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FINANCIAL ANALYSIS: A CASE STUDY OF SOUTH AUSTRALIA HOSPITAL ENGINEERING SYSTEMS

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Abstract: *This paper discusses financial factors that are necessary for the decision making process on cooling system at a local hospital in South Australia. Options of retaining the existing system and installing a new cooling system are considered. Due to limited funding, budget cost is the key factor for final decision making for this particular hospital.*
Key words: *hospital, costing, accounting, engineering, decision-making*

1. INTRODUCTION

This paper discusses financial factors that need to be considered for supporting the decision making process on cost effectiveness of retaining the existing cooling system or installing a new system in a South Australia (SA) hospital. A budgeting process is performed with the aim of determining the option that would provide the most favourable result. Due to limited funding, budgeting plays a significant role for building services in decision making process. With the role of servicing the air cooling systems at the hospital including wards, operating theatres and offices, the mechanical cooling system is one of the most expensive components among all other services.

2. THE CASE STUDY

The case study hospital is located in the northern suburb of SA. It provides various ranges of major complex diagnostic, surgical, medical, and support services for full-speciality and sub-speciality areas. The presence of a clean and hygienic environment is vital for the comfort of patients and also a sanitary work environment for nurses, doctors and employees. Therefore, an efficient cooling system is the main factor considered herein. It is herewith to address the areas that are considered before a decision is made. These areas include operation of the cooling system, budgeting, capital maintenance costs, installation costs, lifespan, and capital maintenance costs.

According to Building Code of Australia 2010, the generally accepted way is to size the flow required on the air change rate of the space underneath the outlets, by approximately 30 to 40 air changes per hour (ACH) in a climate like South Australia. An evaporative cooling system is suitable to be used for this hospital; as it aids in cooling in two main ways. Firstly it removes build up of heat through the introduction of high volumes of evaporative cooled air. Secondly it introduces high volumes of air in space to increase air movement. As evaporative coolers do not actively control temperature within the space and are primarily affected by the ambient humidity levels, the method in which they are sized differ from a conventional air conditioning systems significantly. In evaluating the existing and the new cooling systems, detailed description and calculations of evaporate cooling system are provided herein.

3. PROPOSED COOLING SYSTEMS

The two options considered are:
Option 1 – The existing "Counter flow induced draught" cooling towers system
Option 2 – Muller series closed circuit evaporative coolers system

Option 1 is the existing cooling towers system that have reached their serviceable life of 10 years as advised by the client' s (hospital) technical staffs and be advised that the system may not have sufficient heat rejection capacity on some hot days in SA. The other impact factors of the existing systems present a risk of Legionnaire's disease being present in the exhaust plume.

Additionally, this option considers only the conventional cooling towers, whereby air is induced by the fan through water cooled pads to cool the condenser water. The system is an open-loop recirculated type cooling system and it requires installation at the roof level with condenser water being reticulated via pipework to the basement thermal plant of the building. The water is continuously recirculated and treated in order to reduce the risk of legionella.

Option 2 is the Muller series closed circuit fluid evaporative coolers system with air pre-cooling that were developed to replace conventional cooling towers without the need to alter any existing water lines and pumps. These major advantages of the new system are to reduce the water consumption by approximately 75% compared to a cooling tower system. Importantly, the risk of legionnaire's disease is reduced and the existing pipeworks are unnecessary to be upgraded.

Option 1	**Option 2**
Advantages	
• Lower capital costs • Lower running costs • Smaller plant platform requirements • Lower noise levels	• Legionella free environment • Chemical free operation due to low water temperatures and control system • Closed water circuit – no fouling • Low water usage – reduced by up to 75% • No pipework upgrade necessary when retrofitting • Minimal maintenance • Cost effective – water cooled efficiency • Reduce operating costs
Disadvantages	
• Higher water consumption • Higher risks for legionella • Higher maintenance cost	• Higher running costs • Larger plant platform requirements • Higher noise levels • Higher capital costs

Tab. 1. Advantages and disadvantages of the two systems

The accounting and financial mathematic technique, including future and present values of single sums and payment streams, enable researchers to calculate the value of decision making in different time periods and to answer many questions that clients may have which rely on this understanding (Petty 2008, and Sloan et al. 2009). To ensure that the financial advice provided is appropriate to the specific needs, and goals are met, it is necessary to construct a brief picture to the client's financial situation (Scott 2010 and Jagels 2007).

4. FINANCIAL CALCALATION

Financial analysis are used on net present worth technique which reduces all capital, running and maintenance costs associated with the project to present day values for comparison. The annual running and maintenance costs are multiplied by a present worth factor (PWF) to reduce to the equivalent lump sum that will have to be invested in order to provide the future annual expenditures. The formula for calculating PWF includes interest and inflation rates are presented below. An average interest rate of 7% and an average inflation rate of 3.6% have been assumed for the 15 years period of the analysis (Petty 2008).

Present worth factor (PWF) formula

Where

i = interest rate = 7%

e = inflation rate = 3.6%

n = number of periods = 15 years

$$\text{PWF} = \frac{1+e}{i-e}\left[1-\left(\frac{1+e}{1+i}\right)^{n}\right] \quad (1)$$

PWF = 11.7

4.1 Interest Rate and Inflation Rate

An appropriate interest rate is selected for the life cycle of 15 years. The analysis herein has been carried out on interest rate and inflation rates of 7% and 3.6% respectively, as we consider these rates to be closer as to what can be expected as the average of a 15 years period.

4.2 Capital Cost

Capital cost of the new cooling system relies on the actual tender price obtained from an estimated cost. After checking was done by the experts regarding the condition of existing pipeworks and the electrical power supply to the new cooling system, it was evident that it is unnecessary to upgrade them to reflect the new system. Hence, it does not require any further calculation in Table 2.

4.3 Operating Cost

The operating costs consist of running cost and maintenance cost in this instance. Running costs involves few capacities items as follows:

- Water average unit cost of $1.7/KL for consumption of 130KL and above.
- Electricity average unit cost of $0.14/KWhr
- 24 hours occupancy of the hospital
- The operating costs identified in the Table 2 are based upon annual operating hours of the hospital of 8,760 hours per annum.

The maintenance costs are based upon the life cycle costing analysis, which estimates the maintenance cost of the system associated with the maintenance information provided by the mechanical contractors responsible for maintaining in accordance with mechanical consultants' specification. On this basis, maintenance costs have been included to the anticipated costs in relation to the failure of replacements of components/parts and over the period of their operating life.

Based on the calculated capital, running cost, installation costs, maintenance costs of the cooling air systems, and the net present worth analysis in conjunction with interest rate and inflation rate is presented in Table 2.

Cooling system options		Option 1 existing system	Option 2 Muller series system
Capital cost $	AC plant cost (1)	380,000	940,000
	Builder works (2)	50,000	385,000
Operating cost $	Running cost (3)	65,000	66,000
	Maintenance cost (4)	8,500	11,000
Net present worth calculations $	Capital cost (1+2) (5)	430,000	1,325,000
	Running cost (3)xPWF (6)	760,500	772,200
	Maintenance cost (4)xPWF (7)	99,450	128,700
	Total (5+6+7)	**1,289,950**	**2,225,900**

Tab. 2. Accounting and financial analysis for comparison with existing and new cooling systems

5. CONCLUSION

Based on the calculations presented above, Option 1 has the lowest life cycle compared with Option 2, and Option 2 has the highest initials capital costs and running cost. It is evident that the existing cooling towers should not be replaced by the new cooling towers to suit the current requirements for the heat rejection in the same location in parallel with the limited funding. However, the new cooling system have significant benefits over traditional water-cooled systems, such as eliminating the risk of Legionella, lower water consumption (reduced by 75%), and no water treatment chemicals are required. Furthermore, the limitation of this study is the difference in determining the constraints of weather condition within the budget calculations.

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