Portland State University Maseeh College of Engineering and Computer Science Department of Engineering and Technology Management



ETM 530/630 – Decision Making Spring 2017

Individual Project Paper

<<SELECTION OF THE BEST SMART WATCH>>

<<ANCHAL SINGH>>

ABSTRACT

In this competitive world, technology is changing at very fast rate and people from all around the globe are contributing to it. The impact of technology in our lives is very immense and cannot be ignored. Technology is helping humans to track their fitness and take informed decision related to their health. The wearable technology is gaining a lot of popularity these days, The smart watch is one of the most prominent category of wearable technology. There are number of companies who are involved in making smart watches.

Picking the best smart watch from the plenty of brand new devices is increasingly tough. These days, smart watches do much more than just keep time. They act as a companion to your Smartphone by delivering alerts, notifications, apps and more right on your wrist. The objective of this project is to use a decision model to determine which smart watch is best to buy when a buyer has plethora of options to choose from. Smart watch at its core is a watch which connects to internet via devices like smart phones or tablets. Smart watches allow the user for hands free operation, receives the information on the surrounding environment and It tracks the fitness by integrating sensors as input devices. The objective of this model is to help two segments of customers which are tech savvy and health conscious in choosing the best smart watch. To select the best smart watch for the targeted customers, Hierarchical Decision Model (HDM) has been used based on the criteria and sub criteria associated with the objective. In the study four alternatives are selected for the evaluation based on the perspective and criteria weights obtained by HDM model through the comparison.

In this research, many criteria and sub criteria are selected based on the alternatives but many criteria are not considered which can be considered in future research. This research has been performed on four alternatives but in future it can be done on other alternatives also.

5/30/17

INTRODUCTION

1. Overview of Smart Devices: The significant improvements in our lives is due to the rapid advancements in information technology which has now become more of a necessity than facility. The changes that information technology has brought in products revolution have changed our lives and lifestyle. Today we are so connected with information technology that the gadgets and machines help us reduce half of the efforts in our daily life in order to function effectively. The innovation in new products is changing the structure of the industries, nature of competition and pushing companies to new opportunities. These new type of products are also creating entirely new industries. This revolution has made the lives of human being more convenient and better (Porter et al., (2014).

Over the period of time, products have evolved from just being a combination of mechanical and electrical parts to become very complex in nature and combine hardware, sensors, data storage, microprocessors, software, and connectivity in many possible ways (Porter et al., (2014). Smart devices are helpful in monitoring the condition, operation, and external environment of any product through sensors and external data sources. Monitoring features of smart devices enable companies to track operating characteristics and history of a product to better understand how the product is actually used.

The smart devices that strength human lives have gone through series of disruptive changes over a past several years. Televisions and media players can be connected to internet, This has opened doors for new worlds of digital content. E-readers and tablets have become successful device from being an idea. Smart phones have become mini computers from just being text-based communication tools. Smart watches have evolved from digital watches. These new generation

of smart devices have changed the way people communicate, stay connected, track fitness and entertain themselves(Porter et al., (2014).

The wearable technologies are gaining lot of popularity these days. Cheap sensors, discounted hardware and easy accessibility of internet over the past few years have accelerated wearable computing to become more convenient and thoughtful. Some prominent examples of wearable technologies are Google glass, Fit bit and Nike fuel band. The smart watch is one of the most prominent category of wearable technology (Johnson. K, (May 2014)

2. Overview of smart watches: Smart watch at its core is a watch which connects to internet via devices like smart phones or tablets. It facilitates notifications and real time information on your wrist. It also provides some basic features of smart phones. Once it is connected to smart phone, user can choose what notifications to get on the wrist like messages, emails, calls and social media networks. Smart watches allow the user for hands free operation, receives the information on the surrounding environment and It tracks the fitness by integrating sensors as input devices. Smart watches popularity led many companies to start the manufacturing and marketing. There are many companies which are creating smart watches, the most popular smart watches are Garmin, Apple, Samsung and Pebble. They all have a set of shared features and characteristics. In this project HDM model is developed with the perspective and criteria to help the customer to choose the most suitable one. The targeted customers are who are tech savvy and inculcate healthy practices. The criteria and sub criteria of the objective are retrieved through literature review. With the help of thorough analysis it can be identified that which alternative would be the best considering the criteria and sub criteria. It will also help to understand what features people desire in smart watches.

MAIN OBJECTIVE :

The objective of this study is to choose the best smart watch for the consumers who are tech savvy and inculcate healthy practice. Picking the best smart watch from the plenty of brand new devices is increasingly tough. An initial research about the smart watches showed that the market of smart watches is very huge. Many big brands like Apple, Samsung, LG, Fit-bit etc are into smart watch market but as per the choice of criteria and sub criteria, the choices are narrowed down to four. so the four alternatives are Apple, Samsung, Garmin and Pebble. All the experts involved in this study has to review each of the alternative and the criteria and sub criteria associated with it. This model development would provide a more intuitive understanding of the decision making process to select the best smart watch for the tech savvy and health conscious people. The experts agreed to use HDM models to evaluate the alternatives. HDM structure need to be developed, pair wise comparisons among the elements for each level will be made. Pair wise comparison will help in assigning the weights on each element to get the best outcome.

METHODOLOGY

In this study, the literature review research methodology used to find out the perspective, criteria and alternatives. People use decision model to choose from the alternative and come up with the final decision. These models are developed by mathematical anthropologists and tested in different domains to get the desired result. The construction of decision process model is inductive which is a important characteristic of the process. This inductive approach requires distinguishing unique decision factors from the individuals which is required for making the decision model (Murtaugh et all., (Oct 1980). Developing a general configuration of the required model is one of the elementary need to build a decision model. This would help to identify the

key factors, levels in hierarchical model, and relationship between the factors (Lingga.M., (May 2016). The analytic hierarchy process (AHP), was developed by Thomas Saaty at the Wharton School of Business which enables the user to make a decision of a complex problem through hierarchical structure model (Forman, (2003). HDM model has been developed by Prof. Dundar F.Kocaoglu in 1979. The concept of HDM is same as Analytical Hierarchy Process (AHP) methodology but the way of pair wise comparison is different. HDM also use judgmental quantification technique. (Lingga.M., (May 2016). The generation of Hierarchical Decision Model (HDM) requires a tool named MOGSA which was developed by Cleland and Kocaoglu in 1981 to understand to multiple criteria decision (Belding et all., (2009). The MOGSA stands for five levels named Mission-Goal-Objective-Strategy-Action. There is no restriction for the number of levels but the elements at the same level should be preferentially independent. In the HDM model, hierarchical structure enables the experts to compare the elements whether they are tangible or intangible in a simple and effective way. Through this model a large number of data can be synthesized at different scales and the judgment can be made through quantitative decision making. The number of hierarchical levels represents the level of complexity of decision model. If the levels are less the decision problem would be simple but if the levels are more, the decision problem would be complex. In the HDM model, the top level represents the decision objective. The criteria and sub criteria associated with the objective are placed below the objective level and the bottom level has the potential alternatives. Once the HDM model is developed, all the objective of the model at the same level are compared pair wise and weights are given. Again the strategies, elements and alternatives are also compared in pairs and the contribution to achieving the objective is also measured (Turan et all., (2009). So The model

applied for selecting the best option or alternative for the customer to achieve the objective (Kocaoglu et all., (1988)

DATA AND DATA SOURCE(S)

The targeted segment for choosing best smart watch in this study are tech savvies and people who inculcate healthy practice in their lifestyle. All the experts involved in this study had to study each of the alternative and the criteria and sub criteria associated with it. So seven experts who are tech savvies and inculcate health practice in their lifestyle were invited to contribute in the research.

Criteria: To develop the Hierarchical Decision Model, four perspectives under the objective and nine sub criteria under the perspectives are selected.

1. Performance: For selecting a smart watch, performance plays very important role. There are many factors which contribute towards the performance of the smart watch. Faster Processor is one of the key factor of performance. One of the crucial factor in performance is battery life. The battery life of every smart watch varies. The more the battery life the more it will be preferred. The second factor is accuracy which is measured by how accurate the sensors work in the smart watch

- Battery life: The battery life of a smart watch can be defined as how long the smart watch would run on a single charge of a rechargeable battery. Different smart watches have different battery life. Having more battery life would put that particular smart watch in the list.
- Accuracy: It is defined as the accuracy level of sensors. In the smart watches there are many sensors like accelerometer, pedometer, heart rate monitor and sleep tracker. With

the help of sensors the fitness can be tracked. In this research more accuracy of sensors are preferred.

2. Features: Features of the device can be defined as the set of operation the device is able to perform. It plays an important role in making the users to buy the product. There are number of features available in smart watches like third part apps, cellular connectivity, calendar, weather, music controls, find my phone feature . For the HDM model the features are narrowed down to three which can attract customers like GPS and connectivity.

- **GPS:** The GPS in the smart watches help the user in navigation, calculating the exact position, speed and time. Now smart watches have in built GPS system.
- **Connectivity:** Connectivity feature can be defined as how well the smart watches can connect with the Bluetooth, Wi-fi, and smart phone. Many smart watches now support Wi-Fi (802.11b/g/n 2.4GHz) and Bluetooth 4.0. (Apple, 2017)
- Water resistant: The water resistance feature of the smart watch measures the ability to resist the penetration of water to some degree. Some smart watches have better water resistant capacity. The water resistance value of the smart watches are defined in ATM.

3. Display: The display criteria of smart watches differ in every alternative. Every smart watch has different screen size and screen resolution. The display is clearly the most important and key component in a smart watch and most people will expect a smart watch to have a display with quality comparable to their smart phone. The display quality of smart watches can be calculated by the brightness of the image. Now days all smart watches use LCD or OLED display. For the study two important features are considered which are screen size and screen resolution.

- Screen size: For choosing a smart watch, screen size is very important factor for many customers. In the market, smart watches with different screen shape and size are available. It gives the opportunity to the customer to choose from variety of screen size according to the need.
- Screen resolution: Screen resolution in the smart watch can be defined as the quality of screen display. It is usually width*height with the units in pixel. Smart watches should have fairly high resolution in pixels so that it enhances graphics and make read the fine text easily. The latest versions of smart watches of every brand are focusing on improving the screen resolution more.

4. Style: Every customer has his own choice of choosing the style. Smart watches come with different interchangeable strap color and strap material. The quality of strap material and strap color differ in every smart watch.

- Strap Color: For some people color of the strap matter a lot that is why companies started making interchangeable straps so that customer can choose from the available colors. Brands offer different type of colors for the straps to attract customers of every segment.
- Strap material: Every smart watch offers choice to users to select variety of straps based on different kind of materials. It gives option to the consumers to select different types of bands such as Sport Band, stainless steel band, leather band, Hermès band.

Alternatives: There are number of companies who are involved in making smart watches but as per the selection of perspective and criteria the choices are narrowed down to four. These alternatives are Apple, Samsung, Garmin and Pebble. However each of the alternatives have

different models so it is not possible to navigate all of them. Hence the latest version of each alternative has been considered.

1. Apple: Apple watch was first launched in September 2014. Other smart watches which were launched by different companies were criticized for having big size dial. So Apple decided to make two sizes i.e 38mm and 42mm to attract every segment of customers. However Apple watches have evolved a lot since their inception, the latest model of Apple watch is Apple series 2 and it has Built-in GPS. improved waterproof resistance up to 164 feet. Its Performance is faster than original Apple watch and screen is also very bright. It has wide range of sensors such as Heart rate sensor, Gyroscope, pedometer and Accelerometer for accurate fitness tracking. Plenty of third-party apps. It has Wi-Fi (802.11b/g/n 2.4GHz) and Bluetooth 4.0. It has better screen resolution. It comes with dual core processor to offer improved performance. Apple Series 2 watch case has plenty of options to choose from such as Aluminum, ceramic and stainless steel. It gives option to the consumers to select different types of bands such as Sport Band, stainless steel band, leather band, Hermès band. It comes with the Second-generation OLED Retina display with Force Touch $2 \times$ brighter (1000 nits). It has robust dial which is made of Sapphire crystal. It has better resolution and Ion-X glass. It has stunning magnetic charging cable and battery life up to 18 hours. It increases ease of use by offering Siri AI assistant. It also supports number of third part apps (Apple, 2017)

2. Garmin: There are so many smart watches available from Garmin. For this study the latest model which is Vivoactive HR has been considered for review. In terms of size the Vivoactive HR is quite different than the original Vivoactive. The Vivoactive HR is lighter than the most round faced watch. Improved touch feature which enhances the brightness and it can be adjusted.

5/30/17

This model offers array of new features such as color touch screen, interchangeable bands, and customizable faces. and it has Built-in GPS. waterproof resistance up to 160 feet. It has wide range of sensors such as Heart rate sensor, Gyroscope, pedometer and Accelerometer, Barometric altimeter, Compass and Ambient light sensor. It has daily smart features such as connectivity with Bluetooth and wi-fi, calendar, weather, music controls, find my phone feature, smart phone compatibility with iphone, android and windows, find my watch feature etc. It offers good number of activity features such as step counter, move bar, auto goals, sleep monitoring, calories burned, floors climbed, distance travelled. It also has lot of other important features such as activity tracking, training, planning and analysis, heart rate, running and many more. It has battery life up to 13 hours with GPS mode and as good as 8 days in smart mode. It gives option to the consumers to select different types of interchangeable bands such as Sport Band, stainless steel band, leather band (Garmin, 2017)

.3. Samsung: Samsung launched its first smart watch in 2013. since then several other models have been introduced by Samsung. For this study Samsung gear S3 has been considered. Its Performance is faster than original Samsung watch and screen is also very bright. It has wide range of sensors such as Heart rate sensor, Gyroscope, pedometer and Accelerometer for accurate fitness tracking. The heart rate sensor track the heart rate throughout the day. It also offers third-party apps. There is in built GPS and has features like NFC, Smart Sleep, Alarm, Wireless charging, Photo Viewer, File sharing, Email, Messages. Samsung gear S3 has wide variety of sensors like GPS, Based Speedometer, Altimeter, Accelerometer, Gyro, Heart Rate, Barometer, Pedometer. It has high resolution because of OLED screen. It runs on Operating system Tizen Based Wearable Platform. There are in built microphone and speaker. It also supports iOS and android. The screen type is super AMOLED. The bezel of Samsung gear S3

5/30/17

has rotating dial which let you select apps, spinning left to right or allow you to go through a list. It also has different types of interchangeable bands such as Sport Band, stainless steel band, leather band with different colors (Samsung 2017)

4. Pebble: Pebble was the first smart watch which was compatible with both iOS and android. Among all other models, Pebble 2 is the latest and has been reviewed for this study. The Pebble 2 has a feature of 24/7 heart rate monitor. It also tracks sleep and work as alarm. Pebble 2 is Thin, lightweight, and durable, It has built in speaker and voice dictation. The battery life of Pebble 2 is up to & days. It is a smart fitness tracker which tracks steps, calories, runs, and long walks. It has impressive features such as fitness, gaming and control apps. The display is sharp and bright in any light. Good for swimming since it has water resistant up to 30 m. It provides all the notifications like text, call, events etc. It has a option for good music control. Pebble 2 has a choice of 5 sporty colors: Black Cloud, Charcoal Flame, Charcoal Lime, White Aqua, and White Cloud. It gives option to the consumers to select different types of interchangeable bands such as Sport Band, stainless steel band, leather band. The most important factor which differentiate Pebble 2 with their alternative is its price. It is the most affordable priced watch among all other alternatives (Pebble 2017).

MODEL DEVELOPMENT:

To develop a decision model, first general configuration of the required model need to be developed. This process would help to identify the objective, key elements, hierarchical levels and relationship among elements on every level. This model development would provide a more intuitive understanding of the decision making process to select the best smart watch for the tech savvy and health conscious people. First the goal and objective of the decision making should be defined then next step would be to create the HDM model. The objective of this model is to help

a two segment of customers which is tech savvy and health conscious to choose the best smart watch, Four criteria are selected on the basis of survey obtained from the segments.:

1) Performance, 2) Feature, 3) Display, 4) Style,. Next level has nine sub criteria under every criteria which are battery life, accuracy, GPS, Connectivity, Water resistant, screen size, screen resolution, strap material, and strap color. The last level shows the alternatives. In this model four alternatives are selected based on the popularity among the two segments . Once the perspective, criteria and alternatives are defined, HDM model has been developed for the analysis . As HDM structure is being developed, pair wise comparisons among sub elements for level are made. Pair wise comparison has been performed and weights are assigned. so in the HDM, the experts need to do pair wise comparison among objective, goal, and strategies at every level. The HDM model will help the customers to get the most suitable option by evaluating the alternatives. In this study we are evaluating the alternatives have prices ranging from \$99 to 400\$. All the alternatives have constant specifications during the study.



Figure 1. The HDM model with four levels

MODEL EVALUATION:

Several techniques are being used in HDM to analyze the inputs and outputs for evaluating the process. These techniques are explained below

1. Judgment Quantification: For making a decision, when subjective data is being collected in the absence of objective data then this technique is called judgment quantification. In this technique constant sum method are being used to allocate 100 points between two elements in the HDM decision model at a time. The points are distributed to compare the importance of the two elements with respect to the upper level (Lingga.M, (May 2016),

2. Pair wise Comparisons: For the quantification process, pair wise comparison are being done for the decision elements. The number of pair wise comparison can be defined as

(N) for (n) is [N = n/(n-1)2] (Lingga.M, (May 2016).

3. Inconsistency: Inconsistency value depends on how the expert is judging the quantification process and how valid the judgment is. Once the HDM model is developed, the inconsistency value should be equal or less than 0.10. this value is acceptable for inconsistency measure. (Lingga.M, (May 2016).

4. Disagreement: This is the technique used to check the balance among the experts judgment. In the judgment process, number of experts are involved with diverse expertise and knowledge. so the opinion would also differ. For the decision model, all the inputs are considered, so all the disagreement among experts should be calculated to check the disagreement value and it should be within acceptable range (Lingga.M, (May 2016)..



Figure 2- Screenshot of HDM software used by experts



Figure 3- Screenshot of HDM software used by experts

ANALYSIS AND KEY FINDINGS

There are lot of factors to impact tech savvy and health conscious people to determine to choose smart watch. There are four alternatives in this research: Apple, Garmin, Pebble, and Samsung. The developed criteria and sub criteria are used to make the decision which one is best. The result is obtained by pair wise technique between the elements.

According to the experts judgment, Apple watch has high mean value i.e 0.34 so it is the best choice for the tech savvy and health conscious people to buy the apple smart watch. Next alternative which has second highest value i.e 0.24 is Garmin. so after Apple smart watch, Garmin smart watches are the second choice. The third highest mean value is for Samsung smart watches which is 0.22. The least preferred smart watch according to the judgment is Pebble which has value of 0.20. The results are shown in Appendix B

There are five main criteria at level 1 which is objective level: Performance, Features, Display and Style. All the objectives on the same level are compared then contribution to the mission are calculated. Based upon the experts' judgment, Performance (0.304) is the most important factor for the tech savvy and health conscious, because performance of any smart device is the most important factor for any consumer. The second factor is Feature(.276) because every smart watch has different features and those who have better feature would be considered most. The third factor is Display and style both have (0.209) which has been given the lowest preference by the consumers. The results are shown in Appendix A.

There are nine sub criteria at level 2 in the model, they are Battery life, Accuracy, GPS, Connectivity, Water resistant, screen size, screen resolution, strap material and strap color. these sub criteria's are compared pair wise to get the result. according to the experts judgment, screen resolution has got the highest value (0.626) but the and strap material which is the second

highest value differs with very little margin. its value is (0.620). For consumers accuracy of the features matter a lot. so the third highest value is for Accuracy which is(0.531). Smart watches battery life play very important role in selection of smart watch. so the value obtained for battery life is (0.469). The value for connectivity is(0.4160). All the brands offer attractive interchangeable strap in many colors. so as per the customer's choice the value is (0.380). Screen size of the smart phones got the value of (0.374). The choice of smart watches also depend on how well the watch connect with the GPS. The GPS factor got the value of (0.294). The criteria which has got the least value is water resistant of smart watches. It has got the value (0.290). The inconsistency score of each expert, and the disagreement score in the result are less than 10% which is acceptable.

CONCLUSION: The study serves as the stepping stone to consider the criteria and sub criteria that would help the customers to decide best smart watch. This model also helps to give the perspective to the new customers on the best choice available in the smart watches. The criteria and sub criteria may be weighed differently by different customers. This model will be a helpful decision making to choose the alternative.

FUTURE RESEARCH AND LIMITATIONS

In this research the targeted customers are tech savvy and health conscious people. This research can target the other segment also like elderly people who need to keep track of their health. If the targeted customers were elderly people then some criteria and sub criteria needed to be changed. For example ease of use and weight of the watch would be the most important criteria for them. The model developed can be re used but the factors weighed by different groups should be different. In this model many criteria are not considered which can be considered in future

research like phone compatibility and call receiving. This research can be done on other alternatives also like Sony smart watch, LG and Huawei.

There are many smart watches brand available in the market but in this study only four brand are included. The criteria and sub criteria were chosen according the survey. In this study, smart watches which are more famous are considered because consumers prefer these brands more than other available brands in the market and it also help the experts to do the pair wise comparison more effectively. In the model, the number of criteria and sub criteria are limited to make the model simple and it will ease the experts to do the comparison.

This study expresses the views of tech savvy and health conscious consumers . A consumer may provide expert view on the product that he has been using however but he may not have true expertise to accurately evaluate each alternative. A thorough literature review is performed to research all the features of each alternative. It is important to mention that the materials reviewed were research papers and information available on company website. The sources may not be fully open minded as each company promotes their own product.

REFERENCES

Porter. M. & Heppelmann . J (Nov 2014), " how smart connected products are transforming competition",

Harvard Business Review.

Johnson. Kyle, (May 2014), "Literature Review: An investigation into the usefulness of the Smart Watch Interface for university students and the types of data they would require", wikia.nocookie.net

Murtaugh. M & Gladwin.H, (Oct 1980), " A hierarchical decision-process model for forecasting automobile type-choice", Pages 337-347

Lingga.M, (May 2016), "Developing a Hierarchical Decision Model to Evaluate Nuclear Power Plant Alternative Siting Technologies", Portland state university.

E. Forman and M. A. Selly, "Decision By Objectives," Journal- Operational Research Society, vol. 54, no. 10, p. 1108, 2003

J. Belding, E. Loanzon, H. Millward, L. Seboni, D. Sibanda, and T. Torgeson, "A decision model for purchasing the highest value printer for home use for the least cost," in PICMET '09 - 2009 Portland International Conference on Management of Engineering & Technology, 2009, pp. 494-512

T. Turan, M. Amer, P. Tibbot, M. Almasri, F. Al-Fayez and S. Graham, "Use of Hierarchal Decision Modeling (HDM) for selection of Graduate School," in PICMET 2009 Proceedings, Portland, 2009

Kocaoglu, Dundar F. (1988), "Hierarchical decision modeling." Engineering Management Program, Portland State University

" Apple Watch Series 2 - Technical Specifications" Online. [Available]: https://support.apple.com/kb/SP746?locale=en_US

Online. [Available]: https://www.pebble.com/pebble-2-smartwatch-features

Online. [Available]: https://buy.garmin.com/en-US/US/p/538374#overview

Online. [Available]: http://www.samsung.com/global/galaxy/gear-s3/

APPENDIX A – FINAL, QUANTIFIED MODEL



Figure : Quantified value of elements

Level 1	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Average	
Performance	0.22	0.39	0.25	0.41	0.28	0.28	0.3	0.304	
Feature	0.27	0.28	0.23	0.21	0.16	0.43	0.35	0.276	
Display	0.3	0.13	0.27	0.18	0.24	0.13	0.21	0.209	
Style	0.21	0.2	0.25	0.2	0.31	0.16	0.13	0.209	
Inconsistency	0.04	0.05	0.13	0	0.02	0.03	0.02		
Level 2	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	AVERAGE	STD.DEV
Battery life	0.6	0.7	0.2	0.34	0.45	0.34	0.65	0.469	0.187
Accuracy	0.4	0.3	0.8	0.66	0.55	0.66	0.35	0.531	0.187
GPS	0.41	0.31	0.1	0.39	0.23	0.3	0.32	0.294	0.104
Connectivity	0.29	0.5	0.4	0.35	0.32	0.52	0.53	0.416	0.100
Water resistant	0.29	0.19	0.5	0.27	0.45	0.18	0.15	0.290	0.137
Screen size	0.42	0.3	0.33	0.37	0.35	0.65	0.2	0.374	0.139
Screen resolution	0.58	0.7	0.67	0.63	0.65	0.35	0.8	0.626	0.139
Strap material	0.66	0.65	0.63	0.42	0.6	0.68	0.7	0.620	0.094
strap color	0.34	0.35	0.37	0.58	0.4	0.32	0.3	0.380	0.094

Figure: Quantifies value

Objective	Apple	Garmin	Pebble	Samsung	Inconsistency
Expert 1	0.43	0.25	0.17	0.15	0.01
Expert 2	0.29	0.22	0.28	0.21	0.02
Expert 3	0.33	0.2	0.2	0.26	0.02
Expert 4	0.34	0.23	0.22	0.21	0.01
Expert 5	0.27	0.35	0.17	0.22	0.01
Expert 6	0.33	0.22	0.21	0.24	0.02
Expert 7	0.4	0.19	0.18	0.23	0.02
Mean	0.34	0.24	0.2	0.22	
Minimum	0.27	0.19	0.17	0.15	
Maximum	0.43	0.35	0.28	0.26	
Std. Deviation	0.05	0.05	0.04	0.03	
Disagreement					0.038

APPENDIX B – AHP/HDM PCM DATA TABLES

Figure : Normalized decision weights

Source of Variation	Sum of Square	Deg. of freedom	Mean Square	F-test value
Between Subjects:	0.08	3	.027	9.38
Between Conditions:	0.00	6	0.000	
Residual:	0.05	18	0.003	
Total:	0.13	27		
Critical F-value with	5.09			
Critical F-value with	3.95			
Critical F-value with	3.16			
Critical F-value with	2.42			

Figure: The statistical F-test