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# Physicians' and Users' Perceptions Towards Wearable Health Devices

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***Abstract***

*Healthcare plays a vital role in economic development of a country, and has a major impact on the entire wellness of humankind. One of the biggest issues of all times, Blood Pressure is prevailing in patients of all countries. In developing countries like India, it is prevalent among people of diverse age groups, which somehow permeates into their wellness, reflecting and slowing down the growth of the country as well as that of an individual. One of the major concerns is that, health consciousness among people is overall at stake and they become ignorant of their basic metabolic profile picture like High/Low Blood Pressure. Many do not know that they have abnormality in their blood pressures, and the resultant impacts it would create on them. As Blood Pressure is identified as one of the major contributors to Cardio Vascular Diseases, there is an urge to educate people about the consequences. This research addresses the need to use Mobile Health Management Services and to reduce the risk of emergencies, and hence we have used Technology Acceptance Model to determine the degree of acceptance of these devices. The research focuses on various factors and their levels of impact on acceptance of Mobile Health Management Services. Appropriate tests have been carried out for validating this hypothesis. All the details are presented in the results' section with clear discussion and description.*

***Keywords**: TAM (technology acceptance model); MHMS (mobile health management services); BP (blood pressure); Wearable Devices; PHD (personal health devices)*



## 1. Introduction

A rising trend in hypertension is observed throughout because of change in life style, diet and increased stress. This is mainly due to technological advances, which have shrunk the physical activities leading to a sedentary lifestyle approach, increased automation, high usage of gadgets, and also reduced employment opportunities [1]. Hypertension is one of the major causes for premature mortality rate [2]. It is identified as an influential factor for cardiovascular morbidity and mortality [2]. The Global and Regional Burden of Disease and Risk Factors study ranked Hypertension next to child underweight problem, which tops the list for attributable deaths and attributable disease burden. Our problem statement and the research data taken for reference are mainly in concurrence with the subcontinent's stance. According to Shyamal Kumar Das et al. (2005), "hypertension among the urban population has increased by 30 times in a span of 55 years whereas among the rural population it has increased by 10 times over a period of 36 years [1]." Anchala et al. (2014) found that about 33 percent of urban and 25 percent are hypertensive [3]. Today, hypertension is the leading cause of stroke, heart failure and heart attack. Modifications in life style and medications can reduce Blood Pressure (BP). BP can be lowered by calming the mind and the body, Yoga, increased physical activities, balanced diet and reducing the consumption of junk food [4]. One third of Indians are suffering from hypertension as per the survey conducted by the Cardiological Society of India on September 25, 2015, which definitely is alarming. Human Resources being the strength of India inflicted by this health hazard, remains a major concern. The survey which covered 1.8 lakh people was conducted across 24 states of India [5]. It was observed that 2/3rd of them are unaware of the p6/7 revalence of high BP [5], and 75 percent rural and 58 percent urban are unaware of hypertension [3]. This proves that people are ignorant of the risk to be faced.

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Hypertension management helps to focus on reducing the cardiovascular risk, stroke and kidney diseases [6, 7].

Advancement in electronics has helped for the awareness of continuous health monitoring. Though the use of physiological measurement devices in clinical settings and hospitals have been dominant over years, some unique features of unobtrusive and wearable devices make them essential to be used in some complex situations [8]. These devices help to track the health status and also store realtime information which can be used for remote intervention to address severe conditions like stroke, epilepsy, rise in blood pressure and heart attack. Tracking the health issues and realtime information is essential particularly in rural areas and places that are inaccessible by expert doctors or those which are located far away from hospitals [8]. Acceptance, adoption and usage of mobile health technologies is expected to rise in the future [9]. This is due to necessitating the need for these devices; through compulsion or through media. Quality of healthcare can be improved by hospital information systems. A question of not only fear but also insecurity arises in users as they need to carry an additional device to keep them healthy [10]. Lack of health education, anxiety of health issues, and fear of carrying these gadgets prevent people from using these devices.User acceptance also plays an important role in implementation of these devices. Hence, this study determines the degree of acceptance of these devices among users and also physical practitioners. This research is built based on the results of the survey conducted from the questionnaire framed based on the TAM, followed by demographic analysis, reliability test, construct validity and hypothesis testing. The observations and data collected are used to draw a line of conclusion with suggestions for future.

## 2. Theoretical Foundation

Theoretical models such as Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), and Technology Acceptance Model (TAM) can be used to study the degree of acceptance/adoption, when a technology is introduced to a target group. According to TRA, actual Behaviour or system use is a direct measure of Behavioural Intention. Predecessors of BI are found to be Attitude and Subjective Norms. TPB adds Perceived Behavioural Control as another antecedent of BI [11]. TAM considers PU and EOU as two fundamental constructs influencing Attitude [12, 13]. PU is the improvement in performance, achieved as a result of adoption of a technology. EOU is the degree of easiness with which, a consumer can use the technology [14, 15]. Attitude is the users' insight developed about the technology, whether or not to use them. In initial stages of adoption, men weigh PU as an important factor than EOU, whereas women emphasized on EOU to a higher extent [14]. For implementation of mobile healthcare systems in healthcare organizations, attitude of medical practitioners does not play a vital role since they are just asked to adopt the technologies after the decision has been made by organizations [11]. Nevertheless, for MHMS, Attitude of individuals largely influences the use of the system since they are the end users [11]. However, attitude and intention of physical practitioners towards these devices may influence the effectiveness in which these devices are delivered to people, which in turn would certainly influence people's perception towards the use of these devices [16]. Hence, it is important to equate and study the degree of willingness of physical practitioners and the degree of acceptance of the healthcare seekers as it influences patients' minds [17].

External factors also influence the attitude towards the use of these devices [18, 14]. External variables bridge the internal beliefs, attitude and Behavioural Intention [19, 20]. Gender is one of those factors which has not been considered as highly influential, yet, has a significant difference in thought process and decision making, in the process of adoption of a new technology [14]. Studies reveal that demographic attributes play a major role in acceptance of new technologies [10, 14]. Also, external variables such as vendors, implementation process, which affect the use of technologies, are not included in this research model [21]. Users, performs a cost-benefit analysis before adoption of a technology [22]. Rejection of a technology and non-adoption indicate users' repulsion towards adoption of a technology [23, 24]. Rejection closes doors for future whereas non-adoption may be due to the unawareness or barriers that prevent the use of the introduced technology [23, 25]. Resistance to change and fear of failures are major concerns of users [26, 24]. This can be eliminated by introducing the technology to the consumers and educating them about the benefits they attain as a result of integration of IT into healthcare [27].

## 3. Proposed Research Framework

This research aims to determine the degree of acceptance of MHMS by users from various social backgrounds. A comparison is made between various items of all constructs of the TAM model to relate the scores of healthcare providers (physical practitioners, nurses etc.,) with the corresponding scores the users. The model will prove effective and efficient only if the scores of physical practitioners are equal to or higher than that of the users, as this implies that the physical practitioners are aware of the benefits and the consequences of not using these devices than common people of nonmedical background. Furthermore, the physical practitioners will be able to educate people if and only if they are knowledgeable of these devices. The survey questionnaire consists of three constructs, namely PEU, PU and AT with multiple items in each constructs. Questions measuring each item were in Likert scales from 1 to 5, designating “strongly disagree” to “strongly agree” [11, 28]. The survey collected basic demographic information ofpeople from both medical and non-medical backgrounds in order to compare their preference and perception about the use of MHMS. Each item and their constructs were framed based on previous studies. As the study is focused to create awareness among younger generation of people which will have a definite and greater impact for future, survey included younger participants with age less than 40 in higher fraction. As multi-item approach minimizes impreciseness, multiple items were framed to measure each construct [22]. Various constructs along with the survey items are listed in Tables. It is seen that the construct PEU has all items defining the simplicity of these devices in terms of construction and usage. PU includes variables mentioning about the user benefits. Cost factor is added to find out the cost-benefit relativity. AT contains items related to attitude of people and external factors that can influence the attitude.

## 4. Research Methodology

### 4.1. Demographic Analysis

The survey covers 197 valid responses which includes 55 respondents from medical background. Table 1 shows the number of respondents with means of their responses for various constructs. It is clear that most of the people agree the use of these devices if it would be easier for handling and if these devices help to address health issues and keep track of their health status. The number of people who disagree is less in AT construct, which reveals that people are willing to use these devices regardless of the complexity involved in using these devices. Also, we can see that the number of respondents disagreeing based on PU is less, which shows that people believe that the use of these devices improves their health.

Table 1. Demographic Analysis

| Count | | | | |
|---|---|---|---|---|
| | | PEU | PU | AT |
| All respondents | Agree | 106 | 139 | 101 |
| | Balanced | 55 | 43 | 71 |
| | Disagree | 36 | 15 | 25 |
| % respondents | | | | |
| Health condition | | | | |
| People with severe health issues | Agree | 60.32 | 73.02 | 49.21 |
| | Balanced | 20.63 | 20.63 | 39.68 |
| | Disagree | 19.05 | 6.35 | 11.11 |
| Healthy people | Agree | 50.75 | 69.40 | 52.24 |
| | Balanced | 31.34 | 22.39 | 34.33 |
| | Disagree | 17.91 | 8.21 | 13.43 |
| Academic/Professional Background | | | | |
| Medical | Agree | 60.00 | 72.73 | 47.27 |
| | Balanced | 21.82 | 20.00 | 40.00 |
| | Disagree | 18.18 | 7.27 | 12.73 |

| % respondents | | | | |
|---|---|---|---|---|
| Age | | | | |
| Young (age<40) | Agree | 54.32 | 68.52 | 50.62 |
| | Balanced | 27.78 | 23.46 | 36.42 |
| | Disagree | 17.90 | 8.02 | 12.96 |
| Elder (age>=40) | Agree | 51.43 | 80.00 | 54.29 |
| | Balanced | 28.57 | 14.29 | 34.29 |
| | Disagree | 20.00 | 5.71 | 11.43 |
| Gender | | | | |
| Female | Agree | 59.49 | 74.68 | 59.49 |
| | Balanced | 26.58 | 18.99 | 31.65 |
| | Disagree | 13.92 | 6.33 | 8.86 |
| Male | Agree | 50.00 | 67.80 | 45.76 |
| | Balanced | 28.81 | 23.73 | 38.98 |
| | Disagree | 21.19 | 8.47 | 15.25 |

Table 1 shows the responses of various groups of people for various constructs. The percentage of people agreeing towards the usage of these devices based on the constructs PEU and PU are higher for people having serious health issues which shows that they are aware of the ease of use and the benefits attained by using these devices. This may be because of the direct use of these devices or the knowledge gained from physical practitioners or health care providers, or their exposure to health problems and willingness to find out ways to manage health effectively. Also, comparing between people with medical background and others, the percentage of people agreeing for the constructs PEU and PU, scores are higher for medical people which are obvious. This is because of their exposure to these devices and the importance of using them. It is clear from the scores of PEU that it is almost equal for younger (age < 40) and elder (age >= 40) people [29]. It may be understood that this may be due to the higher exposure of technologies among the younger generation though elder people have higher knowledge of health related subjects. The AT scores are closely equal for younger and elder people and also for medical and non-medical people which is a positive outcome as it would enable younger generation to gain knowledge from elder people. This makes it easy for physical practitioners to deliver health services in a better way to people from non-medical background.

### 4.2. Reliability and Construct Validity

Table 2. Reliability and Construct validity

| Dimensons | | Measured Items | Factor Loading | Eigen-value | % of Variance | Cronbach's 'α' Value |
|---|---|---|---|---|---|---|
| Perceived Ease of Use (PEU) | PEU1 | It is easy to have Mobile Health Management devices | 0.8028 | 7.279 | 48.53 | 0.839 |
| | PEU2 | The usage and instructions for usage of these devices are easier to understand and follow | 0.8179 | | | |
| | PEU3 | Handling is easier | 0.8466 | | | |
| Perceived Usefulness (PU) | PU1 | These devices will help the patients to be aware of their health condition | 0.6689 | 1.53 | 58.731 | 0.864 |
| | PU2 | They help the practitioners to address patients' health issues effectively | 0.7577 | | | |
| | PU3 | Will enable the medical practitioners/ physicians to know their patients' health status | 0.8557 | | | |
| | PU4 | Will enable the medical practitioners/ physicians to provide faster treatment | 0.7811 | | | |
| | PU5 | I would recommend the use only if it is available easily at an affordable cost | 0.6062 | | | |
| Behavioural Attitude (AT) | AT1 | It improves the overall quality of life | 0.6802 | 1.236 | 66.971 | 0.899 |
| | AT2 | I like my patients to use Mobile Health Management Devices | 0.7088 | | | |
| | AT3 | It is necessary to use these devices for prevention of health related problems | 0.8209 | | | |
| | AT4 | I would recommend the use of these devices for Health improvement | 0.7708 | | | |
| | AT5 | These devices are essential to keep track of our health conditions | 0.7473 | | | |
| | AT6 | I would use/recommend the use of these devices if my friends/family suggests | 0.6893 | | | |
| | AT7 | I would use/recommend these devices if my patients tells the benefits of using these devices | 0.5284 | | | |

To ensure reliability, Cronbach’s ‘α’ values were calculated from the scores of each construct [11, 28]. Cronbach’s ‘α’ values lie between zero (unreliable) and one (perfectly reliable). Values greater than 0.5 are acceptable [30]. Cronbach’s ‘α’ values obtained are all above 0.8, indicating strong reliability [11, 30]. Exploratory Factor Analysis (EFA) is used to identify the underlying themes or constructs, which is to verify the validity of the constructs [11, 31]. EFA is helpful to find the loading pattern of variables and to drop the poorly measured constructs. When the items are believed to have strong correlations, oblique rotation is used [28]. Else, when the correlations among items are not known, orthogonal rotation is performed. Hence, varimax rotation (orthogonal) was used during the extraction to weigh the underlying factors. According to this survey, all factor loading values are higher than 0.5, which shows that there is acceptable convergence or correspondence between similar constructs [25, 28]. This reveals adequate convergent validity of the measurement model [11, 31]. Cronbach’s ‘α’ values along with Factor loadings of all items are presented in Table 2. It is observed that the cost-benefit item loaded same as that of PU. The external factors loaded together with the attitude, indicating a direct influence of external factors on users’ attitude.

Table 3 gives the results of Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The KMO value obtained is greater than 0.5 which indicates that there is sufficient sustainability. Bartlett Test of sphericity has a p value less than 0.001 which indicates a prominent relationship among the variables [12].

Table 3. KMO and Bartlett's Test of Sphericity

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy | | 0.927 |
|---|---|---|
| Bartlett's Test of Sphericity | Approx. Chi-Square | 1674.034 |
| | df | 105 |
| | Sig. | 0 |

### 4.3. Hypothesis Testing

Chi-square test is one of the most versatile tests to study the significance of dependence between two parameters [32, 33]. The null hypothesis assumes that there is no significant association/dependence between the parameters while the alternate hypothesis assumes that there is a significant association/dependence [32, 33]. A TAM model, as shown in Figure 1 has been developed based on previous researches and results obtained [34, 20, 29]. The following are the proposed Hypothesis [34, 13]:

H1: Perceived ease of use influences Behavioural Attitude positively

H2: Perceived usefulness influences Behavioural Attitude positively

H3: Perceived ease of use influences Perceived usefulness positively

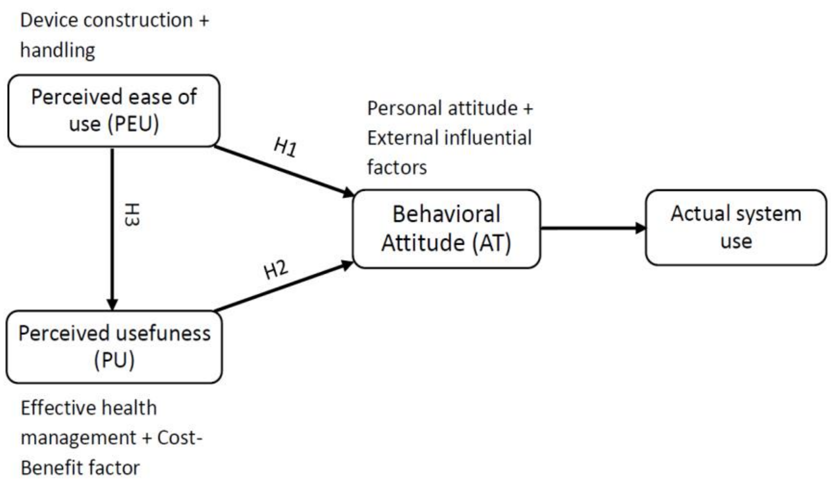


Figure 1. TAM model

One of the important assumptions of Chi-square test is that the percentage of cells having an expected count less than 5 should not exceed 20%, when a cross tabulation is performed.

Table 4. Cross tabulation between PEU and AT

| | | | AT | | | Total |
|---|---|---|---|---|---|---|
| | | | Agree | Balanced | Disagree | |
| PEU | Agree | Count | 76 | 25 | 5 | 106 |
| | | Expected Count | 54.3 | 38.2 | 13.5 | 106.0 |
| | Balanced | Count | 21 | 25 | 9 | 55 |
| | | Expected Count | 28.2 | 19.8 | 7.0 | 55.0 |
| | Disagree | Count | 4 | 21 | 11 | 36 |
| | | Expected Count | 18.5 | 13.0 | 4.6 | 36.0 |

Table 5. Cross tabulation between PU and AT

| | | | AT | | | Total |
|---|---|---|---|---|---|---|
| | | | Agree | Balanced | Disagree | |
| PU | Agree | Count | 95 | 37 | 7 | 139 |
| | | Expected Count | 71.3 | 50.1 | 17.6 | 139.0 |
| | Balanced | Count | 6 | 26 | 11 | 43 |
| | | Expected Count | 22.0 | 15.5 | 5.5 | 43.0 |
| | Disagree | Count | 0 | 8 | 7 | 15 |
| | | Expected Count | 7.7 | 5.4 | 1.9 | 15.0 |

Table 6. Cross tabulation between PEU and PU

| | | | PU | | | Total |
|---|---|---|---|---|---|---|
| | | | Agree | Balanced | Disagree | |
| PEU | Agree | Count | 90 | 12 | 4 | 106 |
| | | Expected Count | 74.8 | 23.1 | 8.1 | 106.0 |
| | Balanced | Count | 30 | 22 | 3 | 55 |
| | | Expected Count | 38.8 | 12.0 | 4.2 | 55.0 |
| | Disagree | Count | 19 | 9 | 8 | 36 |
| | | Expected Count | 25.4 | 7.9 | 2.7 | 36.0 |

Table 7. Chi-square table

| Test | Hypothesis | Value | Df | Asymptotic Significance (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | H1 | 47.619 | 4 | .0000000011334 |
| | H2 | 64.754 | 4 | .0000000000003 |
| | H3 | 33.032 | 4 | .0000011765856 |

The cross tabulation tables (Tables 4, 5, and 6) of chi-square test reveal that H1 and H2 are significant since there was only one cell having expected count less than five, out of nine cells, which is less than 20% of totol number of cells, i.e., nine cells. H3 is insignificant as the percentage of cells with expected count less than 5 was 22.2% i.e., two out of nine cells has expected count less than five. Further, from the Chi-square table (Table 7), Pearson Chi-square Asymptotic significance values ('p' values) are much less than 0.05 (95% confidence interval) which indicates that the results are statistically significant. This confirms the existence of significant dependencies between the constructs in hypotheses H1 and H2 respectively. The results indicate that people are more likely to use these devices if they are ease to handle. From H2, it is seen that people would use these devices if they prove beneficial to manage their health. It is also observed from H3 that there is no significant dependence on PEU and PU. People may find the use of these devices easier if they are well informed of advancements in technologies. People would develop interest if they are exposed about the usefulness of use of these devices.

**5. Results and Discussion**

One of the main goals of this research was to relate the degree of acceptance of wearable devices of physical practitioners with that of the users. It is clear from the results that 60% of the medical people agree towards use of these devices based on PEU. 51.41% of people belonging to a non-medical background agree towards using, considering PEU. This difference is due to the high exposure and awareness about these devices to medical people. Also, the proportion of medical and non-medical people agreeing towards the adoption of these devices is found to be 72.73% and 69.72% respectively. These nearly equal values indicate that people from all academic backgrounds are ready to use these devices if it is beneficial. Also, almost half of the people from both groups i.e., medical and non-medical, show a positive attitude towards these devices. The results obtained for different genders reveal that female users give a higher priority to PEU than male users. 59.49% of female users agree whereas only 50% of male users agree towards the adoption of these devise based on PEU. Also, percentage of people agreeing based on PU is higher for both groups. Results for younger and elderly people are as anticipated. Percentage of younger and elderly people agreeing owing to PU of these devices are 68.52% and 80% respectively, indicating elderly peoples' higher concern about health and awareness wearable health devices. Considering PEU, 54.32% and 51.43% of younger and elderly people agree. This higher proportion in younger population is due to the exposure to advancement in electronics and IT whereas, for elderly people, it is because of the awareness created by practitioners about use of these technologies. Results of people based on health condition are in accordance with these results, people with severe health issues are always on a higher proportion to adopt these devices than normal people as they would have directly used or because of the hunt for options to manage health effectively. It was found that both PEU and PU have a positive impact on attitude of people. Hence, people have to be educated about these devices toequip themselves about the benefits of using these devices. Also, campaigns of how to handle these devices would allow them to get a feel of how to handle these devices to track real-time health status. People may agree to adopt these devices to a higher extent if they experience the benefits of these devices. This could be possible if their practitioners introduce these devices to them. This provides openings for manufacturers to develop devices with a simpler design at a low cost.

**6. Future Recommendations**

Advancement in IT and development of Healthcare have to be integrated to make the most of the available health information beneficial to humankind. There were several positive outcomes for the survey conducted by Health Research Institute and Consumer Intelligence Series (2014) to study the degree of acceptance of wearable devices which are listed in Table 8 [35]. The outcomes of the survey clearly depict the acceptance of participants. 21% of the US consumers own a wearable technology, of which fitness band is used by 45% of people. Other majorly used devices include Smart watch (35%), Smart clothing (20%). One of the major problems was that 43% of people felt uncomfortable to share health issues [35].

Table 8. Outcomes of HRI/CIS Wearables consumer survey (2014)

| HRI/CIS Wearables consumer survey Outcomes | % people agreeing |
|---|---|
| Increases average life expectancy by 10 years because | 56 |
| Decreases obesity by enabling us to monitor our nutrition and exercise | 46 |
| Improves athletic ability as we monitor and fine-tune our sports progress | 42 |

The study serves as a platform to create awareness about these wearable devices. As majority of the people suffering from CVDs are known to have abnormal BPs, recommendation of these devices in order to sense abnormalities in Blood Pressure, ECG, PPG or Heart rate can be useful to avoid risk of CVDs. Currently, majorly available devices in market focus on offline health monitoring [10]. Improvements have been done to enable devices to intervene with the help of actuators placed on the body [8]. Also, the integration of these devices with smartphones would make it easy for the users to accept this technology and enable them to track their health status [8]. Cloud storage allows users to store data online which can be monitored and tracked by physicians [36]. This also helps physicians to take preventive measures whenever he/she spots any abnormality in his/her patient's health condition [8, 37]. However, studies on how to deploy these devices among common people would be of greater use to humankind. Enough efforts are being put in the recent past to improve the health information technology [38].

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