer-centric system. Responding quickly and with high quality to customer demands provides a competitive advantage and increases customer satisfaction. Working with low inventory levels contributes to product quality, prevents potential food safety breaches and waste, and reduces inventory costs.	Establishing and implementing a lean production system may initially require some investment. This situation can lead to increased costs in a high inflationary environment and may create a weak point initially. Training employees is necessary for the successful implementation of lean production. This may require investing time, resources, and costs. Employees who are unwilling to take responsibility or initiative may decrease workforce efficiency or lead to workforce loss.
Opportunities	**Threats**
Lean production focuses on reducing waste. In a high inflation environment, carefully working with factors that increase costs such as materials, energy, and other resources can be an important opportunity to reduce waste. Implementing just-in-time supply requires working with suppliers who are geographically close. This situation can contribute to economic and environmental sustainability by working with local producers and suppliers. Lean production is based on the philosophy of continuous improvement. In a high inflation environment, it can provide an important opportunity for process improvement to reduce costs and increase efficiency.	High inflation rates can increase material costs and procurement expenses. This situation can affect the cost of materials required for mass food production and diminish the cost advantage of lean production. In a high inflation environment, financial resources may be limited. Limited financial resources for investing in lean production systems and improving processes can make implementation challenging.

The model presented in the study serves as a guiding framework for the integration process of lean production systems in mass catering production. It is anticipated that the adoption of the developed model by mass food production businesses will provide a competitive advantage in the sector and elevate quality standards. The study is believed to contribute to the mass catering production sector, industry professionals, and literature.

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