Understanding the Customers Portfolio towards Smart watch and Intension to Recommend Ambient Technology

Gladys Gnana Kiruba B, D. P. Acharjya

***Abstract:** Smart watch is the new generation watches which provide new assistants in the ambient environment. The new hardware technology of smart watch adds up with sensors and internet affords a high human computer interaction all through 24×7 of a person. In order to understand the satisfaction of smart watch users, it is highly necessary to master the technologies behind it. This paper uses the rough set rule generation technique to analyze the customer satisfaction by adopting the various demographics and key features of smart watch there by understanding the importance of ambient technology.*

***Keywords:** Ambient, Rough set, Rule Generation, Smart watch*

I. INTRODUCTION

A new era of human computer interaction leads to a massive development of high performance intelligent techniques and applications. These intellectual applications together with sensors and other embedded systems lead to a new design of technology known as Ambient Intelligence (AmI) [1]. Ambient Intelligence adds up advancement with artificial intelligence and machine learning techniques of computer science by interacting with real life environment through the hardware devices. In day to day life human need high sensitive devices to monitor themselves to provide security and management. For example, in the smart home system, temperature controlled air conditioner system, light on/off indicator, start/stop indicator for washing machine; micro-oven etc. works with sensors to monitor the home [2]. In case of health monitoring of patience devices with technologies are developed to regularly monitor the blood pressure, heart rate etc. [3]. Similarly some smart devices such as smart phone, smart watch, smart ring etc. add up technologies to enhance the people's daily activity. This enables high networking, sensing, acting and reasoning resultant to pervasive and ubiquitous computing. Thus the intelligence is used in ambient environment to enrich the activities of human with more smarter, efficient and enhanced.

Manuscript published on November 30, 2019.
* Correspondence Author
Gladys Gnana Kiruba B*, School of Computer Science and Engineering, VIT, Vellore, Tamilnadu, India. Email:gladys@vit.ac.in
D. P. Acharjya*, School of Computer Science and Engineering, VIT, Vellore, Tamilnadu, India. Email: dpacharjya@gmail.com

Normally enhancing technologies may leads to some pros and cons. It may be acceptable by the user or it may not. Sometimes the system or the device may be adequate based on some key features or by some set of peoples or by some specific needs. So it is highly essential to understand the satisfaction of users and identify the key features of the technologies towards their satisfaction. This research uses the rough set based rule generation techniques towards the behavioral intention of smart watch users based on demographic attributes and key features of smart watch. Many classification techniques are already available such as Naïve Bayes classifier, support vector machine, neural networks etc. [4]. Each techniques has a wide application on different domains [5, 6]. These models work well on crisp data set, but inefficient on uncertain and imprecise data. Rough set developed by Pawlak [7] has its own significance to work well on incomplete information system. In rough set the information system consists of set of attributes which co-relates the objects. The basis of the rough set is the indiscernible relation which identifies the objects which are identical based on the attributes. The rule generation is highly necessary to study the pattern of the system so as to extract a robust knowledge out of them. For example in the case of smart watch, it provides various features. The rules can be generated based on the customer satisfaction as decision attribute with various features of smart watch as conditional attributes. The rules provide a knowledge on which feature provide a high influence towards the customer satisfaction. Hence the product provider may enhance the quality of the product, increase or decrease the features so as to increase their productivity.

II. AMBIENT TECCHNOLOGY IN SMART WATCH

Ambient Technology as the word means the technologies around one's surrounding environment [8]. A person on his conventional day-to-day routine cross many technologies as smart phone, personal computer, smart television, smart home devices, smart watch, smart vehicles etc. Now-a-days there are no devices without technologies. The world around us including various sectors as banking, business, agriculture, education, communication, purchasing, human relationship etc. also customs with various technologies.

Time and tide waits for none. This is the proverb. But if the time machine itself provides us time management, then it is the most pleased job. Smart watch is a small wearable device which is easy to use and can always be associated with one's life.

The simple smart watch is associated with basic features like alarm clock, heart rate, step count, calorie count etc. The advance device may be added up additional features like notifications, Wi-Fi, GPS, internet facilities, blood pressure monitoring, daily activities monitoring and management etc. These features of smart watch enhance the people's activities making smarter and efficient. The smart watch interact with human body through the body-sensors to get the readings and display or notify the information to the user. It will be painless to monitor the healthcare of persons through device. Smart watch can also interact with the smart phone through various apps and provide various notifications and analysis. Similarly in future it may be easy to operate the complete home or surround devices through a single smart watch. Thus the ambient computing which is nothing but ambient intelligence provides a mean of interacting with system themselves and provides the complete assistants to the people. For example, when the washing machine was wear out or not functioning directly a call-service will be booked based on the sensors data and it will be serviced. So in order to improve the facilities of the smart watch, it is essential to study the customer satisfaction based on the ambient technologies.

III. ROUGH SET

Rough set theory introduced by Pawlak [5] is a mathematical tool used which deals with vague, uncertain, imprecise and inconsistent data. The algorithm is easy to understand and had a wide area of applications such as knowledge discovery, knowledge acquisition, decision analysis, pattern recognition, feature selection, machine learning and expert systems.

A. Information Systems

An information system is a two dimensional relational table where the rows represents the objects and the column represents the attributes of the information system. Each object is associated with the attributes to provide the useful information system which forms as the bottom line of the rough set. The objects are portrayed as indiscernible, if they share common characteristic among the objects in the given information systems.

Let (Q,P) be the information system, where Q is a non-empty finite set called the universe and P be the set of attribute. R is an equivalence relation which is defined on Q, partitions the information system into disjoint elementary class known as elementary concepts.. Every union of elementary concepts is known as definable set and (Q,R) is called an approximation space. Further, target set $Z \subseteq Q$ can be defined by a pair of lower and upper approximations $\underline{R}Z$ and $\overline{R}Z$ respectively as given in (1) and (2).

$$\underline{R}Z = \cup\{Y \in Q/R : Y \subseteq Z\} \quad (1)$$

$$\overline{R}Z = \cup\{Y \in Q/R : Y \cap Z \neq \phi\} \quad (2)$$

The objects of Z which are neither member nor non-member of the set with respect to the relation R is said to be in the boundary region and it is denoted as $BN_R Z = \overline{R}Z - \underline{R}Z$ .If $BN_R Z = \phi$, then the set is said to be crisp set, otherwise it is a rough set.

Let us consider a sample information system shown in Table I.

Table- I: Sample Smart user information table

	p_1	p_2	p_3	d
q_1	<25	M	M	1
q_2	>25	M	UM	1
q_3	>25	F	UM	2
q_4	<25	F	UM	2
q_5	<25	M	M	2

Here $\{q_1,q_2,q_3,q_4,q_5\}$ represents the smart users, $\{p_1,p_2,p_3\}$ represents the conditional attributes as age, gender and marital status. d represents the decision attribute as customer satisfaction. On applying the indiscernibility relation on the conditional attributes the following classifications are obtained.

$$Q/P = \{\{q_1,q_5\},\{q_2\},\{q_3\},\{q_4\}\}$$

$$Q/(P-p_1) = \{\{q_1,q_5\},\{q_2\},\{q_3,q_4\}\}$$

$$Q/(P-p_2) = \{\{q_1,q_5\},\{q_2,q_3\},\{q_4\}\}$$

$$Q/(P-p_3) = \{\{q_1,q_5\},\{q_2\},\{q_3\},\{q_4\}\}$$

This shows that the attribute p_3 is superfluous towards the set P and it can be removed from the set as it has no influence. Considering the target set $Z = \{q_3,q_4,q_5\}$, we get $\underline{R}Z = \{q_3,q_4\}$ and $\overline{R}Z = \{q_1,q_3,q_4,q_5\}$

B. Rough Set Rule Generation

Decision rules are generated to classify the instances of the rough set reduct system. The decision rule is of the form $\phi \rightarrow \psi$ where the set of conditional parameters and ψ the set of decision parameters. The quality of decision rules are identified by various measures as support, strength, and accuracy [2]. They are defined in (3), (4) and (5)

$$Support\_Supp(\phi,\psi) = Card(\|\phi \wedge \psi\|) \quad (3)$$

$$Strength\_\sigma(\phi,\psi) = Supp(\phi,\psi) \big/ Card(\|\phi\|_\psi) \quad (4)$$

$$Accuracy = \frac{|Supp(\phi,\psi)|}{|Supp(\phi,\psi) + N_{Supp}(\phi,\psi)|} \quad (5)$$

The steps to generate the decision rule using rough set is brief below in short. Here the qualitative decision system is taken as input, and candidacy rules are provoked as output.

Algorithm 1. *(Decision Rule Generation)*

1. Set decision i = 1

2. Compute a set of reducts considering all the condition parameters for each decision.

3. Replace i = i + 1. If all the objects have been chosen, then go to step 4. Else go to step 5.

4. Compute the number of supporting objects of the decision rule using (3) after combining the same reducts.

5. Compute the strength of each decision rule using (4).

6. Obtain the accuracy (Acc.) of each decision rule using (5).

7. Terminate the process and write the rules.

Now we explain the rough set rule generation procedure for the decision system presented in Table I. The rule generated for the simple and small information system in Table I is given in Table II.

Table- II: Decision Rules generated for Table I

Rule No.	Description	Support	Strength	Acc. (%)
1	IF age>25 and gender=Male THEN CS is low	2	1	67
2	IF gender=Female THEN CS is high	2	0	100

IV. PROPOSED ARHITECTURE

The proposed work consists of two modules as data preparation module and rough set data analysis module as shown in Fig.1. As the part of data preparation module, primarily the target data set is passed on to data cleaning, where the missing, incomplete and irrelevant data are removed .Now the data ready to be processed.

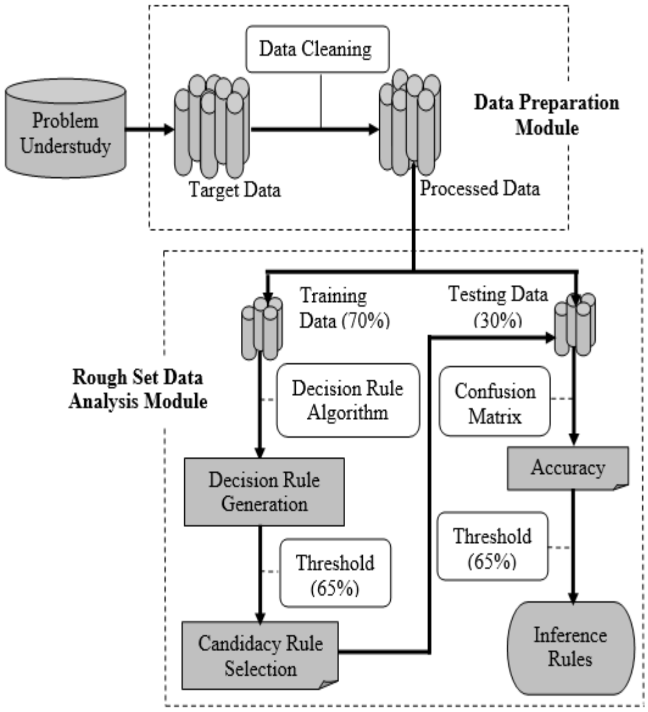

Fig. 1. Proposed Research Design Framework

In the second stage of the research work, the processed data has been taken and divided into training (70%) and testing (30%).The training data is passed to rule generation and rules are generated. Out of the generated rules the candidacy rules are selected and passed on to the testing phase. Finally the accuracy of the generated rules are calculated using the confusion matrix and the rules are inferred.

V. EMPIRICAL STUDY

A systematic approach has been followed to collect the information related to customer satisfaction on adapting to smart watch. A detailed questionnaire was prepared and the information was collected both online and offline. Based on the literature survey a list of demographics parameters and features of smart watch are identified and included in the survey. The Model of the system with the parameters is given in Fig. 2.

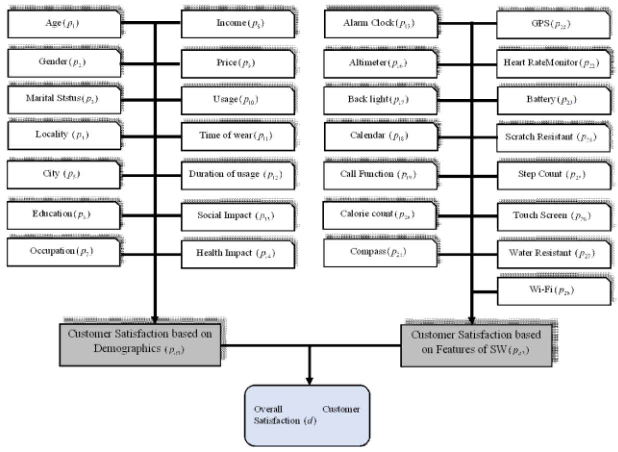

Fig. 2. Various dimensions to study customer's satisfaction

The Demographic parameters include age (p_1), gender (p_2), marital status (p_3), locality (p_4), city (p_5), education (p_6), occupation (p_7), income (p_8), price (p_9), usage (p_{10}), time of wear (p_{11}), duration of usage (p_{12}), social impact (p_{13}) and health impact (p_{14}). Similarly features based on smart watch are identified and listed as alarm (p_{15}), altimeter (p_{16}), black light (p_{17}), calendar (p_{18}), call function (p_{19}), calorie count (p_{20}), compass (p_{21}), GPS (p_{22}), heart rate monitor (p_{23}), battery (p_{24}), scratch resistant (p_{25}), step count (p_{26}), touch screen (p_{28}), water resistant (p_{29}) and Wi-Fi (p_{30}). Finally customer satisfaction (d) taken as the decision parameter with adding to two internal assessments as customer satisfaction based on demographics (p_{d1}) and customer satisfaction based in features (p_{d2}).

Based on the parameters a questionnaire was prepared and got the responses from various classes of people. As an outcome of the survey, 737 responses are received from the smart watch users and non-users. Based on the analysis that it was found that 103 responses are either non users and or some information is missing. Data has been cleaned and the remaining 634 responses are taken for further rule generation process.

VI. RESULT ANALYSIS

This section describes the results obtained based on the primary information system. The 634 responses are taken for the analysis. Further the data are categorized as shown in Table II. We have attached a number to each category for rough set data analysis. However, these numbers do not affect our analysis. Sample data sets of 10 objects based on demographic attributes are shown in Table III.

The processed data set is divided into 70% of training data and 30% of testing data. According to the percentage 444 data are taken for training and 190 data for testing process for both demographics and feature data set. Initially the 444 training data of demographics is taken and rough data rule generation is done. As a result 5 rules on very high, 14 rules for high, 24 rules for medium, 14 rules for low and 4 rules for very low are generated. It is shown in Table IV, Table V, Table VI, Table VII and Table VIII. These results are taken for testing phase and the accuracy obtained for shown in Table IX, Table X, Table XI, Table XII and Table XIII. Summarily the same is carried for Feature based on smart watch. Due to the length of the paper the final generated rules after the testing phase is given in Table XIV.

The overall analysis is given in Table XV. Further the confusion matrix is generated to calculate the accuracy of the rule generated and it is given TABLE XVI.

Table- II: Categorization of Aggregate Values

Parameter	Aggregate value	Parameter	Aggregate value	Parameter	Aggregate value
Age (P1)	18-20 (1)	Occupation (P7)	Student (1)	Usage duration (P12)	Less than 1 (1)
	21-30 (2)		Private Sector (2)		2 to 5 (2)
	31-40 (3)		Public Sector (3)		5 to 10 (3)
	41-50 (4)		Self Employed (4)		More than 10 (4)
	> 50 (5)		Home Maker (5)	Social Impact (P13)	No impact (1)
Gender (P2)	Male (1)		Retired (6)		Minor (2)
	Female (2)		others (7)		Moderate (3)
Marital Status (P3)	Married (1)	Income in Lakh (P8)	< 2 (1)		Major (4)
	Unmarried (2)		2 to 5 (2)		Critical (5)
	Other (3)		5 to 10 (3)	Health Impact (P14)	No impact (1)
Locality (P4)	Rural (1)		> 10 (4)		Minor (2)
	Semi urban (2)	Price in thousand (P9)	< 2 (1)		Moderate (3)
	Urban (3)		2 - 5 (2)		Major (4)
	Metropolitan (4)		5 - 10 (3)		Critical (5)
	Other (5)		10 - 20 (4)	Satisfaction (Pd)	Poor (1)
City (P5)	Mumbai (1)		> 20 (5)		Average (2)
	Delhi (2)	Usage Preferred (P10)	Fitness & Outdoor (1)		Good (3)
	Kolkata (3)		Health & Medical (2)		Very Good (4)
	Chennai (4)		Notifier (3)		Excellent (5)
	Bangalore (5)		Safety & Security (4)		
	Hyderabad (6)		Watchphone (5)		
	Coimbatore (7)		Others (6)		
	other (8)	Time of wear (P11)	Everyday (1)		
Education (P6)	Undergraduate (1)		Most of the time (2)		
	Post Graduate (2)		Sometimes (3)		
	Doctorate (3)		Only on Occasions (4)		
	No formal Education (4)				
	Other (5)				

Table- III: Sample Information System of Empirical Study

	p_1	p_2	p_3	p_4	p_5	p_6	p_7	p_8	p_9	p_{10}	p_{11}	p_{12}	p_{13}	p_{14}	p_{d1}
q_1	5	1	1	3	8	3	2	3	3	2	3	2	4	4	3
q_2	4	1	1	1	7	2	4	3	3	6	1	1	2	2	2
q_3	1	1	2	3	8	1	1	4	1	1	1	1	2	2	2
q_4	1	1	2	3	2	1	1	4	3	1	2	1	2	3	4
q_5	1	1	2	3	8	5	1	3	3	2	3	1	4	3	3
q_6	1	2	2	5	4	5	1	1	1	1	1	1	2	1	2
q_7	2	1	2	3	7	2	4	4	4	5	1	2	3	4	3
q_8	2	1	2	5	7	2	1	4	3	5	3	3	4	4	5
q_9	3	1	2	5	3	2	3	4	4	6	2	1	3	3	2
q_{10}	1	2	2	3	4	1	1	3	3	1	1	2	1	2	3

Table- IV: Decision rules for the decision P_{d1} = Very high

Rule No.	Description of Rule	Accuracy (%)
1	IF (P2 = 1) , (P13 = 1) , (P14 = 5) THEN (d = 1)	100
2	IF (P10 = 5) , (P12 = 1) THEN (d = 5)	100
3	IF (P11 = 5) , (P14 = 4) THEN (d = 5)	100

4	IF (P5 = 6) , (P13 = 3) THEN (d = 5)	100
5	IF (P1 = 1) , (P4 = 3) , (P8 = 4) , (P10 = 2) , (P12 = 1) , (P13 = 1) THEN (d = 5)	100

Table- V: Decision rules for the decision P_{d1} =High

Rule No.	Description of Rule	Accuracy (%)
1	IF (P1 = 2) , (P6 = 2) , (P9 = 4) and (P15 = 3) THEN (d = 2)	100
2	IF (P11 = 1) , (P12 = 2) and (P13 = 2) THEN (d = 2)	100
3	IF (P5 = 8) , (P8 = 4) , (P11 = 1) , (P14 = 2) and (P15 = 2) THEN (d = 2)	50
4	IF (P8 = 1) , (P14 = 2) and (P15 = 1) THEN (d = 2)	100
5	IF (P5 = 3) , (P8 = 4) and (P14 = 3) THEN (d = 2)	63
6	IF (P1 = 4) and (P12 = 3) THEN (d = 2)	50
7	IF (P2 = 1) , (P9 = 1) , (P12 = 1) and(P14 = 2) THEN (d = 2)	100
8	IF (P9 = 5) and (P12 = 2) THEN (d = 2)	33
9	IF (P7 = 2) , (P8 = 4) , (P10 = 1) and (P14 = 3) THEN (d = 2)	50
10	IF (P1 = 5) and (P6 = 1) THEN (d = 2)	100
11	IF (P6 = 2) , (P11 = 1) and (P13 = 4) THEN (d = 2)	100
12	IF (P1 = 2) , (P11 = 3) and (P12 = 1) THEN (d = 2)	100
13	IF (P2 = 1) , (P8 = 4) and (P11 = 2) , (P14 = 3) THEN (d = 2)	50
14	IF (P1 = 2) , (P5 = 4) and (P13 = 2) THEN (d = 2)	100

Table- VI: Decision rules for the decision P_{d1} = Medium

Rule No.	Description of Rule	Accuracy (%)
1	IF (P4 = 5) , (P5 = 8) and (P13 = 1) THEN (d = 3)	50
2	IF (P4 = 1) , (P9 = 3) and (P12 = 1) THEN (d = 3)	100
3	IF (P1 = 1) , (P2 = 1) , (P8 = 3) , (P10 = 2) and (P13 = 1) THEN (d = 3)	63
4	IF (P1 = 1) , (P2 = 1) , (P4 = 3) , (P9 = 4) and (P14 = 3) THEN (d = 3)	100
5	IF (P4 = 3) , (P11 = 1) and (P13 = 2) THEN (d = 3)	100
6	IF (P12 = 4) , (P14 = 3) and (P15 = 3) THEN (d = 3)	63
7	IF (P9 = 4) , (P10 = 2) , (P12 = 1) , (P13 = 2) and (P14 = 2) THEN (d = 3)	33
8	IF (P8 = 1) , (P10 = 2) and (P13 = 1) THEN (d = 3)	100
9	IF (P10 = 1) , (P11 = 2) and (P13 = 1) THEN (d = 3)	97
10	IF (P12 = 2) , (P14 = 1) and (P15 = 1) THEN (d = 3)	100
11	IF (P1 = 1) , (P9 = 2) , (P10 = 1) and (P15 = 2) THEN (d = 3)	100
12	IF (P1 = 1) , (P11 = 1) , (P13 = 1) and (P14 = 1) THEN (d = 3)	50
13	IF (P2 = 1) , (P5 = 8) and (P10 = 3) THEN (d = 3)	63
14	IF (P2 = 2) , (P6 = 1) , (P8 = 4) and (P14 = 3) THEN (d = 3)	100
15	IF (P6 = 3) and (P9 = 3) THEN (d = 3)	100
16	IF (P11 = 1) and (P15 = 5) THEN (d = 3)	33
17	IF (P6 = 2) , (P9 = 4) and (P13 = 2) THEN (d = 3)	100
18	IF (P6 = 4) THEN (d = 3)	50
19	IF (P5 = 4) , (P6 = 1) and (P15 = 3) THEN (d = 3)	100
20	IF (P5 = 1) THEN (d = 3)	100
21	IF (P4 = 5) and (P7 = 4) THEN (d = 3)	93
22	IF (P2 = 2) , (P3 = 1) and (P7 = 1) THEN (d = 3)	100
23	IF (P11 = 5) and (P12 = 1) THEN (d = 3)	100
24	IF (P2 = 2) , (P10 = 3) and (P11 = 6) THEN (d = 3)	50

Table- VII: Decision rules for the decision P_{d1} = Low

Rule No.	Description of Rule	Accuracy (%)
1	IF (P1 = 1) , (P10 = 1) and (P13 = 4) THEN (d = 4)	63
2	IF (P4 = 5) , (P5 = 6) , (P11 = 1) and (P13 = 1) THEN (d = 4)	100
3	IF (P1 = 1) , (P2 = 2) , (P3 = 2) , (P5 = 8) and (P10 = 1) THEN (d = 4)	33
4	IF (P5 = 8) , (P10 = 2) and (P15 = 1) THEN (d = 4)	100
5	IF (P1 = 1) , (P2 = 1) , (P6 = 1) , (P10 = 3) and (P13 = 1) THEN (d = 4)	33
6	IF (P2 = 1) , (P5 = 8) , (P8 = 1) and (P15 = 3) THEN (d = 4)	93
7	IF (P5 = 8) , (P10 = 2) and (P14 = 4) THEN (d = 4)	100
8	IF (P6 = 2) , (P13 = 1) and (P14 = 1) THEN (d = 4)	50
9	IF (P12 = 2) and (P14 = 4) THEN (d = 4)	67
10	IF (P5 = 8) , (P10 = 2) and (P15 = 4) THEN (d = 4)	50
11	IF (P8 = 3) and (P10 = 4) THEN (d = 4)	63
12	IF (P5 = 2) and (P15 = 4) THEN (d = 4)	100
13	IF (P5 = 2) , (P6 = 1) and (P9 = 4) , (P10 = 2) THEN (d = 4)	100
14	IF (P1 = 2) , (P10 = 2) and (P12 = 3) THEN (d = 4)	63

Table- VIII: Decision rules for the decision Pd1 = Very Low

Rule No.	Description of Rule	Accuracy (%)
1	IF (P10 = 5) and (P12 = 1) THEN (d = 5)	100
2	IF (P11 = 5) and (P14 = 4) THEN (d = 5)	100
3	IF (P5 = 6) and (P13 = 3) THEN (d = 5)	100
4	IF (P1 = 1) and (P4 = 3) , (P8 = 4) , (P10 = 2) , (P12 = 1) , (P13 = 1) THEN (d = 5)	97

Table- IX: Decision rules validation for the decision P_{d1} = Very High

Rule No.	Description of Rule	Support	Non Support	Accuracy (%)
1	IF (P2 = 1) , (P13 = 1) , (P14 = 5) THEN (d = 1)	1	0	100
2	IF (P10 = 5) , (P12 = 1) THEN (d = 5)	1	0	100
3	IF (P11 = 5) , (P14 = 4) THEN (d = 5)	1	0	100
4	IF (P5 = 6) , (P13 = 3) THEN (d = 5)	1	0	100
5	IF (P1 = 1) , (P4 = 3) , (P8 = 4) , (P10 = 2) , (P12 = 1) , (P13 = 1) THEN (d = 5)	1	0	100

Table- X: Decision rules validation for the decision P_{d1} = High

Rule No.	Description of Rule	Support	Non Support	Accuracy (%)
1	IF (P1 = 2) , (P6 = 2) , (P9 = 4) and (P15 = 3) THEN (d = 2)	1	0	100
2	IF (P11 = 1) , (P12 = 2) and (P13 = 2) THEN (d = 2)	2	1	67
3	IF (P8 = 1) , (P14 = 2) and (P15 = 1) THEN (d = 2)	1	0	100
4	IF (P2 = 1) , (P9 = 1) , (P12 = 1) and(P14 = 2) THEN (d = 2)	2	2	50
5	IF (P1 = 5) and (P6 = 1) THEN (d = 2)	1	0	100
6	IF (P6 = 2) , (P11 = 1) and (P13 = 4) THEN (d = 2)	1	0	100
7	IF (P1 = 2) , (P11 = 3) and (P12 = 1) THEN (d = 2)	1	1	50
8	IF (P1 = 2) , (P5 = 4) and (P13 = 2) THEN (d = 2)	1	0	100

Retrieval Number: D9067118419/2019©BEIESP
DOI:10.35940/ijrte.D9067.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Table- XI: Decision rules validation for the decision P_{d1} = Medium

Rule No.	Description of Rule	Support	Non Support	Accuracy (%)
1	IF (P4 = 1) , (P9 = 3) and (P12 = 1) THEN (d = 3)	1	0	100
2	IF (P1 = 1) , (P2 = 1) , (P4 = 3) , (P9 = 4) and (P14 = 3) THEN (d = 3)	1	2	33
3	IF (P4 = 3) , (P11 = 1) and (P13 = 2) THEN (d = 3)	1	0	100
4	IF (P8 = 1) , (P10 = 2) and (P13 = 1) THEN (d = 3)	2	0	100
5	IF (P10 = 1) , (P11 = 2) and (P13 = 1) THEN (d = 3)	1	0	100
6	IF (P12 = 2) , (P14 = 1) and (P15 = 1) THEN (d = 3)	1	0	100
7	IF (P1 = 1) , (P9 = 2) , (P10 = 1) and (P15 = 2) THEN (d = 3)	1	1	50
8	IF (P2 = 2) , (P6 = 1) , (P8 = 4) and (P14 = 3) THEN (d = 3)	1	0	100
9	IF (P6 = 3) and (P9 = 3) THEN (d = 3)	2	0	100
10	IF (P6 = 2) , (P9 = 4) and (P13 = 2) THEN (d = 3)	1	0	100
11	IF (P5 = 4) , (P6 = 1) and (P15 = 3) THEN (d = 3)	1	2	33
12	IF (P5 = 1) THEN (d = 3)	2	0	100
13	IF (P4 = 5) and (P7 = 4) THEN (d = 3)	1	0	100
14	IF (P2 = 2) , (P3 = 1) and (P7 = 1) THEN (d = 3)	1	1	50
15	IF (P11 = 5) and (P12 = 1) THEN (d = 3)	1	0	100

Table- XII: Decision rules validation for the decision P_{d1} = Low

Rule No.	Description of Rule	Support	Non Support	Accuracy (%)
1	IF (P4 = 5) , (P5 = 6) , (P11 = 1) and (P13 = 1) THEN (d = 4)	2	0	100
2	IF (P5 = 8) , (P10 = 2) and (P15 = 1) THEN (d = 4)	1	1	50
3	IF (P2 = 1) , (P5 = 8) , (P8 = 1) and (P15 = 3) THEN (d = 4)	1	2	33
4	IF (P5 = 8) , (P10 = 2) and (P14 = 4) THEN (d = 4)	1	0	100
5	IF (P12 = 2) and (P14 = 4) THEN (d = 4)	1	0	100
6	IF (P5 = 2) and (P15 = 4) THEN (d = 4)	1	0	100
7	IF (P5 = 2) , (P6 = 1) and (P9 = 4) , (P10 = 2) THEN (d = 4)	1	1	50

Table- XIII: Decision rules validation for the decision P_{d1} = Very Low

Rule No.	Description of Rule	Support	Non Support	Accuracy (%)
1	IF (P10 = 5) and (P12 = 1) THEN (d = 5)	1	0	100
2	IF (P11 = 5) and (P14 = 4) THEN (d = 5)	1	0	100
3	IF (P5 = 6) and (P13 = 3) THEN (d = 5)	1	0	100
4	IF (P1 = 1) and (P4 = 3) , (P8 = 4) , (P10 = 2) , (P12 = 1) , (P13 = 1) THEN (d = 5)	1	0	100

Table- XIV: Decision rules after validation for the decision P_{d2}

Rule No.	Description of Rule
1	IF (P8 = 1) , (P15 = 1) THEN (d = 1)
2	IF (P4 = 4) , (P11 = 4) , (P13 = 1) THEN (d = 1)
3	IF (P6 = 4) , (P8 = 3) , (P12 = 4) THEN (d = 1)
4	IF (P9 = 2) , (P10 = 3) THEN (d = 2)
5	IF (P2 = 3) , (P13 = 2) , (P15 = 2) THEN (d = 2)
6	IF (P4 = 3) , (P6 = 4) , (P11 = 3) THEN (d = 2)

Retrieval Number: D9067118419/2019©BEIESP
DOI:10.35940/ijrte.D9067.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

7	IF (P10 = 1) , (P15 = 4) THEN (d = 2)
8	IF (P7 = 3) , (P8 = 3) , (P9 = 3) , (P11 = 4) THEN (d = 2)
9	IF (P3 = 4) , (P13 = 2) , (P15 = 4) THEN (d = 3)
10	IF (P4 = 5) , (P5 = 4) , (P7 = 5) , (P8 = 4) THEN (d = 3)
11	IF (P5 = 4) , (P6 = 4) , (P12 = 3) , (P14 = 4) THEN (d = 3)
12	IF (P6 = 3) , (P9 = 3) , (P12 = 1) THEN (d = 3)
13	IF (P3 = 3) , (P4 = 4) , (P12 = 4) THEN (d = 3)
14	IF (P5 = 3) , (P9 = 3) , (P10 = 4) , (P15 = 3) THEN (d = 3)
15	IF (P6 = 3) , (P9 = 5) , (P11 = 3) THEN (d = 3)
16	IF (P7 = 4) , (P8 = 3) , (P9 = 4) THEN (d = 3)
17	IF (P5 = 4) , (P13 = 3) , (P14 = 4) , (P15 = 5) THEN (d = 3)
18	IF (P4 = 5) , (P12 = 4) , (P13 = 5) THEN (d = 3)
19	IF (P10 = 4) , (P11 = 4) , (P14 = 4) , (P15 = 5) THEN (d = 4)
20	IF (P8 = 5) , (P12 = 3) , (P14 = 4) THEN (d = 4)
21	IF (P4 = 1) , (P12 = 4) THEN (d = 4)
22	IF (P6 = 3) , (P11 = 4) , (P13 = 4) , (P15 = 4) THEN (d = 4)
23	IF (P8 = 1) , (P9 = 5) THEN (d = 4)
24	IF (P5 = 3) , (P8 = 4) , (P15 = 1) THEN (d = 4)
25	IF (P7 = 2) , (P9 = 5) THEN (d = 4)
26	IF (P2 = 5) , (P9 = 3) , (P13 = 3) THEN (d = 5)
27	IF (P10 = 2) , (P15 = 5) THEN (d = 5)
28	IF (P5 = 4) , (P6 = 4) , (P9 = 4) , (P10 = 3) , (P12 = 4) THEN (d = 5)

Table XV Description of Data division, Rules generation and Selection

Decision	Category	Total Objects	Training	Testing	Generated Rules	Training Phase	Testing Phase
Demographics	Very high	83	60	23	5	5	5
	High	126	81	45	14	8	6
	Medium	182	116	66	24	15	11
	Low	174	137	37	14	7	4
	Very low	69	50	19	4	4	4
	Total	634	444	190	61	39	30
Features	Very high	78	54	24	3	3	3
	High	134	93	41	12	9	5
	Medium	197	138	59	23	16	10
	Low	162	113	49	18	10	7
	Very low	63	46	17	4	3	3
	Total	634	444	190	60	41	28

Table XVI Confusion Matrix for P_{d1} and P_{d2}

Decision	Category	TP	FN	FP	TN	Precision	Recall	Accuracy (%)
Demographics	Very high	17	5	1	167	0.944	0.773	0.97
	High	40	4	1	145	0.976	0.909	0.97
	Medium	57	7	2	124	0.966	0.891	0.95
	Low	31	4	2	153	0.939	0.886	0.97
	Very low	14	5	3	168	0.824	0.737	0.96
	Total	159	25	9	757	0.946	0.864	0.96
Features	Very high	18	5	1	166	0.947	0.783	0.97
	High	35	4	2	149	0.946	0.897	0.97
	Medium	51	5	3	131	0.944	0.911	0.96
	Low	41	6	2	141	0.953	0.872	0.96
	Very low	13	3	1	173	0.929	0.813	0.98
	Total	158	23	9	760	0.946	0.873	0.97

From the confusion it is clear that for P_{d1} (demographics attribute) the accuracy is 96 % and for features of smart the accuracy is 97%. The graphical representation of both the decision attributes measures with accuracy is presented in Fig. 3 and Fig. 4.

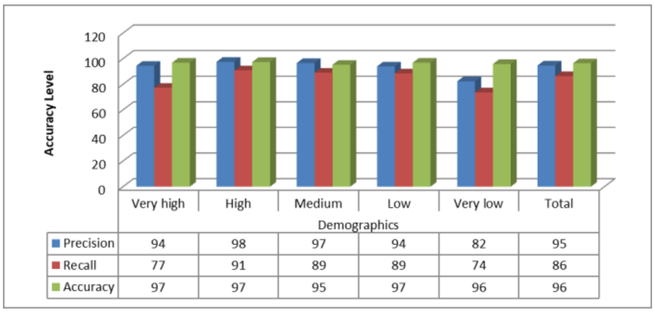

Fig. 3 Measures of decision for Demographic Attributes

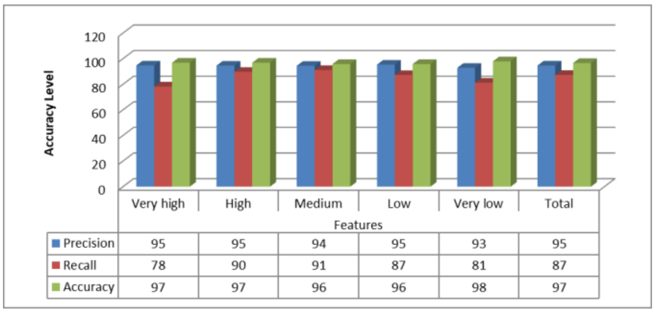

Fig. 4 Measures of decision for Features of Smart Watch

The overall satisfaction of customers of smart-watch based on demographic and features to recommend the ambient technology is presented in Fig. 5

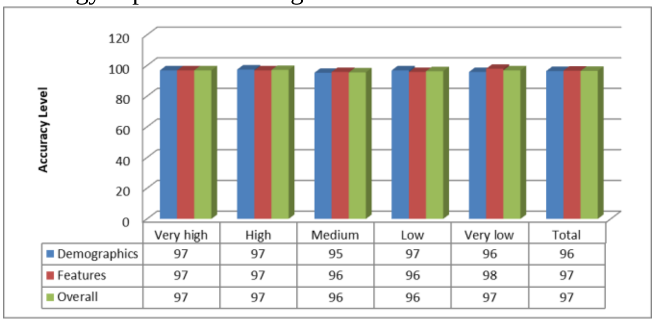

Fig. 5. Overall Satisfaction of Smart-watch Customers

VII. CONCLUSION

As on world-wide, more digital equipment with various technologies are emerging around our surroundings. This introduces the concept of ambient technology. Ambient technology is the technology in the surrounding which make the human life more convenient and efficient. It is essential to understand the customer's satisfaction towards the ambient technology. This is research is carried out by taking the smart-watch users demographic attributes and features of smart watch and analysis the customer satisfaction towards the technologies used in them. The analysis is carried out by applying the rough set and rough set rule generation. From the rules it was observed how well the product technology was accepted based on the demographic attributes like age, price, etc. and which features of smart watch makes the people to accept it.

REFERENCES

1. Aarts, E., & Wichert, R. (2009). Ambient intelligence. In Technology guide (pp. 244-249). Springer, Berlin, Heidelberg.
2. Cook, D. J., Augusto, J. C., & Jakkula, V. R. (2009). Ambient intelligence: Technologies, applications, and opportunities. Pervasive and Mobile Computing, 5(4), 277-298.
3. Salih, A., & Abraham, A. (2013). A review of ambient intelligence assisted healthcare monitoring. International Journal of Computer Information Systems and Industrial Management (IJCISIM), 5, 741-750.
4. Kotsiantis, S. B., Zaharakis, I., & Pintelas, P. (2007). Supervised machine learning: A review of classification techniques. Emerging artificial intelligence applications in computer engineering, 160, 3-24.
5. Ahmed, A., & Hannan, S. A. (2012). Data mining techniques to find out heart diseases: An overview. International Journal of Innovative Technology and Exploring Engineering (IJITEE), 1(4), 18-23.
6. Singh, D., & Kaur, K. (2012). Classification of abnormalities in brain MRI images using GLCM, PCA and SVM. International Journal of Engineering and Advanced Technology (IJEAT), 1(6), 243-248.
7. Z. Pawlak, A. Skowron, Rough sets: some extensions, Information Sciences 177 (1) (2007) 28–40.
8. Payne, R., & Macdonald, B. (2006). Ambient technology—now you see it, now you don't. In Intelligent Spaces (pp. 199-217). Springer, London.

AUTHORS PROFILE

Gladys Gnana Kiruba B received her B.Sc. in computer science from Maharaja College for Women, Perundurai, Tamilnadu. She has obtained M. Sc. (Computer Science) and M. Tech. in computer science and engineering from VIT, Vellore in 2008 and 2011 respectively. Presently, she is perusing her Ph. D. in computer science and engineering from VIT, Vellore. She is working as an Assistant Professor in the school of computer science and engineering, VIT, Vellore, India. She has published many papers in peer reviewed journals. She is a life member of CSI, and Indian Science Congress. Her research interest includes business intelligence, computational intelligence, rough set, and knowledge discovery.

D. P. Acharjya received his Ph. D in computer science from Berhampur University, India; M. Tech. degree in computer science from Utkal University, India in 2002; M. Phil. from Berhampur University, India; and M. Sc. from NIT, Rourkela, India. He has been awarded with Gold Medal in M. Sc. Currently he is working as a Professor in the school of computer science and engineering, VIT, Vellore, India. He has authored many national and international journal papers and five books; Fundamental Approach to Discrete Mathematics, Computer Based on Mathematics, Theory of Computation; Rough Set in Knowledge Representation and Granular Computing; Introduction to Information and Communication Technology and Computer programming to his credit. He has also edited six books to his credit. He has also published many chapters in different books published by International publishers. In addition, he is reviewer of many international journals such as Fuzzy Sets and Systems, Knowledge Based Systems, and Applied Journal of Soft Computing. Dr. Acharjya is actively associated with many professional bodies like CSI, ISTE, IMS, AMTI, ISIAM, OITS, IACSIT, CSTA, IEEE and IAENG. He was founder secretary of OITS Rourkela chapter. His current research interests include rough sets, formal concept analysis, knowledge representation, data mining, granular computing and business intelligence.