TEAM PROJECT

APPLICATION OF HIERARCHY DECISION MODEL IN SELECTING A DSLR CAMERA

Team - 4

Course Title : **Decision Making**
Course Number : **EMGT 530**
Instructor : **Dundar F.Kocaoglu, Professor**
School : **Engineering and Technology Management, Portland State University**
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1. Introduction:

Shopping for a digital single-lens reflex (DSLR) camera would be stressful. A newcomer to the camera world will be presented with an array of options. It's hard to keep tracking of the various specifications, models, brand etc. Also, one cannot find "a best digital camera" with all the features incorporated in a single piece. There's no such thing as a perfect or the best camera. Often, many photographers end up discouraged and even more confused than when they started. Thus, it becomes important to spend a little time considering some basics that may affect the decision-making process. This paper will take a look at several factors worth taking into account when buying a DSLR camera.

In this paper, we will bring in decision making process of selecting the best DSLR camera for a professional. We will apply the Hierarchical decision modeling (HDM) tool proposed by Dr. D. F. Kocaoglu to a simple real life problem. The model breaks down the problem into less complicated smaller segments into a hierarchy. This tool formulates a decision process where either qualitative or quantitative judgments can be measured [1]. Three top rated DSLR cameras are considered and a comparison is made based on the user interested criteria, cost, and features. Our study reveals five different criteria as a base in structuring the decision model. Each of these major criterions is further divided into sub-criteria based on our team's judgment as experts in this project. Each of these sub-criteria contributes as a part of each major criterion's weight or relative importance. A mini-survey and pair wise comparison is implemented to measure preferences. The first level of the hierarchy denotes the main objective and the goals are analyzed in the lower levels. Thus our decision hierarchy is represented by tree diagram with goals, criteria and alternatives.

1.1 Objective:

The objective of this project is to implement the Hierarchical Decision Model methodology to determine the best DSLR camera for a professional photographer. One of our team members, who is planning to buy a DSLR camera will play the role of a professional photographer. She has few preferences with respect to features, but cost is an issue. Thus our model helps to find her a good DSLR camera within her search criteria and price range.

2. Methodology:

To help a professional photographer choose the optimal/ best DSLR camera, Hierarchical Decision Model (HDM) and Pair wise Comparison are used. The Hierarchical decision model is used to develop a solution to a decision problem, where the relationships are described in hierarchy. HDM structure will have the Objective on the top of the hierarchy and alternatives at the bottom. The top level will be followed by the criteria considered by professional users. Then, each criterion is broken down into sub criteria for more explanation on the attributes.

The PICMET paper, “Application of Hierarchical Decision Modeling for Selection of Laptop”, shows us a clear approach how to build the HDM model [2]. In order to evaluate three alternatives and determine which decision would be the best choice for professional photographers, there are 8 steps to follow as shown in Fig. 1.

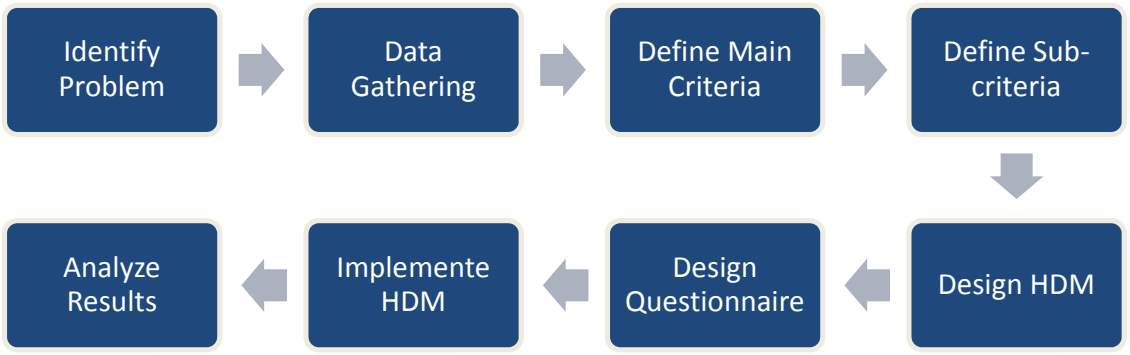


Fig. 1 Decision Approach

The features and characteristics of DSLR camera were found through online research [3]. In the next section, we will decide the criteria and sub criteria for evaluating a DSLR camera based on our expertise. The decision model used here is a combination using pair wise comparisons and the Hierarchical Decision Model. With the help of PCM software, the normalized value of each sub criterion is found.

2.1 Model building:

We establish our model following the above decision approach. Based on the different DSLR camera features we selected 23 sub-criteria which were narrowed down to 12 sub-criteria under 5 main criteria. The descriptions of these criteria and sub-criteria are explained in detail below.

1. Features:

- *Auto Focus (S1):* Auto Focus automatically adjusts the camera focus and makes picture taking easy.

- *Burst Mode (S2):* Continuous shooting mode that allows the photographer to shoot images continuously in rapid succession. It is measured in frames per second.

-*Sensor Size (S3):* It is the size of the digital sensor. The sensor size determines the image quality. Bigger the sensor is, better the image.

- *ISO Range (S4):* ISO Range refers to the sensitivity to light. Camera with a higher ISO Range will help the photographer shoot at faster shutter speeds giving less movement blur.

- *LCD Size/dots (S5):* The size of the LCD screen in inches. Because all three alternative cameras have the same size in LCD (3 inches), so we compare how many dots can be displayed in their LCD screen instead of the size of LCD.

- *Movie Mode (S6):* Camera with movie mode will record a video in mpeg/mpg or similar format.

2. Reliability:

- *Battery Life (S7):* Total number of hours a camera can withstand in standby mode.

- *Camera Stability (S8):* Stability while taking picture for better picture quality.

3. Cost:

- *Buying Cost (S9):* It is the price that is paid by the user to buy the camera.

4. Appearance:

- *Weight (S10):* The physical weight of the camera, measured by gram scale.

5. Customer Satisfaction:

- *Ease of Use (S11):* Ease with which the camera can be handled without any difficulty.

- *Warranty (S12):* Total numbers of years the supplier guarantees against manufacturing defects.

The hierarchy model is shown in Fig 2. It contains the overall objective and criteria broken down into sub criteria.

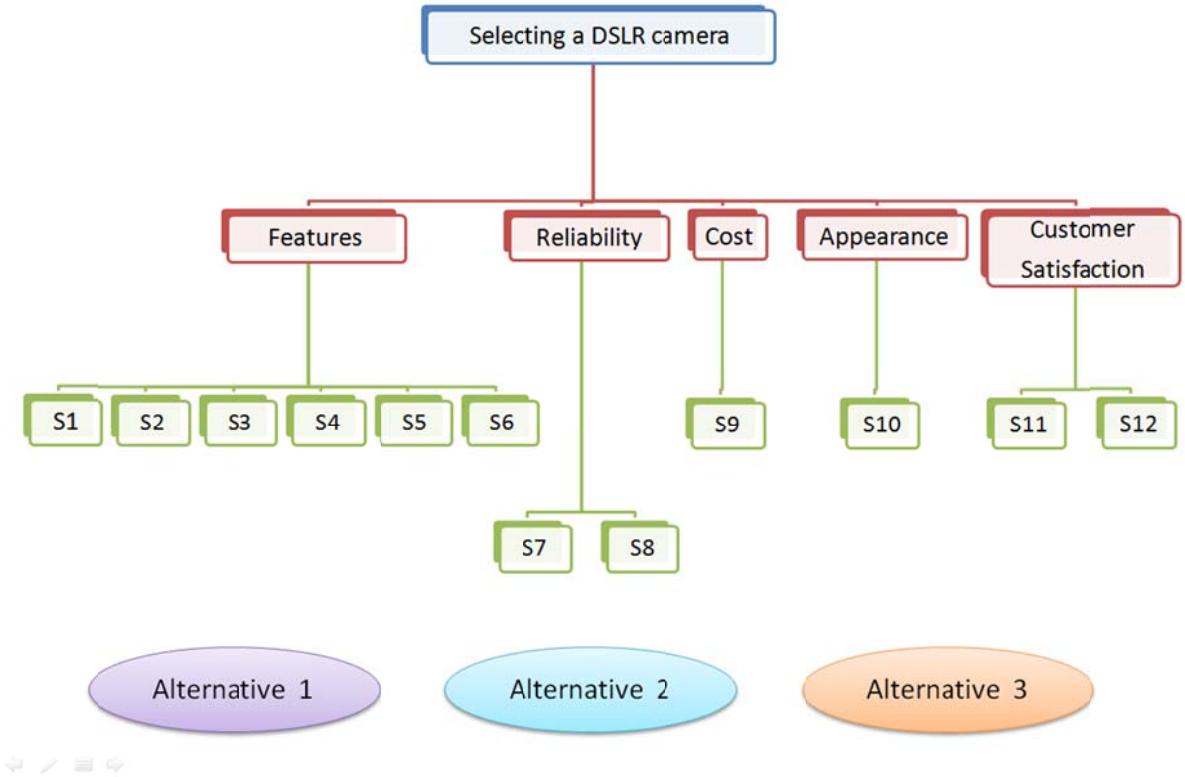


Fig.2 The hierarchy decision model of selecting a DSLR camera

The three alternatives considered are (See Appendix 1):

1. Canon SLR EOS 60D
2. Nikon SLR D7000
3. Olympus SLR E-5

DSLR cameras are often preferred by the professional photographers because they accommodate a wide range of lengths and produce incredible digital images. Since, there are a lot of involved factors like brands, models, features, prices, selecting the best DSLR camera

would be a difficult task. In order to make decision easier, we use hierarchical decision model and pair wise comparison to determine the best alternative that meets the Professional photographer's needs.

2.2 Assumptions:

There are many aspects to consider when buying a DSLR camera.

1. The survey conducted is representative of all professional photographers.

2. We are the experts in selecting the criteria and sub-criteria, and through mini survey which is conducted to get judgments on the criteria and sub-criteria, where subjective pair wise comparisons are made and weights are found.

3. In our evaluation process, the brand name is not the criteria.

4. Considered alternatives were professional DSLR cameras.

2.3 Survey

In order to evaluate the weights of these criteria, our team designed a questionnaire based on pair wise comparison theory. 4 potential users have been asked to answer these questions by their judgments, and they have done all of them individually without discussing. This questionnaire consists of 4 groups of questions. In the first group, participants needed to compare the five criteria that we selected in our model: features, reliability, cost, appearance, and customer satisfaction. The second group of questions asked the participants to compare the sub-criteria belonged to features such as auto focus, burst mode, sensor size and so on. In third and fourth group questions, the participants were required to compare the sub-criteria belonged to reliability and customer scarification. Fig.3 shows the first group of questionnaire, and Fig.4 shows the second to fourth group.

In each pair wise comparison question, the participants had to put the number in the blanks to present their judgments with two selected items. For example, when left-side item is feature and right –side item is reliability, if one potential user puts 67 in the first blank and 33 in the second blank, it means that this user thinks the intensity of importance in feature is two times than reliability. The same principal was used in all following questions.

Questionnaire for Potential Users

Use of a Hierarchical Decision Model and Pair-Wise Comparisons to Measure Relative Importance of the Criteria of DSLR Cameras

Personal Information

Name: Priti Maheshwari

Sex: M ☐ F ☐

Age: 20-30 ☐ 30-40 ☐ Over 40 ☐

Type of Camera user: Normal ☐ Professional ☐

The purpose of this survey is trying to get information about camera users' judgements in the DSLR cameras' criteria
In order to recognize camera users' perspective, our team invite you to answer some questions
For each question, you are asked to compare two selected items related to camera's criteria, perforance, reliability, cost and so on
Please follow the describtions below to answer all questions

In following questions, please put one number between 1 to 100 in the 1st blank column
The number that you select will present your judgement about these two selected items
For exmample:
If you think the left-side item is 4 times as important as the right-side item, please put 80 in the 1st blank column and 20 in the 2nd blank column
If you think the left-side item is 2 times as important as the right-side item, please put 67 in the 1st blank column and 33 in the 2nd blank column
If you think the left-side item is the same in importance as the right-side item, please put 50 in both of the 1st and 2nd blank columns
If you think the left-side item is 10% more important as the right-side item, please put 52 in the 1st blank column and 48 in the 2nd blank column

1 Criteria

Left-side Item	1st		2st	Reft-side Item
Features		vs		Reliability
Features		vs		Cost
Features		vs		Appearance
Features		vs		Customer satisfication
Reliability		vs		Cost
Reliability		vs		Appearance
Reliability		vs		Customer satisfication
Cost		vs		Appearance
Cost		vs		Customer satisfication
Appearance		vs		Customer satisfication

Fig. 3 The first group of questionnaire

2 **Features**

Auto Focus		vs		Burst Mode
Auto Focus		vs		Sesor Size
Auto Focus		vs		ISO Rnage
Auto Focus		vs		LCD Size/dots
Auto Focus		vs		Movie Mode
Burst Mode		vs		Sesor Size
Burst Mode		vs		ISO Rnage
Burst Mode		vs		LCD Size/dots
Burst Mode		vs		Movie Mode
Sesor Size		vs		ISO Range
Sesor Size		vs		LCD Size/dots
Sesor Size		vs		Movie Mode
ISO Rnage		vs		LCD Size/dots
ISO Rnage		vs		Movie Mode
LCD Size/dots		vs		Movie Mode

3 **Reliability**

Battery Life		vs		Camera Stability

4 **Customer Satisfication**

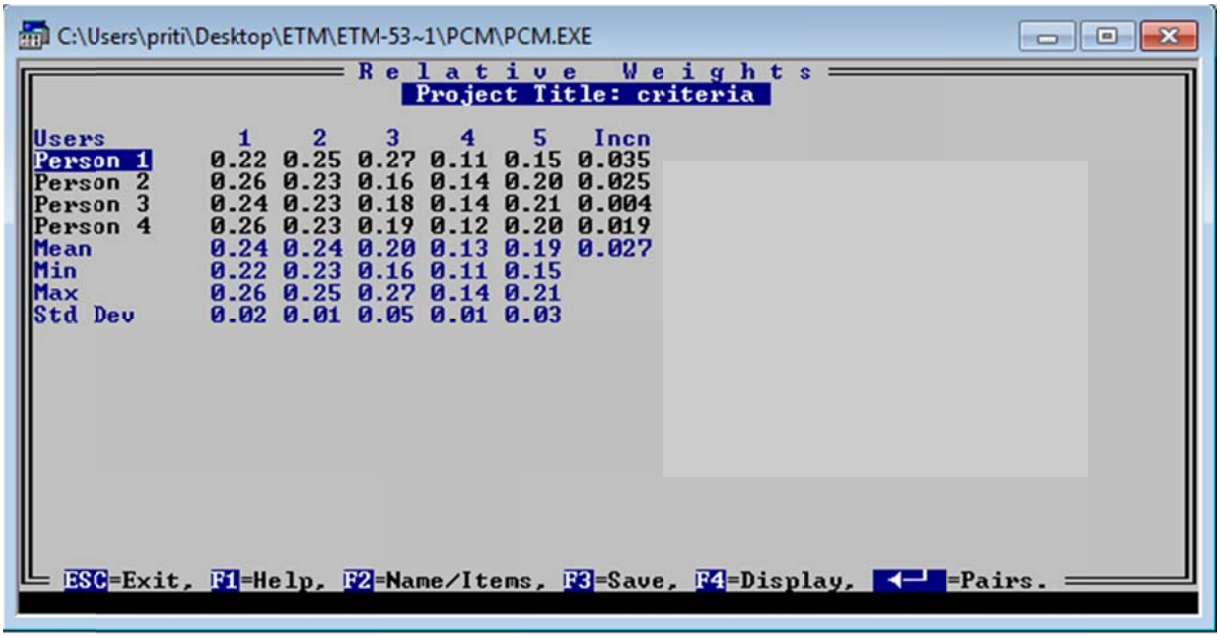
Ease of Use		vs		Warranty

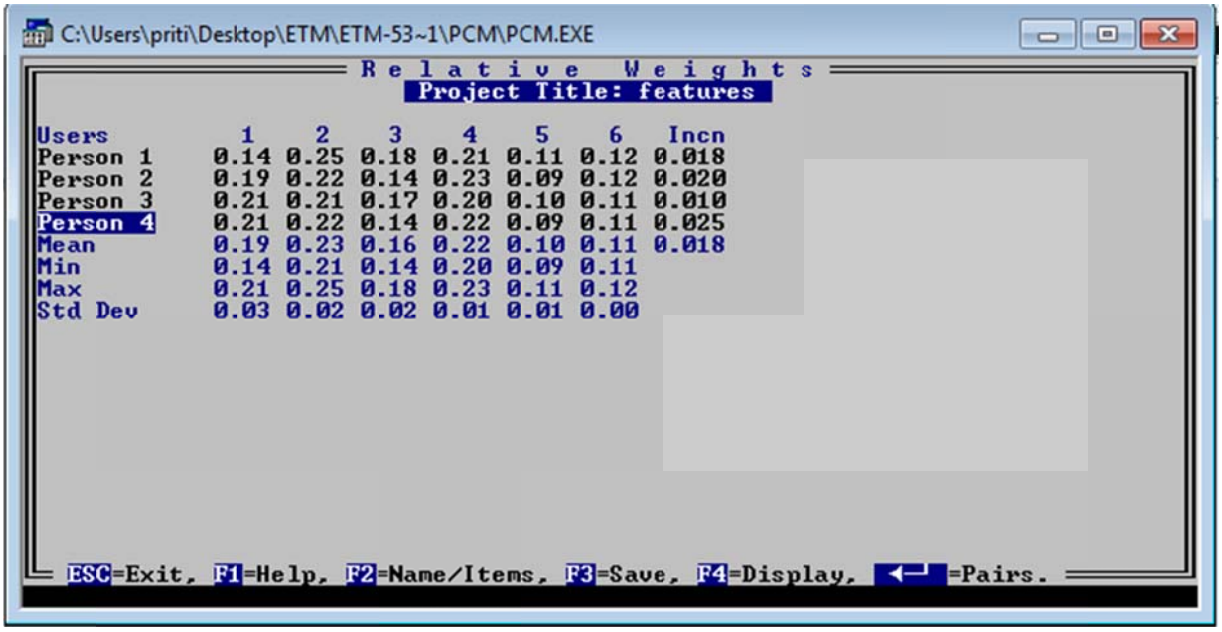
Fig. 4 The second to fourth groups of questionnaire

3. Data Analysis

3.1 Calculating Weights and Inconsistency:

The pairwise comparison taken from the experts were utilized to determine the relative importance. We used PCM software to calculate the normalized weights. The results from the PCM software determined which all criteria have more importance to the professional photographers.





3.2 Utility Curves:

In addition to the questionnaire, one expert was required to evaluate each alternative with respect to the sub-criteria. For example, in LCD size part, when the camera has only 500,000 dots in 3 inches LCD screen, expert will give the value 0 to 100 show that this camera's performance in LCD size is extremely far from potential buyers' requirement. So when the dots in LCD screen are increasing, the values that expert gives will be increasing as well. After expert indentifies the values, we can draw a value curve by connecting all these dots. The utility curves are shown in the Appendix 2. According to this curve, we can easily find the relative values for our three alternative cameras (See Table 1).

Criteria	Canon SLR EOS 60D	Nikon SLR D7000	Olympus SLR E-5
LCD size	96	90	91
Auto focus	81	81	60
Burst rate	43	55	62
Sensor size	82	88	50
ISO range	70	70	70
Movie mode	95	81	30
Battery life	90	86	78
Camera stability	65	85	100
Buying cost	63	61	28
Weight	58	55	50
Ease of use	91	73	99
Warranty	98	75	98

Table 1

3.3 Final Result:

The local weights and global weighs for each criterion are listed in Table 2. The global weight for each criterion is to multiply criteria's local weight by its corresponding sub criteria's local weight. Table 3 summarized the calculation of the total outcomes for each alternative based on the hierarchical model. Canon gets 74.34, followed by Nikon which is 71.98. The last is Olympus with 66.85. In term of outcomes, Canon SLR EOS 60D is the best camera to purchase.

OVERALL LOCAL AND GLOBAL WEIGHTS OF ATTRIBUTES				
Criteria	Local Weight	Sub Criteria	Local Weight	**Global Weight**
Features	0.24	LCD size	0.1	0.024
		Auto focus	0.19	0.0456
		Burst Mode	0.23	0.0552
		Sensor size	0.16	0.0384
		ISO range	0.22	0.0528
		Movie mode	0.11	0.0264
		Sum	*1.01*	*0.24*
Reliability	0.24	Battery life	0.52	0.1248
		Camera stability	0.48	0.1152
		Sum	*1*	*0.24*
Cost	0.2	Buying Cost	1	0.2
Appearance	0.13	Weight	1	0.13
Customer Satisfaction	0.19	Ease of Use	0.65	0.1235
		Warranty	0.35	0.0665
		Sum	*1*	*0.19*
Sum	1			

Table 2

Outcome			
Criteria	Canon SLR EOS 60D	Nikon SLR D7000	Olympus SLR E-5
LCD size	2.304	2.16	2.184
Auto focus	3.6936	3.6936	2.736
Burst rate	2.3736	3.036	3.4224
Sensor size	3.1488	3.3792	1.92
ISO range	3.696	3.696	3.696
Movie mode	2.508	2.1384	0.792
Battery life	11.232	10.7328	9.7344
Camera stability	7.488	9.792	11.52
Buying cost	12.6	12.2	5.6
Weight	7.54	7.15	6.5
Ease of use	11.2385	9.0155	12.2265
Warranty	6.517	4.9875	6.517
Total	74.34	71.98	66.85

Table 3

4. Recommendation

According to our model, Canon gets relatively higher outcome than the other two products. However, there are several things the other two products can be improved based on each unit's utility analysis. Among all the criteria, only ISO range is indifferent for all three products. Generally, Olympus E-5 gets relatively lower outcome for most criteria. For example, its sensor size only gets 1.92 compared to the other two with more than 3. And its movie mode is less than 1 while the other two get more than 2. It only gets 5.6 on buying cost while the other two's buying costs are greater than 12. If the Olympus Company focuses on these three criteria for its E-5 products, then it may gain more competitive advantage in this market. Since Olympus E-5 is better than the other two on the criteria like burst rate, camera stability and ease of use. Besides, its warranty is as good as the winner Canon 60D.

5. Conclusion

Currently, there are many DSLR cameras in the market. Most of them have similar features, function and ability. When people want to buy a camera, they usually select several camera models and put them on their watching list. Then they compare these alternatives to make a final decision.

In our paper, we build a hierarchy model to help us compare three DSLR cameras: Canon EOS 60D, Nikon D7000 and Olympus E-5. We first decide which criteria we need to look at. Then based on the survey, we know the weights for each criterion and we apply the utility theory to

make decision under multiple criteria. Through each alternative's outcome, we conclude that Canon EOS 60D is the best in general. We also discuss the potential for the other two products.

In our hierarchical model, we totally have twelve criteria while at first, we have more. We have to eliminate many important criteria due to their difficulty of measurement. Therefore, our decision is limited. This model requires relatively clear measurement as in order to calculate the outcome, we need to know the utility function for each alternative based on the criteria. We exclude people's bias in our model approach as well. Some people have very strong brand loyalty. Some people rely more on the recommendation from those they trust. In this case, this decision approach won't help them a lot.

References

[1] Ajgaonkar, Priya. Auysakul, Aroonrat. Jefferis, Ryan. Shinriki, Seiji "Use of Hierarchical Decision Modeling for Site Selection of a Major League Baseball Stadium in Portland," PICMET 2004.

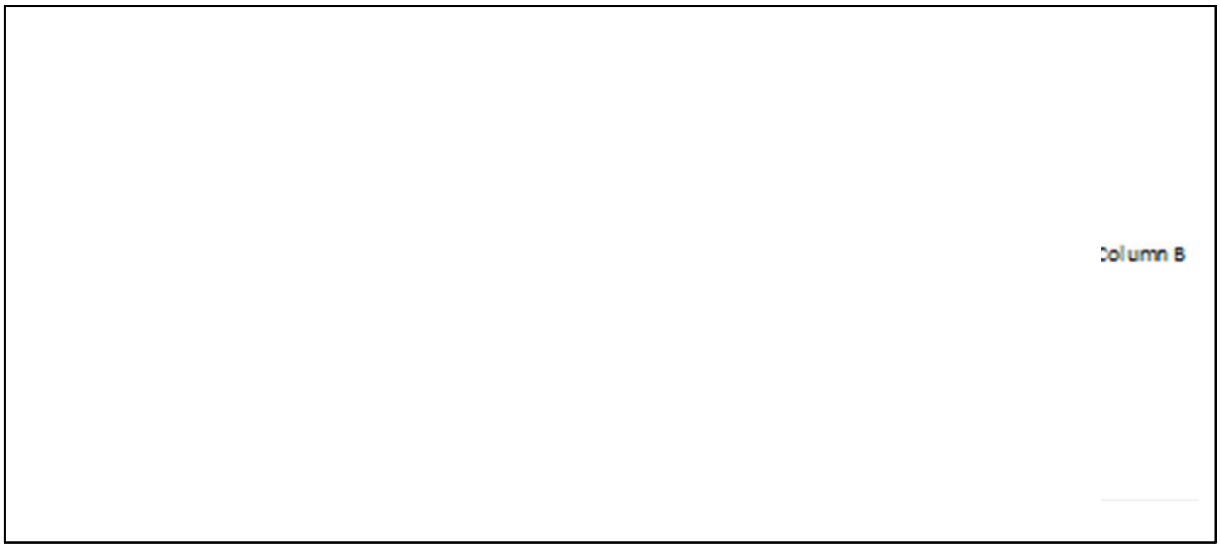
[2] Rimal Abu Taha, Byung Chul Choi, Chuengparsitporn P., Adriana Cutar, Gu Q., Phan K. ," Application of Hierarchical Decision Modeling for Selection of Laptop", PICMET 2007.

[3] http://www.dpreview.com/

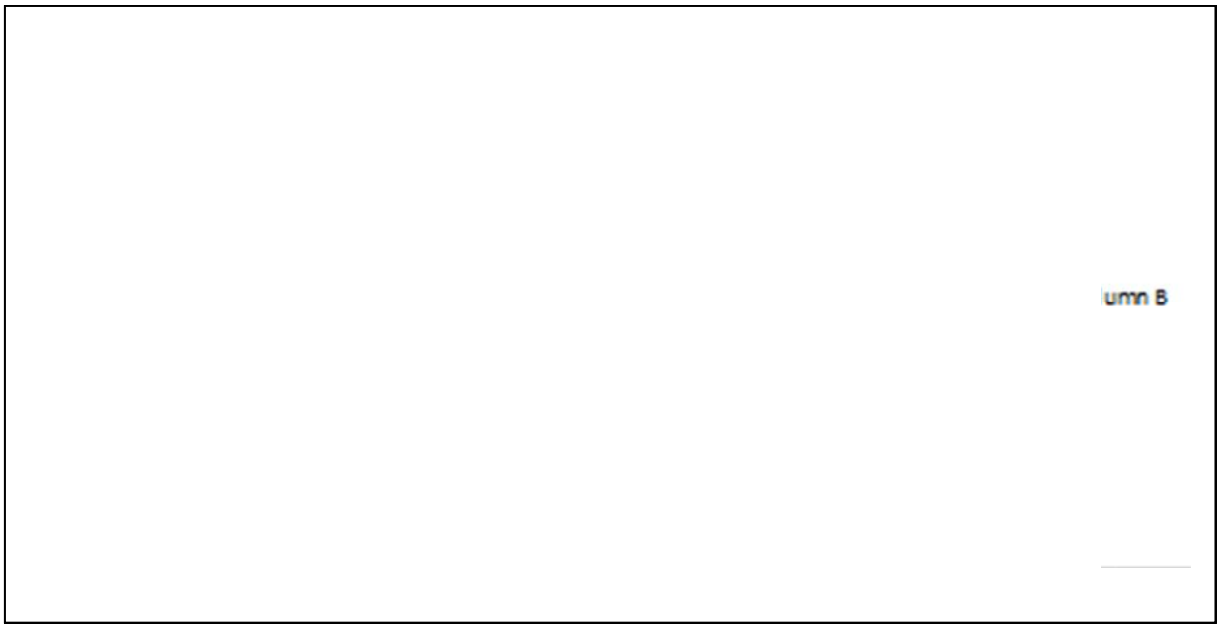
Appendix 1

Name	Canon SLR EOS 60D (Alternative 1)	Nikon SLR D7000 (Alternative 2)	Olympus SLR E-5 (Alternative 3)
ISO	18 M pixels	16.2 M pixels	12.3 M pixels
Sensor Size	22.3x14.9 mm	23.6 x 15.6mm	17.3x13mm
Max video size	5184x3456	4928x3264	4032x3024
Max recording time of movie mode	1920x1080, 30fps	1920x1080, 24fps	1280x720, 30fps
ISO Range	100~6400, expanding to 12800	Auto, 100~6400 , expanding to25600	Auto, 100, 200, 400,800,1600,3200, 6400
Burst Mode	5.3fps, continue 58p	6fps	5fps
Recording media	SD	SD	CF type I,II, Microdrive, xD-picture
LCD	1040,000 pixels，3 inch	Support Live View function，920,000 pixels，3 inch	Support Live View function，20,000 pixels，3 inch
Video out	NTSC/PAL/HDMI	NTSC/PAL/HDMI	NTSC/PAL
Battery	LP-E6 (1100p, CIPA)	EN-EL15	BLM- (870p, CIPA)
Size	145 x 106 x 79mm	132 x 105 x 77mm	143 x 117 x 75mm
Camera weight	net: 675g total: 755g	net: 690g total: 780g	net: 800g total: 892g

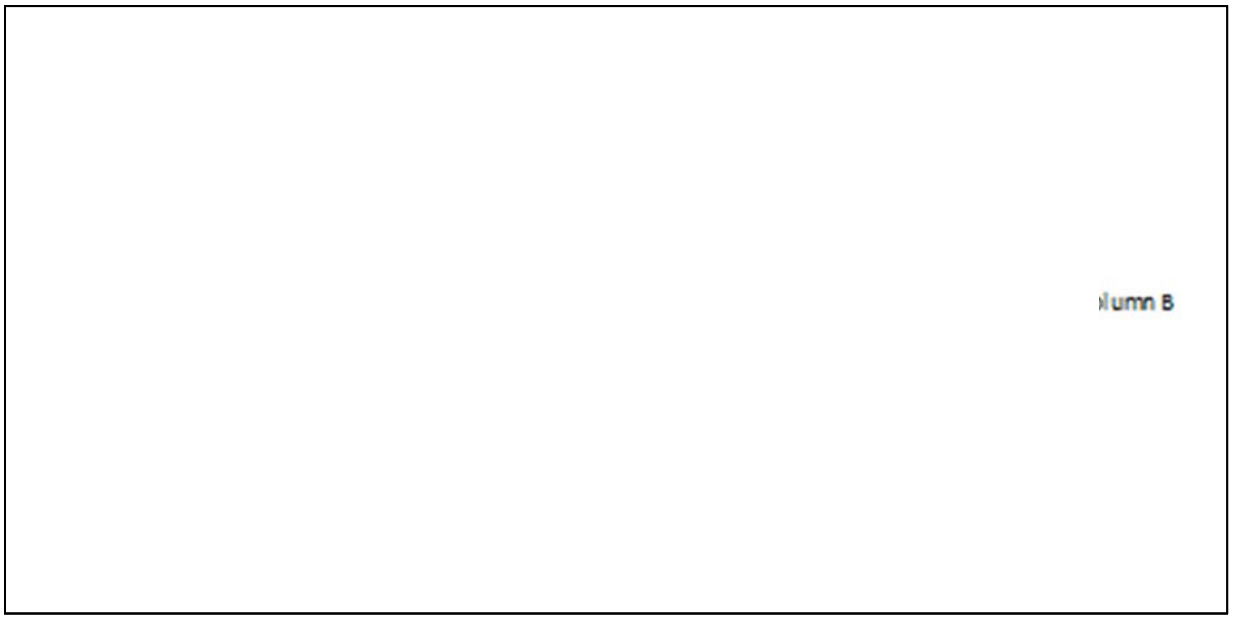
Appendix 2



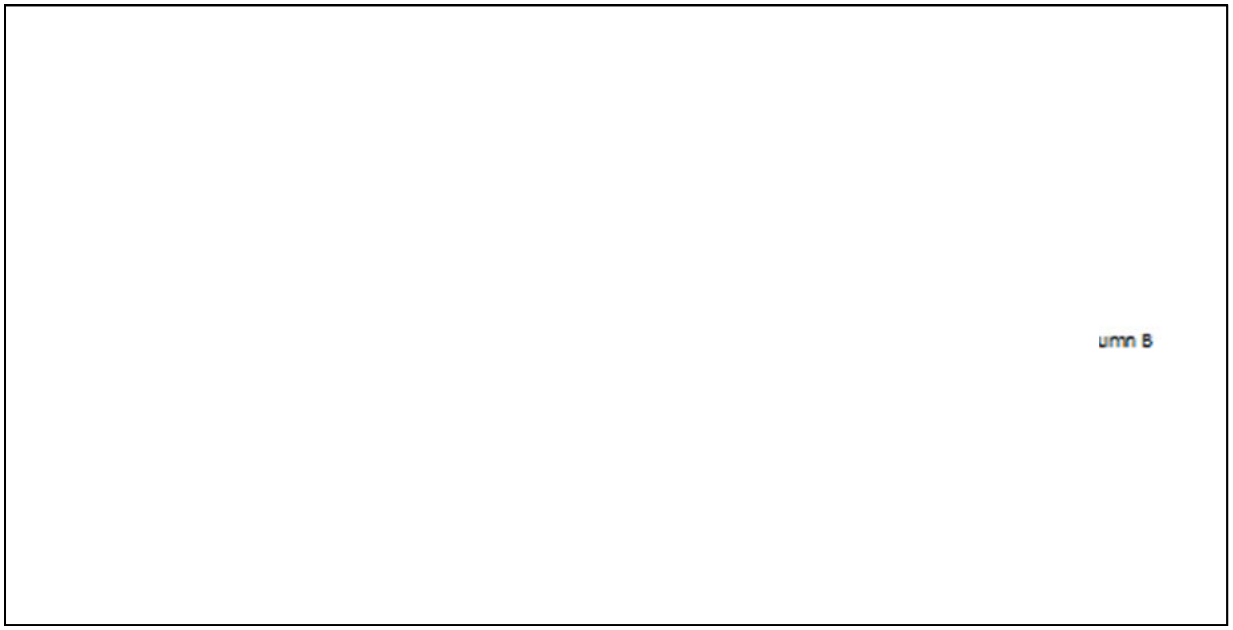
Utility curve for LCD size



Utility curve for Auto focus

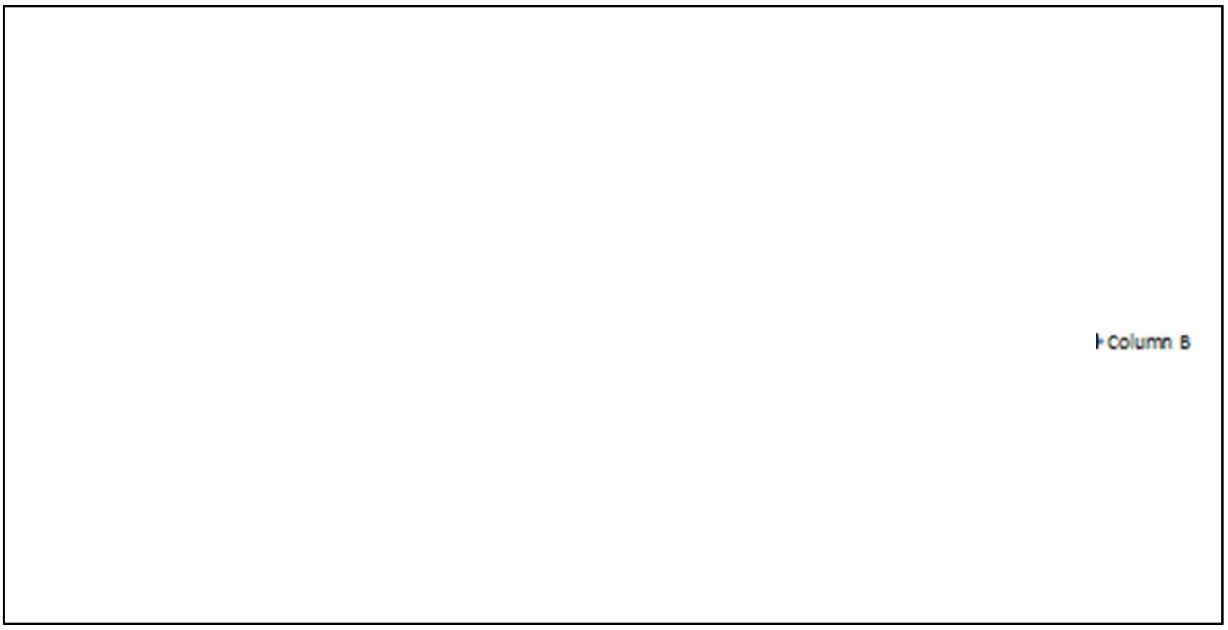


Utility curve for Burst Rate



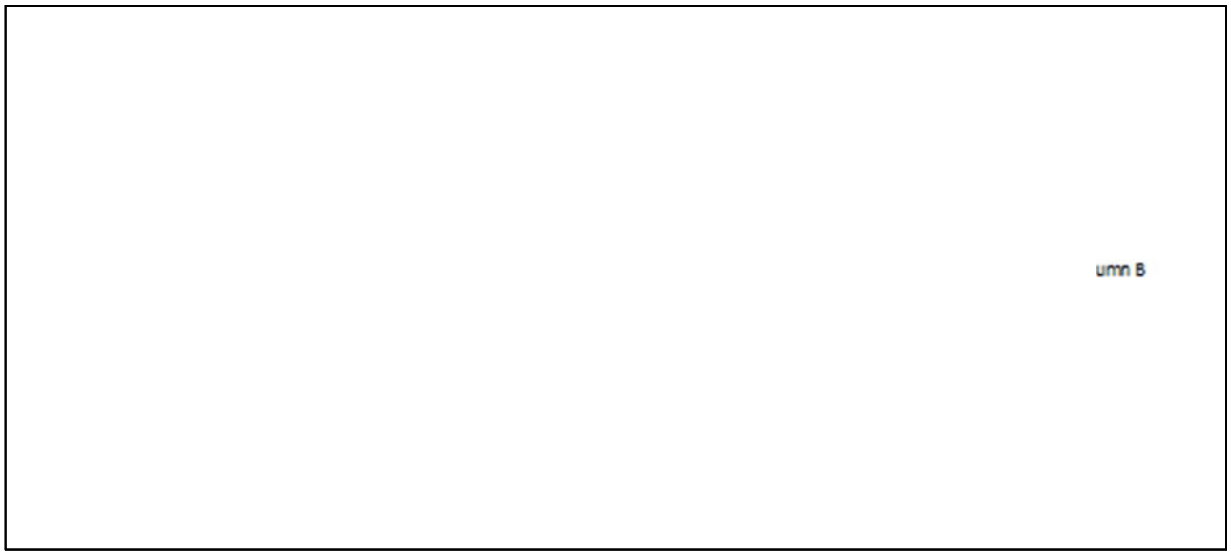
Utility curve for Sensor Size

Utility curve for ISO Range

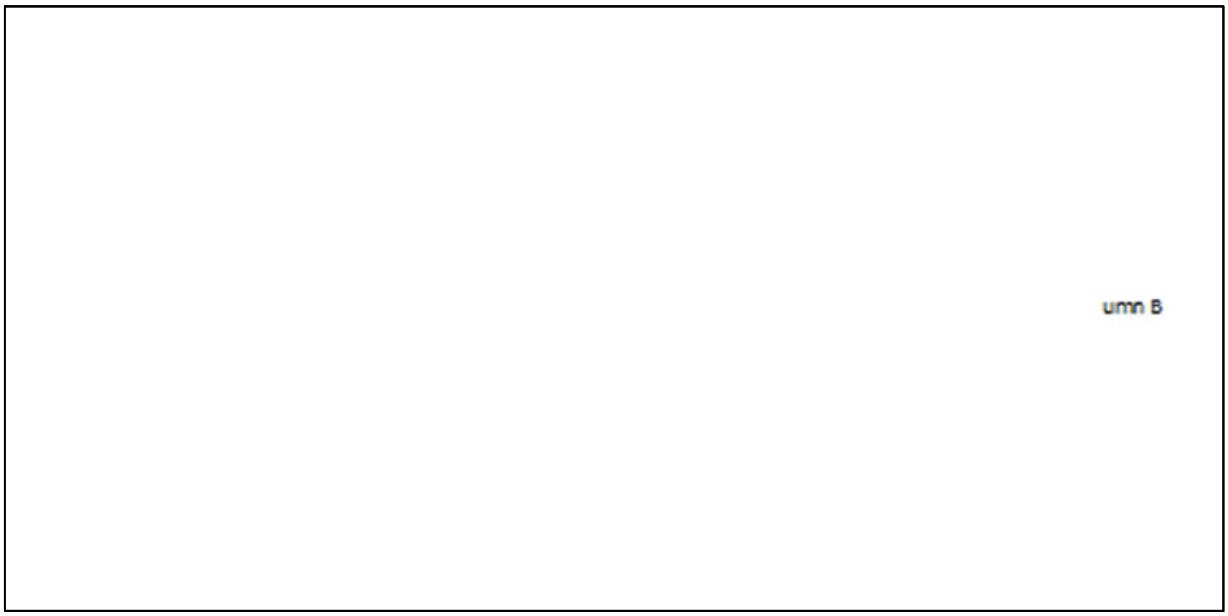


Utility curve for Movie Mode

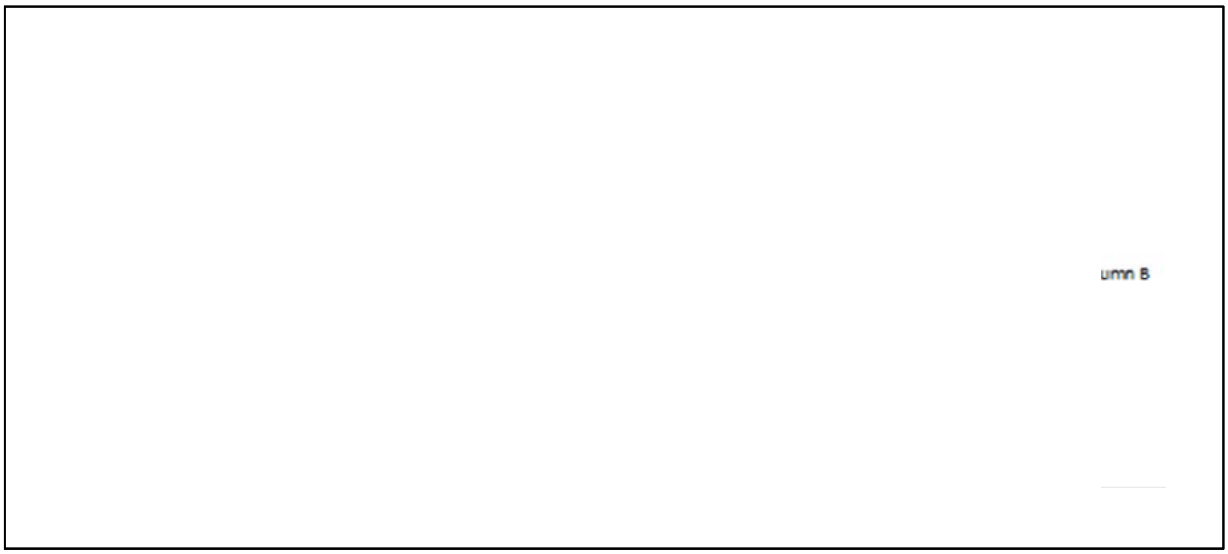
Utility curve for Battery Life



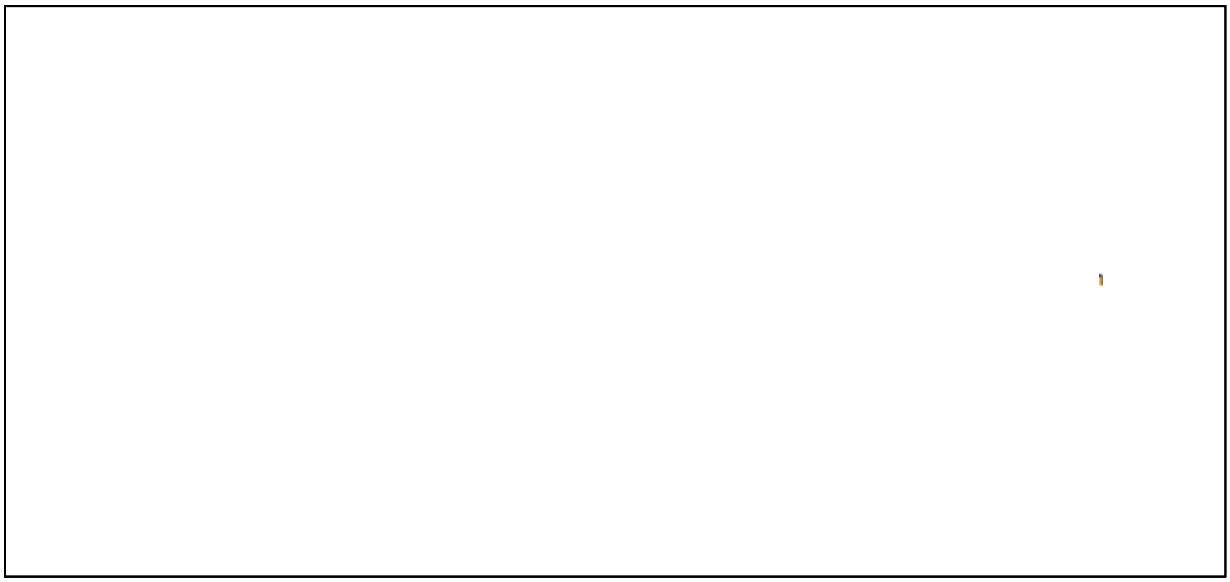
Utility curve for Camera Stability



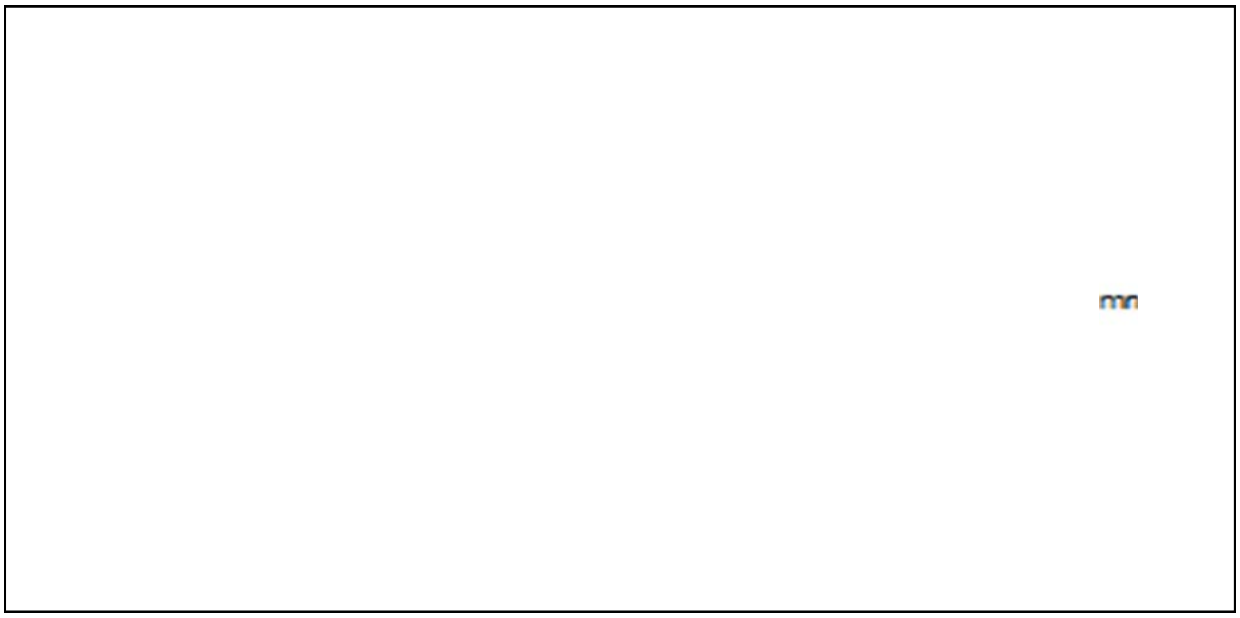
Utility curve for Buying Cost



Utility curve for Weight



Utility curve for Ease of Use



Utility curve for Warranty