The role of integration between the earned value management model and the value flow map in rationalizing the costs of construction projects / applied research in Al-Rasheed General Company for Construction Contracting

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Abstract:

The research problem is that most of the construction projects exceed the planned value, due to the failure to implement the plans on time .The current study aims to monitor the implementation of the project and for each of the executed tasks of the table of quantities in order to detect deviations at the time they occur, evaluate the time and cost performance, and then identify the areas of waste and analyze the implementation of each task in order to diagnose the underlying problems and find possible and applicable solutions in the environment Iraqi .The research was applied in one of the companies specialized in the field of construction projects, and one of the most important conclusions reached is the possibility of applying the Earned value management model to the tasks executed during the work stages, as well as the possibility of applying a value stream map to construction projects to rationalize their costs.

Keywords: Earned value management model, value stream map.

Introduction:

The construction industries are distinguished from other industries by a special nature in terms of their large size, their continuous growth, and the dependence of many industries on them to secure their needs from various facilities, as the construction industry is a productive industry whose main product is the construction project .The construction contracting business and its management constitute the vital and largest part in the means of implementing this industry. Therefore, the need to monitor and manage these projects appeared in line with the degree of complexity in the implementation of their work, and therefore this study came to adopt finding possible ways and solutions to be applied in the Iraqi environment, represented by the earned value management model, and then guide its costs through the application of the value stream map. The research also dealt with four Topics as follows:-

1- The first topic: research methodology.
2- The second topic: the theoretical aspect / definition of the earned value management model and the value stream map to rationalize costs
3- The third topic: the practical aspect / the mechanism of applying the earned value management model and the value stream map
4- The Fourth topic: conclusions and recommendations.

The first topic \ Research Methodology

1-1 Research Methodology

1-1-1 **Research problem**: The research problem is that most of the construction projects exceed the planned value, due to the failure to implement the plans on time.

1-1-2 **The aim of the research**: The research seeks to rationalize the cost of construction projects and reduce waste of resources.

1-1-3 **Importance of research**: The importance of research is crystallized in monitoring the implementation of the bills of quantities for the construction project in order to identify cost deviations and identify their sources and then to provide possible solutions and proposals that would reduce waste and loss in future projects.

1-1-4 **Research hypothesis**: The research stems from a main hypothesis that ((The application of integration, the earned value management model and the value flow map leads to cost rationalization).

1-1-5 **Spatial and temporal limits**: In completing the practical aspect, the researcher relied on the cost statements and assignment forms for the year 2019 related to the implementation of the paragraph setting up a control panel for the operation of the pushers for electrical work, which was obtained from the Financial Department / Division of Costs and Revenues and from the electrical engineer specialized in implementation.

The second topic \Theoretical aspect:

Introducing the earned value management model and the value stream map to rationalize costs

2-1 **Earned Value Management Model**

The Earned Value Management model can be defined as a methodology that combines scope, schedule, and resource measures to assess project performance and progress in the work schedule (PMBOK, 2013:217). Earned value (EV) was formerly known as Planned Cost of Work Performed (BCWP) - the value of work done, i.e. the planned value of work already completed.

Each of these core values can be defined as follows (Holm, 2018:113) (Vyas&Birajdar, 2016:830) (Potts, 2008:207):

1- Planned value (PV): formerly known as Planned Cost of Work Scheduled (BCWS) - that portion of approved cost estimates planned to be spent on a specific activity in a given period.

2- Actual Cost (AC): Formerly known as Actual Cost of Work Performed (ACWP) - the total costs incurred in completing work on an activity in a given period. Actual cost should correspond to all the planned performance value (PV) and earned value (EV) eg wages, materials, construction equipment and indirect costs.

3- Earned Value (EV): Formerly known as Planned Cost of Work Performed (BCWP) - It is the value of work done, ie the planned value of work already completed.
EV= PC[1] * PV

The deviations and indicators of the earned value of all kinds can be defined as follows - (Pooja et al, 2018:1399)

A- Cost Deviation (CV): It is used to check the difference between the planned project cost and the current project cost on the specified date.
CV=EV-AC

B- Schedule Deviation (SV): It is used to check the deviation of the completion period of the current project from the planned project duration.
SV=EV-PV

C- Cost performance index = Earned value / Actual cost
CPI = EV /AC

D- The Schedule Performance Index = Earned Value / Planned Value
SPI = EV / PV

[1] PC Percentage Completed

Deviations and indicators of all kinds can be defined as follows (Pooja et al, 2018: 1399): -

a) Schedule Performance Indicator (SPI): - SPI can be used to estimate the expected time to complete a project, if it is:

SPI = 1 means that the project was completed on schedule

1 > SPI means the project is behind schedule

1 < SPI means the project is ahead of schedule

b) Cost Performance Index (CPI): - CPI can be used to estimate the project cost to complete the project based on performance so far. If (Vyas& Birajdar, 2016:831): -

CPI = 1 means that the actual cost is the same as the planned cost

CPI > 1 means that the actual project cost exceeded the planned cost

CPI < 1 means that the actual project cost is less than the planned cost

Meanwhile, positive SV and CV values indicate that the project is in line with the planned schedule and within the specified budget, respectively (Potts, 2008: 207).

We can also measure the project's performance in total and at any point of the curve (Milestones), meaning at any specific point of the curve, through the project cost scheduling indicator (CSI), which is called the overall performance indicator because it allows giving a clear picture of the extent of project implementation within The specific plan (whether it is a time or financial plan),

This indicator provides an opportunity for the project manager to monitor the progress of the project as a whole as well as early detection of problems, in addition to allowing senior management to follow up and compare a group of projects (regardless of the technical aspect of implementation). Cost performance indicator as in the following formula:-

Total performance index = cost performance index * schedule performance index

SPI * CPI = CSI

If it is:- CSI < 1 This means that the project is being implemented with good performance, i.e. it is going faster than the plan (financially and in time).

CSI = 1 This means that the project is implemented within the required performance, that is, it is going according to the plan (financially and temporally).

CSI > 1 This means that the project's performance is low, that is, it is running slower than the plan (financially and in time) (Jones, 2007:190).

2-2 Value Stream Map

The value is defined as everything the customer is willing to pay a certain amount in order to obtain it, whether it is material or information (Rahayu, 2009: 116). As for the flow of value, it is defined as a set of activities, whether or not they add value to the product, which transforms the product from being a concept to starting, from being a mere request to delivery, and from a raw material to a complete product (Barbara, 2011:22). The value flow according to (Rother and Shook 2003) is also defined as all the actions (both that add or not add value) that are currently required to create a product through the basic major flows of each product: (1) the flow of production from raw materials to down to the customer, (2) design flow from concept to launch, value flow map (VSM) is specific procedures for creating final products from raw materials to meet customer demand, where VSM focuses on information management and transformation tasks, and VSM procedures are implemented through Mapping the current situation, drawing a map of the future situation, preparing an implementation and improvement plan, and distinguishing between value-added and non-value-added activities helps determine the vision for what can be accomplished in the future with the required changes (Forbes & Lincoln, 2010: 116) The value flow map is also defined as the process that helps managers understand how value is added to the flow of

materials and information from the production process as a whole (Heizer et al., 2017: 290). And (Schroeder & Goldstein) defines it as a tool that creates a visual representation of the value flow of a particular process that requires direct monitoring of the work and flow within the process and that enables the organization to identify opportunities for improvement (Schroeder & Goldstein, 2018: 116). The reason for naming the value flow map is due to its focus on the activities that add value or not, and the distinction between them (Slack, 2010: 436). The value flow map also includes important aspects that need clarification, as follows: -

2.2.1 Components of a Value stream Map

The value stream map consists of three main components (King&King2017:5-7):-

1- Material flow - shows the flow of materials as it progresses from raw materials, through each major process step (machine, tank, ship arrangement) to the final goods moving towards the customer. This is a high-level view showing only the major parts of equipment or processing systems, with data boxes showing the performance of each part. All inventories are also displayed along the flow, with data boxes showing the contents of each store of items.

2- Information flow - the flow of all the main types of information that govern what should be done and when it is done. This starts with orders from the customer, traces from all the important planning and scheduling processes, and ends with schedules and control signals to the production floor. Information usually flows in the opposite direction to the flow of materials.

3-Timeline - rises at the time of value addition and decreases with the time of no value addition, plotted at the bottom of the Value Stream Map (VSM) as a square wave. It shows the effect of wastage rather than the cause that should be diagnosed from the other two components of VSM.

2-2-2 Value Stream Map Steps

The value stream map is created through four basic steps (Keyte & Locher, 2016:7) (Apel, et al., 2007: 11):-

1- Define the product family
2- Draw the current map
3- Analysis and evaluation of the current situation
4- Draw the future map
5- Planning and execution

2.2.3 Value Stream Map Metrics

1- **Takt time**: It is the cycle time required in the production system to match the pace of production with the demand rate, and it can be calculated through the following steps (Stevenson, 2018: 618):-

Determining the net time available for work resulting from the total available time minus the pause and rest times, i.e. the times that do not add value to the product.

Calculate the frequency of time by dividing the net available time by the required quantity.

Takt time = net production time / quantity demanded

2- **Targeted productivity rate**: The target productivity rate is the quantity of production required in a specific period, and it is calculated through the following equation (Gunduz & Naser, 2017: 8):

Target productivity = Number of units needed / Duration

3- **Cycle time**: It is the maximum time allowed at each workstation to complete its set of tasks on the unit. The cycle time also determines the line output rate. For example, if the cycle time is two minutes, the units will come out from the end of the line at a rate of one every two minutes. Hence, the amplitude of the line is a function of its time cycle (Stevenson, 2018: 270).

The application of the value flow map in the construction industry has not received sufficient attention by researchers because of the difficulty of implementing the value flow map on construction activities (Gunduz & Naser, 2019:69). Therefore, and due to the lack of its application

in the construction projects sector, the researcher chose to enrich this aspect with modern studies, as well as explaining the implementation stages in detail and clarifying the flow of value to know the areas of deviation and their causes in order to work on correction and reduce them as much as possible to benefit from them in rationalizing the costs of construction projects.

The third topic \ Practical aspect: the mechanism of applying the earned value management model and the value flow map

3.1 Applying the Earned Value Management Model

3-1-1 **Calculating the percentage of the current actual technical achievement**

We need to calculate the actual technical achievement percentages for each selected paragraph because it is the basis for calculating the acquired value, but the company does not use the actual percentages of achievement during the implementation stages, meaning that the work progress program calculates the technical achievement percentages for the total achievement of all works and paragraphs implemented at a certain point in time and not for paragraphs in detail Therefore, in order to be able to compare and apply the model to the selected paragraphs, the actual technical achievement percentages will be calculated for each paragraph during the implementation phase by calculating the percentage of the planned completion days, at which the planned technical completion percentage is equal to (100%) to the actual work days to know the current actual completion percentage that Corresponding to the planned ratio, as shown in Table (1):

Table (1) the current actual technical achievement percentages for the selected paragraphs

Name of the task executed	Number of days planned	Current planned technical completion percentage	Number of days of actual implementation	Current actual technical completion percentage
install control panel	10	100%	20	50%

Table (1) shows the calculation of the current actual technical achievement percentages from the following equation: -

The current actual technical completion percentage =
(The number of planned days / the number of days of actual implementation) * 100%

For example:

The current actual technical achievement percentage (the Task of control panel installation)
= (10/20) * 100%
= 50%

That is, on the 10th day of the actual implementation, the actual completion rate was 50%.

From the percentage that was calculated in Table (30), the acquired value and the current actual cost can be calculated at these percentages and for each paragraph as shown in Table (2): -

Table (2) calculating the earned value and the current actual cost for the task of setting up the control panel

Planned Value	current Actual Technical Completion Percentage	Earned Value	Final Actual Cost	Current Actual Cost
8000000	50%	4000000	12500000	6250000

Source: based on table (1)

Table (2) shows the method of calculating **the Earned value** as follow: -

(8000000*50% = 4000000)

while the method of calculating **the current actual cost** as follow: -

(12500000*50% = 6250000)

3-1-3 Calculating deviations and indicators of the earned value management model

After preparing the three basic values for each paragraph, it is now possible to calculate deviations and performance indicators for the earned value management model, as shown in Table (3): -

Table (3) Calculation of deviations and indicators of the EVM model for the task of setting up the control panel

Planned Value PV (1)	Earned Value EV (2)	Current Actual Cost AC (3)	CV (2)-(3) (4)	SV (2)-(1) (5)	CPI (2) \ (3) (6)	SPI (2) \ (1) (7)	CSI (6) *(7) (8)
8000000	4000000	6250000	(2250000)	(4000000)	0.64	0.50	0.32

Source: Based on Table (2)

Table (3) shows that the cost skew is negative as well as the scheduling skew. As for the performance indicators, whether the cost performance indicator or the schedule performance indicator, both are less than one. Finally, the overall performance indicator is also less than one, and this means that this task has been implemented In a way that exceeds the planned cost according to the budget and also implemented slower than the time plan specified in the work progress program Therefore, the value flow map will be applied in detail in order to search for sources of waste and their causes and work to find appropriate solutions for each problem through other lean construction techniques that support the value flow map to rationalize the cost of this task, to be a model that can be used in rationalizing the costs of any task of construction projects future similar problems.

3.2 Applying a Value stream Map

The application of lean construction tools is the next stage for the application of the acquired value management model, because the latter identifies areas of defects and cost and time deviations, and therefore it is necessary to follow them with steps to correct the project path through lean construction techniques to achieve the desired benefit from the application of the model, as the value stream map uses symbols to represent the flow of information And inventory within the system as it is a technique to reduce waste and improve efficiency in order to provide optimal value to the customer in the form of products or services provided to him. The value-stream map is also related to lean manufacturing, but it can be applied in various fields, including industries related to services, administrative and office operations, and software development, in addition to its application in the construction sector Creating a map to visually represent the steps involved in producing products and services and presenting them to the customer can be valuable for any business. The value flow map makes it easier to assess the current state of the production process to determine what is successful and what problems cause inefficiency. Once you draw and analyze the current map, We can create ideal and future state maps to provide a clear plan to improve the implementation of phases and tasks of future projects, and the details of selected Task of electrical work in the table (4) as follow: -

Table (4) the details of the installing a control panel's task (2019)

S	details	Cost \ Day
1	The price (planned) in the bill of quantities or the contract annex, for single meter/number	10000000
2	(Planed value)80% of contract price	8000000
3	Actual cost, per meter/number	12500000
4	The time required for implementation (planned) day, as stated in the work progress program	10[1]
5	Actual execution period \ day	20[2]
6	Actual execution period \ working days	18

1- Identification of the product family

Determining the product family in the construction projects sector differs from that chosen in the other industries sector. The reason is that the construction projects result in multiple and atypical products, as well as the unique character of each product that differs from other products. The same product cannot be repeated unless the demand for the product itself is exactly the same, as the construction companies implement what the employer or the customer requires and according to the specifications and conditions in the contract concluded between the two parties. Therefore, the products of these companies abound among the government buildings used as state institutions. Such as schools, hospitals, universities, colleges, infrastructure as well as residential complexes, whether apartments or houses of religious centers and other buildings and according to the required need, the product family is selected for identical projects, due to the impossibility of drawing a value flow map for all the implementing paragraphs of a project Specific and for all stages, as they cannot be included in one research due to the complexity of the operations in them and their overlap and the magnitude of the information and materials contained in each executed paragraph. Therefore, the researcher chose a paragraph about setting up the control panel to operate the impulses from the electrical works to apply the value flow map, the details of which are shown in Table (4).

2- Present value stream map

Mapping the value stream in construction projects is a complex matter due to the difference between construction projects and other industries, due to the magnitude of the details, activities, and paragraphs related to implementation and completion of projects. Therefore, in order to apply the value stream map, the project is divided into stages and stages into civil, electrical, mechanical and These works are also divided into sub-tasks according to the work progress

[1] The numbers of days planned for executing the task of installing a control panel was 31 days, as stated in the work progress program, taking into account the time taken for the arrival of the Geller associated with the work of the control panel, while the actual implementation of the installation of the panel does not take more than 10 actual days, according to the information of the competent engineer.

[2] The number of days to carry out this task was calculated according to the execution days only, regardless of the waiting days until the replacement and arrival of the Geller conforming to the specifications with the certificate of origin.

program that is prepared to implement what is mentioned in the bill of quantities, if the value stream map includes details and information that should be clarified as follows:

1- Information flow: the information flow begins when the project is implemented to complete the paragraphs in the bill of quantities and according to the dates specified in the work progress program that is prepared at the company's headquarters / Planning Department - Programs and Follow-up Division to be implemented by the project management, which directs each engineer according to his specialization to implement and program completion.

2- The flow of materials: the flow of materials is of two types, either ready-made materials from the local markets, which are purchased under special committees for project purchases, or materials located in the main warehouses of the company, which are flowed by submitting an order in the required quantity and obtaining approvals to prepare a warehouse exchange document in the specified quantity and transfer it To the project site, these materials are represented by the construction materials that the company manufactures through factories and quarries, such as gravel, sand, ready-made concrete, etc. from the company's products.

3- Timeline: The timeline is illustrated in the form of square waves on the bottom line of the value flow map, which includes the time of adding and not adding value. The time of adding value is calculated according to the company's working hours, which take place according to the official working hours of government departments, which is the time between (8- 3) From eight in the morning until three in the afternoon at a rate of (7) working hours, which is equivalent to (420) minutes per day, and an hour of rest (time of not adding value) is allotted for workers in project sites, and after subtracting the time of rest, the net available time (time of adding value)) as follows:-

Net time available = 420 - 60

= 360 minutes a day

The Task of setting up, linking and operating a control panel includes several stages to operate the pushers remotely, and it has an iron structure and a tightly closed door where it is installed on the ground and with appropriate dimensions to contain the on and off buttons for all pushers with sound indicators.

This Task has also been changed from what was stated in the table of quantities due to the forced cessation of the project, as the implementation of this paragraph took place in 2012. The Star-delta control panel was purchased at a price of 5500000 dinars from the local markets to connect and configure it before the arrival of the compressor for the cooling system, and the wages of work and mechanisms amounted to 1000000 dinars Where the painting was transferred from the market to the project site at a cost of 100,000 dinars, including transportation and loading. When it arrives at the work site, it asks to lift it from the ground to the surface by means of a special lifting machine called (the crane), then transport and install it in the concrete at an amount of 500,000 dinars, so that the total cost of the mechanisms is 600,000. 1 electrician with a wage of 25000 dinars, so that the total wages of work (1 * 4 * 50000 + 2 * 4 * 25000) equal 400,000 dinars, as the total cost of this paragraph was 6,500,000 dinars During this period, the jet pumps reached the 2012 model and specification, which is modern at the time, but it was not approved by the employer due to the lack of a certificate of origin, and it was rejected and returned. After the project stopped for 4 years and work resumed again in 2018, the bushings were imported again instead of the rejected ones in 2012, but what happened is when the new bushing pumps arrived with modern specifications, the electrical engineer could not

connect them with the operating panel because the latter no longer fit with Modern pumps, which requires replacing part of the materials in the old panel to be suitable for the modern pump. A replacement order was prepared with the new materials required to complete this paragraph at a price of 5,000,000 dinars, but the replacement order was not approved due to the abuse of the employer, which led the company to bear the improvement of specification The electric board is switched to the KW30 soft-starter type in order to work with the modern pump, the picture of which is shown after completion
After the project had prepared the materials needed to modernize the old board, the old contactors (Delta\star, wiring supplies, copper tapes, sub- and main circuit breakers) were started, which cost 400,000 dinars. The new materials were replaced and the old materials were replaced with the new ones, with paying the difference of 500,000 dinars only, so that the total cost of the new materials was 4,500,000 dinars. Then the old materials were removed from the electrical board. This work required a period of 2 days, with the number of electric technician workers, 1 and the wages of 50000 dinars per day, and 2 electric workers with a wage of 25,000 dinars per worker For each working day, and before installing the new materials, work stops for a period of 2 days due to the work that is required inside the technician's workshop in order to perforate and adjust the new materials that are outside the site , in the installation phase, which lasts 4 days, where you need 2 electricians and 2 electricians for each working day, with the same wage as for the previous phase to install the new materials, which are soft starter 3 at a price of 1,500,000 dinars per individual, as well as copper tapes and wiring supplies at a price of 2,000,000 dinars and main and subsidiary circuit breakers. At a price of 2,000,000 dinars, the total cost of the new materials will be 850,000,000 dinars, but only (4,500,000) dinars were paid after trading with the contractor as we explained in advance Then comes the wiring phase, which takes 4 days and requires labor, with 1 electrician and 2 electrician workers for each working day and the same previous wages. Finally, the operating phase, which requires 2 working days, 2 electric technicians and 2 electricians for each working day during the operating phase. a summary of the previous stages and a basis for calculating their cost in Table (5).

Table (5) costs of the current value stream map (installing a control panel to operate the impellers)

s	Labor				Mechanical				Material				Total cost of the activity
	employment type (1)	The number of workers for the required period (2)	worker's wages per day (3)	Total labor wages (3)*(2) (4)	Mechanism type (5)	Number of mechanisms for the required period (6)	Mechanism fees per day (7)	Total vehicle fees for the required period (7)*(6) (8)	Material (9)	Quantity of material required (10)	Material prices per person (11)	Total price of materials required (11)*(10) (12)	(12)+(8)+(4) (13)
1	worker	2	50000	100000	crane	2	250000	500000	Star-delta control panel	1	5500000	5500000	6100000
2	electrical technician electricity worker	4 8	50000 25000	200000 200000	-	-	-		0	0	0	0	400000
3	electrical technician electricity worker	2 4	50000 25000	100000 100000	-	-	-		Delta\star Wiring accessories, copper tapes, sub and main cutters	3	-	-	200000
4	electrical technician electricity worker	8 8	50000 25000	400000 200000	-	-	-		Soft-starter-KW ٣٠ Copper tapes and wiring accessories Main and - subsidiary cutters	3	1500000	4500000	5100000
5	electrical technician electricity worker	4 8	50000 25000	200000 200000	-	-	-		-	-	-	-	400000
6	electrical technician electricity worker	4 8	50000 25000	200000 100000	-	-	-		-	-	-	-	300000
	Total			2000000	-	-	-	500000				10000000	12500000

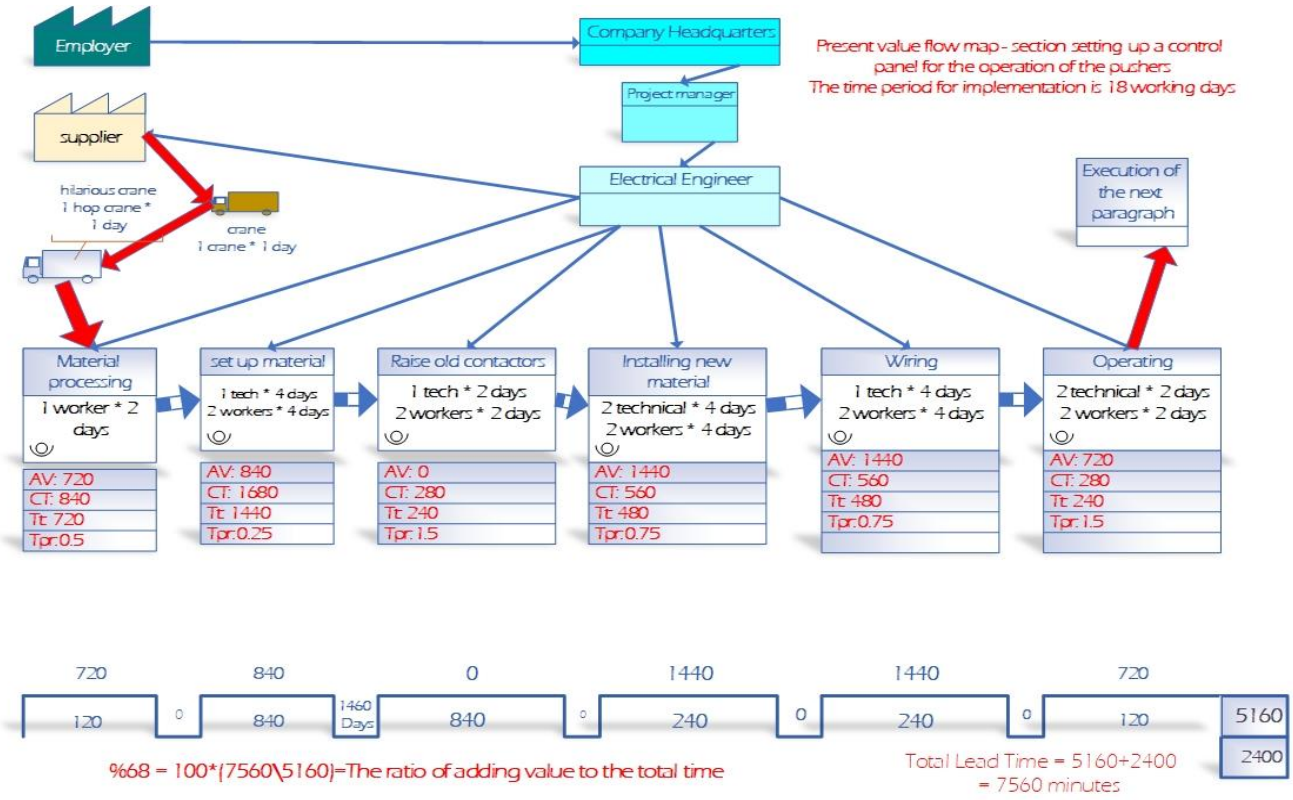

Figure (1) Present value flow map - electrical works
Source: Based on Visio Professional \ Office 2016 application

3- Present Value stream Map Analysis

After collecting and organizing data in regular tables for the stages of implementing the Tasks and calculating costs, then calculating the standards for the data box, ending with drawing the current map of the value flow for each tasks of civil, electrical, mechanical and sanitary works, it became possible to notice glitches and waste in costs or time as well as discovering places for improvement. To improve the construction work and to disseminate the proposed ideas on a larger scale to apply them to the implementation of future construction projects All types of construction work need to apply some lean construction tools in order to reduce waste in cost and time and raise the efficiency of the completed works. One of these tools is the standard work SW, which requires a set of tasks represented in achievement, technical procedures, tools, equipment and responsibilities that must be well defined Good through standard quality standards and scheduling the completion of each activity clearly through written documents available to all employees, The work is also supposed to be carried out continuously to complete 100% of the work committed in the contract. Therefore, leaving tasks or activities that are not properly implemented is supposed to be unacceptable, and all of this will be taken into account when drawing the proposed map. By comparing the current implementation of works with the standard guide for price analysis for the building and construction sector for civil works in the first part of the year 2013, we note that the standard works are calculated taking into account the actual working hours 8 hours / day (Ministry of Construction and Housing, 2013:7), accordingly 8 will be approved Daily

working hours at a rate of one hour break for all work and subsequent paragraphs in order to improve productivity and raise efficiency. Therefore, gaps and areas of improvement were identified for each paragraph of the works, as follows: -

a) The project incurred costs and time to implement the second activity represented by installing the old materials that were purchased in 2012, as the cost of work to implement this activity amounted to 400,000 dinars, while the implementation period amounted to 1680 minutes, which were replaced with new materials and installed again.
b) The project incurred additional costs and time for the implementation of the third activity of this paragraph, which is to raise the old concrete blocks, as the cost of work to implement this activity amounted to 200,000 dinars, while it took 840 minutes to implement.

4- Mapping the value proposition flow

After analyzing and evaluating the operating panel task, we find that it is possible to reduce costs and durations if the installation of the thrusters operating panel is synchronized with the arrival, receipt and installation of the jars of the thruster rooms, that is, the import procedures for mechanical works are initiated before the start of the electrical work so that they are ready at the time Paragraphs related to electrical and mechanical works. The suggested improvements to the dashboard operation section can be listed as in Table (6): -

Table (6) improvements in the dashboard operation task

S	Details	Current status	New status
1	Launchpad setup activity		
a	Reducing labor cost	400000	200000 Dinar
b	Reducing the implementation time	1680	840 Minute
2	Canceling the activity of raising old contactors		
a	labor cost	200000 Dinar	0
b	Execution time	840 Minute	0

And from applying the improvements in Table (6), we can start the procedures for drawing the proposed map of the value flow:-

Table (7) costs of the proposed value stream map (installing a control panel to operate the impellers) for electrical works

s	Activity name	Labor				Mechanical				Material				Total cost of the activity
		employment type (1)	The number of workers for the required period (2)	worker's wages per day (3)	Total labor wages (3)*(2) (4)	Mechanism type (5)	Number of mechanisms for the required period (6)	Mechanism fees per day (7)	Total vehicle fees for the required period (7)*(6) (8)	Material (9)	Quantity of material required (10)	Material prices per person (11)	Total price of materials required (11)*(10) (12)	(12)+(8)+(4) (13)
1	plate processing	worker	2	50000	**100000**	crane	2	250000	500000	Star-delta control panel	1	5500000	**5500000**	**6100000**
2	set up panel	electrical technician electricity worker	3 6	50000 25000	**150000** **150000**	-	-	-	-	Installing the Delta\Star type operating panel	0	0	**0**	**300000**
3	amusement	electrical technician electricity worker	3 6	50000 25000	**150000** **150000**	-	-	-	-	-	-	-	-	**300000**
4	running	electrical technician electricity worker	4 4	50000 25000	**200000** **100000**	-	-	-	-	-	-	-	-	**300000**
		Total			**1000000**	-	-	-	500000				**5500000**	**7000000**

Table (7) shows that the cost of completing the paragraph of setting up the dashboard has decreased to (7,000,000) dinars when work is done simultaneously between electrical and mechanical works, but in the case if the paragraph is implemented completely after resuming work on the project, in these cases it is dealt with radically, starting from The planning stage, studying the paragraph accurately, calculating the cost of processing with the required specifications, up to the implementation stage, commitment to the specified time, and synchronizing the implementation with the arrival of the electrical panels' strokes, then it is possible to avoid the increase in cost and achieve the expected profit margin from implementing similar paragraphs in future works.

Table (8) Comparison between the results and measures of the current and proposed map of the value stream for the task setting up a control panel for the operation of the pushers

Detail	processing plate	set up panel	Lift the contactors	erecting material	wiring	running	processing plate
Current target productivity	0.5	0.25	1.5	0.75	0.75	1.5	0.5
Suggested target productivity	0.5	0.333	0	0	1	1.5	0.5
Increase	0	0.083	(1.5)	(0.75)	0.25	0	0
Current Takt time (minutes)	720	1440	240	480	480	240	720
Suggested Takt time (minutes)	840	1261	0	0	420	280	840
Reduction	(120)	179	240	480	60	(40)	(120)
Current value addition time (minutes)	720	840	0	1440	1440	720	720
Suggested value addition time (minutes)	840	1260	0	0	1260	840	840
Reduction	(120)	(420)	0	1440	180	(120)	(120)
Current non-adding time (minutes)	120	840	840	240	240	120	120
Suggested non-adding time (minutes)	120	180	0	0	180	120	120
Reduction	0	660	840	240	60	0	0
Cycle time current (minutes.)	840	1680	280	560	560	280	840
Cycle time (minutes) Suggested	960	1440	0	0	480	320	960
Reduction	(120)	240	280	560	80	(40)	(120)

Table (8) shows the presence of some negative results, whether by an increase or a decrease, due to the reduction in the number of activities with the stability of productivity and the increase in the time for adding value from the increase in working hours. The official as mentioned in the standard manual of the Ministry of Construction and Housing, so these results are good in both cases because they contribute to reducing the cost of implementation and reducing the time of completion while performing efficiently and meeting the conditions and specifications as

requested by the employer. Based on the previous suggestions and improvements, we can draw the proposed map as shown in Figure (2).

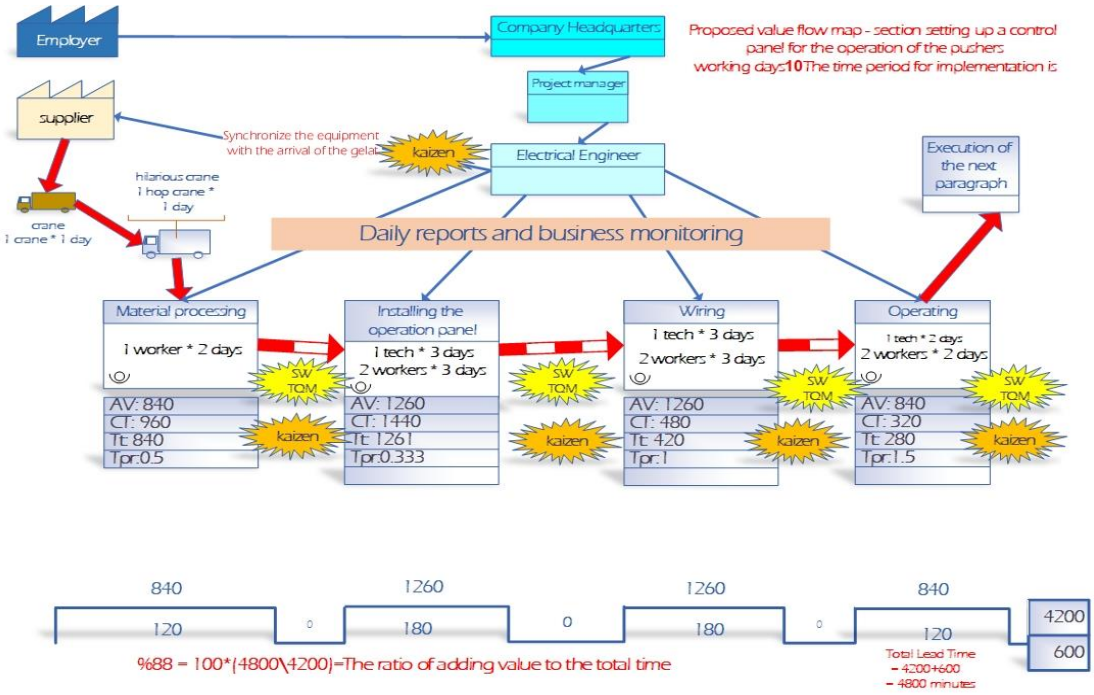

Figure (2) the proposed value flow chart for electrical works Source: Based on Visio Professional \ Office 2016 application

It can be noted the differences between the planned, current and proposed results as in Table (9):-

Table (9) changes in the results of the current and proposed value flow map for a control panel task for operating payers

s	Details	Planned results	Current results	Suggested results
1	Implementation time/day	10	18	10
2	Task cost	8000000	12500000	7000000

5- Planning and Execution

After drawing the proposed map, we can compare between the current situation and the proposed in order to infer a plan that can be applied and implemented in the future. Therefore, we need to stand with each comparable area to diagnose areas of improvement and analyze them to advance the reality of work. When comparing the ratio of value-added time to total time, the differences were obtained. As in Table (10):-

Table (10)Comparison of time ratios of added value to the total time of the current and proposed maps

Details / business and tasks	Ratio of value-added time to total time	
	Suggested	current
Pusher operation panel installation task	%88	%68

Source: Based on the ratios calculated in the proposed and present value flow maps

Table (10) shows the increase in the percentage of value-added time to the total time of electrical works represented in the paragraph of installing the control panel, and it was (20%) As we conclude from the above differences in the paragraph of setting up the operation panel, the synchronization of electrical works with the rest of the related works successively helps to avoid

cases of differences between specifications for electrical materials that are purchased in advance before the associated parts of mechanical works and imposed directly with the import procedures for mechanical materials before starting work The associated electrical work in order to prevent the occurrence of discrepancies in specifications and mismatch of work as is the case in the operation panel of the impellers, which helps in increasing the times of adding value to the electrical works executed while reducing the total time by canceling the activities that do not add value and the correction activities and the removal of damaged or invalid materials for work .

Table (11) Comparison of the planned, current and proposed completion time period

Details / business and tasks	Completion time period			The number of days reduced after the proposals are implemented
	Planned	Current	Suggested	
Pusher operation panel installation task	10	18	10	8

Table (11) shows the reflection of the results of the differences in the percentages of value addition on the total implementation period by reducing the actual working days, and accordingly we conclude that the operation panel paragraph, the implementation time was reduced by (8) working days, which is the cancellation of unnecessary activities after applying corrective measures for some areas defect.

As for the differences related to the cost of work as in Table (9), they were a result of the differences in the time period, which resulted in a rationalization of workers' wages after reducing working days, as well as the abolition of unnecessary transportation, loading, storage and guarding costs with the implementation of proposals and improvements, all of which contributed to reducing the cost of the selected Tasks. Which is a very small part of the Tasks executing the project as a whole. If each task is treated as a defect or a proposal for improvement is applied, as a result, it affects the total cost of the project and the time period for implementation, which would add value to the work done, increase the customer's conviction represented by the employer and maximize the company's profitability by reducing costs Eliminate waste as much as possible.

Table (12) Comparison of Planned, Current and Proposed Cost

Details	the cost			The proposed cost difference to be rationalized from the current (2-3) cost (4)	The number of work performed (5)	The total amount of rationalization for the task as a whole (Dinar) (5)* (4) (6)	rationalization ratio (2)/(4) (7)
	planned (Dinar) (1)	current (Dinar) (2)	Suggested (Dinar) (3)				
Pusher operation panel installation task	8000000	12500000	7000000	5500000	1	5500000	44%
The total amount of cost savings						5500000	

The fourth topic \ Conclusions and recommendations

4-1 Conclusions: Through field visits to the project implementation site, the following conclusions were determined:

1- The construction projects take a long time to implement, in addition to sudden stops and laws imposed according to the conditions of the country, which leads to price inflation during the years of implementation, which affects the estimated costs in which the project is implemented and then appears in the form of a cost deviation.

2- In the task of the control panel for the operation of the pushers for electrical work, we note that the company incurred the costs of updating the specifications of the electrical board because it did not conform to the specifications of the bushings, as it arrived at the project site after installing the electrical board.

4-2 Recommendations: Based on the conclusions, the following recommendations were made: -

1- Work to adhere to the work progress program and strictly monitor the implementation of each task and work to know the reasons for the deviation of each task from its specified period in order to implement projects within the agreed period and not be affected by price inflation for unplanned periods.

2- Working on starting the import procedures in advance and before starting the implementation of electrical works related to mechanical works in order to avoid a difference in specifications between works.

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