Selecting the Best Laptop for College Graduate Students

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Table of Contents

1. Abstract

Buying a new computer can be a complicated and intimidating process in which one must make a decision after attempting to evaluate and weigh multiple criteria. In order to make the appropriate decision, one must understand how each criteria factors into the decision, and which criteria are more important than others. Furthermore, each set of criteria is determined by the intended use of the device by the buyer. The decision process can be simplified through the application of a decision making model which helps the buyer arrange criteria, weigh different factors, perform alternative comparison, and make a decision. This paper illustrates this process using the Hierarchical Decision Model (HDM) and Pair-wise comparison to aid in the selection of a laptop for college graduate students.

2. Introduction

A laptop has become an essential resource in a student's life irrespective of his age, course, or purpose, a laptop is mandatory, it's only the specifications that change according to the usage of buyer. In today's technologically advanced world, even if you know your need, it is difficult to find a laptop that fits your need because of the wide range of options available in the market. To avoid these mistakes and to make the complex decision of selecting a laptop simple, we have designed a decision making model. This is a comparison model that allows a user to select some important attributes that most of people consider while buying a laptop, and finally helps to decide what laptop to select from all available options that match with their purpose.

With Windows 8.1 here and Windows 10 on the way, Ultrabooks are losing their popularity and laptop-tablet hybrids seeing more releases, figuring out what is the best laptop is more difficult than ever. Cheap laptops, like Chromebooks, are more powerful and capable than ever nowadays, while high-end devices with high level specifications are often perfectly good replacements for any desktop computer, able to cope with more intensive programs. To pick the best laptop for your needs, it's important to start off by deciding what it is that you're going to be doing with it. Serious gamers will want a machine designed to their graphical and processing needs, while those after flexibility might prefer a convertible laptop-tablet hybrid. This decision modeling process is aimed to take complex decision making scenarios and simplify them to help the user make a selection with confidence.

3. Methodology

Buying a laptop is almost an essential task for a graduate student. To get what a student needs and expects for their investment is a challenging task because many students are left unhappy with the product that

they selected. We have built a model for the purchasing a laptop from a graduate students' perspective. What important features are required by the user? How do they prioritize the different attributes? What configuration would they like? All these are the basic questions that a student must answer before buying a laptop. After researching on different models for decision making, we selected pairwise comparison and the Hierarchical Decision Model (HDM) for this study as it is very efficient in comparing the different elements in respect to other elements. We have conducted a survey to understand the student needs better and came up with multiple related criteria for the questionnaire. The primary criteria consists of Price, OS type, Configuration and size. The second criteria is the OS. The third criteria consists of features, the size being the last criteria. We have provided a tabular form in each criteria, where the students who took the survey can assign weightage between two different elements, on a scale of 100(1-99).

Five experts were asked to take a survey and the results are analyzed. Pair wise comparison model was used to weigh between the key features which are involved in the decision making process to buy a laptop. In the survey we considered each element and the weightage assigned to between two elements. Using the Hierarchical Decision Model (HDM) tool, we calculated the priority between all the attributes (like in A&B, B&C, C&A among A, B, &C) using the weightages assigned in the four criteria. The results are then calculated by the HDM tool, where we analyzed these weights. Then we calculated relative total weight values, using which we created utility curves. HDM is a tool that helps with rational decision making and also reduces the bias as it forces the expert to choose between the alternatives independent of each others.

4. Decision Model

Purchasing a laptop is an important decision for students which involves many different considerations and affected by many factors. Some of these factors include: technical specifications, features, style, practicality, cost, opinions from others, needs and expectations. Through the use of the pairwise

comparative model, we can weigh all the different alternatives involved in the decision making process in order to achieve the right decision according to your needs and preferences.

The tool used in order to analyze the results is called HDM (Hierarchical Decision Model), which assists the decision maker in making rational decisions. It helps in reducing bias due to the fact that it forces the expert to choose between different criteria independent to the decision. The process for creating an HDM involves a few steps. The first step is to select the main criteria, meaning what influences students the most when purchasing a laptop. Then the main criteria can be broken down into sub criteria. Now the model can be developed and a survey is sent to experts in order for them to weight the different criteria. Each criteria compared is under the same level.

In this case, there were five experts involved in weighting the different criteria through a survey. This criterion was selected through discussion and brainstorming of the same five experts in order to make sure all the main attributes were included in the study.

a. Criteria and Sub criteria

Through research and personal experience in the technological retail environment, we were able to determine and establish the criteria for the model. After this information was set, a survey was made to students to specify the priority or importance of the top alternatives. This criteria involves:

i. OS Type:

Operating systems is the software that operates the hardware and the software resources of a computer. There are various types of OS such as Linux, Windows and Macintosh. Depending on a user needs and preferences then they would choose that OS type accordingly. There are two categories in our study:

- IBM PC Compatible: This includes everything that is IBM compatible such as Linux and Windows based platforms.

- Apple Macintosh: This category includes the Apple Macintosh OS, which is the only one in its group.

ii. Configuration/Features:

In this section is hardware specifications that a student would be interested in while purchasing a laptop depending on what software they need and the desired performance capabilities.

- CPU (Central Processing Unit): Commonly known as the processor of the device which is the electronic circuitry within a computer that carries out the instructions of a computer program. It is important depending on the software to be ran. If it is light software such as basic Office then lower CPU speed would suffice, otherwise a heftier one might be needed.

- RAM (Random Access Memory): It is a form of data storage, which allows data to be read and written in the same amount of time no matter the order that this data came in. In order words this affects your multi-tasking capabilities and also the booting up of certain software. For example, someone using Adobe Photoshop might want at least 8GB of RAM vs just 2GB.

- Hard Disk Size: This is the computer's permanent storage, this is important to store files. There are two types of hard drives including solid state or optical drive.

- Graphic Capabilities: This usually refers to the graphics card and its performance capabilities. The graphic card generates output images to display which are important for students in graphic design or game development. Screen resolution

gives a better quality and more accurate image which is important in case the user needs to see details.

iii. Battery Life:

As a student it is important to know how often you need to charge your laptop, especially if you travel a lot and use your computer at all times. There are three different categories in our survey that classify the level of usage of each user.

- ○ >6 hours
- ○ 6-12 hours
- ○ 12-20 hours

iv. Size:

A laptop's size is important depending on what you are planning to use it for and how much you are travelling. For a student who carries the laptop everywhere they go, then a lighter weight might be more convenient. On the other hand, if you are just going to mainly use it at home then weight, size might be such a decisive factor. Screen size is important for students with bad vision, or that are going to use it to watch movies or want a screen that has more space to work on.

- ○ Weight: Heavy vs a light.
- ○ Dimensions: thickness, and area.
- ○ Screen Size: small, medium or large screen.

b. Alternatives

When it comes to graduate students, doing research is a common activity. Therefore, it is fair to assume that in order to purchase a laptop there is going to be research involved. A popular

consumer website, www.laptogmag.com, was used in this case to look at some of the best alternatives offered for this year (2015). These alternatives include (see appendix for details on each laptop):

- Alternative 1. Top laptop overall Laptop: Dell XPS 13

- Alternative 2. Best Video Editing Laptop: Apple R-MBP 15

- Alternative 3. Best cheap Laptop: Asus X205TA

- Alternative 4. Best Battery Life Laptop: Lenovo X240

- Alternative 5. Best Gaming Laptop: MSI GT80 Titan SLI

- Alternative 6. Best OS X Laptop: Apple MB Air 11"

These alternatives covered all the main characteristics, technical specs, and types of systems that might appeal to a graduate student such as: high performance, low cost, business class, lightweight, portable and decent battery life.

c. Assumptions

There are many factors influencing the decision of purchasing a laptop; therefore a few assumptions had to be made when creating the decision model.

- The survey is targeted towards graduate students, so assumptions have to be made that the survey responses represent the majority of opinion of that segment of the population.

- The first round of the criteria is assumed from our own expertise as students therefore showing some bias towards our own preferences, beliefs and past experiences.

- Criteria can have different meaning to different people, the criteria was made as clear as possible so that all experts be at the same level of understanding.

- Acting as experts on this topic, one student respondent was asked to define utility curve values for each of the criteria, based on relative knowledge regarding each item.

- Criteria can have different meaning to different people, the criteria was made as clear as possible so that all experts be at the same level of understanding but interpretation is something that cannot be controlled at the moment.

d. The Decision Model

The pairwise comparison model compares entities in pairs to judge which one is the preferred one by assigning weights to the criteria, see figure 1. The reasoning behind using this model is because there are more than two criteria in order to make the decision of purchasing a laptop. This method allows a ranking scheme of importance in respect to the other criteria.

The method involves: identify the criteria, arrange the criteria in an NxN Matrix, compare pairs, create the ranking and assigning the weights. Some of the weaknesses of this model includes: prone to ties, the method is time-consuming, and it could lead to bias answers due to many alternatives.
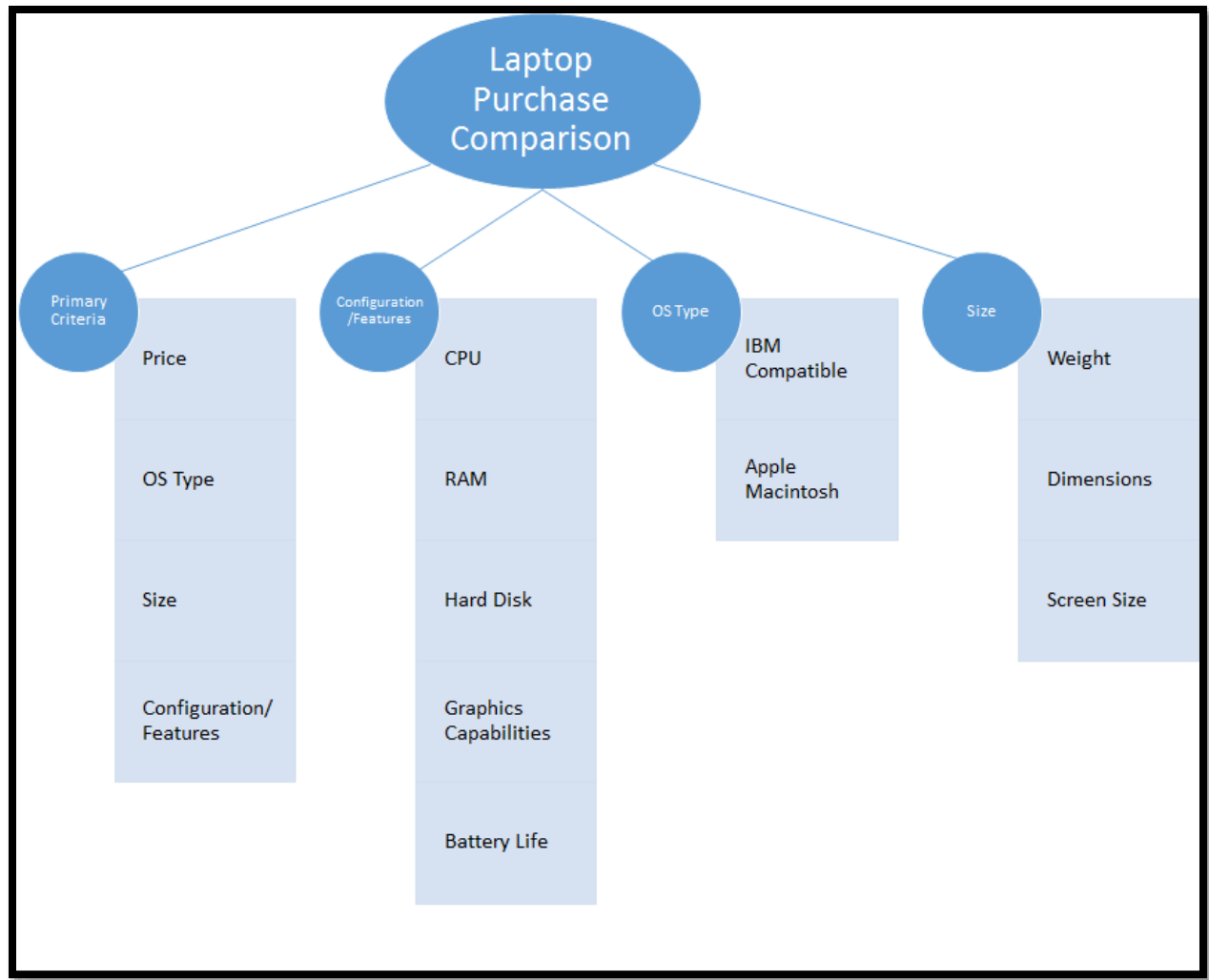
Figure 1. Pairwise comparison Model of Buying a Laptop

5. Implementation

a. Generate A Survey Targeting Experts:

In order to understand the requirements for buying a laptop, we have conducted a survey among graduate students. The survey is targeted towards graduate students, so assumptions have to be made that the survey responses represent the majority of opinion of that segment of the population. Firstly, we have created a questionnaire which is illustrated in appendix b. We created a questionnaire survey based on the pairwise comparison and HDM model. The

questionnaire is categorized into four sections mainly Price, OS type, Configuration/Features, and Size criteria's.

b. Input Survey Results Into HDM Tool:

The survey result was given as input to the HDM tool, which evaluated relative weights of subjective decisions to reach a ranking among the alternatives. To choose best laptop we divided into four criteria in the model and gave our inputs (survey results) for all the four criteria as shown in the responses. When the HDM tool was stimulated with given inputs it provided us output from which we got mean, minimum, maximum, std. deviation and disagreement values as show in tables 1 - 6.

c. Normalize Survey Results:

The results and the mean of each result gave us a weighted average of norms describing what the experts in our project believed were important. The comparison determined the relative importance for each criterion with respect to the main objective, and then we determined the relative weight each sub-criterion has from the main criterion. Multiplying these weights as shown in table 4&5, and comparing them with the alternatives gives us how much each sub-criterion we defined compensate in the decision making for the ultimate goal.

d. Identify Alternatives For Comparison:

Our assumption is that graduate students today will do basic research to determine what laptops they should consider before weighing alternatives and making a decision. The results from the questionnaire are given to the HDM tool. The results obtained from HDM are compared with popular consumer websites, we selected six alternatives for comparison that were listed on their recently selected "Best Laptops of 2015" guide. These alternatives covered different types of

systems that might be appealing to graduate students and related to our survey questionnaire, which include:

- ◦ High performance systems

- ◦ Low cost systems

- ◦ Business class systems

- ◦ Lightweight and portable systems

e. Plot Alternatives Using Utility Curve Method:

To evaluate each alternative with respect to the sub-criteria we have determined the relative weight with respect to the main objective. We constructed utility curves from the expert's ratings according to percentage given to each sub-criterion. We have plotted the experts' preference or rating of importance for the sub-criteria with respect to each criterion while assigning a value of 100 to the best case and a value of 0 to the least case. All utility curves are shown in appendix d. The alternatives are then plotted on each corresponding curve and the utility value of each alternative is calculated from the curve. All alternatives' specifications and their corresponding utility values are shown in table 7.

f. Compare Alternatives & Make A Recommendation:
After implementing and reviewing the model to validate our data, we considered six different alternatives from popular consumer site that were compared with the survey results and the output was similar as shown in the table 7.

6. Results and analysis

After getting our results from the experts, these were entered into the HDM tool for analysis. There are 5 experts and 4 main criteria. Table #1 show the average results for every main category for each expert

individually with a summary of the average value (mean), the smallest value (min) , the highest value (max) and the standard deviation which tells us the amount of variation for each criteria. We can see price falls last with the lowest mean of 0.18 which means that this happens to be the least influential to our group of experts when purchasing a laptop. It also has standard deviation of 0.07, a minimum of 0.12 and a maximum of 0.07. The most important criteria, from the results in Table #1, is configuration and features with a mean of 0.38. The minimum is 0.29, the maximum is 0.48 and the standard deviation is 0.06. The second most important criteria is a tie between OS Type and Size with a mean of 0.23. The rest of the results for OS Type are: a minimum of 0.19, a maximum of 0.32 and a standard deviation of 0.05. The other results for the Size criteria are: a minimum of 0.17, a maximum of 0.3 and a standard deviation of 0.05.

Best Laptop	Price	OS Type	Configuration & Features	Size	Inconsistency
Amitabha Worcester	0.12	0.23	0.48	0.17	0.07
Jacqueline McPherson	0.17	0.19	0.34	0.3	0.03
Kranthi Reddy	0.14	0.32	0.37	0.18	0.05
Pratheek Chintala	0.13	0.19	0.4	0.28	0.02
Shiva Singireddy	0.32	0.2	0.29	0.2	0
Mean	**0.18**	**0.23**	**0.38**	**0.23**	
Minimum	0.12	0.19	0.29	0.17	
Maximum	0.32	0.32	0.48	0.3	
Std. Deviation	0.07	0.05	0.06	0.05	

Table 1. Results of Primary Criteria

Table #2 shows the details of the Operating Systems criteria and its respective sub-criteria. There are two sub-criteria: IBM PC Compatible and Apple Macintosh with a mean of 0.53 and 0.47 respectively. In this

case our experts show a preference for the IBM PC Compatible machines when making the decision of purchasing a laptop. The minimum is 0.2; the maximum is 0.99 and the standard deviation of 0.29 for the IBM sub-criteria. On the other had for the Apple Macintosh sub-criteria, the minimum is 0.01, the maximum is 0.8 and the standard deviation of 0.29 for the IBM sub-criteria. The disagreement for this table is a 0.29, which is very high the reasoning behind this is that some of the experts in particular one is very one sided to the OS type of his/her laptop.

Operating System	IBM PC Compatible	Apple Macintosh	Inconsistency
Amitabha Worcester	0.25	0.75	0
Jacqueline McPherson	0.5	0.5	0
Kranthi Reddy	0.99	0.01	0
Pratheek Chintala	0.2	0.8	0
Shiva Singireddy	0.7	0.3	0
Mean	0.53	0.47	
Minimum	0.2	0.01	
Maximum	0.99	0.8	
Std. Deviation	0.29	0.29	

Table 2. Results of Secondary Criteria: Operating Systems

Table #3 shows the details of the Technical Features criteria and its respective sub-criteria which includes CPU, RAM, Hard Disk, Graphics Capabilities and Battery Life. The most influential sub-criteria in this main criterion is the RAM with a mean of 0.24, a minimum of 0.2, and a maximum of 0.28 and a standard deviation of 0.03. The second most influential, following very closely, is the Battery Life with a mean of 0.23 (only 0.01 difference from the top choice), a minimum of 0.15, a maximum of 0.34 and a standard deviation of 0.08. The third most influential is the Hard Disk with a mean of 0.19, a minimum of 0.13, and

a maximum of 0.23 and a standard deviation of 0.03. The least influential of the 5 sub-criteria are a tie between the CPU and the graphics capabilities with a mean of 0.17. The technical features criteria shows a disagreement of 0.05.

Technical Features	CPU	RAM	Hard Disk	Graphics Capabilities	Battery Life	Inconsistency
Amitabha Worcester	0.23	0.21	0.13	0.28	0.15	0.02
Jacqueline McPherson	0.14	0.25	0.18	0.09	0.34	0.01
Kranthi Reddy	0.23	0.28	0.21	0.12	0.17	0.01
Pratheek Chintala	0.12	0.25	0.18	0.27	0.19	0.02
Shiva Singireddy	0.15	0.2	0.23	0.11	0.3	0
Mean	**0.17**	**0.24**	**0.19**	**0.17**	**0.23**	
Minimum	0.12	0.2	0.13	0.09	0.15	
Maximum	0.23	0.28	0.23	0.28	0.34	
Std. Deviation	0.05	0.03	0.03	0.08	0.08	

Table 3. Results of Secondary Criteria: Technical Features

Table #4 shows the details of the Physical Characteristics criterion and its respective sub-criteria which including weight, dimensions and screen size. The most important in this case is the weight with a mean of 0.4, a minimum of 0.21, a maximum of 0.64 and a standard deviation of 0.15. This is followed by screen size with a mean of 0.34, a minimum of 0.26, a maximum of 0.45 and a standard deviation of 0.07. Then the leas influential in the decision making of buying a laptop for this category is; dimensions with a mean of 0.26, a minimum of 0.1, a maximum of 0.34 and a standard deviation of 0.09. This section shows a disagreement of 0.1.

Physical Characteristics	Weight	Dimensions	Screen Size	Inconsistency
Amitabha Worcester	0.29	0.33	0.38	0
Jacqueline McPherson	0.43	0.29	0.29	0
Kranthi Reddy	0.64	0.1	0.26	0.05
Pratheek Chintala	0.43	0.24	0.32	0.02
Shiva Singireddy	0.21	0.34	0.45	0
Mean	0.4	0.26	0.34	
Minimum	0.21	0.1	0.26	
Maximum	0.64	0.34	0.45	
Std. Deviation	0.15	0.09	0.07	

Table 4. Results of Secondary Criteria: Physical Characteristics

Table #5 summarizes the weights and the relative weight for each criteria and sub-criteria. As we can see, from the weight results, Configuration and Features is the one that dictates the decision making process for graduate students purchasing a laptop. Followed by OS Type and size tied on second place, and finally but not least price.

Criteria	Weight	Relative	Final
Price	0.18		0.18
OS Type	0.23		
IBM PC Compatible		0.53	0.1219
Apple Macintosh		0.47	0.1081
Configuration & Features	0.38		
CPU		0.17	0.0646
RAM		0.24	0.0912

Hard Disk		0.19	0.0722
Graphics Capabilities		0.17	0.0646
Battery Life		0.23	0.0874
Size	0.23		
Weight		0.4	0.092
Dimensions		0.26	0.0598
Screen Size		0.34	0.0782
Sum			1

Table 5. Summary of Total Weights

In order to analyze our results and be able to give a recommendation out of the six alternatives mention earlier, we have to run the data gather through utility curves so we can get a score at the end and see which laptop is the best option for graduate students. This has to be done with each criteria included in the survey, in other words there is a utility curve for price, CPU, RAM, Hard drive, graphics capabilities, battery life, weight, dimensions (thickness) and screen size.

For each one of these there is the top choice which gets a score of 100 and a bottom choice which gets a value relative value score which is obtain by dividing 100 by the number of alternatives. Every values in between these two gets a value with the comparative difference on the graph. For example, Table 5 demonstrates the utility curve for price for each of the alternatives chosen. In this case we see that A3 has a utility value of 100, making it the cheapest laptop therefore the most preferred. Then A1, A6 with 83.1, followed by A4 with 49.99, then A2 with 33.33, and A5 with 16.66; this shows the 16.66 increments from the lowest to the top. See appendix for all utility curves.
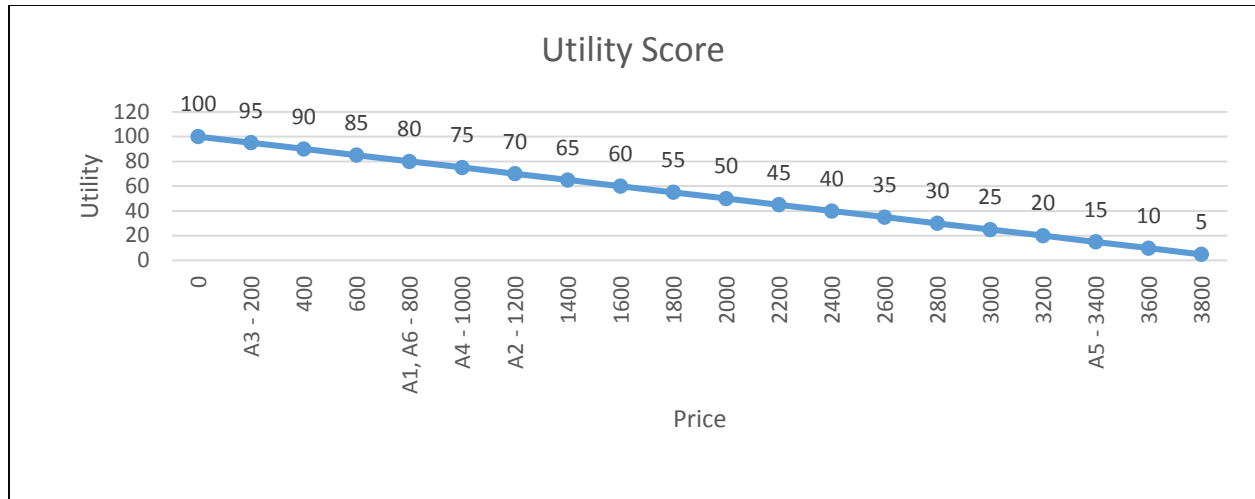
Table 5. Utility Curve for Price

Now that we have gather the utility curve values, these are multiplied by the weight shown in table 4. Price has a weight of 0.18 which is used to give us the final score of each alternative in respect to the criteria. All the final scores are shown in Table 6, from where alternative A1 is chosen: Dell XPS 13 laptop. This is the same result laptopmag.com shows on their website as the best overall laptop for 2015.

Criteria	Relative Weight	A1	A2	A3	A4	A5	A6
Price	0.18	14.4	12.6	**17.1**	13.5	2.7	14.4
OS	0.23	23	23	23	23	23	23
CPU	0.0646	4.04	3.23	0.81	1.62	**5.65**	2.42
RAM	0.0912	2.28	4.56	1.14	4.56	**9.12**	2.28
HD Size	0.0722	0.82	0.82	0.21	1.65	**7.22**	0.82
Graphics	0.0646	4.31	5.38	1.08	2.15	**6.46**	3.23
Battery Life	0.0874	6.87	6.24	7.49	**8.74**	1.25	5.62
Weight	0.092	8.52	7.61	**9.09**	7.84	0.23	8.86
Dimensions	0.0598	**5.38**	4.19	4.49	3.89	0.6	5.98
Screen Size	0.0782	2.93	4.89	0.98	2.93	**7.82**	0.98
Total Score		**72.55**	72.52	65.38	69.88	64.05	67.59

Table 6. Results and Recommendations

7. Conclusion

In this project we came to learn that the decision process is very essential in every decision making process. By understanding and determining the key criteria individually and then comparing, we can rank the choices according to decision maker or experts. There were five experts who took the surveys for pair wise comparison but the results can be accurate when larger groups take up the pair wise comparison. The model can be further expanded by adding more criteria and sub criteria. Unlike decisions such as which laptop to buy, other decisions can also be made according to necessity and the preference of the experts, which might impact the decision making process. We made the utility curves on entirely personal preferences and they could be more realistic and accurate if those preferences are based on actual probabilities. Overall, the decision making process proved to be valuable in comparing non-numerical data and abstract comparison in order to reach a final and conclusive decision. This decision was further validated in this example by illustrating that the best laptop selected through this process also matched the best overall laptop selected by www.laptopmag.com.

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9. Appendix

a. Alternatives

Alternative 1. : Dell XPS 13 LaptopMag - Top Laptop Overall:

Specification Name	Value
Price	$ 799
Operating System	MS Windows
CPU	Intel Core i5-5200U
RAM	4 GB
Hard Disk	128 GB
Graphics Capabilities	Intel HD Graphics 5500
Battery Life	11 Hours
Weight	2.6 Lbs
Dimensions	11.98 x 7.88 x 0.33 Inches
Screen Size	13 Inch

Alternative 2. Apple R-MBP 15 LaptopMag - Best Video Editing Laptop:

Specification Name	Value
Price	$ 1299
Operating System	Apple Macintosh
CPU	Intel Core i5-4278U
RAM	8 GB
Hard Disk	128 GB
Graphics Capabilities	Intel Iris
Battery Life	10 Hours
Weight	3.4 Lbs
Dimensions	12.35 x 8.62 x 0.71 Inches
Screen Size	15 Inch

Alternative 3. Asus X205TA LaptopMag - Best Cheap Laptop:

Specification Name	Value
Price	$ 199
Operating System	MS Windows
CPU	Intel Atom Z3735
RAM	2 GB
Hard Disk	32 GB
Graphics Capabilities	Intel HD
Battery Life	12 Hours
Weight	2.16 Lbs
Dimensions	11.2 x 7.6 x 0.6 Inches
Screen Size	11 Inch

Alternative 4. Lenovo X240 LaptopMag - Best Battery Life Laptop:

Specification Name	Value
Price	$ 999
Operating System	MS Windows
CPU	Intel Core i5-4200U
RAM	8 GB
Hard Disk	256 GB
Graphics Capabilities	Intel HD 4400
Battery Life	14 Hours
Weight	3.2 Lbs
Dimensions	12 x 8.2 x .8 Inches
Screen Size	13 Inch

Alternative 5. MSI GT80 Titan SLI LaptopMag - Best Gaming Laptop:

Specification Name	Value
Price	$ 3399
Operating System	MS Windows
CPU	Intel Core i7-4720HQ
RAM	16 GB
Hard Disk	1.1 TB
Graphics Capabilities	Dual Nvidia GeForce GTX 980M
Battery Life	2 Hours
Weight	9.9 Lbs
Dimensions	17.95 x 13 x 1.9 Inches
Screen Size	18 Inch

Alternative 6. Apple MB Air 11 LaptopMag - Best OS X Laptop:

Specification Name	Value
Price	$ 889
Operating System	Apple Macintosh
CPU	Intel Core i5-4260U
RAM	4 GB
Hard Disk	128 GB
Graphics Capabilities	Intel HD Graphics 5000
Battery Life	9 Hours
Weight	2.38 Lbs
Dimensions	11.8 x 7.56 x 0.11 Inches
Screen Size	11 Inch

b. Survey

Laptop Purchase Comparison Survey

1: Primary Criteria:
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Price			OS Type
Price			Configuration/Features
Price			Size
OS Type			Configuration/Features
OS Type			Size
Configuration/Features			Size

A. Configuration / Features refers to the capabilities of the system including the CPU, RAM, Hard Disk Size, Graphics capabilities, and Battery Life.
B. Size refers to the overall footprint of the device including weight, dimensions, and screen size.
C. OS Type refers to IBM PC Compatible vs Apple Macintosh Compatible.

2: Secondary Criteria (OS Type):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
IBM PC Compatible			Apple Macintosh

3: Secondary Criteria (Configuration/Features):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
CPU			RAM
CPU			Hard Disk
CPU			Graphics Capabilities
CPU			Battery Life
RAM			Hard Disk
RAM			Graphics Capabilities
RAM			Battery Life
Hard Disk			Graphics Capabilities
Hard Disk			Battery Life
Graphics Capabilities			Battery Life

4: Secondary Criteria (Size):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Weight			Dimensions
Weight			Screen Size
Dimensions			Screen Size

c. Responses

Laptop Purchase Comparison Survey

1: Primary Criteria:
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Price	45	55	OS Type
Price	25	75	Configuration/Features
Price	25	75	Size
OS Type	25	75	Configuration/Features
OS Type	75	25	Size
Configuration/Features	75	25	Size

    A. Configuration / Features refers to the capabilities of the system including the CPU, RAM, Hard Disk Size, Graphics capabilities, and Battery Life.
    B. Size refers to the overall footprint of the device including weight, dimensions, and screen size.
    C. OS Type refers to IBM PC Compatible vs Apple Macintosh Compatible.

2: Secondary Criteria (OS Type):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
IBM PC Compatible	25	75	Apple Macintosh

3: Secondary Criteria (Configuration/Features):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
CPU	55	45	RAM
CPU	55	45	Hard Disk
CPU	50	50	Graphics Capabilities
CPU	65	35	Battery Life
RAM	65	35	Hard Disk
RAM	35	65	Graphics Capabilities
RAM	65	35	Battery Life
Hard Disk	35	65	Graphics Capabilities
Hard Disk	35	65	Battery Life
Graphics Capabilities	65	35	Battery Life

4: Secondary Criteria (Size):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Weight	45	55	Dimensions
Weight	45	55	Screen Size
Dimensions	45	55	Screen Size

Laptop Purchase Comparison Survey

1: Primary Criteria:
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Price	50	50	OS Type
Price	20	80	Configuration/Features
Price	30	70	Size
OS Type	40	60	Configuration/Features
OS Type	40	60	Size
Configuration/Features	60	40	Size

 A. Configuration / Features refers to the capabilities of the system including the CPU, RAM, Hard Disk Size, Graphics capabilities, and Battery Life.
 B. Size refers to the overall footprint of the device including weight, dimensions, and screen size.
 C. OS Type refers to IBM PC Compatible vs Apple Macintosh Compatible.

2: Secondary Criteria (OS Type):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
IBM PC Compatible	**20**	**80**	Apple Macintosh

3: Secondary Criteria (Configuration/Features):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
CPU	40	60	RAM
CPU	30	70	Hard Disk
CPU	30	70	Graphics Capabilities
CPU	40	60	Battery Life
RAM	70	30	Hard Disk
RAM	50	50	Graphics Capabilities
RAM	50	50	Battery Life
Hard Disk	40	60	Graphics Capabilities
Hard Disk	50	50	Battery Life
Graphics Capabilities	60	40	Battery Life

4: Secondary Criteria (Size):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Weight	70	30	Dimensions
Weight	50	50	Screen Size
Dimensions	50	50	Screen Size

Laptop Purchase Comparison Survey

1: Primary Criteria:
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Price	60	40	OS Type
Price	30	70	Configuration/Features
Price	30	70	Size
OS Type	45	55	Configuration/Features
OS Type	40	60	Size
Configuration/Features	60	40	Size

A. Configuration / Features refers to the capabilities of the system including the CPU, RAM, Hard Disk Size, Graphics capabilities, and Battery Life.
B. Size refers to the overall footprint of the device including weight, dimensions, and screen size.
C. OS Type refers to IBM PC Compatible vs Apple Macintosh Compatible.

2: Secondary Criteria (OS Type):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
IBM PC Compatible	50	50	Apple Macintosh

3: Secondary Criteria (Configuration/Features):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
CPU	40	60	RAM
CPU	40	60	Hard Disk
CPU	60	40	Graphics Capabilities
CPU	30	70	Battery Life
RAM	60	40	Hard Disk
RAM	70	30	Graphics Capabilities
RAM	50	50	Battery Life
Hard Disk	70	30	Graphics Capabilities
Hard Disk	30	70	Battery Life
Graphics Capabilities	20	80	Battery Life

4: Secondary Criteria (Size):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Weight	60	40	Dimensions
Weight	60	40	Screen Size
Dimensions	50	50	Screen Size

Laptop Purchase Comparison Survey

1: Primary Criteria:

For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Price	30	70	OS Type
Price	30	70	Configuration/Features
Price	40	60	Size
OS Type	60	40	Configuration/Features
OS Type	50	50	Size
Configuration/Features	80	20	Size

A.   Configuration / Features refers to the capabilities of the system including the CPU, RAM, Hard Disk Size, Graphics capabilities, and Battery Life.
B.   Size refers to the overall footprint of the device including weight, dimensions, and screen size.
C.   OS Type refers to IBM PC Compatible vs Apple Macintosh Compatible.

2: Secondary Criteria (OS Type):

For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
IBM PC Compatible	100	0	Apple Macintosh

3: Secondary Criteria (Configuration/Features):

For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
CPU	50	50	RAM
CPU	50	50	Hard Disk
CPU	60	40	Graphics Capabilities
CPU	60	40	Battery Life
RAM	60	40	Hard Disk
RAM	70	30	Graphics Capabilities
RAM	65	35	Battery Life
Hard Disk	60	40	Graphics Capabilities
Hard Disk	60	40	Battery Life
Graphics Capabilities	30	70	Battery Life

4: Secondary Criteria (Size):

For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Weight	80	20	Dimensions
Weight	80	20	Screen Size
Dimensions	20	80	Screen Size

Laptop Purchase Comparison Survey

1: Primary Criteria:
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
Price	60	40	OS Type
Price	55	45	Configuration/Features
Price	60	40	Size
OS Type	40	60	Configuration/Features
OS Type	50	50	Size
Configuration/Features	60	40	Size

A. Configuration / Features refers to the capabilities of the system including the CPU, RAM, Hard Disk Size, Graphics capabilities, and Battery Life.
B. Size refers to the overall footprint of the device including weight, dimensions, and screen size.
C. OS Type refers to IBM PC Compatible vs Apple Macintosh Compatible.

2: Secondary Criteria (OS Type):
For each row, please assign a total of 100 points between the two items.

ITEM A	SCORE	SCORE	ITEM B
IBM PC Compatible	**70**	**30**	Apple Macintosh

3: Secondary Criteria (Configuration/Features):
For each row, please assign a total of 100 points between the two items.

| ITEM A	SCORE	SCORE	ITEM B
CPU	45	55	RAM
CPU	40	60	Hard Disk
CPU	60	40	Graphics Capabilities
CPU	30	70	Battery Life
RAM	50	50	Hard Disk
RAM	60	50	Graphics Capabilities
RAM	40	60	Battery Life
Hard Disk	70	30	Graphics Capabilities
Hard Disk	45	55	Battery Life
Graphics Capabilities	30	70	Battery Life

4: Secondary Criteria (Size):
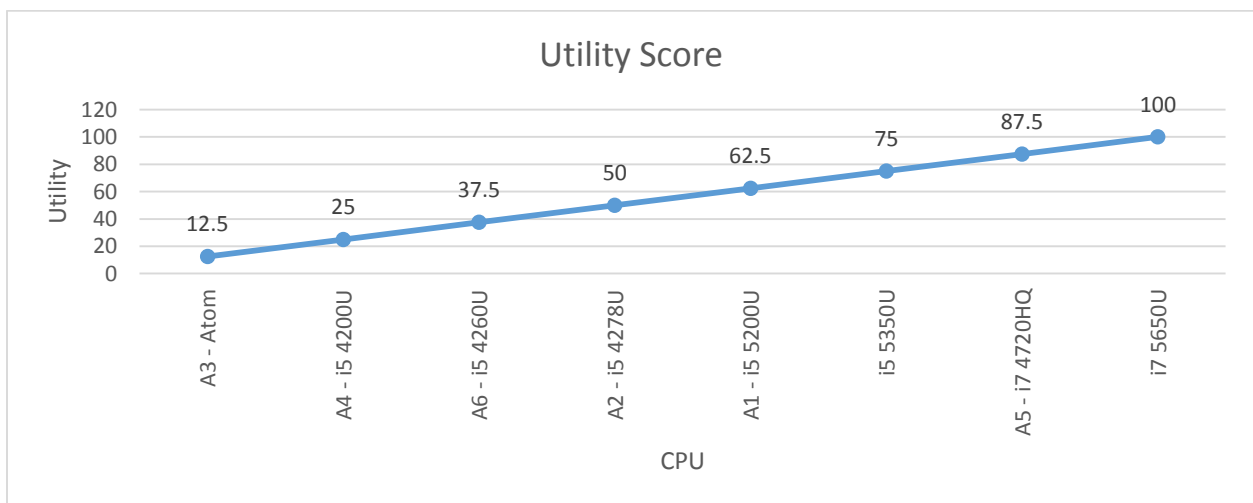For each row, please assign a total of 100 points between the two items.

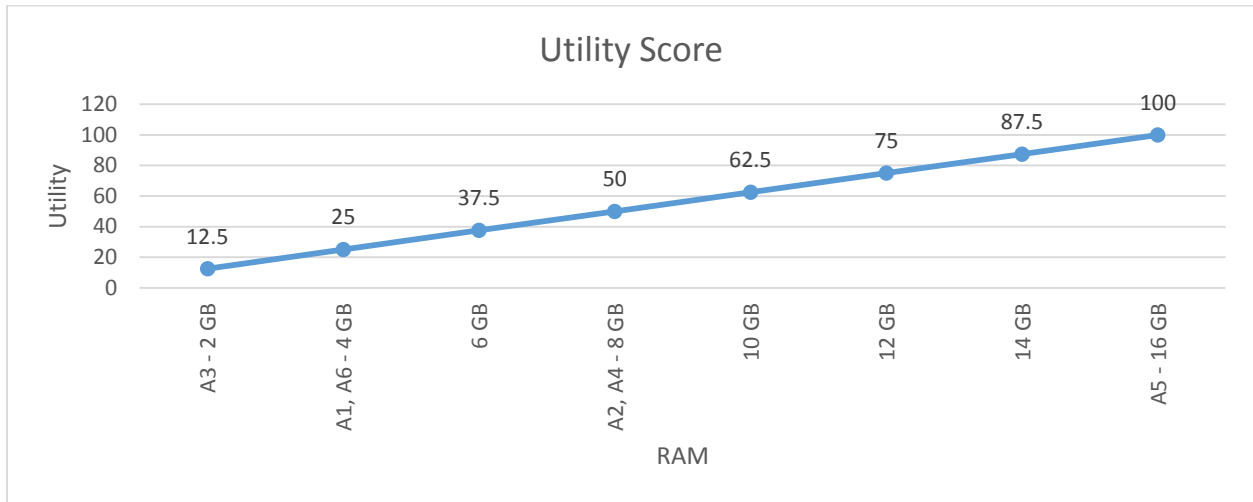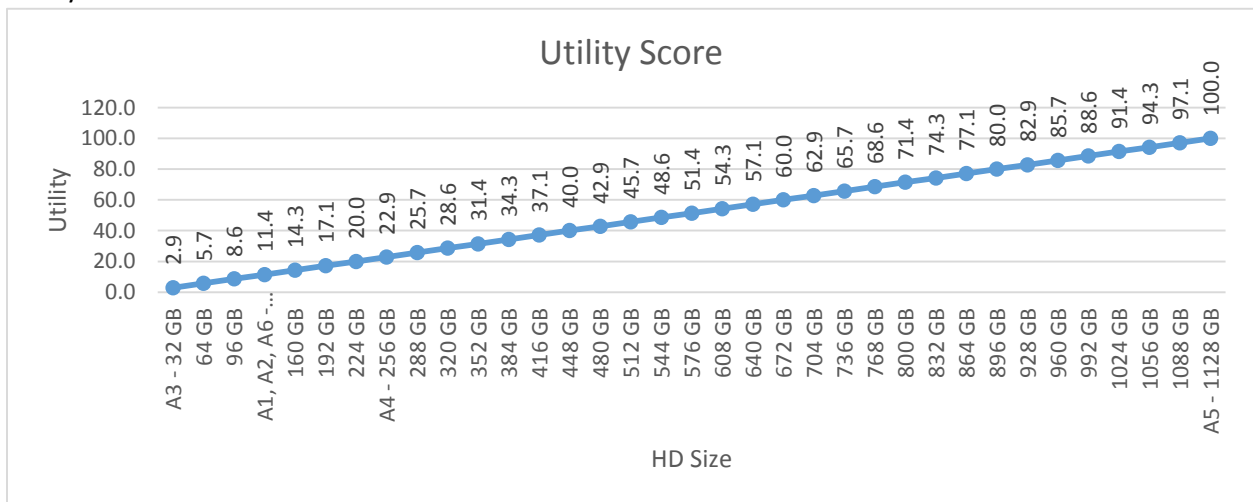| ITEM A	SCORE	SCORE	ITEM B
Weight	40	60	Dimensions
Weight	30	70	Screen Size
Dimensions	45	55	Screen Size

d. Utility Curves

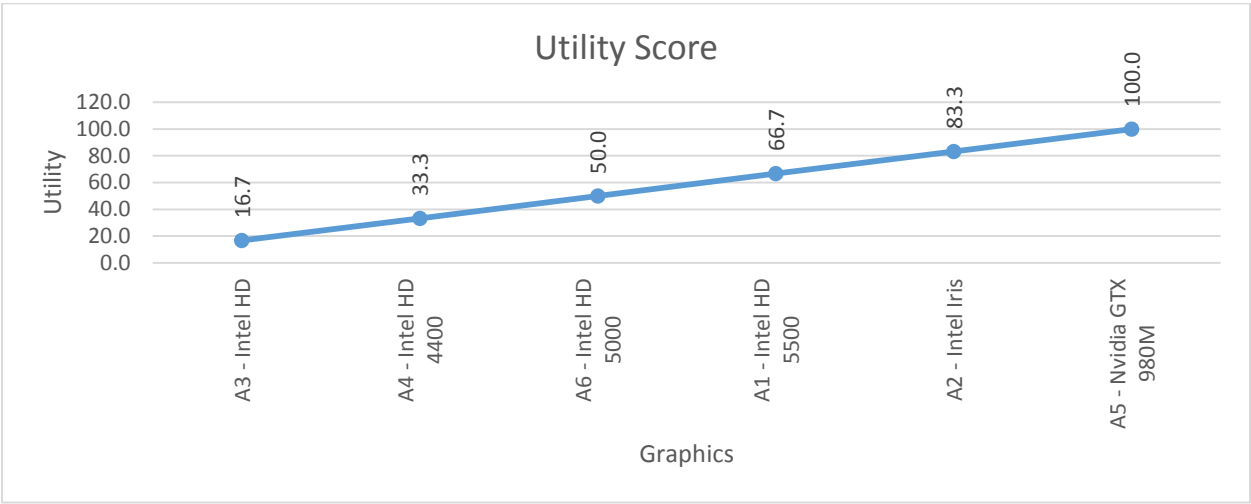Utility Curve for Price:
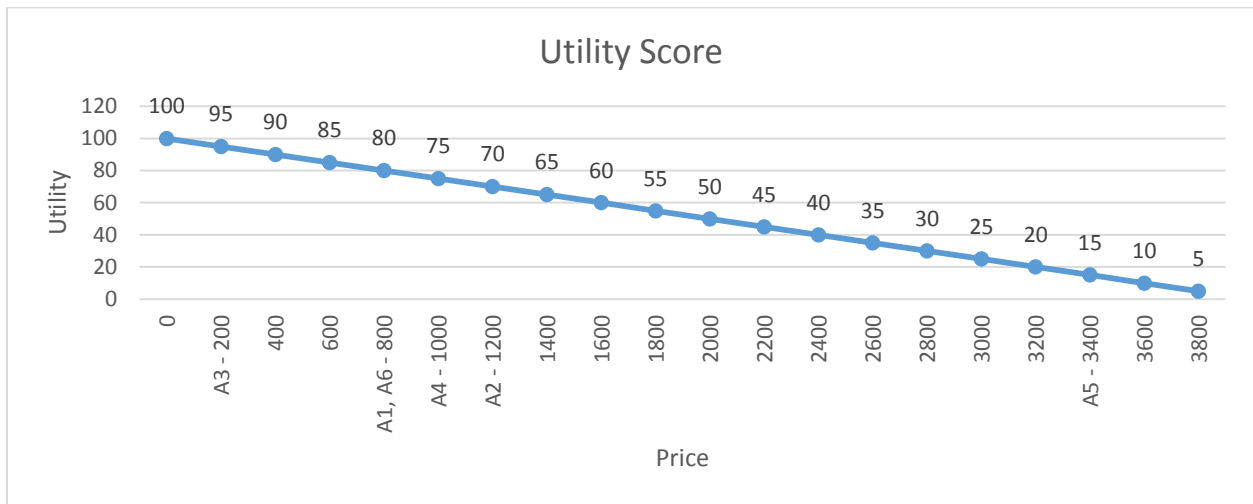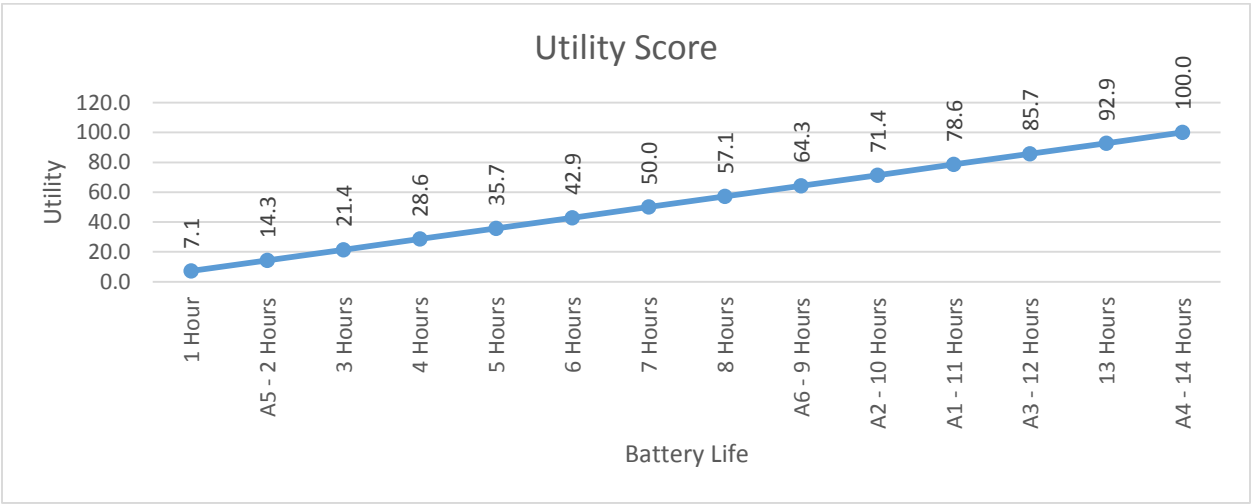

Utility Curve for CPU:

Utility Curve for RAM:

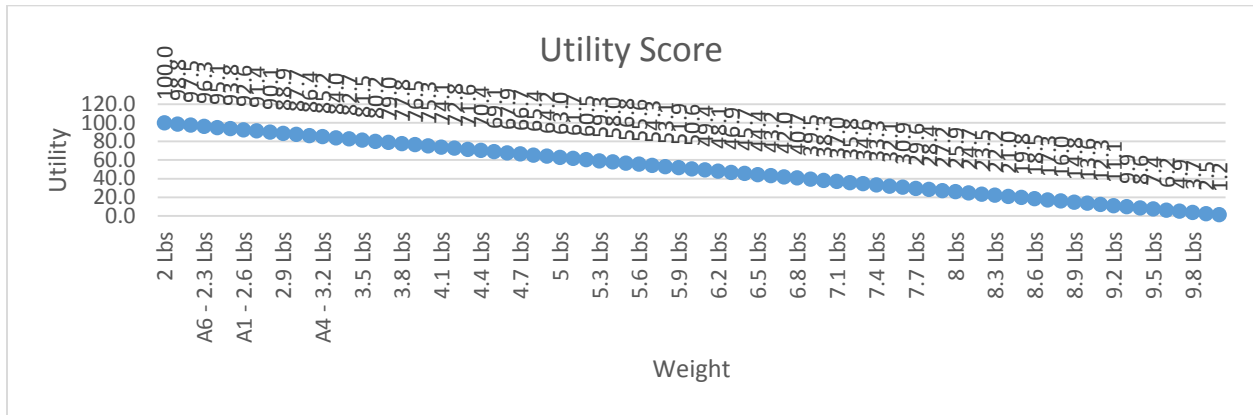

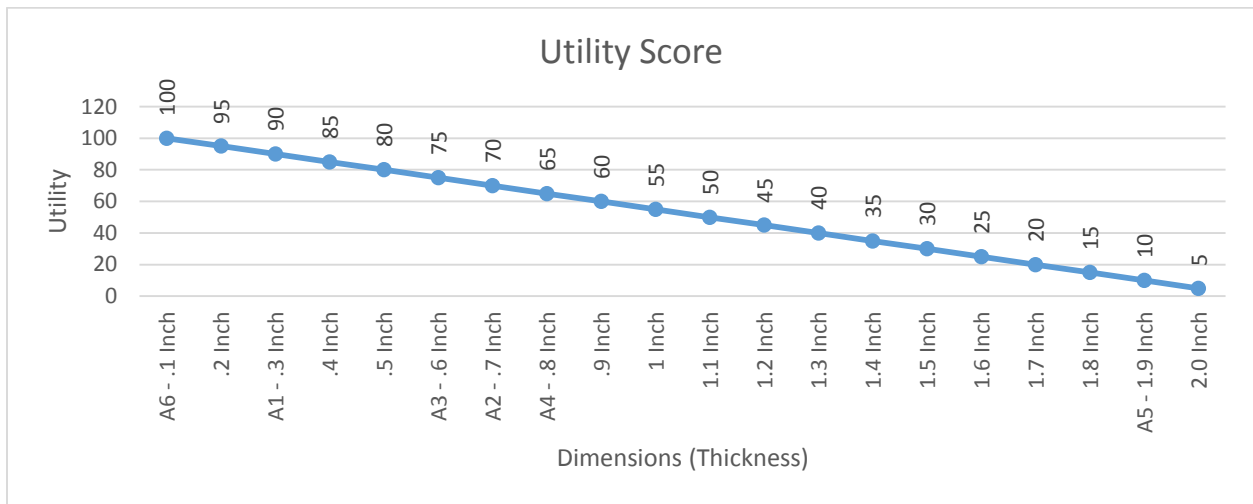Utility Curve for Hard drive size:

Utility Curve for Graphic Capabilities:

Utility Score

Utility vs Graphics

- A3 - Intel HD: 16.7
- A4 - Intel HD 4400: 33.3
- A6 - Intel HD 5000: 50.0
- A1 - Intel HD 5500: 66.7
- A2 - Intel Iris: 83.3
- A5 - Nvidia GTX 980M: 100.0

Utility Curve for Battery Life:

Utility Score

Utility vs Battery Life

- 1 Hour: 7.1
- A5 - 2 Hours: 14.3
- 3 Hours: 21.4
- 4 Hours: 28.6
- 5 Hours: 35.7
- 6 Hours: 42.9
- 7 Hours: 50.0
- 8 Hours: 57.1
- A6 - 9 Hours: 64.3
- A2 - 10 Hours: 71.4
- A1 - 11 Hours: 78.6
- A3 - 12 Hours: 85.7
- 13 Hours: 92.9
- A4 - 14 Hours: 100.0

Utility Curve for Weight:

Utility Curve for Dimensions:

Utility Curve for Screen Size: