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Product-Mix Decision Using Lean Production and Activity-Based Costing: An Integrated Model

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Abstract

While the two principles of lean manufacturing and time-driven activity-based costing (TDABC) have been established out of multiple incentives and do not follow the same particular targets, there is substantial commonality between them. In these conditions, the supply management of a multi-product system needs a rigorous production model to minimize costs. In this sense, this paper proposes an interactive model with the consideration of optimizing product-mix decisions using both lean development tools and TDABC. This paper proposes a qualitative approach using the case study of the Iraqi state company for battery production. The suggested model decreased manufacturing time and costs, along with some substantial reduction in idle production capacity by 26 percent in 2019, based on the findings of the case study. On the other hand, the proposed model gives two side advantages: an efficient division of costs on goods due to the use of time spent as a cost factor for products and cost savings due to the introduction of the lean manufacturing approach that reduces all additional costs and increases product-mix decisions. Furthermore, the analytical data gathered here suggests that the incorporation of lean management concepts and TDABC has a strong and important influence on product-mix decisions.

Keywords: Time-Driven Activity-Based Costing (TDABC), Lean Production, Product Cost Reduction

JEL Classification Code: E16, H83, M41, Q56

1. Introduction

Since the beginning of the twentieth century, markets have begun to expand, and competition has increased, which has led many companies to adopt manufacturing philosophies that they have not undertaken before for excellence or maintain their competitive capabilities. Companies strive to meet their customers' requirements by focusing on quality, flexibility, and time when presenting products (Tran, Pham, & Bui, 2020; Wulandari et al., 2020). In response to the goal that these units are seeking, several new production systems have emerged in recent years. For example, Lean Production System, Accelerated Production System, and Nano Production Systems eliminate all forms of waste resulting from production processes that do not add value to the product and reduce the cost and time of production (Hoang, Pham, Nguyen, & Nguyen, 2020; Shin, 2020).

In conjunction with this development in production systems, new methods and cost systems have also emerged, for example, the Activity-Based Costing system (ABC) and the Time-Driven Activity-Based Costing system (TDABC) (Almusawi, Almagtome, & Shaker, 2019). These systems may open the door for companies to achieve the desired goals by reducing production time and cost. TDABC monitors the costs for each activity of the economic unit based on the average time and for each activity on the one hand. On the other hand, it works to rationalize these costs by identifying and monitoring the non-host production value (idle capacity). Adopting and employing lean production

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system tools will eliminate all kinds of waste, whether with money, time or effort (Kbelah, Almusawi, & Almagtome, 2019; Sriyono, 2020).

Moreover, the complementarity between them will achieve flexibility and rapid response to customer requirements by providing the product promptly (Tran, Pham, & Bui, 2020). This integration requires the Iraqi industrial units to restructure, which has become necessary, mostly because it suffers from several problems, whether productive or marketing, in light of global competition. We require businesses to strive earnestly to secure themselves from global competition by employing modern cost management philosophies Management must also incorporate a new production system and contemporary cost methods to facilitate this. The current study explores the knowledge bases based on time-oriented activities for lean production and cost systems (TDABC). The paper also seeks to integrate the philosophy of lean production and TDABC to achieve the required reduction in production time and cost. It also aims to achieve the desired goals by achieving value for the customer and improving competitiveness.

2. Literature Review

2.1. Lean Production Philosophy

Lean production was developed in Japan by Toyota Corporation during the Second World War and served as the savior of Japan's auto industry (Hampson, 1999). Japan's industrial companies, particularly after the Second World War, were faced with a lack of capital, which led them to look for production systems that could fix this deficit (Rinehart, Huxley, & Robertson, 2018). This definition is an alternative or effective way to cope with a lack of resources. Multinational corporations such as Taiich Ohno and Eiji Toyoda play a key role in creating this idea (Yamamoto, Milstead, & LIoyd, 2019). The Japanese were the first to embark on a revolution in mass production, by purchasing some old American presses and pursuing innovation in the late 1940s. Daiichi Ohno established his groundbreaking speed-setting computer method (speed of changing molds). By the late fifties, he managed to minimize the time required to prepare machines from one day to three minutes, which is a record time and eliminating the need for drivers specialized in machine preparation.

The invention of Quick Die Changes is an essential event in the history of the growth of production processes and costs, as it managed to remove the expense of preparing machines and did not add value to the activities that accompany them (Chiarini, Baccarani, & Mascherpa, 2018). It also reduced the inventory cost needed by mass production systems and made it possible for business units to manufacture small batches. In turn, this technique improved customer loyalty and instantly allowed the identification of harm and error in production and enabled production staff to pay attention to quality. Therefore, lean production is a series of actions that must be carried out correctly by the correct sequence and at the right time to generate value for a specific customer (Womack, 2004).

The lean production methodology is a manner of operations that satisfies demand immediately, with the quality needed, without waste. This method differs from traditional operations systems, as it focuses on waste management and fast handling and leads to the reduction of stored materials (Slack, Chambers, & Johnston, 2010). According to Abushaaban (2012), lean production is a philosophy based on the Toyota production system and other Japanese methods that seek to reduce the timeframe between customer demand and product production and access, focusing on eliminating all kinds of waste. Lean production allows to schedule customers' orders from sending the product's purchase order. Thus, it does not allow the waste of resources and reduces production costs to the lowest possible level without affecting the product's quality (Dennis, 2016).

2.2. The Main Tools of Lean Production

Lean production adopts lean tools and techniques that help identify and exclude or reduce loss, improve quality, and reduce production time and costs. The optimal plant is the one that adopts the gravity to represent the flow mechanism required by Toyota's production system to ensure effective operation. Among these tools are, for example, continuous process improvement (Kaizen), job site organization (S5), and avoiding neglected errors (Poka-yoke) that all help to solve loss problems (Chiarini, 2014). The following is an explanation of some of the tools necessary for implementing lean production:

Total Productive Maintenance

It represents the total production maintenance costs related to all organizational functions, mainly production and maintenance functions to continuously improve product quality and enhance operational efficiency (Ahuja & Khamba, 2008; Faber, 2009). This system has emerged due to the need to integrate maintenance operations with the production process to improve productivity and maintain equipment readiness for work (Wireman, 2004). Industrial companies are currently seeking to obtain a competitive advantage by reducing costs and increasing quality levels by applying new methods to improve operations and increase production effectiveness. One of the most important ways is to implement comprehensive productive maintenance (Gadzik, 2009).

Workplace Organizing (5S)

The real benefit of lean production is that it cannot succeed in a chaotic or non-functioning workplace. This system

helps organize the workplace to achieve efficiency, reduce waste and improve quality and productivity by monitoring the work environment (Nouri, Hosseini, & Dalvandi, 2014). The 5S name refers to a series of five words borrowed from Japanese, starting with the translated English letter S. The similar words also start with a S in English. These five words ultimately reflect the five stages to organizational and process excellence:

- **Sort**: Separate from those not required the requisite equipment, supplies and guidance. Delete from the work environment all that is not required.
- **Store**: Sort and arrange for fast, simple location and use all software, equipment, information, records, material and services. Mark all storage places, resources and computers.
- **Shine**: Set new cleanliness guidelines. Comb all litter, grass, and gravel, and remove it. All has to be tidy, clean and well positioned. Cleanliness offers a safe workplace—and highlights likely issues, e.g., machinery spills, loose pieces, lost guardians, misplaced documents or products.
- **Standardize**: Engage the workers to systemically execute steps 1, 2, and 3 above every day to keep the office as a regular procedure in perfect shape. Set timetables and standards for compliance.
- **Sustain**: Make 5S part of your culture and include it in your business philosophy. Create interpersonal involvement to make 5S one of the organizational principles such that everyone establishes 5S as their habit. Combine 5S in the performance improvement system.

Setup/Quick Change

In many economic units today, a large amount of a specific product is produced due to the vast number of times this product can produce up to 50% of the total production time. It also increases inventory levels and reduces capacity when production lines stop during preparation. Moreover, final assembly operations must wait for the numbers to complete Production (Trovinger & Bohn, 2005). Lean production aims to reduce the machine's unnecessary downtime, caused by the configuration and numbers of machines or a change in product models. The down machine time is an essential source of waste. Therefore, economic units are continually seeking ways to reduce the number/change time (Rotaru, 2008).

Cellular Manufacturing

To the proper application of the lean production system, they must arrange factory internally in a manner that helps to smooth the flow of production process and to eliminate costs that do not add value to the product. In this meaning, the factory includes several small factories within one (Aalaei & Davoudpour, 2017). It is essential to adopt a machine configuration scheme whereby the similar machines are positioned with each other or in a house. This process avoids high handling costs, semi-manufactured stock accumulation, and smooth production movement from one stage to another, representing a functional classification.

Kaizen

Continuous improvement is an essential component of the lean production system and is the center of the system that affects all other elements. The term Kaizen means the process of continuous improvement in which both senior management, management personnel and all other employees participate. Everyone identifies problems, sources, proposes appropriate solutions and follows up on their application. This principle requires a change in individuals and authority's behavior based on experience. Kaizen is focused on experience, assuming that all workers work together better. The word Kaizen is a combination of two words in Japanese that, combined, mean 'change is for the better' (Jakubiec & Brodnicka, 2016).

2.3. Lean vs. Traditional Production Systems

The basic concepts of production systems differ according to the grace approach, in light of the traditional production systems in many points. Table 1 shows the differences between lean production systems and traditional production systems.

2.4. Steps of Lean Production

Figure 1 summarizes lean production implementation steps and shows how the value flow path helps eliminate damage (waste) and identify unwanted effects in operations. It seeks to find the root cause of the problem and then develop solutions or redesign the process to ensure the value flow's stability to customers. In each of these steps, the workplace team implement the above-mentioned lean production tools to ensure proper implementation (Melton, 2005).

To implement TDABC, we need to implement the following steps:

***Capacity Cost Assessment**:* to identify the capacity costs of activities, we have to implement the following steps:

[1] Determine the total resources that carry out the activities.
[2] Determine the costs of each group of resources. These costs represent the firm's resources, and the team extracts them from the trial balance and balance sheet.
[3] Estimate each resource group's practical capacity, (often practical time capacity).
[4] Calculate capacity cost rates for each resource group separately.

Table 1: Comparison Between Lean and Traditional Production Systems

#	Concepts	Lean Production System	Traditional Production System
1.	Main Focus	Reducing cost.	Meet the customer's request with a short production time.
2.	Production Scheduling	Reduces the overall waiting time.	Reduce the level of overproduction and inventory.
3.	Batch Production	Meeting the expected demand (with payment system): Push production in large batches	Production moves to meet customers 'demands (Pull system: through clients' orders).
4.	Production Constraints	Reduce the number of preparation times to reduce the cost of preparation.	Reducing setup time to maximize production flexibility, reduce inventory; maximize the ability to meet diverse customer needs; a principle of flow unit by unit.
5.	The Problems		Eliminates all obstacles to make the value flow easily.
6.	Employees	It treats it as an existing reality to adapt the products.	Provide solutions to problems.
7.	Change	Provides temporary solutions to overcome problems and restart	The problems are the source of continuous improvement and improvement.
8.	Relationship with The Supplier	The worker is a cost and works to implement the management orders.	The worker is an investment and a partner in improvement, development and success.
9.	Processes	Limited powers and responsibility.	It is considered an essential element in solving problems.
10.	Errors	Management is responsible for the change.	Extensive powers and responsibility.

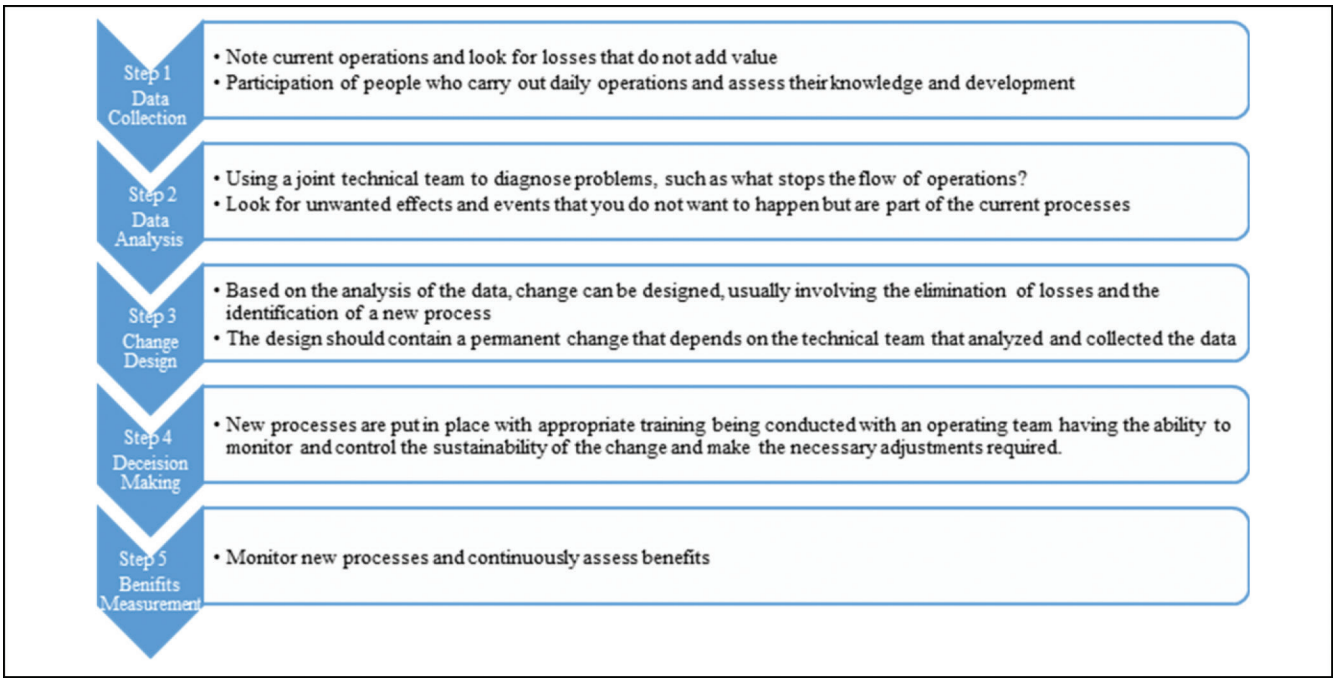

Figure 1: Steps of Lean Production Implementation

Estimating of Activities Time Equations: To calculate the Time Equations of resources, we have to perform the following steps:

[1] Analyze operations within departments or activities.
[2] Determine the factors that affect the time duration of the activity appropriately (the time driver). When the activities are not homogeneous and contain different tasks (variables), each has its driver.
[3] Prepare the time formula that expresses the current time dependence on all factors and their values. The total time equation's general form is the sum of all time spent on all tasks (variables).

$$tE, A = \beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \beta_P * X_P \quad (1)$$

Where:
E, A_i: Time required to complete event E from activity A
β_0: base time (constant) for activity A
β_1: Time consuming one unit of X_1 time drive
X_1: First-time driver, X_2 second time driver, ... X_P time driver p
P: Number of time drivers that determine the time required to complete the activity

Determination of Total Product Cost: Total Product Cost is the result of the multiplication of each resource group's capacity by the total capacity consumed (time consumed) for the products during the different production operations.

2.5. Time-Driven Activity-Based Costing and Product-Mix Decision

TDABC is a system based on the traditional ABC system with reduced application costs, speed in construction and implementation, and ease of updating. Besides, it depends on the time-cost drivers (Anzai et al., 2017). The widespread implementation of TDABC leads to simplifying the application and maintenance of cost management systems. It focuses on eliminating the difficulties administrations face in implementing the ABC system by replacing cost drivers with quantitative-based activities with time-based cost drivers (Thomas & Mackey, 1994). TDABC uses time as its main cost driver, because most resources, such as employees and equipment, possess energies that can be easily measured by the amount of time available to complete the work. The team measures the time by direct observation (Wegmann & Stephen, 2009). TDABC relies on practical time equations to carefully surround various complicated processes. These formulas summarize the time needed to complete each activity within the process (Lelkes, 2009).

The workplace team identify the time equations based on the unit of activity time and the number of consumed times units (the activity's actual use). The difference between the time owed based on practical activity and the time owed based on actual activity represents the untapped production capacity. Therefore, the actual activity (the user) is the number of times the activity performed. The practical activity is the production capacity when carried out under normal operating conditions. TDABC is an alternative and emerging cost approach that addresses most of the traditional ABC approach's problems and shortcomings. The emergence of the optimal time method for cost integrated with the cost method based on activity has led to overcoming the disadvantages and criticisms of the cost method based on traditional activity (ABC). It is is less expensive than the cost method based on the actual capacity to supply resources (Gervais, Levant, & Ducrocq, 2010). This new version works to exclude problems of use and implementation of the activities basis and define procedures for calculating the activity's cost. Moreover, this method takes a comprehensive view of the resources that consist of materials, work and services. It uses time as the primary or primary vector, meaning the time used to allocate costs directly to cost goals such as products and services, customers, etc.

2.6. The Integration of Lean Production and TDABC for Product-Mix Decision

One of the lean approaches' most important objectives is to eliminate losses within the value stream during production processes. The Japanese use the term 'Muda' to express waste. Grasso (2005) believes that the waste is any activity that adds cost or time to the product, but does not add value to it from the customer's point of view. The customer then would not want to pay for this service because, due to the reason of the failure, they distribute the loss over the following:

[1] **Over-production loss**: This type of waste arises because the economic unit produces more quantities than the market needs, which entails additional storage costs, or the product has expired before being used.
[2] **Loss's waiting time**: It results from waiting machines to complete a stage, transition to a new stage, or transition from one product to another.
[3] **Transportation loss**. It arises because of unnecessary movements of raw materials or products due to not being placed in the right place or machines' failure to suit each product.
[4] **Operation loss**: It results from additional operations while adding cost, and not adding value to the product.
[5] **Inventory loss**: It arises because of the purchase of raw materials in large quantities, or the production

of quantities more significant than the market need, which causes the presence of stocks in a quantity more significant than the minimum necessary for the flow or flow of production processes from one stage to another.

[6] **Actions loss**: (lost time due to unexpected behavior). It is an unnecessary movement or behavior, whether associated with individuals or machines.

[7] **Defective loss**: (wasted time restarting). Defective or damaged both arise from allowed and arises from the misuse of raw materials or machines' inefficiency.

Other types of losses cause waste of time, including losses in human capacity, losses due to inappropriate systems and losses in services and office work, and losses in the time of the customer and customers (Bicheno, 2008). Reducing losses of all kinds occur by getting rid of unnecessary processes and activities that do not add value to the product. This procedure will significantly help produce distinctive products of high quality, on time, and at the right price. Strategic thinking style. While eliminating or reducing losses is the lean thinking style's operational dimension, the main objective of the economic units at present and in light of the intense competition is to reduce the costs used in production operations, bearing in mind that such a reduction is not inconsistent with the efficiency and quality required to provide those products and services. It is necessary to reduce the time required to carry out activities related to products and services.

Accordingly, they can obtain the same products and services at a lower cost, lower time, and high quality. By focusing on improving and increasing operational efficiency, economic units can reduce their costs (Kristensen, 2020). The concept of cost reduction is a real reduction in products' costs by using modern technologies that perform the same operations at a lower cost and more quickly without affecting these production efficiencies or quality. The economic units and the big competition at present and in the presence of limited markets and many competitors are facing difficulties in increasing sales. Consequently, these units tend to reduce costs for the products and services they provide (Eslami, Moradi, & Khanmohammadi, 2019). Finally, reducing costs is reduced by reducing production time and eliminating all losses in the production process that cause waste production time.

3. Data and Methodology

This paper uses a qualitative approach using a case study in the state company for Batteries Production. Throughout the define, measure, analyze, improve, and control (DMAIC) process, we can explicitly identify the problems and critical concerns to improve the products' quality and reduce production costs. The company includes three factories:

- **Al-Nour Factory**: According to the international standard (JISC8501-19), Al-Nour Factory produces dry zinc-manganese batteries, which uses lamps and many other devices in different sizes. The factory area is 28 dunums and contains many production halls, large stores, administrative and service buildings, approximately 36 buildings, including 17 large stores. It also contains many technical workshops with broad areas. There are three production lines in this factory for dry batteries production in three standard sizes (large size, medium, pen). It was established in 1974 under a contract signed with the Japanese company Hitachi Maxell, and work started in 1978.
- **Lead Foundry Factory**: The lead foundry produces lead ingots and pure lead with high production capacity, which enter into the manufacture of liquid batteries with advanced technology, with modern equipment's availability to purify the atmosphere from lead dust that causes environmental pollution. This plant is concerned with extracting and melting industrial waste for batteries to produce pure lead and alloyed metal (used as a base material in the manufacture of batteries).
- **Babylon Factory**: Babylon Factory was established in 1969 and began production to the Iraqi market in 1971 with a annual production capacity of 100,000 liquid batteries. With the country's increasing need for the product, the Babylon II Factory was built in 1982 to produce liquid lead batteries according to the international standards under the English company Florida's authorization. The study's application will be limited to the Babylon II Factory, which manufactures liquid batteries as a case study.

4. Results and Discussion

This section provides a numerical illustration and explains how the integrated model suggested in this paper is implemented. Thus, it discusses two methodologies: one is the technique of lean manufacturing and the other is TDABC as the integrated decision-making approach to product mix.

4.1. Application of TDABC in the Case Company

The company is considering manufacturing products such as AMP62, AMP135, and AMP150. We consider that 11 core activities are required, including six production-level activities in Process P1 to P#6 and five service-level activities in Process P7 to P#11. The practices below provide a way to get closer to the manufacturing practice necessary for a successful decision to mix-product:

- Service activities
  P1: Technical and Financial Department

P2: Stores
P3: Maintenance
P4: Transportation and social services
P5: Lean management

- Production activities
  P6: Casting activity
  P7: Oxide and Ficus activity
  P8: Shipping and cutting activity
  P9: Plastic activity
  P10: Preparation of electrodes, connectors and rings
  P11: Assembly activity

To implement the TDABC methodology we need to go through the following steps:

***Step 1.* Calculate the cost rate of resources (service activities)**: we calculate the total costs of all resources based on practical capacity in service and administrative centers (2019), as shown in Table 2:

***Step 2.* Calculate the cost of resources (production activities)**: we calculate the cost of all resources based on practical capacity in production centers for the year (2019). Table (3) indicates the time-cost rate of service activities:

4.2. Application of Lean Tools in the Case Company

To implement lean production, we need to achieve two steps:

***Step 1.* Gathering data and planning for changes**: In this step, the data provided by the time-driven activity-based costing (TDABC) system on the cost of activities and the time needed to accomplish is the basis of the analysis. The justification for this is to explore ways to produce outcomes to eliminate repetitive tasks and procedures that cause unnecessary losses or time increases. To this end, a working team was formed from several specializations to achieve the desired objectives, and the following is a table of their numbers and their workplaces.

Table 2: Capacity Cost Rate of Time in Service Activities

Details	Technical and Financial Department P1	Stores P2	Maintenance P3	Transportation and social services P4	Lean management P5
Total costs (1)	734583394	616564694	775001765	108252640	703294330
The number of employees in each center	86	20	103	30	87
Total hours (annual)	158928	36960	190344	55440	160776
Total minutes (annual)	9535680	2217600	11420640	3326400	9646560
(80%) of practical capacity (2)	7628544	1774080	9136512	2661120	7717248
Cost per minute (3 = 1,2)	96	347	85	41	91

Table 3: Capacity Cost Rate of Time in production Activities

Details	Technical and Financial Department P1	Stores P2	Maintenance P3	Transportation and social services P4	Lean management P5
Total costs (1)	734583394	616564694	775001765	108252640	703294330
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Cost per minute (3 = 1,2)	96	347	85	41	91

Table 4: Description of Lean Workplace Team

#	Workplace	No	Description
1	Lean management	1	Associate Factory Director
2	Technical Service	2	Department Director and Technical Officer
3	Casting department	2	Section manager and casting supervisor
4	Department of oxide and Ficus	2	Section manager and oxidation and Ficus supervisor
5	Slicing, assembling and charging sections	3	Department directors
6	Maintenance	1	maintenance manager
7	Stores	1	Store manager
8	Financial Department	2	Chief Financial Officer and Cost Division Officer

Table 5: Lean Approach of Cost Reduction

#	Reduction tools	Lean activity	Reduced time
1	Comprehensive productive maintenance	Maintenance / integrating maintenance with Production	75,000 hours
2	Worksite organization (S5)	Casting activity	1400 hours
		Oxide and Ficus activity	2200 hours
		Shipping and cutting activity	2600 hours
		Plastic activity	2100 hours
		The activity of electrodes, connectors, and loops	2300 hours
		Assembly activity	1400 hours
3	Quick setup/change	Technical Service / Production Preparation	1500 hours
		Casting activity	1600 hours
		Oxide and Ficus activity	2300 hours
		Shipping and cutting activity	2800 hours
		Plastic activity	1900 hours
		The activity of electrodes, connectors, and loops	1500 hours
4	Cellular Production	Casting activity	2700 hours
		Oxide and Ficus activity	2500 hours
		Shipping and cutting activity	2200 hours
		Plastic activity	2800 hours
		The activity of electrodes, connectors, and loops	2600 hours
		Assembly activity	2500 hours
5	continuous improvement	All activities	2000 hours for each activity
6	On-time production and supply chain management	Storage activity	36,960 hours

Besides, team members discussed the opportunities for development and disposal of unnecessary time or activities that do not add value by using lean production tools as a basis for this. Table 5 shows some of the proposed tools that expected to reduce time and cost of production processes.

Table 5 shows the reduced time due to adopting both the comprehensive productive maintenance tool, the production

on time, and the supply chain management. These tools lead eliminate the storage activity and reduce the maintenance activity to almost half since these activities do not add value. Accordingly, the application of these two mechanisms negates the need for them because production will depend on the withdrawal and supply system on time. The maintenance carried out in conjunction with the production.

Step 2. **Measuring benefits and change**: In this step, we identify the total impact of our integrated model in order to improve the product mix decision. Table 6 indicates that adoption of the TDABC-oriented lean production methodology in the case company positively affects the production time and accordingly influences the product-mix costs.

Table 6 indicates that the highest reduced cost is the maintenance and warehouse activities since these activities do not add value to production and represent secondary activities. The plastic activity had the highest reduced cost among productive activities. We can conclude that the adoption of lean production methods and TDABC would significantly reduce all types of waste in the production process. Consequently, it will lead to a reduction in production cost and time.

5. Conclusion

The adoption of TDABC will meet the needs of organization managers for cost details. In addition, lean development tools can be an effective approach to increase the efficiency, expense, distribution, support, personnel, and competitiveness of company organizational capabilities in a multi-product manufacturing environment. This paper presents an integrated model for optimizing product-mix decisions by the use of lean manufacturing tools to reduce the cost of non-added benefit operations and the application of TDABC as a cost-cutting mechanism. The successful application of lean principles led to identifying wasteful activities and elements in the curriculum and the internship placement process. Lean adoption in manufacturing processes can also lead to less customer satisfaction problems.

The purpose of this paper is to identify lean production methods and the Toyota Production System as tools to reduce production costs and time involved with a case study in a public manufacturing company. This paper addresses two aspects; it firstly reviews specific lean concepts, tools and nonvalue-added activities and how they operate in manufacturing settings. In this case study, the workplace team of factory members implements lean tools to improve production at a factory's specific operations. The study indicates that incorporating the TDABC in management decisions makes it easier to identify activities that add value or consume more resources. Besides, as manufacturing firms move from large to lean production and adopt modern cost and management accounting systems, they're more competitive and meet customer requirements.

The investigation shows that implementing a lean production system virtually eliminates non-value activities and times. The estimated cost reduction was 1,579,297,200 dinars when adoption the lean production in the case study company, which represents about 26 per cent of the annual practical capacity cost of activities in 2019 of 6,063,476,053 dinars. It will result in more generous incentives for greater

Table 6: Product Cost Reduction due to TDABC Oriented Lean Production Model

Activity Code	Activity Name	Annual reduced minutes	Costs per minute	Total reduced costs
P1	Technical and Financial Department	210000	96	20160000
P2	Stores	2217600	347	769507200
P3	Maintenance	4500000	85	382500000
P4	Transportation and social services	120000	41	4920000
P5	Lean management	120000	91	10920000
P6	Casting activity	462000	132	60984000
P7	Oxide and ficus activity	540000	90	48600000
P8	Shipping and cutting activity	576000	154	88704000
P9	Plastic activity	528000	174	91872000
P10	The activity of electrodes, connectors, and loops	504000	155	78120000
P11	Assembly activity	354000	65	23010000
	Total			1,579,297,200

competitiveness. By adopting the time-driven activity-based costing (TDABC) and lean production simultaneously, we will achieve the desired objectives of reducing cost and time. This study's findings put pressure on Iraqi production companies to adopt a more modern production system like lean production instead of traditional mass production. To achieve the desired aim, modern cost accounting methods, especially the TDABC system, are required to reduce operating costs and improve production efficiency.

This paper's main contribution is its integration of lean production and TDABC methodology, a cost reduction and productivity improvement method, in a developing country manufacturing public corporation. This paper aims to integrate lean production and TDABC to control the cost of product quality and eliminate waste in production with balancing cost and product quality. This study intends to provide a solution for strategic cost management by utilizing an integrated model to shed light on companies' crucial problem, i.e., pricing decisions, mix-cost decisions.

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