Aquatics Hiring Problem

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Decision Situation and Scenario

The COVID-19 pandemic disrupted an innumerable plethora of problems across the nation. The one seemingly perpetual issue has arisen in the field of hiring and employment, where it seems as though many positions are difficult to keep staffed. For example, at the beginning of the pandemic in 2020, nurses became scarce. This became an increasingly dangerous situation, with hospitals filling up at a much quicker rate than in the past. This problem seems to plague more than just health care but seems to have spread into many other fields, including recreation. Understaffing is plaguing the country, especially in jobs that are geared toward younger ages or part-time employment. Analyzing this problem and finding ways to fight against these trends could support businesses as times are changing and the future becomes increasingly difficult to predict.

To focus on the scope of this idea, one department is focused on that is currently struggling with this problem. The Aquatics team in the Prince William County Department of Parks, Recreation, and Tourism (referenced as DPRT) is annually tasked with hiring many new employees to work as lifeguards seasonally. In the past, it has not been difficult to staff the pools, according to the main Aquatics Director. When the COVID-19 pandemic hit in 2020, all 8 aquatic facilities run by the county were closed for the summer. These facilities include 2 recreation centers, 3 neighborhood pools, and 3 water parks, each of which supports both public use as well as private programs such as swim teams, swim lessons, and events. As a county-owned entity, community support is a top priority, so keeping these pools open and running while still making a profit is necessary to maintain their goals.

During the summer of 2019, the pools were open and ran as usual as this was pre-pandemic. 2021 became a different story. It became increasingly difficult to obtain the staff necessary to operate the pools at the optimal level. Due to a mixture of new leadership and low funds, the pools were only opened at a reduced capacity. This entailed only allowing for limited county-run programming and specific hours for public use.

Our overarching central decision revolves around the concept of opening at reduced capacity or full. With the department struggling to obtain the number of new hires necessary to operate at full capacity, there needs to be some assessment of whether to continue planning to open at full capacity or go with reduced, as well as the consequences of either. To begin our analysis, we first created a tree to outline all our objectives. Our overarching objective is to be able to function while simultaneously achieving the highest profit possible. These objectives are measured in different ways, so placing those as our fundamental objective(s), we created means objectives to provide a way to measure.

The stakeholder consulted in this scenario is the aquatics director. She was interviewed multiple times to gather both numerical data as well as subjective opinions on uncertainty. The aquatic director as a stakeholder makes many of the decisions herself for the department. As the primary decision maker, it is her responsibility to open the pools at the proper capacity, hire the appropriate number of lifeguards, and ensure those above her in the department are satisfied with the operations. The main decision, which in turn can affect many uncertainties, is to open the pool at full or reduced capacity, with the goal of opening at full. One important aspect of this analysis is to make the bulk of the analysis easily interpretable to the stakeholders involved. For example, the stakeholder was not versed in many of the technical analytic terms so it is important to be able to translate our results and process into a format anyone can understand.

Data Collection/Assumptions

The decision to operate at full capacity is crucial to determine how many additional employees to hire to avoid employee shortages that could potentially result in the inability to manage the pools, leading to unnecessary liabilities placed upon the aquatic center and increasing employee burnout. Although opening at full capacity would increase expected profits, the aquatic center will have to hire more employees, resulting in increased costs.

The initial objective hierarchy created encapsulates many variables, based on brainstorming prior to speaking with the stakeholder (Figure 1). With a problem where money is involved at a prominent level like this scenario, there could be an infinite number of variables to consider, so these are some we were looking to encapsulate. As we further spoke with the stakeholder, we found that some variables were not as important as others in the consideration of the problem. One example is the benefits package provided to the lifeguards upon being hired. The stakeholder did not believe this variable to play a role in both cost and attraction of applicants, as the only employee benefit was to use facilities. As shown further into the analysis, many of these variables are relevant to the scenario, but may not affect our specific analysis per stakeholder suggestion.

Hence, for both scenarios, our stakeholder has decided to hire an average of 299 employees for full capacity and 237 employees for reduced capacity. Since we are uncertain about the number of applicants that will end up accepting the job offer, a binomial distribution (Figure 2) is used to obtain the probabilities for the number of applicants that will accept the job offer. The Extended-Pearson Tukey method is also utilized to find the discrete approximation of the number of applicants that will accept the offer, providing us with a good estimate of how much hiring costs the aquatic center would incur. As turnover for summer jobs is expected to happen, we have incorporated turnover costs into the cost of total salary, which represents the additional hours the hiring manager must spend outside their current responsibility to replace an employee. Another alternative that we considered is the option of hiring a recruiter to handle the screening process for the applicants. Recruiters are specialized in this specific task and have experience in hiring applicants that are well suited to the job responsibility. This could potentially allow the aquatics department to solve their hiring problems, which would in turn increase expected profits as there will be enough employees to allow the pools to operate at full capacity.

Methodology and Analysis

i. Structure: Influence Diagram and Decision Tree

Influence Diagram

Before beginning any analysis, it is important to layout the information used in a theoretical form. We utilized an influence diagram to do so, showing how different decisions, actions, and uncertainties relate to each other and eventually our objective (Figure 3). At the top are the uncertain events, which are events that may have a variety of outcomes based on chance. The number of applicants ends up affecting the number of accepted offers, which relates to the turnover rate cost calculations. Some necessary decisions in this problem relate to the central decision and objective. First is the overarching decision of opening to full or reduced capacity. This in turn determines how many employees are hired, since the department needs fewer employees if opened at reduced capacity. Lastly, salary costs are computed from how many employees end up being accepted. Then the cost of turnover, advertising, and salary are incorporated with the associated profit from opening at reduced or full. The numerical associations are then associated with a decision tree, which mathematically explains the problem through monetary values.

Decision Tree

We utilized a decision tree to allow us to analyze our decisions between opening the pools at full capacity or at reduced capacity. The decision tree is structured with one decision node that indicates pool capacity, and three chance nodes indicating the number of applicants the aquatic center could receive based on the advertising cost spend ($5,500), salary costs depending on the number of accepted offers, and the revenue from expected visits that the pools are to receive during the summer. We initially incorporated turnover rate as a chance node branching off our tree. However, after careful consideration, the turnover rate would be classified as a cost to the hiring manager, hence, the turnover costs are then included within salary costs, to represent the cost to replace an employee.

As mentioned in the data collection section, the Extended Pearson-Tukey method is used to approximate the probabilities for the number of applicants and the probabilities for the number of accepted offers which uses both the binomial and triangle distribution (Figure 4). A triangle distribution is also utilized to obtain the min, max, and most likely probability for the number of expected visits based on data provided by the stakeholder from 2019 and 2021; the data for 2020 was not included as COVID created an anomaly, which would skew our probabilities, therefore, not providing an accurate assumption. The Extended Swanson-Megill method is used in our decision tree to approximate the expected number of people that will visit the pools during the upcoming summer.

According to the decision tree, opening the pools at full capacity will maximize expected profit, at $213,487.14, whereas reducing capacity would result in a loss of $152,792.44 as the revenue from expected visits will not be sufficient to cover the salary costs of the employees. As additional support, the cumulative risk profile (Figure 5) shows that opening at full capacity is "right and below", which indicates that this decision will stochastically dominate the decision to reduce capacity. This concludes that the chances of maximizing expected profit will always be greater if the pools were to open at full capacity.

Sensitivity Analysis

The decision-maker has trouble assessing the most important attributes such as revenue from guests, advertising cost, and pay rate. A sensitivity analysis of these attributes, though, can reveal whether the decision-maker must make a more precise judgment. To invest in certain efforts to attract applicants, first, the decision-maker needs to analyze the most important items that have the greatest influence on the profit that they are going to make. For this specific problem, the variable cost should be taken into consideration. Because it not only affects the cost directly but also can be considered as a factor that is going to increase profit by increasing the number of applicants. In addition, the pay rate and revenue that this department gains from guests affect the total revenue and their profitability. Besides, based on the manager's perspective, advertising plays a major role in their decision as they pay for advertising before, they make any decisions. Then, to find the most influential items we played around with different things and varied them. Finally, we figured out that sensitivity analysis on advertising cost, pay rate, and revenue from guests would work and would give us useful information about the expected value which is helpful for the decision-maker to approach the variety of decisions and the values that she faces.

The upward trend that we got for revenue from guests (Fig 9, APPENDIX) shows that when the revenue goes up, the value of the output increases as well. On the other hand, the advertising cost and pay rate have a downward trend (Fig 10,11. APPENDIX) which states that by increasing these items, the expected value goes down.

By constructing the tornado graph for this problem, the decision-maker can gain insight into the attributes that have the most effect on profitability. The results of this graph show that revenue from guests has the biggest effect. In other words, the profit is not sensitive to advertising cost but very sensitive first to the revenue from guests and then to the pay rate (Fig12.)

Value of Perfect Information

One of our alternative decisions to evaluate is to consider if the aquatic center should hire a recruiter to conduct candidate screenings and potentially meet the targeted goal to hire a certain number of employees to keep the pools operating as recruiting companies are under contract to meet the hiring requirements of their clients. Recruiter cost varies between 15%-20% of hired employees' first year salary[1], depending on the type of roles and the candidates' skillset. Since job

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[1] [1] https://eddy.com/hr-encyclopedia/recruitment-fees

positions for the aquatic department do not necessarily require a specialized skillset (except for lifeguards) and do not require working experience, we used our subjective judgment to estimate the recruitment cost to cover 10% of the hired seasonal employees' salary for the summer.

As recruiters are considered experts in their field, we expect that the recruiter would provide us with "perfect information." Hence, we want to evaluate the value of the information the recruiter could potentially provide to the aquatics department by removing the uncertainties concerning our outcome. Since we are evaluating the EVPI, the decision tree (Figure 6) is altered by removing the uncertainties and expecting the "best-case scenario" to happen for all our uncertain nodes. This resulted in an expected profit of $449,904.80 for opening at full capacity, which means our EVPI is $236,417.66. However, based on our calculations, the total recruiter cost will result to $185,840.96 for hiring 294 seasonal employees. This means the aquatics department could potentially consider hiring a recruiter as they will be making an additional $50,576.70 if opened at full capacity. Although it seems like a hefty cost, this would solve the aquatic department's hiring problem, and would also allow the managers to optimize their time by allocating the recruitment time to creating a strategy to increase the expected number of visitors to the pools during the summer. This would be fruitful overall, as expected profits will increase, with the increase in the number of visitors.

Advertising Alternative

Originally in the plan for the analysis, advertising was going to be a major decision, altering costs and the number of applicants. After speaking with the stakeholder, it ended up not being realistic to their actual situation. The department pays the same amount in advertising costs whether they decide to open at full or reduced capacity. Despite not giving much thought to advertising, the stakeholder specified that advertising is crucial to attracting applicants. Attracting more applicants would help ensure the opening is at full capacity. The department advertises by purchasing social media advertisements, including Snapchat, Twitter, Instagram, and Facebook. One example is provided by a real-time advertisement found (Figure 7).

Since the stakeholder weighed this attribute so highly, stating that advertising attracts 90% of applicants, it may be beneficial to create some prospective alternatives. In conjunction with some subjectivity and assumptions from the stakeholder, an altered decision tree was created along with a cumulative risk profile (APPENDIX). In this new tree, only the full capacity option was utilized, mainly because the model became too large for interpretation by the PrecisionTree tool. This still allows for insight into how advertising can potentially affect profit and costs. The new alternative in this scenario lies in the cost of advertising, deciding whether to spend $10,000 on advertising or the baseline of $5,500. The value of $10,000 comes from the higher end that the department is willing to pay for advertising, according to the stakeholder. Compared to the expected value, these costs will not likely play a significant role, but the effect of more advertising is what may cause a shift in decision making.

The stakeholder stated that the lower end of turnover rate, based on past summers of employees, was around 0.25. In the original tree, an average turnover rate of 0.5 was used. When more is spent on advertising, the stakeholder agrees that the turnover rate would be affected. There would be more applicants, who would mean that there are more options for applicants to give offers to. There is a subjective aspect of choosing motivated and reliable employees when there is a larger applicant pool to choose from. In this case, we can assume the turnover rate is at the lower end of this scenario since now those who accepted offers are more likely to stay for the whole summer. In turn, we will expect to see lower turnover costs. The question lies in whether paying more for advertising is worth the lower cost of turnover.

Looking at the tree for full capacity, it shows that the most profitable option in this scenario is to choose to spend more on advertisements, specifically $4500 more. It is important to note that these numbers may not reflect reality as closely as those represented by historical data. Although, this could help the department make better decisions and show that it may not be a poor investment to try and spend more on advertising. It does show to not change the expected value by a lot, about $10,000. Although, there is a layer of subjectivity not picked up by the monetary value. Turnover incurs a monetary cost but also takes less effort. On top of this, the employees hired will be more reliable and harder workers. If this alternative is chosen in future summers, it would be beneficial to record this information, including a subjective rating of reliability. This could help solve some understaffing issues and better the department in times when understaffing may not be an issue any longer.

Conclusion

The different approaches used to analyze this decision problem have given us insights into the many solutions we are able to provide to allow our stakeholders to make an informed decision to achieve the organization's objective. Although this scenario contains many uncertainties, similarly to what many other organizations/businesses are facing, especially with the added factor of the pandemic, our ability to use PrecisionTree to construct our decision tree and @Risk, allowed us to create different theoretical probability models, helped us better comprehend the uncertainties, and allowed us to provide a potential solution to our stakeholder. Our base decision tree model has set the foundation for us to provide different recommendations on how the aquatics director should approach this decision problem. However, the director's risk attitude could impact her ultimate decision regarding our recommendations. If our stakeholder's attitude leans more towards being risk-neutral, she will have no concerns about risks, as her goal is to choose a decision to maximize the expected profit. This means that she will choose the decision to hire a recruiter for summer employee recruitment as this decision could bring in an additional profit of $50,576.70, with recruiting cost of $185,840.96.

However, we would personally make the decision to spend more on advertising. This approach is a bit more risk-averse, as there is not a large differentiation in the expected value. It also uses a system already in place. As shown in Figure 7, advertisements have been implemented into the hiring process and are utilized effectively. Since the department knows that the advertisements are already successful, there is not too much risk of increasing the cost of advertising and risking a little bit to see if it will be more useful, especially since it is predicted to be. It may not be able to solve every issue but could aid in easing the stress and make the job of hiring a bit more streamlined.

Although recruiters can provide us with perfect information when it comes to recruitment and hiring employees, they would not necessarily be able to predict that the aquatic center will receive the highest number of expected visitors during the summer. There is always a slight chance that additional profit will not equal exactly $50,576.70, even with perfect information.

Appendix

Figure 1: Fundamental and Means Objective Tree

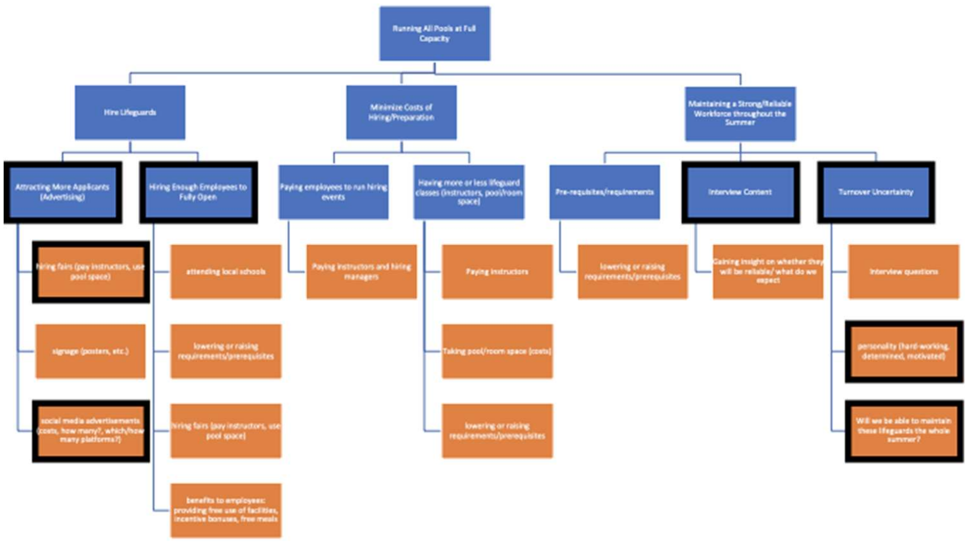

Figure 2: Binomial distribution calculated via BINOM.INV formula, with p = 0.95

FULL	5%	50%	95%
294	273	279	285
299	278	284	290
303	281	288	294
REDUCED			
219	203	208	213
255	236	242	248
237	219	225	230

Figure 3: Influence Diagram

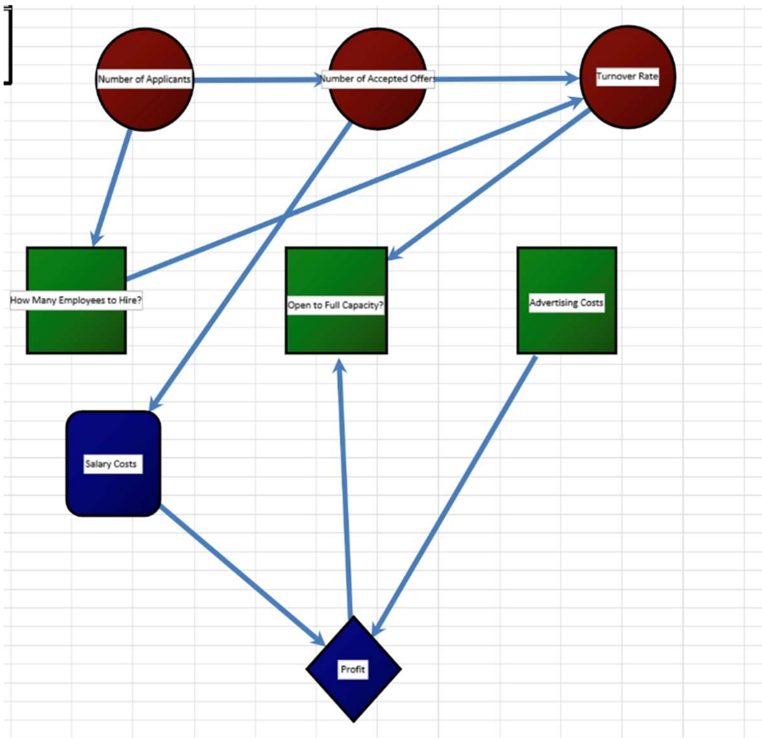

Figure 4: Triangle distribution for full and reduced capacity

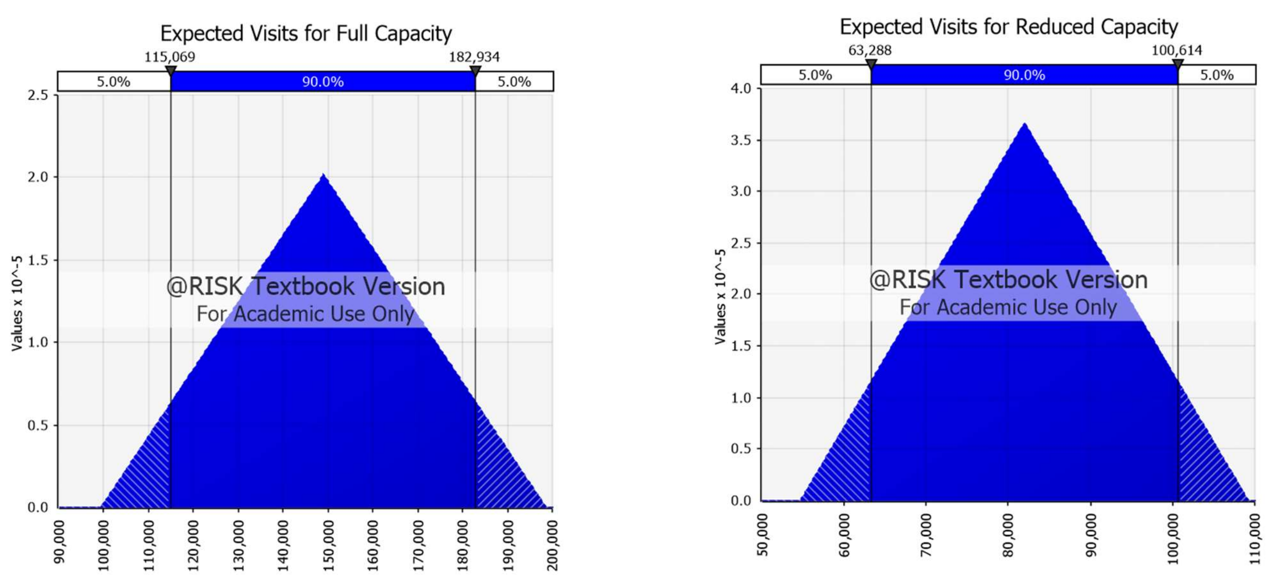

Figure 5: Cumulative risk profile

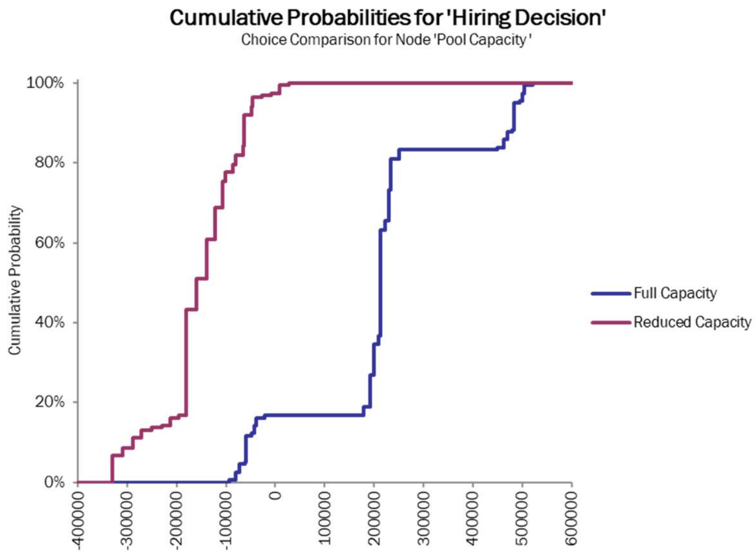

Figure 6: Decision tree for EVPI

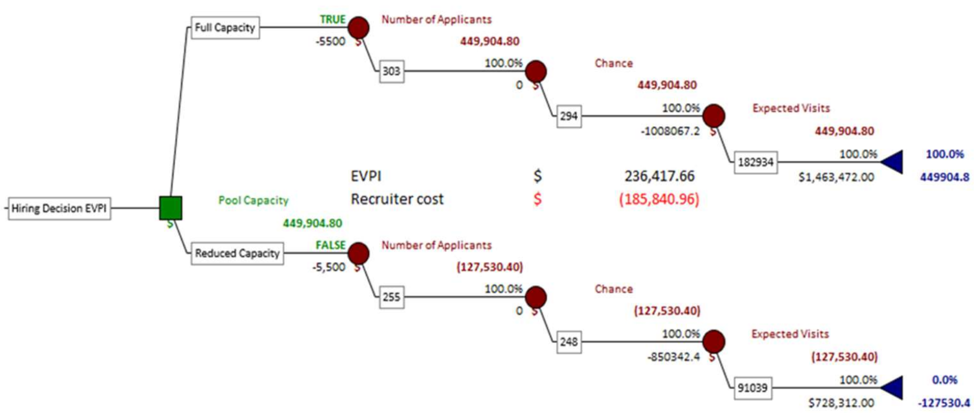

Figure 7: Advertisement Example

Figure 8: Cumulative Risk Profile for Advertising Alternative

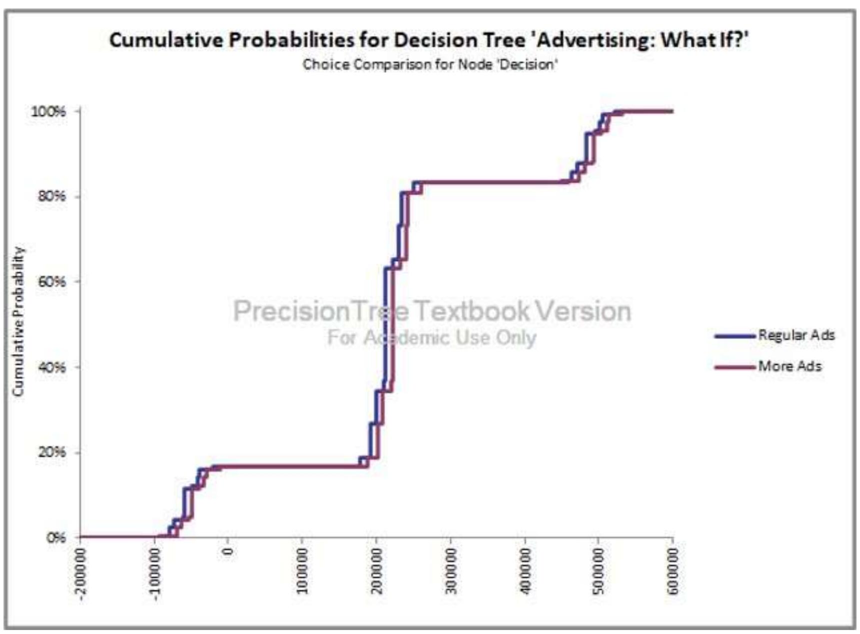

Fig 9: Guest Revenue Analysis

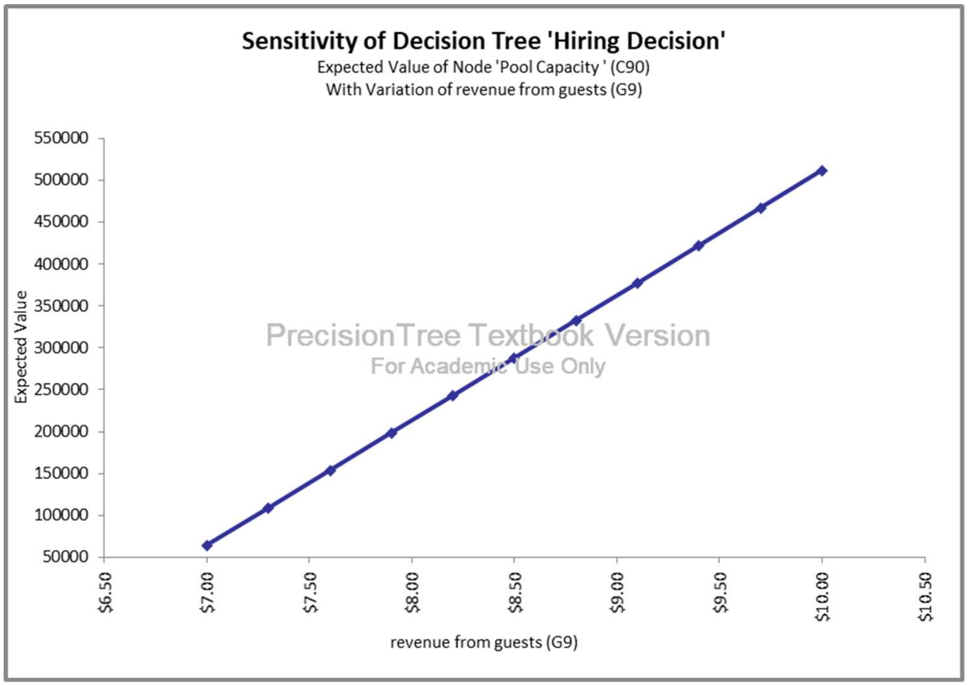

Fig 10: Advertising Cost Analysis

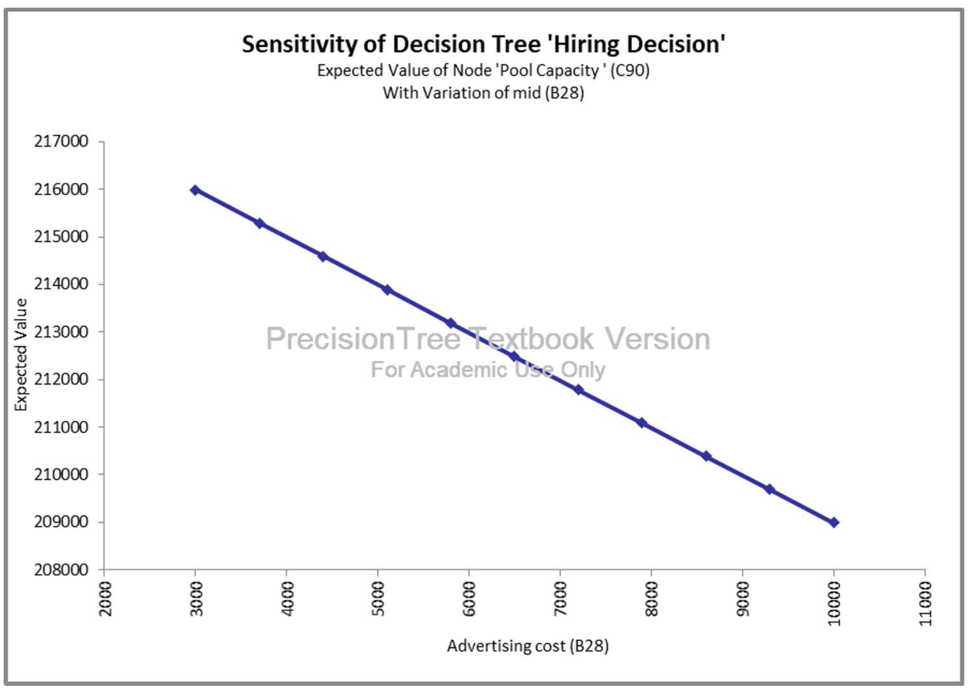

Fig 11: Pay Rate Analysis

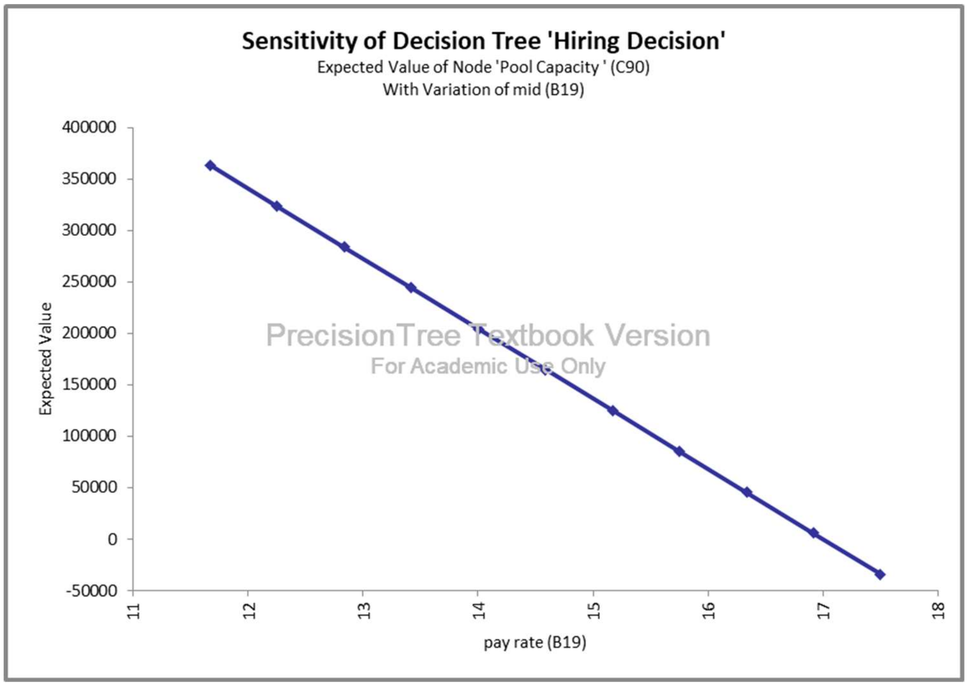

Fig12: Tornado Graph