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Applying Value Engineering Technique to Health Clinics During The Design Stage (Salah Al Din Governorate A Case Study)

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ABSTRACT

Because of rising the need to health clinics in recent years, as well as the current economic climate, the researcher used value engineering to reduce costs while retaining the necessity of these initiatives. The aim of this study is to increase the value of health clinics through applying value engineering approach to the main building (two and a half floors). Collected data, function analysis, brainstorming and alternatives, evaluating and selection, and generating the value report are the steps followed. According to the study, using the value engineering process resulted in a cost savings of 32.15 percent, or (258.305.000) million Iraqi dinars without jeopardizing the desired outcome.

1. Introduction

Value engineering is a structured group effort based on scientific methodology that is performed by a professional team with the purpose of examining the element's components, functions, and costs, and then offering alternatives that ensure the attainment of those functions at the lowest total cost without sacrificing quality or performance (Refaiya, 2017). Value engineering, like any other technology, requires steps to apply, but it is still a strategy. Because it is based on variables (quality - efficiency - cost), value engineering is distinguished by its reliance on practical practices rather than theory. As a result, it necessitates the work of a workshop with a methodology for examining problems, alternatives, and proposals, as well as the steps of this workshop (Sadiq, 2016).

These steps are distinguished by their logical order and the need of finishing each one before moving on to the next (Sadiq, 2016).

1.1. Previous Studies

- Heralova, 2016

The researcher looked into whether value engineering may be used in highway projects in the Czech Republic, as well as the causes for criticism and opposition to such projects. This, according to the study, is due to three factors: first, it fails to meet the project's intended objectives, second, it is not implemented on time, and third, the expenditures exceed the budget's restrictions. The researcher addressed how value engineering may be used to improve solutions to these problems by balancing cost, time, and scope while also offering novel alternatives. The study concluded with the advice that using the value engineering

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methodology, the quality and cost of motorways and other public works projects may be greatly improved (Heralova, 2016).

- Mosakhane et al, 2017

The purpose of this study is using value engineering improving the massive path project in the Hamdan Governorate that joins Iran's central provinces to Tahran. Analysts presented modern road options and routes, which were evaluated on quality, cost, and ability to perform the needed functions. After providing three options, the researchers decided on the most acceptable route. The most cost-effective option was determined, which minimizes the traveler's time on the road and saves on total road costs, including future maintenance work. The amount of money saved by employing this strategy was around 40% (Mousakhani, 2017).

- Shetwan and Shlack, 2020

The goal of this research is to use value engineering technologies to lower the costs of engineering projects. A model school in Libya with a capacity of 24 semesters was used to apply value engineering methods. This study concentrated on the finishing touches rather than making any major alterations, redesigning architectural and structural aspects, for example. The study's findings demonstrated that value engineering saves money and time, with a savings of 392,493 Libyan dinars (equal to 9% of the project's expenditures) and a 3 day project duration decrease (Shetwan, & Shlack, 2020).

2. The Methodology of Value Engineering

a. Information gathering stage
   Information is the biggest impact on any study, as collecting information before starting the study gives the team a better understanding of the problems, which gives the study a greater chance of success (Sadiq, 2016).
b. Function analysis stage
   The function analysis stage is the stage that distinguishes value engineering from the rest of the problem-solving methods. In this step, the project jobs are identified and the relationship between those functions is realized. This is done by (identifying functions, then classifying functions, then linking functions to the fast diagram, then choosing functions that can be improved) (Sadiq, 2016).
c. Idea generation stage
   This step is the core of the study, in which all creative ideas are unleashed and possible alternatives are proposed to perform primary and secondary functions and eliminate or reduce redundant functions in a more effective manner in performance and lower in total cost (Shetwan, & Shlack, 2020).
d. Evaluation stage
   It is the fourth stage of the value engineering technology implementation plan, with the goal of evaluating and judging the proposed ideas and selecting the best ones from among the many that were recorded in the previous stage in terms of quality, required performance, cost, and the least and most applicable risks (Salem, 2019).
e. Development stage
   It is a stage in which a specialist from the value studies team transforms the concepts and solutions accepted in the previous step into a precise work plan, in which the idea is developed into an integrated work with clear details according to the engineering principles in the preparation of drawings and specifications that can be implemented containing the method of application, as well as a comprehensive estimate of the total cost (Babker, 2016).
f. Presentation stage
   For those with the authority to put the recommended solutions into action, the presentation stage is actually the best alternative (or alternatives). The purpose of this step is to get the administration's permission so that the study's recommendations can be implemented (Baadi, 2020).
g. Implementation stage
   The purpose of this stage is to guarantee that the suggestions and possible benefits that can bring value are really executed, because bad implementation will almost always result in the process failing (Abdulla et al., 2019).

3. The Best Period to Use Value Engineering in Projects

Technical studies on value engineering can be employed at any phase of a Project, from the beginning (Feasibility Study and Planning) to the end (Operation and Maintenance), However, value engineering should be

used as a project engineering study during the early stages of design and before any of the project's systems are implemented (Rad & Yamini, 2016) Given that the design stage has the greatest impact on the project's costs and quality, with a 49 percent impact among other important factors, despite the fact that the cost of this phase does not exceed 3% of the total cost as shown in Figure(1), in order to realize the most amount of savings possible. As a result, at this point, the project must be carefully managed in terms of design quality and total cost control, using a value analysis and the selection of suitable alternatives that fulfill the project's functions and needed quality at the lowest possible cost (Salem, 2019).

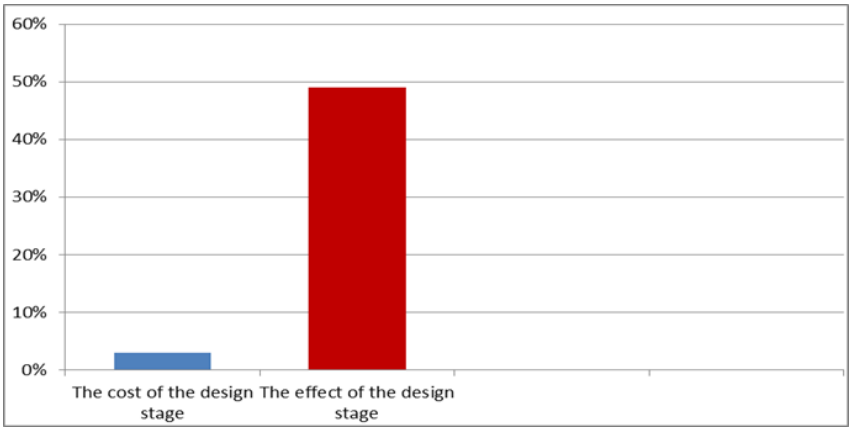

Figure.1 The link between the design phase's impact and the project's cost (Salem, 2019).

Figure (2) shows that the possibility of rectifying errors is better and the cost of modification is cheaper when analyzing the project in its early phases. In the year 2000, Al-Yousifi claimed that the further along a project is in its implementation, the lesser the prospect of cost accumulation and the greater cost of change. The best strategy to use value engineering is doing two value studies: first before the design or after the design programming phase is completed, with the purpose of discovering the owner's genuine requirements and laying the foundations for the design. the second is conducted after the first conceptualization (i.e., when 25 to 30 % of the design has been finished), with the goal of proposing cost-effective alternatives and ensuring that the design is advancing in accordance with the design principles defined in the first study(Refaiya, 2017).
Finally, as Al-Yousifi stated in 2000, before beginning the detailed designs, a technical evaluation study of the design is undertaken (at about 80 percent of the design). The goal of this study is to make sure the owner's accepted proposals are used in the second value studies, additionally; the design satisfies the owner's objectives and criterion (Refaiya, 2017).

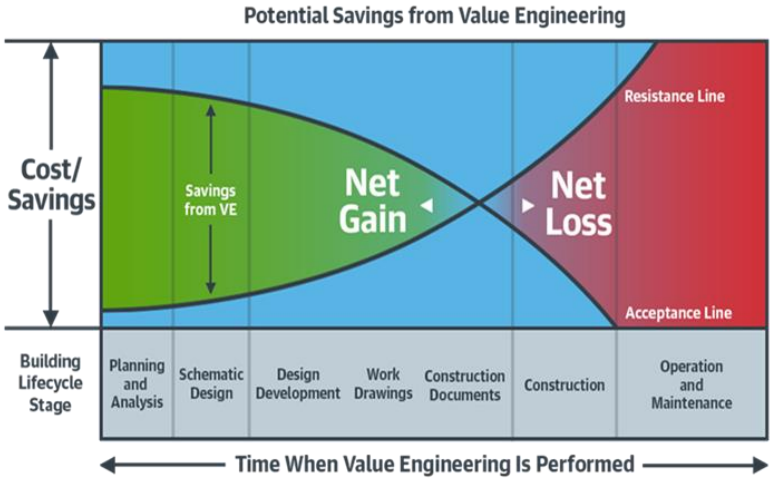

Figure.2 Value engineering's potential for cost savings (Refaiya, 2017).

As a result, we conclude that the optimal moment to start using the value study is before or early in the design process, when the savings are higher and the cost of application is lower, as well as when ideas are more easily accepted (Refaiya, 2017).

4. Practical Study

Figure (3) depicts the stages that will be taken for using value engineering technique in to reach the desired result

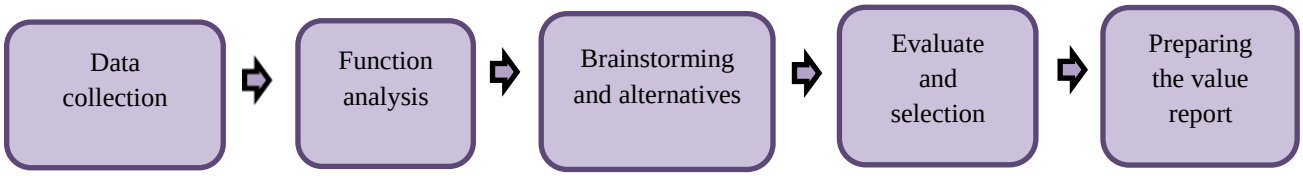

Figure.3 The value engineering methodology's steps.

Step 1: Data Collection

Collecting data is one of the most precise stages. The more accurate information and credible sources available, the easier it is to create a comprehensive picture of the project.

This phase is split into two halves:

1. Collection of data and information: The following documents are provided as part of the information gathering process:
    a. Design documents include maps and drawings, specifications, bill of materials, and a cost estimate.
    b. Visit the Salah al-Din Health Department's Engineering Division to meet the specialist engineers. During this process, a significant amount of data and information on the projects was acquired.
2. Data analysis: After acquiring information, the next step is to analyze it, as indicated in figure (3).

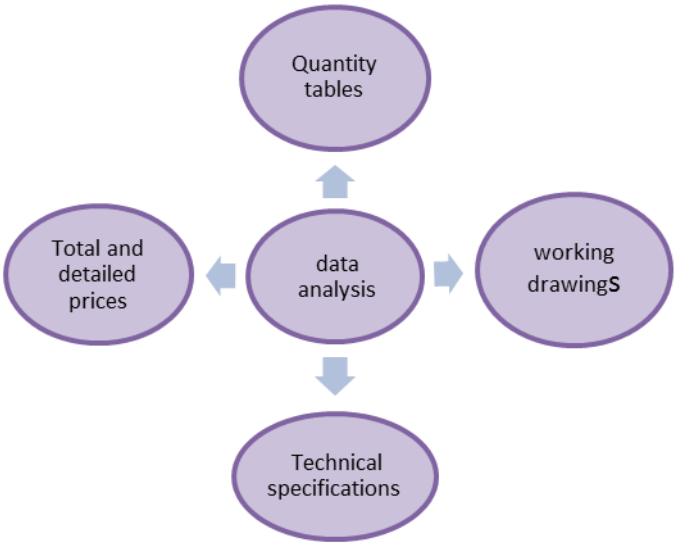

Figure.3 The most important aspects of data analysis.

a. Price analysis of major building components: Table (1) lists the building's most expensive components according to Pareto (20% of the items are responsible for 80% of the costs). The highest price among these goods was discovered through analysis, and it has the biggest impact on the decrease. 20% of the primary project's products start at 20 million Iraqi dinars.

Table1 - Analysis of the total price of the main building's items.

-	Item	Item detail	The price of the detail item in Iraqi dinars (IQD)(*10 ^{6})	Total item price in (IQD) (*10^{6})	Percentage of total item price to overall total price(%)
1.	Construction and plastering industry	Construction industry	0294.1000	0327.8500	040.810
		Plastering industry	033.7500		
2.	Wall, floor, and ceiling cladding industry	Floor cladding	0170.0000	0222.4250	027.690
		Wall cladding	023.6250		
		Ceiling cladding	028.8000		
3.	Wood ,paints, and plastic industry	Paints industry	022.8000	070.2000	08.740
		Wood industry	027.4000		
		Plastic industry	020.0000		
4.	Flattening industry	Flattening industry	0020.0000	0020.0000	002.490
5.	Air conditioning industry	Air conditioning industry	00162.8000	0162.800	020.27
Overall total price				0803,275,0000	100

Table 1 reveals (construction and plastering industry, wall, floor, and ceiling cladding industry) account for 68.50 percent of the overall price of building items, making these works and goods are a top priority for research and reduction, and their impact will be visible in price reductions.

Step 2:Function analysis

All of the project phases' functions will be examined in this step. For example, the primary function of building works is to divide the work into sections based on the needs of the building, while the secondary function is to provide thermal and moisture insulation. By determining the appropriate function, we are able to assess the significance of the phase to be performed as well as materials to be employed.

There are two types of functions: the core job and the selection of optional jobs, components, and activities. These distinctions are shown in Table 2.

Table2- Function Analysis.

-	Item	Main function	Secondary function
1.	Constructin and plastering industry	For plastering works aesthetic view	Protecting the building from external factors
		For building works make divisions according to the needs of the building	Thermal insulation and moisture insulation
			Preparing for the required plastering and paints
2.	Wall, floor cladding industry	Providing a healthy environment by protecting floors and walls in wet areas	Ease of cleaning
			Sound insulation
			Thermal insulation
			Aesthetic view
3.	Paints, wood and plastic industry	Aesthetic view of paints	Insulate and protect the facility from moisture
		For plastic and wood works covering and protection	Maintaining temperature
			Provide a healthy and easy-to-clean environment
4.	Flattening industry	Roof protection in wet areas	Sound insulation
			Thermal insulation
			Aesthetic view
5.	Air conditioning industry	Cooling and heating all sections	Building ventilation
			Aesthetic view

Step 3: Brainstorming and Alternatives

This phase offers and develops whole points of view and suggestions which will decrease the project's overall price (without compromising project's functions), identify benefits and downsides, compare and choose the most suitable and fabulous for these alternatives and ideas. Current items and proposed alternatives are listed in the table below.

Table 3. current items and proposed alternatives.

-	item	current item	-	Suggested alternatives
1.	construction and plastering industry	building with red bricks under and above the Damp Proof Course(DPC), except for the external fence	1.	insulating block
			2.	yellow bricks+cork
			3.	thermiston+cork
			4.	red cutter brick+crok
		solid block building under and above the DPC for the external fence	1.	hollow block over moisture blocker
		halan stone for facade	1.	ali coupon cladding
			2.	styropor plates cladding
			3.	scattering cladding
2.	wall, floor and ceiling cladding industry	- cladding with Turkish alabaster for the main building	1.	ceramic cladding
			2.	porcelain cladding
		spanish ceramic cladding for walls	1.	iranian, indian, egyptian, italian ceramics .
		saudi drop ceilings for the ceiling	1.	turkish, egyptian, indian gypsum drop ceilings .
			2.	borax whiteness
3.	paints, wood and plastic industry	turkish plastic dye	1.	iraqi plastic dye (Al-Marjan)
			2.	iraqi plastic dye(Al-Yaqoot)
		-mdf wood doors -plastic windows	1.	PVC doors
			2.	aluminum doors
			3.	double glass aluminum windows
			4.	double glass PVC windows
4.	flattening industry	-brushes of two opposite layers of silicate bitumen -brushes Two layers of felt -An insulating layer of Styropor, (50) mm thick - Brush clean dust layer - Applying shtiger pieces with dimensions (80*80*4) cm and filling joints with mastic	1.	replacing the regular curtain with a pressurized curtain (20) kg/m^3 and a thickness of (50) mm
			2.	replacing styropor with rock wool boards
5.	air conditioning industry	ductless mini-split	1.	central Conditioner
			2.	"window conditioner"

It deserves noting the main building has an alarm system for fires, yet no fire extinguishing system, so the researcher installed one to increase safety in light of the recent spate of fires, as well as the absence of fire extinguisher maintenance.

Step 4: Evaluate and Selection

Following the presentation of the alternatives, the process of researching, assessing, and comparing them to the current item occurs in order to select the best option.

In addition to scientific literature and websites, 22 specialist engineers (18 civil and 4 mechanical) researched the alternatives.

1) construction and plastering industry

a. construction industry (construction under DPC)

The current item and the selected alternative and the total price difference are illustrated in table (4).

Table 4 –Total Price Difference For Constructing Under DPC

-	Item	Total Price ($*10^6$)	The Value ($*10^{-6}$)	Total Price Difference ($*10^6$)	Add Money / Save Money
Current Item	Red Brick Construction	022.5000	00.04400	012.000	Save Money
Selected Alternative	Solid Block Construction	010.5000	00.09500		

Usage of the solid block reduces the cost, time and mortar utilized, resulting in a rise in the value.

b. construction industry (construction above DPC)

Instead of red brick, insulating block was utilized for outside borders and hollow block was used for internal partitions in this project. Table (5) shows current item, the selected alternatives, and the total price difference.

Table5 – Difference of Total Price For Constructing Above DPC.

-	Item	Total Price ($*10^6$)	The Value ($*10^{-6}$)	Total Price Difference($*10^6$)	Add Money/ Save Money
Current Item	Red Brick Construction	0231.6000	00.0040	0137.750	Save Money
Selected Alternative	Insulation Block And Hollow Block Construction	093.8500	00.011		

Due to Qaduri and Ali's study in 2010 which shows the thermal transfer of the iraqi building walls, where the researchers adopted Gulf specifications (UAE and Saudi Arabia) that the two temperatures are the same or close, the overall price is reduced when insulating block and hollow block are used, as shown in Table (5), the insulating block is described by excellent thermal insulation, the study exposed the heat transfer value (U-value) for a wall of insulating block is (0.431 $W/m^{2}{}^{\circ}c$), which is less than the heat transfer value specified in the specification It is specified at ($U \leq 0.5 W/m^2\,{}^{\circ}c$) and therefore the use (Kaduri & Ali, 2010) of insulating block and hollow block leads to an increase in the value. Because heat comes from outside, insulating block on the outside circumference of the building is used.

c. Construction industry (construction of the external fence)

The current item and the selected alternative and the total price difference are shown in table (6).

Table6 – Difference of Total Price For Constructing The External Fence.

-	Item	Total Price ($*10^6$)	The Value ($*10^{-6}$)	Total Price Difference ($*10^6$)	Add Money/ Save Money
Current Item	Solid Block Construction	040.000	0.025	1.800	Save Money
Selected Alternative	HollowBlock Construction	038.200	0.026		

The hollow block decreases overall costs and hence increases value. Hollow blocks require less mortar than solid blocks since they are larger and lighter, putting less stress on the foundation. It's worth noting that the external fence's construction includes excavation, foundation pouring, and construction under and over DPC. Because the structure beneath the DPC was solid block, the option comprised building over the DPC.

a. plastering works (facade cladding)

The current item and the selected alternative and the total price difference are shown in table (7).

Table7 - Difference of Total Price For Facades Cladding Industry.

-	Item	Total Price (*10 ^{6})	The Value (*10 $^{-6}$)	Total Price Difference (*10 ^{6})	Add Money / Save Money
Current Item	Halan Stone Cladding	33.750	0.029	24.835	Save Money
Selected Alternative	Prose Cladding + Column′S Halan Stone Cladding	8.915	0.112		

Preferred option reduces the whole cost which leads to increase of value. the columns are thermal bridges, therefore they should be covered with halan stone since halan stones are considered thermal insulation and gives aesthetic look .

2) wall, floor and ceiling cladding industry

a. floor cladding industry

The current item and the selected alternative and the total price difference are shown in table (8).

Table8 – total price difference for floor cladding works .

-	item	total price (*10 ^{6})	the value (*10 $^{-6}$)	total price difference (*10 ^{6})	add money / save money
current item	turkish alabaster cladding	0170.0000	00.0060	0116.8750	save money
selected alternative	egyptian porcelain cladding	053.1250	00. 0120		

The total price is reduced for using porcelain; therefore it leads to increase of value.

b. wall cladding industry

Table (9) shows the current item, the selected alternative, and the total price difference.

Table9 - Difference of Total Price For Wall Cladding Industry.

-	Item	Total Price (*10 ^{6})	The Value (*10 $^{-6}$)	Total Price Difference (*10 ^{6})	Add Money / Save Money
Current Item	SpanishCeramic Cladding	23.625	00.042	7.425	Save Money
Selected Alternative	EgyptianCeramic (Cleopatra)Cladding	16.200	00.062		

Usage of Egypt porcelain (Cleopatra) reduces the overall cost while increasing the value. The ceramics in this item are used in sanitary facilities, laboratory, x-ray and acidification rooms, and other areas as determined by the supervising engineer.

c. ceiling cladding industry

Table (10) shows the current item, the selected alternative, and the total price difference.

Table10 – Difference Of Total Price For Ceiling Cladding Industry.

-	Item	Total Price (*10 ^{6})	The Value (*10 $^{-6}$)	Total Price Difference (*10 ^{6})	Add Money / Save Money
Current Item	Cladding With Gypsum Board Drop Ceilings of Saudi Origin	28.8000	0.0350	10.800	Save Money
Selected Alternative	Cladding With Gypsum Board Drop Ceilings of Turkish Origin	18.0000	0.0560		

Usage of Turkish drop ceilings lowers the cost and consequently raises the value of the property. It's worth noting that the drop ceilings used in health facilities are plastic drop ceilings that cost lower than 20 million Iraqi dinars and are mentioned separately in the quantity tables.

3) paints, wood and plastic works

a. paints works

Table (11) shows the current item, the selected alternative, and the total price difference.

Table11 - Difference of Total Price For Paints Industry.

-	Item	Total Price ($*10^{6}$)	The Value ($*10^{-6}$)	Total Price Difference($*10^{6}$)	Add Money / Save Money
Current Item	Painting The Walls With Turkish Plastic Paint	22.8000	0. 0440	7.600	Save Money
Selected Alternative	Painting The Walls With Iraqi Plastic Paint (Al-Marjan)	15.2000	0. 0660		

The use of Iraqi paint (Al-Marjan) lowers the price, resulting in an increase in the value.

b. wood works

Table (12) shows the current item, the selected alternative, and the total price difference.

Table12 - Difference For Total Price For Wood Industry.

-	Item	Total price ($*10^{6}$)	The value ($*10^{-6}$)	Total price difference ($*10^{6}$)	Add money / save money
Current item	mdf wooden doors	27. 400	0. 036	8.320	save money
Selected alternative	aluminum doors	19. 080	0. 052		

Aluminum doors are less expensive overall, and they are more durable and have a longer lifespan than MDF doors. As a result, its utilization results in a raise in value. It is worth to mention that health-care facility doors are a separate component. It's worth mentioning that the sanitary ware doors are made of plastic, are listed separately in the quantity tables, and cost less than 20 million Iraqi dinars.

c. plastic works

Table (13) shows the current item, the selected alternative, and the total price difference.

Table13 - Difference Total Price For Plastic Industry.

-	Item	Total price ($*10^{6}$)	The value ($*10^{-6}$)	Total price difference ($*10^{6}$)	Add money / save money
Current item	plastic windows	020. 0000	00. 0500	7.300	save money
Selected alternative	aluminum windows double glass	12. 700	0. 079		

The installation of double-glazed aluminum windows lowers the overall cost while improving thermal insulation. As a result, its utilization raises the value.

4) flattening industry

This item uses good materials except styrbour. Rock wool panels are used for having higher thermal insulation than styrbour. One disadvantage in comparison to curtains: their high cost. Table 14 displays the overall cost difference between the present item and the alternative.

Table14 - Difference of Total Price For Flattening Industry.

-	Item	Total price ($*10^{6}$)	The value ($*10^{-6}$)	Total price difference ($*10^{6}$)	Add money / save money
Current item	styropor flattening industry	020. 0000	00. 0500	02.500	add money
Selected alternative	rock wool boards flattening industry	022. 500	00. 044		

Using rock wool boards raises the total cost, but it also raises the value because it improves thermal insulation.

5) air conditioning works

Table (15) shows the current item, the selected alternative, and the total price difference.

Table15 - difference of total price for air conditioning industry.

-	Item	Total price ($*10^{6}$)	The value ($*10^{-6}$)	Total price difference ($*10^{6}$)	Add money / save money
Current item	Ductless mini-split	0162. 8000	00. 0060	02.300	Add money
Selected alternative	Central air conditioner (VRV)	0165. 100	00. 006		

The use of a VRV (Variable Refrigerant Volume) system raises the overall cost, but it saves a lot of electricity and so adds value.

6) add fire extinguishing system

Firefighting is an essential topic having taken center stage and Preventive safety as (AlBashir, 2019). Table no. 16 shows the number of extinguishing devices available.

Table16 - table of quantities for fire extinguishing system.

-	Paragraph	Unit	Quantity	Price (*10 ^{6})	Total Price (*10 ^{6})
1.	supplying and installing a water tank for the fire extinguishing system with a capacity of (6000) liters made from pallets with a thickness of (8) mm, with the work of a reinforced concrete raft with a thickness of (50) cm, and all the requirements for the connection of locks, pipes, and valves, and according to the tank's dimensions	number	1	055. 000	055. 0000
2.	supplying, erecting, constructing, and installing an integrated fire extinguisher cabin with original linen fire hose reels of at least (30) meters in length It is linked to the firefighting pipe system and complies with all lock and connection criteria. A (CO2) pipe with a capacity of (6) kg is installed within the cabin	number	8	01.000	08.000
3.	The fire extinguisher system is delivered, installed, and connected with water pumps. They're connected to a water tank and installed atop an armed concrete platform. The pumps are European-made and meet all safety requirements: Q=60m^3/h H=30m P=4bar M.P=5kw With the electric board for the operation of the pumps.	number	2	0. 5	1. 000
4.	The firefighting network pipe system is provided, linked, and inspected from the tank to the pumps to the firefighting booths inside the building. The pipes are constructed of black iron or galvanized iron and are of the greatest quality, meeting all of the standards for connection, including locks and various measures: - Black iron or galvanized tube 4 inch - Black iron or galvanized tube 2.5 inch - Black iron or galvanized tube 2 inch	 m m m	 30 60 80	 0. 035 0. 030 0. 025	 1. 050 1. 800 2. 000
5.	providing, installing, and connecting (SIAMESE) on the main line of the firefighting system after (4)-inch pumps to connect the hose to the fire truck when needed, including all criteria for attaching locks and valves	number	1	0. 75	0. 75
6.	CO2 powder fire extinguishers with a capacity of 50 kg were delivered and installed	number	4	0. 5	2. 000
	total				**71.6**

Adding a fire extinguishing system raises the expense, but it also improves the degree of safety in health clinics, increasing their worth.

Step Five: Preparing the Value Report

The project's overall price (Pareto) = 803,275,000 million Iraqi dinars.

1. Savings in construction and plastering industry amount to 53.8 %=176,385,000 million Iraqi dinars.
2. Savings in wall, floor, and ceiling cladding industry amount to 60.73%=135,100,000 million Iraqi dinars.
3. Savings percentage in paints, wood, and plastics is 33.07 %=23,220,000 million Iraqi dinars.
4. Rise in flattering industry is 12.5 % = 2,500,000 million Iraqi dinars.
5. Rise in flattering industry is 12.5 %= 2,500,000 million Iraqi dinars.

6. Including a fire extinguishing system increased the total cost by 8.91 %= 71,600,000 million Iraqi dinars. Total savings ratio is (32.15%) = 258,305,000 million Iraqi dinars.

10. Conclusion

The purpose of using value engineering technology to health clinic projects is to increase the value of these projects by reducing costs and highlighting the relevance of the project over the additional cost of installing a fire extinguishing system. It is vital to use communications to coordinate and communicate among members of the work team, as well as to arrange periodic meetings during work hours. People must also have experience, activity, and cooperation among themselves, as well as the ability to receive counsel and advise because it is a critical component of project success.

11. Acknowledgements

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