Application of Some Lean Production Tools to Improve the Production Process - An Applied Study in The General Company for Food Products/ Yogurt Factory

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ABSTRACT

Purpose – The researcher noticed the low production levels of some factories, including the yogurt factory, as well as the appearance of spoilage, and a delay in the production process, as well as the deterioration of the situation in the work environment inside the factories. From a decrease in the level of lighting, ventilation, energy, noise and other environmental aspects affecting the work environment.

Here, the problem can be identified through a number of questions, namely:

1. Can some lean production tools be applied in the company's factories?

2. Does the lean production method contribute to the elimination of the problems experienced by the production process in the factories?

3. Does lean production contribute to improving the production process? Is it possible to apply some of the tools of sustainable and lean production in the yogurt factory?

4. How does the sustainable value map contribute to improving the production process in the yogurt factory.

Design/methodology/approach - The study adopted an applied study approach in identifying the reality of the yogurt production plant in the General Company for Food Products of Abu Ghraib factories, identifying problems and their treatments and proposing appropriate solutions and their suitability for the subject of the study, through field visits to record observations, collect data, conduct personal interviews, inquire and analyze And to identify the production processes, the problems that occur, and the opinions of working individuals about dealing with those problems in the production process

Originality/value – The senior management of the General Company for Food Products helps to build its production plans in a way that conforms to the trends of the times, and to adopt modern scientific methods in managing production processes within the factories. And The scientific importance of the study is reflected in the clarity of the impact and importance of spreading the culture of lean production, as an important method to achieve it in a production company, and the resulting reduction in rejected production, improving performance rates, reducing waste and pollution rates, rationalizing the use of

resources, and spreading the culture of concern for the work environment and achieving sustainability And Attempting to detect errors in production processes by using the Poka-Yoke tool and internal arrangement, specifically in weak operations.

Findings -The result was It showed savings in terms of effort, time and improvement of the production process.

Paper type- Applied study

Keywords, lean, Sustainable lean production, Poka-Yoke, Waste, Value stream mapping.

1: BASICS OF A SUSTAINABLE LEAN PRODUCTION SYSTEM

1-1: A general introduction to the lean production system

The word 'lean' means thin or skinny, so the basic idea is to reduce the process from all unnecessary activities (Järvenpää, & Lanz, 2019:2) Waste or any action that does not add value to the product or service (Mrugalska & Wyrwicka, 2017: 466). It may aim to eliminate waste in every area of production, including customer relations, product design, supplier networks, plant management as well as doing business with minimal effort, inventory, time and space, to develop products and reach a speedy response to customer demand, and by producing high-quality products. In the most efficient and economical way possible, lean systems are based on a comprehensive system approach that depends on establishing an effective process, together with best practices (Reid&Sanders, 2013:20)

Part of the philosophy of lean production is designing efficient and highly flexible processes to meet the changing requirements of customers. Lean thinking enhances the total quantity of production through small batch sizes and rapid changes, reducing production time and focusing on product quality and diversity at a competitive price, thus achieving the main goal of improving the production process. (Lacerda etal, :1708) 2016 Hence, and according to the scientific ideas presented by researchers to the concept of lean production, the researcher believes that the concept of lean production is the main engine in developing and improving production processes in a way that achieves the highest level of quality in the materials or service provided in a way that achieves higher than what the customer expects.

1-2: Characteristics of the application of a lean production system

Lean production tools can be applied to all types of organizations, regardless of their size, and a lot of work can be implemented in the manufacturing sector, because in different functional areas, the level of implementation varies according to the different sectors and their size.

. (Shah & Patel, 2018:379). A number of researchers agree with a set of characteristics that characterize the application of lean production, as well as the possibility of transforming it into benefits for all industrial organizations that follow and apply lean production, as follows:

a. Characteristics related to quality: where the lean production tools focus on speed and efficiency of the process and through strengthening the relationships between the quality control system of the organization and the supplier to increase trust and mutual cooperation between the two parties (Syahputr et al., 2018:1)**.**

b**.** Characteristics related to factory design: The application of the lean production concept requires the design of the plant in a manner that ensures a balanced workflow in the process with a minimum work inventory, as each workstation is part of the production line, and the capacity is balanced using the same logic for the assembly line (Jacobs, et al.,2018:358)

c. The application of the philosophy and principles of lean production requires working with low levels of inventory, and the organizations that use them need a close relationship with their suppliers, due to the necessity to complete the shipment of raw materials in short periods of time, and to arrive on time with high quality with prior notice of volume changes so that the supplier is allowed to synchronize his production with customer order (Krajewski et al.,2016:231).

1-3: Factors for the success of implementing a lean production system

There are some more important aspects of the lean production philosophy, including the principle of "everyone's participation" through adopting basic work practices, which include the following:

a. Discipline: It means the work standards that are important to the safety of workers in the organization and the environment, and everyone must follow quality at all time.

b. Flexibility: It must be possible to expand the scope of responsibilities to the extent of the capabilities of the employees and this applies to managers as it is to workers in the organization with the need to remove barriers to flexibility.

c. Development of personne: The goal is to find more members of the organization who can support dangerous competition.

d. Quality of working life: Is participation in decision-making, and the security and safety of the work environment (Netland,2016:20).

2: AN OVERVIEW OF THE LEAN PRODUCTION TOOLS

a. Value Stream Map: It is a visual tool for continuous improvement that enables the organization to identify the steps of the production process, in detail, and clarifies the movement of the physical and information product flow and the time required between transformations through which it is possible to detect weaknesses (waste) and thus its sources can be analyzed and addressed and as a result, costs are saved when removed according to the plan Potential future implementation in the short term(Acero,etal,2020:4).

b. Continuous improvement program: A process management system can be described as a variety of concepts and methods for improving value streams and an appropriate approach to improving processes, the value flow itself consists of operational processes and information and data flows that describe the process (Sunk et al, 2016:4).

c. Arrangement Lean inner: (Ratnayake & Dinosha, 2018:18) Lean planning is a concept close to the concept of cellular manufacturing, the cell is a mixture of workers, machines and work stations that are arranged according to the flow of the process, to manufacture the entire production unit or part of it and it helps reduce work in the process stock, by preparing a balanced flow of materials from the machine to Others, improve communication between workers, improve scheduling and better use of machines, and reduce problems with reduced work in the design process, all of which reduces productivity time and helps in developing the capabilities of workers, through multiple skills.

d. poka-yoke: There are several reasons for errors as follows: (Kumar, et al., 2017: 2):

1. Processing error: The process failed or was not performed according to the standard business strategy.

2. Setup Errors: Using the wrong tools or inaccurately modifying the device.

3. Missing part: Not all parts are included in meeting, welding, or various procedures.

4. Bad section / something: Wrong part used as part of the procedure.

5. Operation error: Inaccurate operation performed.

6. Measurement error: errors in machine adjustment.

3: SUSTAINABLE LEAN PRODUCTION AND THE TRANSITION TO SUSTAINABLE ENVIRONMENT-CONSCIOUS MANUFACTURING

3-1: The concept of sustainable lean production

New technological trends continue to emerge, which are adopted by organizations with different capabilities, seeking to improve the methods of production processes, and to gain new competitive capabilities in which they outperform competitors. Industrial and service organizations have tried, not only to possess the competitive dimensions (cost, quality, flexibility, delivery time, innovation) but have sought to sustain these dimensions (Sezen & Cankaya, 2013:157) .

Lean production is the appropriate approach to achieve a new comprehensive vision of sustainability, by integrating process efficiency (cost, time, quality) with the concept of sustainability (environmental quality, social

justice, health) (Khodeir & Othman, 2018:1628). As for sustainable manufacturing, it requires taking into account all economic, environmental and social aspects related to the production and delivery of materials, as sustainable manufacturing depends on descriptive standards, advanced decision-making and general policy for implementation, evaluation and feedback, through the coexistence of manufacturing systems alongside individuals, the environment and subsystems.

Therefore, sustainable manufacturing is a philosophy that cannot be considered independent of environmental, social and economic systems (Haapala, et al., 2013:3).

3-2: Benefits of sustainable lean production

Industrial and service organizations in the twenty-first century tried to pay attention to environmental aspects, instead of focusing on economic growth, in order to enhance their sustainable competitive ability by applying sustainable lean production practices that achieve the following benefits:

a. Reducing waste and polluting air emissions.

b. Reducing the amount of waste, saving energy and utilizing resources more efficiently, which can lead to saving financial costs, protecting the environment and improving it. Lean production has focused on the economic and some social aspects of sustainability (Found, 2009: 3)

c. Efficiency in product handling and productivity improvements (energy sources, water and materials used in production).

d. Reducing environmental and occupational risks for workers (Kurdve, 2014: 4).

e. That high performance of lean production practices in managing industrial processes not only increases manufacturing productivity but is able to increase the chances of achieving high sustainability in manufacturing (Yusup et al., 2015: 128).

f. The philosophy of lean production has been a major concept for increasing efficiency in industrial organizations in recent times and due to globalization trends, increasing customer demands and increasing sustainability challenges, sustainable lean production has moved to being more than a competitive advantage. Many organizations have realized the benefits of designing sustainable lean production systems in an early stage of improving the production process in terms of time, cost, quality and increasing stakeholder value (Jaghbeer, et al., 2017:52)

3-3: The relationship between lean production and sustainability

The relationship between lean production and sustainability calls for a deeper understanding, to accommodate the comparison across economic, social and environmental aspects (Francis & Thomas, 2019: 1187).

Lean production has contributed to the trend towards sustainability, by studying the views of many researchers on the integration of lean production practices with sustainability approaches.

Especially after the year (2010) the number of publications has increased that combine lean production with sustainability, through their sharing of many similar goals and supporting each other, as sustainable manufacturing is a kind of development from lean production, and the development extends through reducing waste to the use of a closed loop of materials In addition, lean production practices are used as a catalyst, to develop the best strategies for green and sustainable production (Järvenpää, & Lanz,2019: 7).

Lean production is the starting point for achieving the success of the organization, through which it is possible to achieve integration with the objectives and practices of green and sustainable production. Therefore, sustainable practices combine green and lean production methodologies (Abreu et al., 2017: 2). Lean production in the production system focuses on eliminating waste, through continuous improvement and practical changes to reduce activities that do not add value to the product, while green production aims to eliminate waste. Loss that affects the environment (Miller et al, 2010: 12).

3-4: Enabling factors for sustainable business practice

Sustainability has become an imperative and every organization needs to respond to it (Chofreh etal, 2016: 1) as implementing lean green processes can achieve process excellence and improve environmental performance, as well as contribute to key performance metrics for sustainability. Four main categories of enablers are

presented: integrated strategies, continuous improvement, stakeholder participation, and streamlined processes (Caldera etal, 2019: 581).

a. Integrated strategy: The manufacturing industry needs to adopt integrated strategies to achieve their strategic goals, through sustainable practices, as industrialists have expressed improvement in product quality by eliminating wasted practices and wastes or reducing the waiting period and reducing costs. With the necessity of aligning lean and green strategies with the organizational strategic objectives, lean production goes beyond green and needs However, not all small and medium organizations have been able to take advantage of the opportunities offered by lean and green practices due to their dispersed nature of use.

b. continuous improvement: Utilizing sustainable and lean production tools for continuous improvement as manufacturing processes have been noted as important.5S has been a commonly used tool among small and medium enterprises to create a system in a clean, tidy environment and reduce waste and leaks through early detection. This tool created a starting point for small and medium-sized organizations to engage in the methodology of waste management and disposal. The importance of having (workplace organization) as a basic tool to enhance performance improvement, which leads to increased awareness of workers. If the organization cannot obtain the correct basic tools, how can it be implemented to improve another process.

c. Stakeholder participation: The organization focuses on the stakeholders, because they can generate restrictions on the work of the organization, and it means the stakeholders are customers, workers, investors, regulators, government authorities, local communities and supply chain partners. In order to improve sustainable performance. In addition, clients play a critical role in enabling the achievement of sustainable practice. When a customer is asked to improve levels of resource efficiency in the manufacture of products, and the organization must buy or deal with suppliers who can provide them with sustainable materials, which is a good evidence to involve suppliers in sustainable practices.

d. Streamline operations: The sustainable lean production system provides a realistic and robust approach to simplify organizational and production processes. Sustainable lean production tools have facilitated the simplification of business and operations by helping them adhere to internationally accepted methods and standards. Some tools have helped collect and analyze environmental management data on energy, solid and chemical wastes, such as extended use. From value flow mapping (VSM) and sustainable value mapping (SVSM) to visualize production and energy flows and the principles of (VSM) were used in the process of identifying bottlenecks and areas of excessive electricity use,

This decrease in energy has caused a significant reduction in emissions as well as the design is another tool that can be used integrated with energy-reducing measures when rethinking the sequence of the machines site to reduce unnecessary movement of workers and energy consumption using this tool, and there are other tools such as (Total Productivity maintenance) (TPM), which maintains machinery and equipment, and reduces the leakage of dust and chemical fumes (Caldera etal, 2019: 582).

4 .AN ANALYTICAL DESCRIPTION OF THEREALITY OF THE WORK OF THE STATE COMPANY FOR FOOD PRODUCTS (yogurt factory)

4-1: The nature of the yogurt factory

yogurt: It is one of the milk products that we obtain from the fermentation of milk using special bacteria, which help to ferment the milk sugar known as lactose, which gives milk its thick texture and distinctive taste. The yogurt factory produces main products: the production of the Shanina milk, the afia milk, the Kashwa milk.

The average daily production of the milk product is (4) tons and for all its types with different weights, and the quantity of production increases in the summer until it reaches (7) tons due to The increase in demand and here, its production may not depend on the sorting milk, it may be produced from powdered milk that is of high quality and is imported from international origins. An example of this is that Al-Maka Konai Company imports milk from Turkey, and its inclusion in the consolidation process is when needed to increase the quality when the milk is less fatty. Figure (1) shows the process of producing yogurt

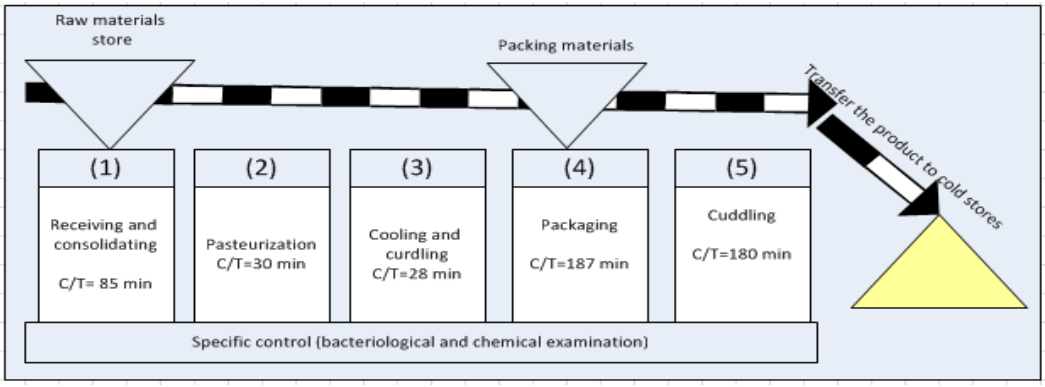

Fig. (1) The path of the yogurt production process

4-2: **Implementation**

1: **Daily customer requirements:** The number of daily products performed by the market. The daily production amount was determined (1750) kilograms of curd product with specifying (26) working days per month resulting in a delicious quantity.

2: **Information on each production stage in the value stream:**
a. **Cycle time:** The amount of time to accomplish the standard work sequence for one product, excluding waiting.

Table (1) Cycle time, number of meal and workers for each production process

The production process	Cycle time (min) C / T 1750 / kg	Shift number	Number of Workers
Cementing	45	1	2
Pasteurization	30	1	2
Cooling and curdling	28	1	2
Packaging	187	1	16
Incubation	180	1	1
	470		23

b. **Changeover Time:** It is the time that elapses between the completion of one production run and the beginning of another production run

c. **Available production time** :refers to the setting and configuration time, which is the time required to change from setting one device to another It can be found by applying the following equation:
Available time = Total production time - Planned down time(Vinodh, et al.,2010:892)
To extract the results, the available production time for each meal was determined by fixing the total production time for each meal and equal (9) hours An hour equivalent to (540) minutes and subtracted planned stop times (60) minutes Clean and sterilize the production halls at the beginning of the work, (30) minutes of maintenance,30-minute break) So I can apply the formula for my agencies:

Available production time =540- (60 + 30 + 30) = 420 minutes

Table (2) Available production time, , employees, and available production time daily, weekly and monthly

The production process	Available Production time (min)	Shift number	Number of Workers	Available production time for each production stage	Available production time per week (Min / 6 days)	Available production time per month (min / 26 days)
Milk fortification	420	1	2	840	5040	21840
Pasteurization	420	1	2	840	5040	21840
Cooling and curdling	420	1	2	840	5040	21840
Packaging	420	1	16	6720	40320	174720
Incubation	420	1	1	420	2520	10920
				9660	57960	251160

d. **Uptime**: It represents the percentage of work time that a particular machine or work spends working time from the total available time. The results can be extracted by applying the following equation: Table(3). shows Uptime for each production stage

Uptime= Available time - Changeover time / Available time*100% (Vinodh, et al.,2010:892)

and as shown in Table (3) as follows:

Table (3) Cycle and conversion times and percentage of available time for each production stage

The production process	Cycle time (min) C / T 1750 / kg	The conversion times C \ O	Time ratio available for production process (CT-CO) X100 / CT
Milk fortification	45	0	100%
Pasteurization	30	0	100%
Cooling and curdling	28	0	100%
Packaging	187	0	100%
Incubation	180	0	100%

e. **Takt Time**:

Takt time = Available work time/ Customer’s demand

The relative time is determined by dividing the available production time (420) minutes per day by the required quantity (1750) kilograms resulting in 14 seconds.

f. **Calculating the number of workers**: In order to know the number of workers required for each production process in the milk factory, equation can be applied, and as shown in Table (4) as follows:

Table (4) The number of workers required for each production process in the yogurt plant

The production process	The actual number of employees	available time/min	operation time/ min	Number of employees required
Milk fortification	2	420	470	1
Pasteurization	2	420	470	1
Cooling and curdling	2	420	470	1
Packaging	16	420	470	11
Incubation	1	420	494	1
Total				16

The results related to the calculation of the number of workers in the dairy factory show a significant difference in the number of workers compared to the cream factory. Where we find that the difference between the actual number of workers is (23) workers and the number of workers required (16) workers, meaning up to (7) workers, which is a somewhat large number, and we also note that the reality of the problem in increasing the number of workers is due to the packaging process.

g. Lead **Time:** Lead time = Value add time + Non-value-added time (Swarna & Mia:2018).

The waiting time for production starting from the receipt of the raw material for milk production from the receiving department to produce the required quantity of (1750) kilograms of curd, and the waiting and delay times that the required quantity passes daily, whether in examination, transport, rework, or unplanned stops until the final product is delivered for marketing My agencies:

40 + 10 + 15 + 15 + 1440 = 1520 minutes, which equals approximately 25.3 hours

Available energy for the plant: The available energy for the dairy plant can be calculated by applying equation and according to the results obtained, by calculating the total available time, it is 9660 minutes / day.

According to the results in calculating the relative time, it is 14 seconds

Available power = 9660 * 60 * 0.8 / 14 = 33120 (sec)

33120/60 = 552 (minutes) which equals 9.2 (hours)

4-3: **Present value mapping**

In light of the results achieved for all steps of the value map and for the purpose of drawing the current value map, the problems related to sustainability within the milk plant must be identified, and after the field experience that the researcher spent in the laboratory and the observation and conducting a number of personal interviews as in Appendix (2) with the director of the plant and some workers and coexistence with conditions Work The problems related to sustainability were identified in terms of pollution sources and the main influences, which were identified by the researcher in three aspects: economic, yellow, social, blue, and environmental, green, as follows:

a. The water used from the production processes of the milk product contains solids (protein, fats, carbohydrates, lactose) as well as the water used for cleaning, which contains cleaning materials and disinfectants and may contain viruses and disease-causing bacteria that affect the safety of workers.

b. The yogurt plant consumes large amounts of energy, and the percentage of energy required for the process of pasteurization, incubation and cooling is about 80% of the total energy in order to produce hot water and steam to complete the operations, in addition to the hot water used for cleaning.

c The power failure and then the operation of the generators affect the quality of product processing and may lead to damage in the pasteurization stage or result in defects in the packaging stage.

d. There is no specific measure for the water used for cleaning or for the production process, as all laboratories share the standard indicator for the amount of water used.

This has made it difficult to identify the amount of water used and set a scale for it. The plastic tube does not have a (open and close) switch, as well as its aging and damage which led to a leak. A large part of it is on the floor of the laboratory.

e. Smells, humidity, temperature and low level of lighting inside the production halls. Here, a map of the value flow can be drawn and the economic aspects represented in yellow, blue as an indicator of the social aspect, and the green color for the environmental aspect, and Figure (2) shows a map of the current value flow of the yogurt product.

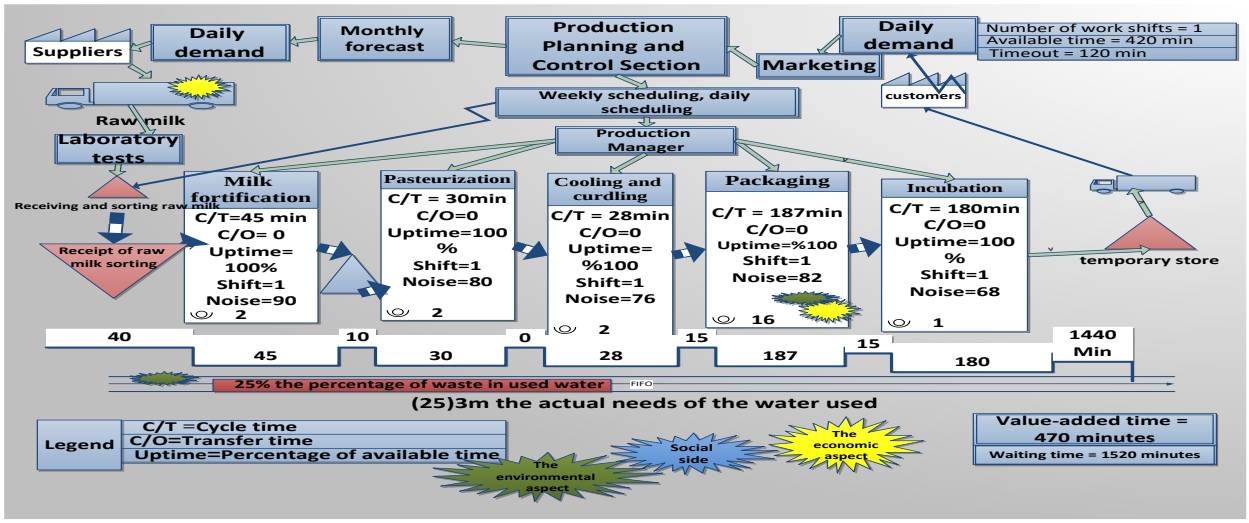

Fig. (2) Map of the current value stream of yogurt

4-4: **Mapping the flow of sustainable future value**

For the possibility of mapping the flow of sustainable future value, some suggested solutions and guidelines must be developed as follows:

a. Pollution in the used water stream can be reduced by reducing the rates of milk loss resulting from spillage and leakage through the adoption of proper practices and procedures, maintenance of the machines and periodically proposing changes to reduce the time of activities that do not add value to the final product.

b. Providing all workers with personal protective clothing and stressing them to wear it throughout the work period, namely:

- White head covers and protective masks - Non-slip leather clothing and shoes - Disposable plastic gloves and noise proof seals for all production workers.

- Conducting medical examinations for all factory employees to ensure that they are free of contagious diseases, and follow-up renewal of workers' health certificates and the need to affix the health card on their chests throughout the work period.

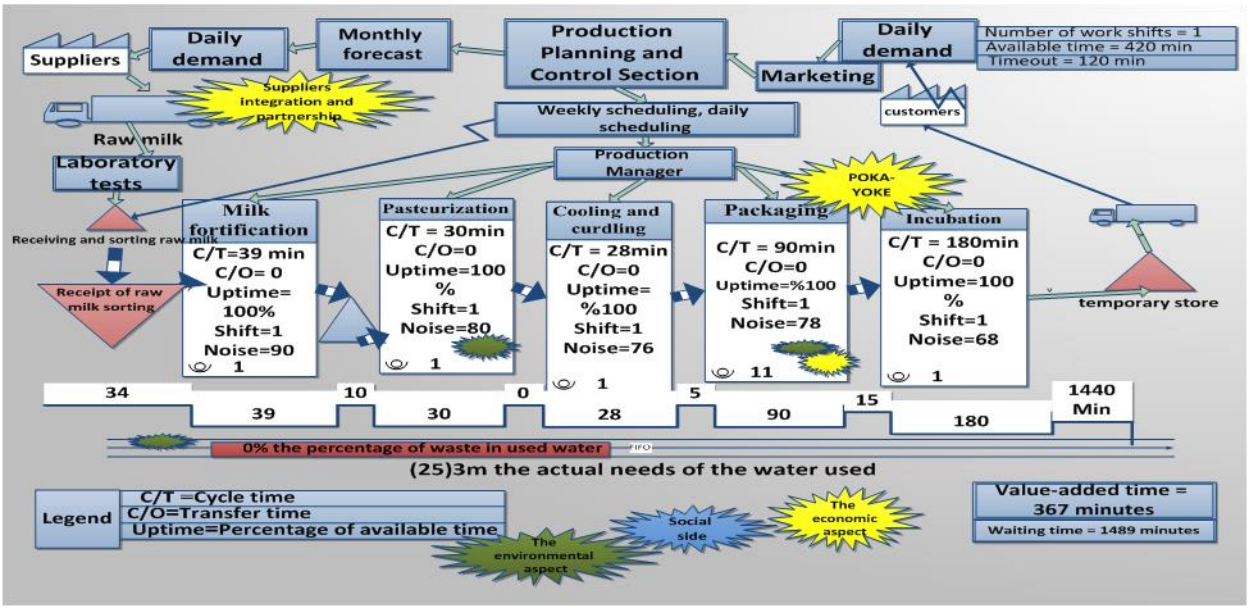

Fig. (3) Map of the future sustainable value stream of yogurt

4-5: **Error Checking (Poka-Yoke)**

Poka-Yoke is a Japanese phrase meaning to prevent mistakes. Poka Yoke is used to prevent and resolve defects during the production process, eliminating the need for post-process quality control and to ensure the least amount of errors in the production process. It is about measures that prevent an increase in errors. They can be incorporated into product design or in a process step.

1. **Description of the problem (Curd Milk Filling and Packaging Machine (400 grams):**

In order to improve operational processes and apply lean production in the field of machinery, there must be sufficient knowledge of products and processes, a detailed analysis of the process is necessary to gain knowledge on the production process, as workers in the milk factory use a number of packaging machines to complete the production of yogurt and requires before working on a machine Filling (400) grams of the curd product Preparing the plastic boxes and sealing them using a video jet numbering device located in a special room located 20 meters away from the yogurt plant to fix the date of production and expiration of the product, and this is due to the lack of numbering device and because the design of the machine does not Allow this device to exist.

Therefore, workers are forced to number the cans in a number greater than required for production, in order to avoid the lack of the required number or the appearance of a defective. And when the packaging process begins, there may be a malfunction in the machine, and in this case, all the boxes will be useless, so the workers remove the previously coded dates manually and then return them to the store, and this causes pollution and increases the workload. Figure (4) Packaging process before poka-yoke application

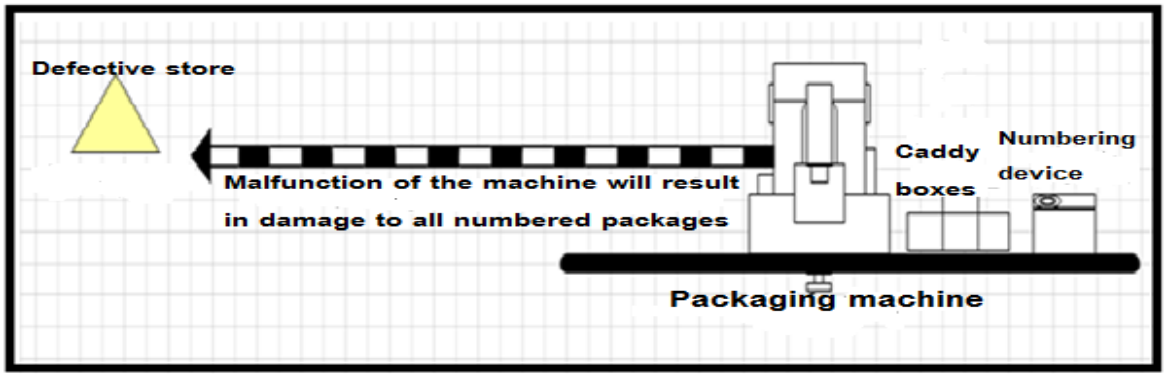

Fig. (4) Packaging process before poka-yoke application

2. **Improvement opportunities by applying(poka-yoke)**

The poka-yoke tool can be used to check errors during the packaging process and reduce cycle time to avoid defects by organizing the process in a way that reduces movement and excessive effort by workers, protecting the product from contamination and reducing wasted time by setting the following instructions:

a. Adding a moving path length of (2.5) meters that extends from the end of the exit path for milk cans from the machine.

b. The numbering device is placed next to the moving track on one side and there is enough space for the worker to sit on a chair on the other side.

c. The operator checks the condition of the product leaving the machine in terms of external shape and weight to the moving track until it reaches the numbering device and prevents the numbering of defective packages.

d. When there is a malfunction inside the machine, the operator returns the paper boxes containing the unnumbered milk cartons to the warehouse without contaminating them with hands. The researcher finds that this tool expands the innovative practical ideas of optimization and this is mainly related to the experience of the operator who is in contact with the machine and which is an important part within the production process. In return, the factory management must take these ideas and try to respond to their requirements in a way that contributes to improving the production environment and its development. Figure (5) illustrates the improvement using poka-yoke.

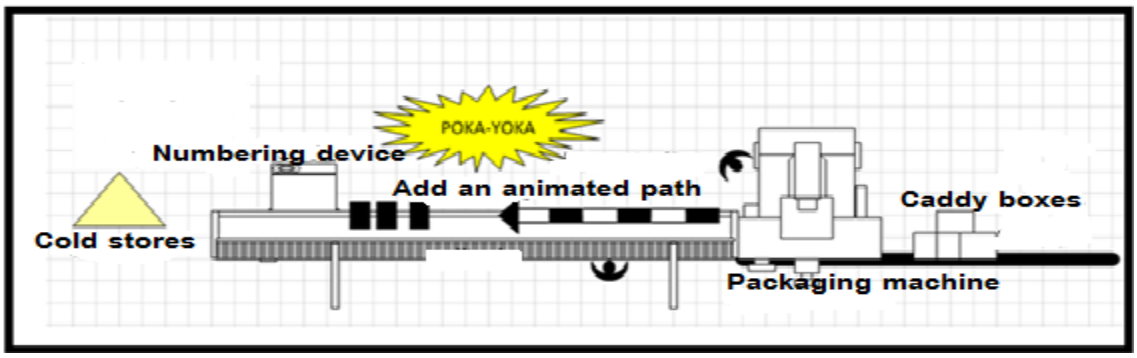

Fig. (5) illustrates the improvement using poka-yoke

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