Developing a Ten Year Capital Investment Plan for the Chesapeake Yacht Club

Lee Vorthman, Ben Abdul-Khalek, Rabia Khurshid, Jamie Brust, Rohit Paul

Abstract—**The Chesapeake Yacht Club (CYC) is a not-for-profit yacht club located on the West River in Maryland. In order to remain financially viable the CYC must maintain a certain level of membership. Lack of a long-term investment plan places the CYC at risk due to a decrease in membership resulting from an increase in fuel prices or failure to maintain and/or improve its current infrastructure. Our team identified five investment alternatives, based on CYC member preferences, by distributing a survey and constructing a value hierarchy. The investments that rank highest to the club members include the installation of new docks and the implementation of renewable energy, such as solar and geothermal, to reduce the impact of utility usage on the club's revenue stream. Our team used decision theory and an integer-programming model to identify investment combinations that will provide maximum value based on a given budget. Using these investment combinations our team conducted sensitivity and risk analyses and then conducted a financial analysis for a twenty-year period. The results of these analyses have shown that renewable energies, such as solar and geothermal, are high-pay-off investment for the club. Using the aforementioned alternatives, methods and decision criteria, we developed a capital investment plan for the CYC that will safeguard their future financial viability.**

I. INTRODUCTION

The Chesapeake Yacht Club (CYC) is a private, non-profit yacht club located on the West River in Maryland. Established in 1947 as a member owned and managed club, it provides 135 slips and currently has 95 members. Of its 95 members 15% operate displacement hull yachts (sailing vessels) and 85% operate planing hull yachts (powerboats). The CYC is a full service club that provides many services beyond boat slips, such as fuel docks, a swimming pool and dining services.

The CYC is dependant on maintaining a certain level of membership in order to remain financially viable. Recent economic changes have caused an increase in fuel prices, which has led to a decrease in membership at the club. Historical club data shows as the price of fuel increases members buy less fuel and therefore operate their boats less. Additionally, past improvements to the club have been reactive improvements with minimal consideration for the long-term future of the club or for potential investment opportunities.

The CYC is now charged with the task of evaluating the current membership structure, looking towards the future and adopting an investment plan that will ensure the viability of the club over the next ten years. Therefore, the CYC requires a long-term plan that will focus on anticipating and accommodating economic and membership changes accordingly. With membership being a priority, the CYC needs to renovate its facilities and improve its current infrastructure in order to present a positive image to current and future members.

The remainder of this paper is organized as follows: In section II we present our approach to this problem including conducting surveys and identifying alternatives. In section III we describe our Integer Programming (IP) model used to identify investment packages. We also describe the methods used to determine the utility and risk associated with each package as well as a financial analysis of the three most interesting packages. Section IV presents our specific recommendations to the CYC and in Sections V and VI we present follow on work and conclude our analysis.

II. PROBLEM APPROACH

1. Requirements

Based on feedback from our sponsor our team derived the following top-level requirements:

1. The investment plan shall encompass a duration of ten years.
2. The CYC shall maintain a sufficient number of club members to remain financially viable.
3. The investment plan shall include a model to simulate the revenue of the CYC over a ten-year period.

2. Identifying Investment Alternatives

Our team conducted several interviews with our sponsor and CYC members to determine areas of improvement and potential investments. Based on these interviews our team identified the following investment alternatives:

Docks: The CYC has four fixed docks each of which need varying levels of improvement. The fixed docks present a problem because they do not adjust with the tide and the underlying cableways are subject to damage and potential safety risks during a storm. Additionally, the sub-structure and pilings of the docks are in poor condition and need to be

replaced. Investment alternatives for the docks range from repairing the current infrastructure and maintaining fixed docks, to replacing the existing infrastructure and installing floating docks.

Dredging: Prior to our team's involvement with this project, the CYC identified the need for dredging. The current water depth at the CYC is 4'-5' and is restrictive for displacement hull yachts (sailboats) that require a deeper draft. Dredging will not only attract members with deeper draft boats, but also will restore the water depth to 1970s levels (5'-6') and ensure the CYC can continue to support its boats in the future. Dredging operations will need to be coordinated with any improvements to the docks.

Renewable Energy: The CYC is an ideal location for renewable energy. Its location on the water provides an unobstructed view for its approximately $3800ft^2$ southwest roof face which is ideal for the installation of a solar system. Solar energy will provide a clean, efficient and abundant energy source that will help significantly reduce the CYC's almost $30,000 per year electricity bill. Additionally, a geothermal system will help the CYC improve the efficiency of its heating and cooling, further reducing its electricity costs. A geothermal system can be installed underneath the existing parking lot.

Parking Lot: The existing parking lot needs to be repaved and possibly made more environmentally friendly by reducing the amount of runoff that enters the west river. Repaving the parking lot also presents an opportunity to install a geothermal system.

Addition: A second story addition will add valuable space for offices, social events or a potential fitness room. As a full service yacht club the additional space can be attractive to current and potential members.

Membership Fee Structure: Current CYC members pay both a membership fee and a slip fee, which is based on the size (ft^2) of their slip. The existing fee structure is high relative to surrounding club rates. By creating a new fee structure the CYC can attract new members while maintaining their revenue stream.

1. Value Hierarchy

Our team created a value hierarchy (Fig 1) to assess the value each investment alternative will provide to the CYC. The overall goal is to maintain or increase membership and each investment alternative will in some way provide a value that will help the CYC achieve this goal. Additionally, the hierarchy has three measures that our team used to evaluate each alternative: revenue, attractiveness/appeal and usefulness.

The revenue measure evaluates what type of revenue the investment alternative will generate. Investment alternatives that did not contribute direct revenue to the club were weighted zero. The attractiveness/appeal measure evaluates the aesthetic appeal each investment alternative will provide in terms of attracting new membership to the club. Investment alternatives that could not be seen, such as geothermal, were weighted as zero. Lastly, the usefulness

measure is an evaluation of how useful each investment alternative will be to the club.
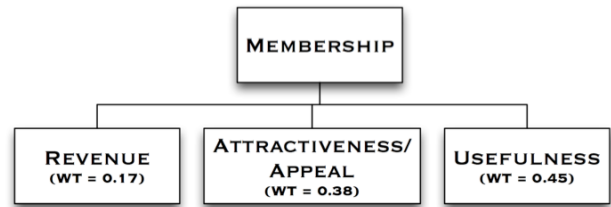

Fig. 1. CYC Value Hierarchy

2. Survey

Our team conducted several surveys of the CYC Board of Governors, Long Range Planning Committee and CYC members. The format of the survey asked CYC members to place themselves in the year 2020 and reflect back on the changes the club made over the past 10 years. Members were asked to specifically rate which investment alternatives provided the most value to the club and what age demographic was most beneficial to the growth and financial health of the club. The ultimate goal of the survey was to determine the investment preferences of the CYC members and to elicit weights for the measures within the value hierarchy.

3. Alternative Weights

Using the results from the survey our team used Logical Decisions® for Windows (LDW) to determine the ranking and utility for each alternative. Our team directly assessed the utility for each investment alternative for each measure. Finally, we entered the weight results from the survey into the weight assessment for the membership goal. The result produced an alternative ranking (Fig 2) showing the utility each alternative will provide to the CYC in terms of membership.
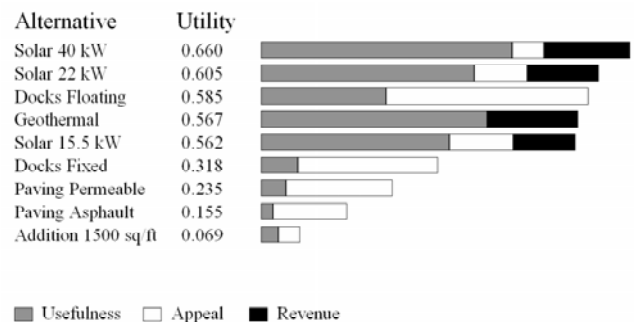

Fig. 2. Alternative Utility Rankings. The figure above shows a breakdown of how much each measure contributes to the total utility of each alternative (v_i).

4. Cost Estimation

In order to create an accurate revenue model, our team obtained cost estimates for each investment alternative from contractors local to the CYC. For membership costs our team contacted comparable yacht clubs near the CYC.

Membership Fee Structure: Based on data from

surrounding yacht clubs [11]-[13] our team was able to determine the total membership cost for each club and compare that to the membership cost at the CYC. The data indicates that the total cost for a CYC member with a 35' or 45' boat is significantly higher than surrounding club rates. However, members with a 55' boat or larger are paying significantly less than surround club rates. This data suggests that the CYC is not competitive for members with boats between 35' and 45', but the club is losing potential revenue by under charging members with 55' boats or larger.

Docks: Our team investigated both fixed and floating docks as options to replace the existing dock infrastructure. We contacted several local dock vendors such as A-1 Marine Construction [7], EZDock Mid Chesapeake [8] and Chesapeake Dock Outfitters [6] to obtain pricing estimates. Based on our inquiries and on site surveys, the price to replace the docks ranges from $15/ft^2 to $30/ft^2 depending on material and type of dock (fixed or floating). These options are represented as $Docks_i$ in the IP model.

Dredging: Prior to our team's involvement with this project, the CYC obtained quotes for dredging from Bayland Consultants & Designers LLC. The total cost for dredging all four docks is estimated at $300,000. Our team will use the estimate from this quote for the dredging cost in our revenue model.

Renewable Energy: Based on our research our team used a 15kW, 22kW and 40kW solar system size for our price estimation. Several resources were used to obtain cost estimates for each system size. Online resources such as Roofray.com [1] were used for initial estimates. Local solar vendors such as GroSolar [3], SolarTechInc [4] and Standard Solar [2] were also contacted to obtain installation estimates. Based on our research the cost for a solar system ranges from $3750/kW to $5500/kW depending on array size and type of installation. Additionally, estimates for a 240,000 BTU geothermal installation place the cost at approximately $160,000. These options are represented as $Solar_i$ and $Geothermal$ in the IP model.

Parking: Our team researched both asphalt and permeable paving as options to replace the existing parking lot. Estimates from local area pavers, such as Pat's Paving and Trucking Inc. [14] and O'leary Asphalt [15], estimate the cost of repaving the parking lot with asphalt to be between $60,000 and $85,000. An environmentally friendly parking lot using permeable paving stones is estimated to cost approximately $300,000. These options are represented as $Parking_i$ in the IP model.

Addition: Our team contacted local construction companies and used online resources [9], [16] to estimate the cost per square foot for a second story addition. Based on our research the cost for a 1500ft^2 addition to the yacht club will cost between $150/ft^2 to $170/ft^2.

II. MODEL

1. Integer Programming Model

Using the utilities from LDW and the cost estimates from our research our team formulated an Integer Programming

(IP) model [5] to maximize the value of an investment strategy for a given budget. As evidenced by equations (1),(2) and (4) the objective of our IP model is to maximize the value of the sum of the chosen options. The initial constraints of the model (5), (6) and (7) indicate that only one particular alternative from each investment type can be selected. For example the CYC can choose to invest in a 40kW solar array or a 22kW solar array, but not both. The last constraint (8), along with equation (3), limits the total cost of the selected options to within a given budget.

$$x_i = \begin{cases} 1, \text{ alternative i is chosen} \\ 0, \text{ otherwise} \end{cases} \quad (1)$$

$$v_i = \text{value of option i} \quad (2)$$

$$c_i = \text{cost of option i} \quad (3)$$

$$\max \sum_{i=1}^{n} v_i x_i \quad \text{s.t.} \quad (4)$$

$$\left(\sum_{i=1}^{n} Solar_i \right) + Addition \le 1 \qquad i = 1,2,3 \quad (5)$$

$$Geothermal - \left(\sum_{i=1}^{n} Parking_i \right) = 0 \quad i = 1,2 \quad (6)$$

$$Dredging - \left(\sum_{i=1}^{n} Docks_i \right) = 0 \qquad i = 1,2 \quad (7)$$

$$\sum_{i=1}^{n} c_i x_i \le Budget \quad (8)$$

TABLE I
INVESTMENT PACKAGES

Package	Investments	Cost (x $1000)
A	22kW Solar	$78.00
B	40kW Solar	$225.00
C	Geothermal/Asphalt	$240.00
D	15kW Solar/Geothermal/Asphalt	$295.00
E	22kW Solar/Geothermal/Asphalt	$318.00
F	40kW Solar/Geothermal/Asphalt	$465.00
G	40kW Solar/0.5Floating Docks/0.5Dredge	$510.00
H	22kW Solar/Geothermal/Permeable Paving	$538.00
I	40kW Solar/Geothermal/Permeable Paving	$685.00
J	22kW Solar/Floating Docks/Dredge	$928.00
K	Geothermal/Floating Docks/Dredge/Asphalt	$1090.00
L	22kW Solar/Geothermal/Floating Docks/Dredge/Asphalt	$1,168.00
M	15kW Solar/Geothermal/Floating Docks/2nd Story Addition	$1,295.00
N	40kW Solar/Geothermal/Floating Docks/Dredge/Asphalt	$1,315.00
O	22kW/Geothermal/Floating Docks/Dredge/Permeable Paving	$1,388.00
P	40kW Solar/Geothermal/Floating Docks/Dredge/Permeable Paving	$1,535.00

Table 1. Investment Packages. This table shows the individual investments included in each investment package along with the total package cost.

Using the IP model our team parametrically varied the budget amount, the results of which identified various investment packages and their costs (Table 1). As shown in Fig 3, by varying the budget amount from $200,000 to $1.6 million, and plotting the corresponding utility versus cost, several interesting points appear. The first interesting point

is the point corresponding to package L. This point indicates the package that provides the largest increase in utility per dollar.
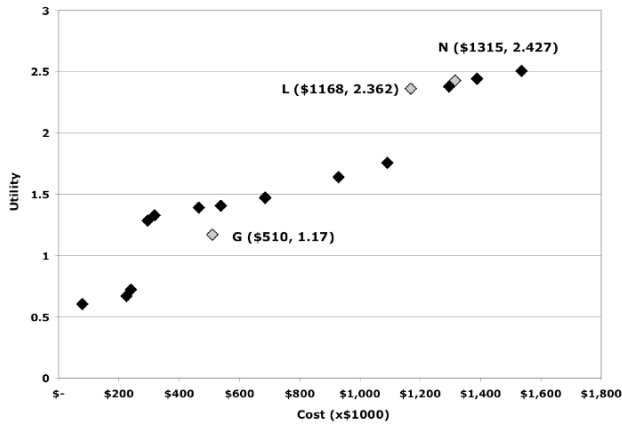

Fig. 3. Utility vs Cost. This figure shows the relationship between the cost of a package and the expected utility of that package.

2. Sensitivity & Risk Analysis

Using package L as a baseline, or team varied the options in package L with the goal of creating a new package that will provide the largest reduction in existing costs. Package N provides a marginal increase in utility based on its cost, but includes the largest solar array and therefore it is expected to provide the largest decrease in existing costs (see Fig. 3.).

Next, our team assessed the risk associated with each investment package. Using LDW, we evaluated each package based on its ability to generate new membership, the amount of debt the CYC will be required to assume if that package is chosen, and the expected payoff time for each package. A plot of the risk versus cost indicates that packages N and L are high-risk investments (Fig. 4.).
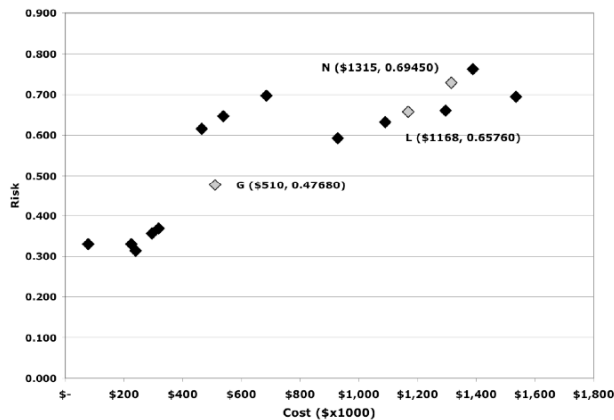

Fig. 4. Risk vs Cost. This figure shows the expected risk versus the expected cost of each investment package.

Based on the results of the risk analysis we attempted to identify an additional investment package that would continue to provide utility, but with reduced risk. The initial survey indicated the investments that ranked the highest by the members were the improvement of the docks and installation of renewable energy. Our team created an additional investment package (package G) that is in line with these preferences. Package G includes the installation of the largest solar array, but only includes replacing and dredging two out of the four docks (see Table 1). The two docks we selected as part of this package are the docks in the worst condition as specified by on site assessments conducted by marine construction companies [6]-[8]. Package G provides less utility than packages N and L, as shown in Fig. 3, but it involves significantly less risk (see Fig. 4).

3. Financial Analysis

Once we identified the utility and risk associated with each package, our team conducted a financial analysis of packages G, L and N. Based on feedback from our sponsor we used a 20 year fixed loan with a 7.5% annual percentage rate (APR) and an inflation rate of 4% [10] to model each investment. All three packages include the installation of solar and the money saved from the reduced utility service costs was paid towards the loan. Also, based on past CYC financial data we used a normal distribution with a mean of $0 and a standard deviation of $6667 to model any profit generated by the CYC. This profit was also paid towards the remaining balance on the loan. Additionally, after the loan for each investment is satisfied the annual payment amount contributes towards the value of that investment.
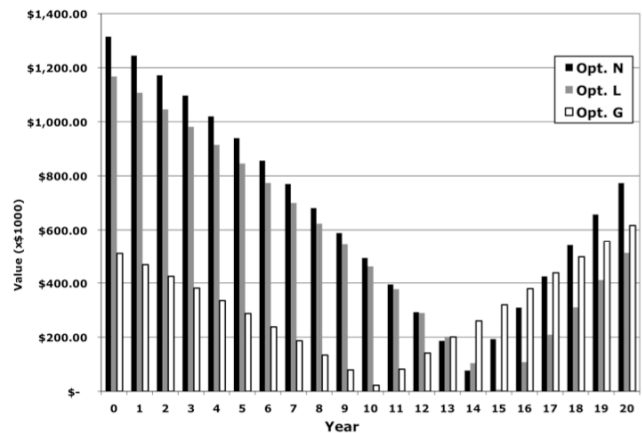

Fig. 5. Financial Analysis. This figure shows the results of a financial analysis of packages G, L and N over a 20-year initial loan term.

As shown in Fig. 5, package N will have the highest value after 20 years, but package G will have the shortest return on investment (ROI) at ten years. Package L has the longest ROI and least value after 20 years making it a less desirable investment compared to packages G and N.

III. RECOMMENDATIONS

1. Investment Package

Based on the modeling results our team recommends the CYC select package G for their capital investment plan.

Package G includes improvements to the areas ranked highest by its members as indicated by the initial survey. While package G has a lower utility, it is also the lowest risk package. Most importantly, package G has the only ROI that falls within the time frame of ten years, which will present the CYC the opportunity to make further investments at the end of the capital investment plan. While our team has recommended an investment package, the decision will ultimately depend on a vote by CYC members and the type of loan the CYC acquires.

2. Membership Fee Structure

In order to attract new membership our team recommends the CYC adopt a new membership fee structure. The new fee structure will charge members with the largest boats a fixed fee. Subsequent smaller boats will be charged a percentage of this fixed fee in proportion to their length. The new fee structure will reduce the current fees for members with smaller boats while keeping total revenue from membership fees within 5% of the existing fee structure.

IV. FOLLOW ON WORK

Avenues of follow on work include analyzing the benefits social members can provide to the CYC and refining the CYC's business model. The addition of social members can provide the CYC with an additional stream of revenue that will help cushion the CYC from difficult economic conditions. Refining the CYC business model will help reduce the possibility of the loss of revenue from operating the club while remaining within the 15% profit limits imposed on a not-for-profit business.

V. CONCLUSION

Lack of a long-term investment plan places the CYC at risk due to changing economic conditions or reduced membership. In order to remain financially viable, the CYC must invest in its infrastructure. These investments will attract new membership and reduce operating costs.

The goal of this project was to develop a long-term investment plan and provide sufficient analysis to allow the CYC to plan for the future. In order to do this our team first identified investment alternatives based on CYC member preferences. We assessed the value of each alternative and their associated costs. Using the utility and cost estimations we formulated an integer-programming model, the results of which produced several investment packages. Next, we assessed the risk of each package and conducted a financial analysis of the three most interesting investment packages. The financial analysis also showed the expected return on investment of the three packages. Finally, our team recommended a specific investment package and provided suggestions for an improved membership fee structure that will help attract new membership.

The CYC must now make critical decisions that will shape the future of the club. These decisions will be based on several factors such as risk preference and desired return on investment. Our research and analysis will assist the CYC in making this difficult decision and has opened up new avenues of potential follow on work.

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