

## APPLYING THE VALUE STREAM MAP (VSM) AS AN LEAN TOOL TO INCREASE VALUE ADDED AND ELIMINATE THE INHERENT WASTE OF THE PRODUCTION SYSTEM A CASE STUDY AT THE IRAQI DRILLING COMPANY

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### ABSTRACT

This research discusses the use of Value Stream Map (VSM) as an improvement technique in a case study company in particular to reduce waste, improve process efficiency and quality, and hence improve process performance. The purpose of this research is to use the Value Stream Map (VSM) to identify the waste present in the process and remove it or reduce it by the use of lean tools, activities that did not add any value are eliminated or modified. As a result, value added is increased, the delivery time is reduced to improve the performance of the whole process. This study follows the case study method, during site visits, researchers conducted interviews to gather information. A set of appropriate quantitative methods such as (cycle time, waiting time, changeover time, etc.) were used. The research concluded that VSM can be used in the Iraqi Drilling Company, as it has proven its ability to improve operations performance and thus improve efficiency and productivity.

**Keywords:** VSM, lean, lean production, value added, production system, TPM, 5S.

### INTRODUCTION

Lean manufacturing is a set of tools and methodologies aimed at the continuous elimination of waste in the production process. It is a system to improve productivity and product quality in the sense of the most value with the least work, and the philosophy of lean manufacturing lies in reducing the time between the customer's request and building the product or shipping by eliminating the sources of waste. Lean can also be seen as aiming to achieve the same outputs with a reduction in inputs or an increase in outputs by a greater percentage than the increase in inputs with less time, less space, less human effort, less materials and less cost.

As a historical review, after World War II, Japanese manufacturers faced a significant decline in material, human and financial resources. The problems they faced in manufacturing were very different from their Western counterparts. These conditions distinguished the Japanese in the field of new development and reduced manufacturing costs. Many companies have adopted many methods and agile methodologies that lead their companies towards getting rid of waste in the production process, which do not add value to the product through their use of lean tools

that exceed 25 methods, including value stream maps. The activities represented from the first step in the stages of the production process to the delivery of the final product to the customer and through this map and follow up of the production process the amount of time it takes to produce a single unit and the diagnosis of activities that add value and activities that do not add value , In other words, the value stream map is one of the best tools of leanness in portraying the course of the production process, and it is a great methodology for determining the volume of waste inherent in the production system, and in light of this, a plan is developed to eliminate it to improve the flow of the production process and reduce the production cycle, which in turn leads to lower costs and pressure costs, This makes it easier for the company to find a competitive price that will benefit the company as well as achieve customer satisfaction, whose conviction is indispensable . In light of the above, and in order to shed light on the course of the research, it has been divided into four investigations, the first of which is devoted to the research methodology that includes delving into the field of defining the problem, the importance of the research, its objectives, hypotheses, its scientific and spatial fields as well as the research sample, while the second topic is devoted to presenting the aspect The theoretical one, which included defining the concept and importance of lean, the value stream map and its contributions to identifying activities that add value and isolating them from activities that do not add value. As for the third topic, it came to depict the production process and its path from the first step to industrialization and ending with the delivery of the final product, while the fourth topic is devoted to the most important conclusions and recommendations.

## RESEARCH METHODOLOGY

### First: The Research Problem

Also, our goal in preparing this research is to define the course of the production process and build a map of the value stream. We had field visits to the reality of the Southern Refineries Company, which suffers from lost production in the production process, an increase in waiting time, processing time, retreat, and the presence of a large number of stocks in the production process, transportation and other things. Which led to an increase in the time that does not add value and to reduce the amount of time that adds value, especially in the field of improving productivity, which raised these problems the researcher's interest in choosing one of the most important tools of leanness to map the production process, accompanied by the possibility of recording standard times for each activity and marking the wastes Accompanying the process, and in light of the above, the following questions can be raised:

1. What are the unnecessary operations that can be eliminated?
2. What unnecessary transfers can be removed or combined?
3. What are the processes that can be added?

### Second: The Research Importance

The development of current products and the pursuit of improving the quality level and reducing the production cycle can be achieved through the value stream map, which is one of the tools of lean manufacturing, and is based upon redesigning the standard processes, especially the frequent development of products in order to achieve flowing processes. The use of the value stream map as a tool helps in creating a complete perception of the interaction

between the components of the production process and thus it facilitates the process of identifying the problem by identifying it on the map and discussing the problem with some objectivity in addition to providing a structure to ensure the continuous improvement of the process as the value stream supports the necessary integration of various departments in the value stream, it is also a new approach to communicating with customers.

#### Third: The Research Objective

In light of the above, the most important goals that the research seeks to achieve can be identified as follows:

1. Determine how activities that add value and activities that do not add value and are not necessary are approved.
2. How to reduce the phenomenon of delay between operations and how to improve the quality of work in each process?
3. Get product quality, processing speed, capacity, cost, and information on the competitive landscape.
4. How to create a more effective value stream map (achieving greater customer value)?

#### Fourth: Research limits

Search limits can be defined as follows:

1. Knowledge boundaries: Knowledge boundaries are represented in research contributions within the framework of business administration.
2. Spatial boundaries: within the boundaries of the Southern Refineries Company - Basra.
3. Temporal limits: It includes the time period between the beginning of the year 2019 and its end.

#### Fifthly: Objective justifications

All studies and research in various disciplines must be subject to objective justifications that give the research sobriety and the possibility of recording a distinguished scientific presence that rises to distinction from other researches that do not carry a justification for delving into the aspects that have been framed within the research methodology, and accordingly it is necessary to refer to the following:

1. Knowledge justification: As long as the topic of the research falls within the framework of management studies and within the scope of business administration, this research may contribute by setting a fingerprint to identify the concepts of value stream, added value, lean production and the production system and how to map the current value stream and determine the activities that contribute , in adding value and others that do not contribute, and thus the door remains open to research and studies in order to ensure the continuation of the modernization process whenever something comes up to serve scientific communication.
2. Empirical justifications: Through this research, an appropriate design process can be conducted after identifying the actual reality of the value stream map and developing appropriate solutions to the problems that the company under study suffers from.



### Sixth: Research Method

The research method is represented in two aspects, namely:

1. The theoretical aspect: In writing the theoretical side, the researcher relied on Arab and foreign sources in order to enrich this aspect with a set of information on the same topic from libraries and the Internet.
2. The practical aspect: The South Refineries Company was elected as one of the leading companies in the field of the oil sector, as it constitutes a basic pillar in supplying the local markets with oil derivatives, searching for information related to the main aspect of the research topic to build a value stream map.

### Seventh: The Research Hypothetical Outline

The hypothetical outline of the research is based on three basic pillars, the first of which is the Value Stream Map (VSM), which is the Lean Manufacturing Tool to visualize the system and determine the current production path, and through it the system is analysed, the activities that add value and the wastes inherent in the system are determined and a plan is drawn up, and in light of identifying the activities that adds customer value by reducing process cycle times and implementing process improvement to ensure sustainability and continuous improvement.

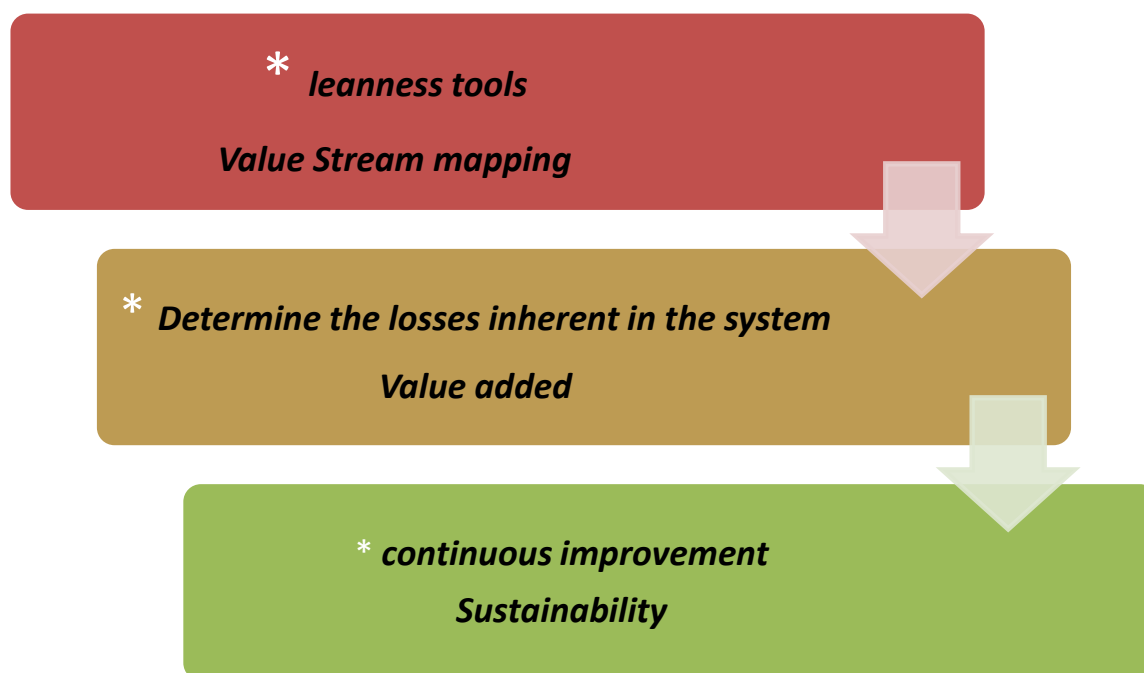


Figure (1) illustrates the components of the research hypothesis scheme

### Eighth: The Research's Questions and Hypotheses

Any study must be based on hypotheses or a group of questions that help to reach the truth and find an optimal solution to the problem under study that faces the company's management, and for this purpose the research was based on the following questions:

1. Is it possible for the company to avoid waste in the production process and reduce the production cycle time?

2. Does building a value stream map help to emphasize all units and divisions of the company in a serious contribution to raising the level of responsibility and reducing the volume of costs represented by increasing the time of the production cycle and the accumulation of storage?
3. Does the increase in costs make the process of building a value stream map necessary to avoid material loss first, raise the level of quality and achieve customer value secondly?

### LITERATURE REVIEW

In the literature review, two aspects were highlighted, the first is the concept of lean production and its most important principles and tools, while the second aspect deals with the application of VSM.

#### • Lean Production

Lean production, or lean manufacturing was developed by Taiichi Ohno and called the Toyota Production System (TPS). this system supports many innovations including: waste elimination, quality in (jidoka) source, and continuous improvement (kaizen). Lean production concepts are not necessarily limited to the supply of materials and inventory, but rather aims to improve processes and make them more efficient and reduce defects, and in fact, they penetrate all the value-adding activities of the organization (Kovacheva, 2010). Lean is the methodology of the constant focus on understanding and increasing the customer's value, by reducing the time of the product or service delivery cycle, which occurs by eliminating all forms of "muda", a Japanese term for waste, "muri", for overburdening of individuals and machines, "mura" for "disparity in workflow or imbalance of demand", within the organization, and these three reasons are linked in a circular manner. Waste causes disparity, which causes an increase in the burden that in turn causes waste. Therefore, it is important to deal with the three concepts to improve system performance (Skalle & Hahn, 2013). These three causes of waste (muda, mura, muri) emanate from them seven types of waste in many different operations, for both service and production, which form the core of the lean philosophy, which is (over-production, waiting time, transport, process, inventory, motion, defectives) (Slack, et al., 2013 & Groover, 2002 & Kumar & Suresh, 2008). As for the lean production, (Heizer, 2011) defined it as the end result of a well-functioning process management function. JIT and TPS tend to be internally focused, while lean manufacturing begins from the outside. Focusing on the customer, to understand what the customer desires, while ensuring that those desires are inputs, as well as feedback, points from which to start lean manufacturing, and lean operations mean determining the value for the customer by analyzing all the activities necessary to produce the product and then improving the whole process from a point of view look the customer.

The two writers (Womack & Jones, 2003) in their book "Lean Thinking" have defined five principles of lean manufacturing that work with manufacturing and service organizations, namely:

- 1- The value of the customer's perspective,
- 2- Determine the value stream,
- 3- Flow,

- 4- Pull, and
- 5- Perfection

- **Value Stream Mapping (VSM)**

Modern production plants around the world, lean manufacturing technologies are being used to meet the growing demands of manufacturers. It was originally developed as a methodology to make production processes highly efficient by identifying waste and defining the new case of future mapping in an enterprise (Che Ani, et. al, 2014). One of these lean manufacturing techniques is Value Stream mapping (VSM). First, before we get to Value Stream Mapping (VSM), we explain what is value, "Value" is what the customer pays his money to buy, as it provides the customer with the highest quality, in a timely manner, and at a reasonable price, from the customer's point of view. (VSM) is a tested lean technique and is useful in any industry or business. It is means from Heizer's point of view, it is the process by which managers can understand how to add value to the customer in the flow of materials and information through the total production process (Heizer, et. al, 2017). (VSM) is a method for drawing the flow of materials and information needed to create a product or provide a service that meets a customer's need. A (VSM) uses a series of icons to display work and information flows, and another to indicate whether or not these elements are adding value. Thus the map planner can see which elements do not add value from the customer's point of view ([www.miro.com](http://www.miro.com)). (VSM) is a widely used qualitative lean tool aimed at eliminating waste or muda. Waste in many processes can be up to 60 % (Krajewski, et. al, 2013). Thus increasing the efficiency of a value stream. Waste removal aims to increase productivity by creating smaller scale operations which in turn make identifying waste and quality problems easier ([www.en.wikipedia.org](http://www.en.wikipedia.org)). Although (VSM) is often related with manufacturing, it is also used in the logistics, supply chain, service of industries, healthcare, program development, product development, and administrative and office operations ([www.en.wikipedia.org](http://www.en.wikipedia.org)).

- ❖ **Practical Side**

In this research, a case study is applied with a statistical analysis of data obtained from Iraqi Drilling Company. This segment manages insights concerning case organization, background details of case study, current state value stream map and future state value stream map.

### **Background of Case Company**

The Iraqi Drilling Company is an Iraqi company affiliated to the Iraqi Ministry of Oil, established in 1990, concerned with drilling and reclamation of oil wells throughout Iraq. The purpose of its establishment was to focus drilling and reclamation operations in one Iraqi company, after these operations were carried out by extraction companies such as the South Oil Company and North Oil. And after the year 2003, the Iraqi Drilling Company was able to own 43 drilling and reclamation rigs, and during that process the company was able to complete the drilling of 230 wells and reclaim 600 wells between 1990 and 2003. After the year 2003 until now, about 423 wells were drilled and more than 1077 wells were reclaimed due to the increase in the company's capacity from modern equipment, which means that the company was able

during the last 10 years to accomplish double what was accomplished before 2003 ([www.iq.linkedin.com](http://www.iq.linkedin.com)).

### **Research Development**

The measurements in this research test both qualitative and quantitative aspects of waste. (1) The qualitative aspect analyses the reasons beyond the waste, (2) The quantitative aspect deals with the application of lean measurements to measure the efficiency of each step (Wenchi, et. Al, 2015). The research was conducted based on the historical data of a well drilled by the case company. VSM was carried out using the final well drilling reports provided by the company under study.

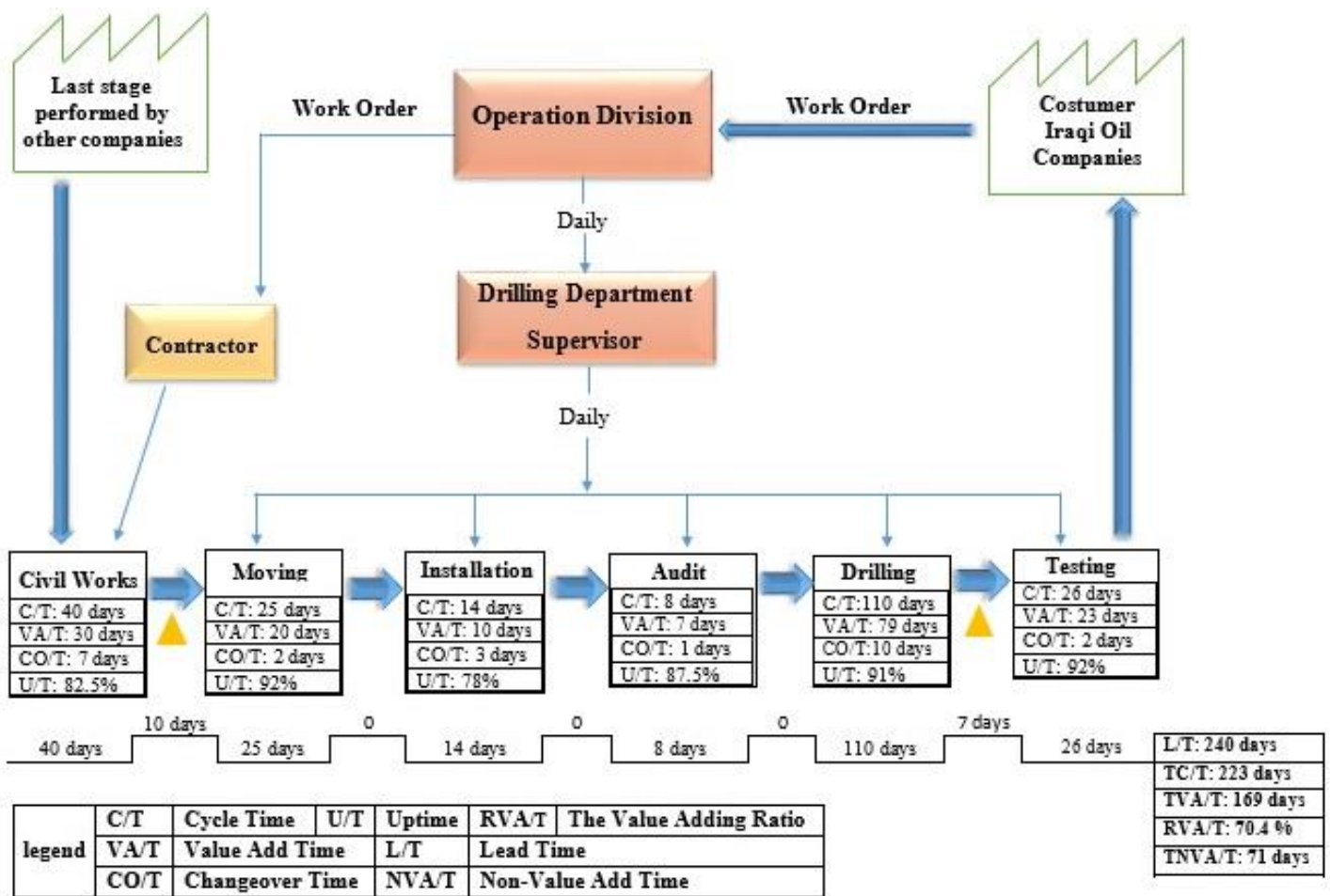
### **Current State Value Stream Map**

The current value stream for drilling a well is generated using data collected from the case company. Figure 1 illustrates a company's present value map. VSM refers to all Changeover Time, cycle times, lead time, Uptime, efficiency and information flow (Mudgal, et. Al, 2020). The drilling company receives orders from the Iraqi oil companies after stages are carried out by other companies. The first step that the company takes after receiving the order is to contract with a contractor to carry out civil works, it is carried out through direct daily supervision by the drilling department. Comes the stage of transporting the drilling rig to the work site. And then the stage of installing the drilling rig. Then the audit stage, this stage is carried out by external auditors, in which records and all documentation related to the drilling process are checked, because the company is an ISO certified company. Then comes the stage of drilling the well, and finally the stage of testing before handing over the well to the oil company.



Relying on the information obtained from the case company, which helps determine the times of added value that does not add value and that can be disposed of or reduced in order to increase the speed of product delivery, reduce costs, and improve the performance of the process, this map is shown in Figure (1) which shows the total lead time of this stages is 240 days (total time of delivery), which is calculated based on the start time and finish time of this stages. The total cycle time is 223 days (total cycle time = sum of cycle time of each stage). The total value adding time is 169 days, the sum of each process value adding time, the value adding ratio is 70.4% (Value adding time ratio = Total value adding time / Total lead time). Changeover time (COT) which is the idle time that one of the phases must wait before completing its previous phase. Uptime = (cycle time - Changeover time) / cycle time. Finally the total non-value adding time is 71 days, it is the sum of times that non-value adding within and between stages.

**Future State Value Stream Map**



**Figure 1. Current State Value Stream Map**

The purpose of value flow maps is to highlight sources of waste and eliminate or reduce them as much as possible by implementing a future state value flow map. The future map is built by redesigning the value flows to reduce waste using appropriate tools, achieving a future vision that aligns with the principles of lean manufacturing (Husby & Hamilton, 2018). Figure 2 shows a future state map showing the various modifications made in the drilling operations.



The Iraqi Drilling Company seeks to improve its operations by searching for waste in the operations associated with drilling an oil well and knowing its causes to get rid of it or reduce it. After the analysis of wastes existing with operation of drilling an oil well, the first stage of the process is to contract with a contractor to conduct civil works to pour the base of the well. The time for this stage can be reduced from (40 days to 30 days) by adding a penalty clause in the contract for the contractor to abide by the date, thus reducing the time to ten days, so that the percentage of uptime 0%. The second reduction is by eliminating the waiting time between the first and second stages through the correct scheduling of works and the transfer of drilling equipment in a timely manner, thus reducing (7 days) the waiting time between the two stages. The third reduction will be in the fourth stage, which is the audit stage, and the reduction will be for one day through good organization by the committee designated for this work, so that the percentage of uptime 0%. The fifth stage includes drilling the well. The cycle time is 110 days, while the time for value added is 79 days. percentage of uptime 91%. It is possible to reduce the cycle time to 100 days, by using one of the lean tools, which is the Total Productive Maintenance (TPM). It includes all preventive and predictive maintenance practices and maintenance improvement techniques based on maximizing the effectiveness of technological equipment, and this package also includes safety improvement programs and safety improvement programs is an exemplary practice implemented within the lean philosophy (De Visser, 2014). With (TPM), overall maintenance is managed for machines, equipment, processes and employees that add value to the company's business, in order to reduce downtime caused by sudden vacations that occur during the well drilling process and thus improve productivity. This leads to continuous operation improvement, which is the main principle of the Lean Thinking philosophy. Thus, the reduction in time at this stage will be by 10 days, which are the days in which work stops occurred due to sudden maintenance, so that the period of the cycle becomes 100 days, to become the percentage of uptime 90%. The next reduction comes from eliminating the 7 days waiting time between the fifth and final stage, usually this wasted time resulting from not organizing and arranging equipment and machinery in the workplace. By using workplace organization technique (5S), which is the philosophy of caring for the workplace by organizing, cleaning and simplifying its environment, thus reducing waste and improving quality and safety. (5S) stands for the first letters of five Japanese words, which are (Seirri) organization, (Seiton) arrangement, (Seiso) cleaning, (Seiketsn) maintenance and (Shitsuke) discipline.

## DISCUSSION

The future value stream flow map shows the highest reduction in time in the first phase (Civil works), and the fifth phase (Drilling), as the reduction value reached 10 days. This came through analyzing the waste and using litter tools to reduce it. As for the lowest reduction, it was in the fourth stage (Audit), as it reached one day. Also, the highest deletion of waiting time was 10 days between the first and second phases. The reasons for not removing or reducing waste in the rest of the stages are due to the difficulty of covering waste in well drilling operations, unlike production lines, the variation in operations makes it difficult to prepare value flow maps, and this is the most important challenge in research.

The improvements compared to times in the current state value stream map and future state value stream map are noted in Table 1.

**Table 1: comparison between current state map and future state map**

Description	Current value map	Future value map
Total lead time	240 day	202 day
Total cycle time	223 day	202 day
Value adding ratio	70.4 %	83.66 %
Total non-value adding time	71 day	33 day

We observe a reducing in the total lead time of the value stream from 240 day to 202 day, so the amount of the reduction is 38 days. Most of the wastes were eliminated through the use of lean tools and work scheduling. This decrease led to an increase in the value adding ratio by 13.26 %, which changed from 70.4 to 83.66 %. Also notice a 21-day decrease in the total cycle time, from 223 days to 202 days. All improvements to the future value stream map have reduced the total non-value-added time by 38 days from 71 days to 33 days. Therefore, we conclude that VSM can be used in the Iraqi Drilling Company, as it has been proven through the results we obtained to have the ability to improve operations performance and thus improve efficiency and increase productivity.

### CONCLUSION

This paper presents a methodology for developing a value stream map (VSM) in a company in a company based on the pull system. (VSM) is an effective tool for diagnosing and designing lean processes, detecting and quantifying waste at different stages of the process. The main purpose of this research is the lead time, which is the most important to comply with the requirements of the product as desired and portrayed by the customer. Through the use and development of (VSM), lead time is reduced, thus reducing delivery time and this leads to improved efficiency of operations and consequently a reduction in costs and an increase in profits. The research also reviews recent literature on how to make a lean future value stream map (VSM).

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