Value Engineering CEM 512

Term Paper # 10

POTABALE WATER FOR VILLA COMPLEX

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To

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OUTLINE

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  - Implementation Phase
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INTRODUCION

In Fakhriah camp at Dammam city, new villa complex consisting of six new villas are under construction. The owner of these villas has planned to rent these villas after the completion of the construction work. The owner also planned to charge each villa SR 200 for getting the sweet and potable water. Therefore, he would like to find suitable way for getting sweet water for villa complex with lowest possible cost.

Currently the camp has its own water wells. But the camp is not yet connected to the water network coming from Saline Water Conversion Corporation (SWCC). SWCC water is not sweet water and requires further desalination.

Project Description

The designer has selected to install new RO system which consisted of 2 main RO units that desalinate the raw water from water wells. The new RO unit produces 9,000 gallon per day (gpd) to satisfy the potable and sweet water demand of the complex users. The potable water produced from the RO unit shall meet the potable water EPA (Environmental Protection Agency) specifications such as:

- TDS: below 500 ppm
- pH: 6.5-8.5
- Microorganism: zero

The new RO unit will be installed only in the south part of the complex. The allowed area that will accommodate the unit is about 14.0 m sq. (See picture).

Objective

This report will examine this proposal with other possible ways and recommend the most suitable system using Value Engineering techniques.

The value engineering **job plan** will include the followings:

- **Information Phase**
- **Creative Phase**
- **Judicial Phase**
- **Development Phase**

- **Implementation Phase**

Pic. 1 : Picture of the Villa Complex and potable water network

INFORMATION PHASE

Value Engineering Team

The V.E. team is only one member and this is because of the requirement of the course CEM 512. The information and contact of the team is as follows:

Contact Name: Fawaz Al-Ghamdi
Tel. No. 6785990 ext 213
Major Points: RO Unit Engineer

Fawaz has excellent working experience in the RO unit since he worked as process engineer in Saudi Aramco Water Treatment plant. He attended international conferences concerning World Wide Water Supply and he has established good relationship with RO unit specialists.

Consultation Records:

For the purpose of gathering data for the V.E. study, the team has identified two main contacts for source of information as shown in below table:

Contact	Tel. No.	Major Points
SAMMNAN Co.	**03-8681122**	**RO unit dealer**
ZAID ALHUSSAN	**03-8175204**	**Potable water provider**

Objective or Required Criteria:

Mainly, there are two main performance criteria that need to be maintained:

1. To provide total of 9,000 gpd potable water to the storage tank. This criteria is mainly based on the number of people who will utilize the villas.
2. Minimum potable water specification shall be met per EPA standard. This specification is required to ensure the water is healthy for human use and drink and does not harm the sewer and water system of villas as saline water do.

Goals, Desired Criteria or Features:

The team has also identified additional desired criteria along with the previous two criteria; these criteria can be considered as features which were based on previous projects:

a. The material shall be in-kingdom
b. Vendor support shall be provided when needed
c. Spare parts shall be available
d. Area size should not exceeds 14 m sq for new RO unit.
e. Control system shall be easy.
f. Minimum use of hazardous chemicals shall be considered.

Cost Data

The cost data was calculated based on the market prices using Saudi Riyals as currency unit. In this V.E. study, the team recognized three common cases as main option based on the market experience.

First option is using feed water from the existing water wells to be treated in the new RO unit. The unit cost was calculated based on the RO unit maintenance, labor and operating costs. The cost of water from water wells zero.

Second option is same as the first case except that the new RO unit will take its feed from the SWCC water. In addition, the team has made an assumption that the SWCC water pipes were installed till the new RO unit for simplicity reason. When calculating the unit cost for this option, the SWCC water bill cost was added. As a result, the unit price of this case was slightly higher than the first case.

Third option is using potable water from local provider. The unit cost was based on the market annual contract cost for single villa and then was adjusted to six villas. This was an input from local water provider adjusted from the annual contract price. It was

noticeable that the unit price of this option is much lower than the other two cases by about 67 %.

The summary of unit price cost is as follows:

Option	**Unit Price (SR/100 gal)**
RO Unit (water well)	4.34
RO Unit (SWCC)	5.51
Local Provider	1.82

FUNCTION PHASE

Function Worksheet

← Why	Function	How →
For obtaining sweet/potable water that meet EPA requirement	Treat raw water	Install new RO skid

Identify Present Function

What does it now do?

verb	***noun***
Drain	water

What must it do?

verb	***noun***
Treat	raw water
Transfer	water

CREATIVE PHASE:

Generate Ideas:

Using brainstorming technique, the team could generate 10 ideas including the original proposal. These ideas are listed below:

1. Install new RO skid using the raw water from SWCC
2. Dig water well to search for sweet water.
3. Have annual contract with potable water provider.
4. Extend pipe from closest sweet water source.
5. Use raw water from the water well.
6. Have individual RO skids for the 10 houses.
7. Use multistage vaporization process.
8. Wait for upgrading (SWCC)
9. Provide separate potable water piping network and raw water network.
10. Use solar cells to provide electricity to the new skid.

JUDICAL PHASE

Feasibility Ranking

The purpose of conducting feasibility ranking is to preliminarily evaluate the ideas and screen the unfeasible or impractical ones.

Idea	Quality of Water	Probability of implementation	Time to Implement	Cost to Develop	Experience using this alternative	Total	Rank
1	10	8	7	6	9	40	2
2	1	2	2	6	7	18	6
3	8	9	8	8	10	43	1
4	8	1	2	2	3	16	7
5	9	9	6	5	9	38	3
6	10	3	2	4	5	24	4
7	10	1	1	1	1	14	9
8	9	1	1	1	1	13	10
9	5	3	4	5	6	23	5
10	10	1	2	1	1	15	8

1. Install new RO skid using the raw water from SWCC
2. Dig water well to search for sweet water.
3. Have annual contract with potable water provider.
4. Extend pipe from closest sweet water source.
5. Use raw water from the water well for the new RO unit.
6. Have individual RO skids for each house.
7. Use multistage vaporization process.
8. Wait for upgrading (SWCC)
9. Provide separate potable water piping network and raw water network.
10. Use solar cells to provide electricity to the new skid.

It is noticed that the difference between the first three ideas and remaining ideas based on initial ranking are large, therefore, the team has selected the first three and eliminate the others.

Idea Comparison

The selected ideas were compared against each other by find out the advantages and disadvantages of each. This step would have great help for final evaluation step. Table below summarize the ideas comparison:

Idea	Advantages	Disadvantages	Rank
Have annual contract with potable water provider.	• Safe operation • Doe not required electricity • Requires less manpower • No need to have draining facilities as there is no rejected water • No major Maint. or spare part required • Saving money	• Require continuous follow up. Service may discontinue anytime unless backup is provided • Quality of water is not as high as RO unit production (higher TSS).	**1**
Install new RO skid using the raw water from SWCC	• Very pure water • Service is continues	• The recovery is only 80 %- • Initial Cost is high • Safety is lower than the others • High noise is possible • Need regular checking	**2**
Use raw water from the water well for the new RO unit	• Very pure water • Eliminate the need for and increase the feed water to the system	• The unit recovery is only 80 % • Initial Cost is high as well cost • Safety is lower than the others. • High noise is possible • Need regular checking for both RO unit and well condition.	**3**

Determining Criteria:

The value engineering team ranked the ideas according to the following criteria:

Initial Cost	1-10	Low-High cost
Safety	1-10	Low- Highly Safe
Magnitude of saving	1-10	Small-Large saving
Continuation of service	1-10	Low-High
Efforts to monitor/operate	1-10	Low-High efforts

The score range is from 1 to 10. One is the very poor value and as the score goes toward 10, its value is increasing till it reaches 10 which is the outstanding value.

Determining Weights for Evaluation

Prior to evaluate the ideas against the criteria, the criteria must be weighted. Therefore, the importance of each criterion against other was determined first in below matrix, then the raw score was obtained and finally it is adjusted to the assigned weight.

		Raw Score	Assigned Weight
A	Initial Cost	3	6
B	Safety	5	10
C	Cleanliness	3	6
D	Continuation of service	4	8
E	Efforts to monitor/operate	2	4

How important

3 Major Preference
2 Medium Preference
1 Minor Preference

	B	**C**	**D**	**E**
A	A-B-1	A-C-1	D-2	A-E-1
	B	B-2	B-D-1	B-1
		C	C-2	E-2
			D	D-E-1

Evaluation Matrix

Final step in judicial phase is evaluating the ideas against the selected criteria, the results reveled that the second idea "Have annual contract with potable water provider" scored the highest. However, the difference of scores between the highest and second highest was minor, which indicated that the two ideas are very close to each other. The second highest idea was the original proposal "Use raw water from the water well for the new RO". Consequently, the team thinks that the best judgment in this case is using total cost and life cycle cost as final judgment of the suitable idea. The table below summarizes the results of ideas final evaluation:

		CRITERIA					
		Initial Cost	**Safety**	**Cleanliness**	**Continuation of service**	**Efforts to monitor/operate**	**TOTAL**
IDEA	**Wt.**	**6**	**10**	**6**	**8**	**4**	**RANK**
Original method: **Use raw water from the water well for the new RO**		**3**	**5**	**10**	**10**	**7**	**2**
	Sub Tot.	**18**	**50**	**60**	**80**	**28**	**236**
Have annual contract with potable water provider.		**8**	**9**	**8**	**5**	**4**	**1**
	Sub Tot.	**48**	**90**	**48**	**40**	**16**	**242**
Install new RO skid using the raw water from SWCC		**4**	**5**	**10**	**8**	**7**	**3**
	Sub Tot.	**24**	**50**	**60**	**64**	**28**	**226**

DEVELOPMENT PHASE

In the previous phase, it was concluded that the cost will be the determining factor for selecting the proper method. In development phase the winning idea will be based on the savings and life cycle cost results
Note: the calculations details are in attachments. The service life assumed is 10 years.

Savings

Item	Total Cost (SR)
Original:	
Install new RO skid using the raw water from SWCC	**299, 700**
Proposed:	
Have annual contract with potable water provider	**65,000**
Total saving in initial & Ownership costs	**234,700**
% Reduction	**78 %**

Life Cycle Cost Results

Project	Present Worth	Annual Amount
Original	**186,387**	**36,048**
Proposed	**174,576**	**4,814**
Total Saving	**11,811**	**31,234**
Percentage Reduction %	**7 %**	**87 %**

Project	Annual Amount
Original	**36,048**
Proposed	**4,814**
Total Saving	**31,234**
Percentage Reduction %	**87 %**

VALUE STUDY SUMMARY

The original design can be very well accomplished without jeopardizing basic or secondary function by install new RO units.

The selected proposed method "**Have annual contract with potable water provider**" will:

- Save money as it reduce the total cost by 78 % and annual life cycle cost by 87 %.
- Improve the safety
- Eliminate or minimize the use of electricity and storing hazardous chemicals.
- Reduces the manpower required
- Eliminate installing draining facilities as there is no rejected water
- Reduce the consumption of spare parts and lesser the maintenance.

The proposed idea will meet the basic requirement and will cost mush less. The change needed to implement the new proposal is a very minor engineering work. So, the team has selected this proposal.

IMPLEMENTATION PHASE

How should it be implemented?
The proposed case will be negotiated with local potable water providers and then the best offer will be selected. The local providers normally transport the sweet water by using big trucks in weekly basis.

What should be changed and in what sequence?
No major modification work is required. Only preparing the road to the storage tank need to be prepared.

Who should do it?
The selected local potable water provider will transport the water to the storage tank.

How long should it take to start? Any deadline?
Negotiation and selection take 20 days.
Deadline: before the end of construction work of the Villas

Implementation cost, internal hours?
The estimated man hour to implement this idea is 15 man hours. Total cost is SR 300.

ATTACHMENTS

Attachment#1: Calculation of operating and maintenance cost for RO unit

Work Type	Quantity	Unit	Calculation	Labor Cost ($R)	Operating ($R/yr)	Material Cost $R/yr	Total Cost $R/yr
RO Unit operate maintain	6 small or 2 large	PCS *RO package*	**Maintenance (Labor cost):**				
			Labor Unit Cost for monitoring and maintaining the equipment $R 500 per PCS/yr				
			6 units x $R 500/yr =	3000			3000
			Operating Cost:				
			Utilities (2 kw-hr per pump & total of 6 pumps)				
			= 2 (kw-hr) x (0.1 $R/kw-hr) (12 hr/day x 365 day) x 6 pumps =		5270		5270
			Material: Spare parts				
			Filters ($300/Filters) = $ 300 x 6 x 2 =			3600	3600
			Membrane = $ 400/yr x 6 =			2400	2400
				3000	5270	6000	**14270**
TOTAL COST After 10 years service				142700			

Development Phase: Calculation Sheet

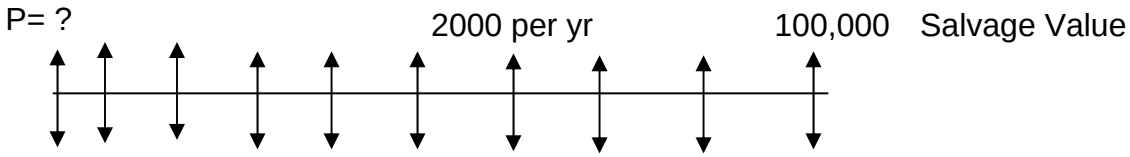
Original: Install new RO skid using the raw water from SWCC

A. TOTAL COST

Initial Cost		150,000
Ownership cost		
Operating Costs (see table)		142,700
Replacement Cost		7,000
Total Ownership Cost		149,700
TOTAL COST FOR THIS IDEA		**299,700**

B. LCC Calculations

Using present worth method



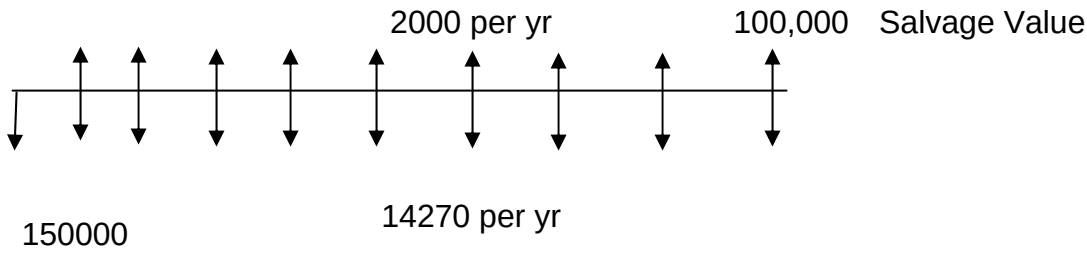
150000 14270 per yr

n= 10
i = 10

P = 150000 + 14270 (P/A, 10%, 10) - 2000 (P/A, 10%, 10) - 100000 (P/F, 10%, 10) =

P= 186,837 $R

Using Uniform annual worth method



A= 14270 + 150000 (A/P , 10 %, 10) - 10000 (A/F , 10 %, 10)- 2000

A = 36048 SR/yr

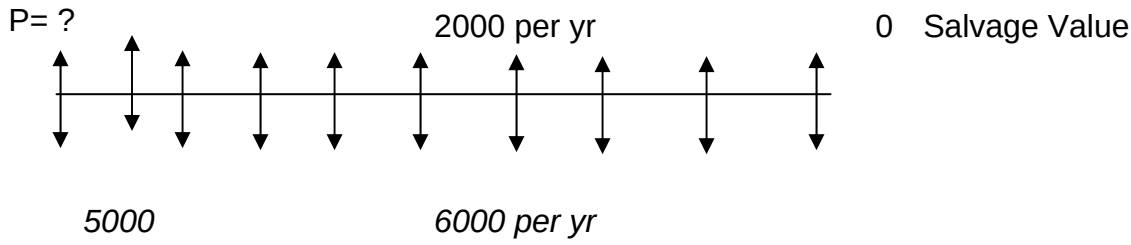
Proposal: Have contract with local potable water provider

A. TOTAL COST

Initial Cost		5,000
Ownership cost		
Operating Costs		60,000
Replacement Cost		0
Total Ownership Cost		60,000
TOTAL COST FOR THIS IDEA		**65,000**

B. LCC Calculations

Using present worth method:



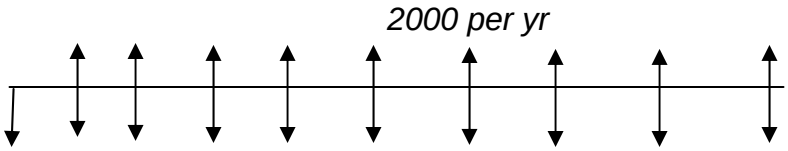
n= 10

i = 10 %

P = 5000 + 6000 (P/A, 10%, 10) - 2000 (P/A, 10%, 10) =

P= 174,576 $R

Using Uniform annual worth method



5000 *6000 per yr*

A= 6000 + 5000 (A/P , 10 %, 10) - 2000

A = 4814 SR/yr