Acceptance of Athletes in Using Smartwatches to Monitor Health and Performance Data

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***Abstract*—Traditionally, sports performance has been measured, monitored, and managed by human observation, making it susceptible to inaccuracies. With rapid advancements in sensor and wearable technologies, smartwatches have emerged as valuable tools for enhancing athletic performance. However, research exploring the sociotechnical factors driving their broader adoption within the sports community remains either limited or underdeveloped. In this study, we surveyed 161 athletes in the Philippines using a validated instrument grounded in a modified Technology Acceptance Model (TAM). Through Partial Least Squares Structural Equation Modeling (PLS-SEM), our exploratory quantitative analysis found that convenience positively influences perceived usefulness, prior experience positively affects perceived ease of use, perceived usefulness significantly impacts attitude, and attitude, in turn, influences the behavioral intention to use smartwatches.**

***Keywords*—athletic performance, smartwatches, technology acceptance model**

I. Introduction

In the relentless world of sports, where every second and every heartbeat matter, athletes grapple with numerous factors that may define their success. From battling the elements to managing their training and recovery, athletes often find themselves juggling an overwhelming array of factors. This could include external factors such as weather and the condition of the playing field, or other factors such as how much they've trained for a competition. In addition to these factors, an athlete's physical condition is said to affect their overall performance. An example of this would be how much sleep an athlete is able to get [1]. To ensure maximum performance, athletes must keep track of this data manually, as well as gauge how these factors affect their overall performance for the day, however, this could be difficult with all the things athletes have to take note of during their training.

As technology continues to evolve, we have seen the emergence of wearable technologies, specifically smartwatches, that give additional convenience to how we carry on with our daily tasks such as viewing notifications or answering calls in a more convenient way. Smartwatches also present its users a new way of keeping track of their fitness data such that it can collect the users' heart rate, calories burned, heart rate, and process these data through health monitoring apps on their smartphones to present to its users in the form of a health score which easily gives them an idea how they are performing [2].

Seeing how smartwatches can provide a health score to its users, the researchers see this as an opportunity for athletes to use this technology that can automatically collect and process their health data and relate it to their performance. Thus, this study would like to investigate the level of acceptance of the use of smartwatches within athletes to monitor their health and performance data. The succeeding chapter will further discuss the basis for the extended Technology Acceptance Model used that guided this study as well as the results.

II. Literature Review

In this section, we review related studies that investigated the adoption of smart watches in athletes. One representation of convenience in a sports-related context is how much technology or equipment hinders the flow of activity. The less intrusive it is, the more convenient [3]. As a result, we hypothesize that:

H1: Convenience has a positive influence on the perceived usefulness

Individuals who purchase smartwatches are already likely to own other gadgets, making it easier for them to understand how to operate it [4]. Moreover, habitually using health information systems allows individuals to be more familiar with the functionalities of the technology [5]. Thus, as a result, we hypothesize that:

H2: Prior experience has a positive influence on the perceived ease of use

For athletes, perceived usefulness in the acceptance model can be referred to as performance expectancy, meaning that the wearable technology must be able to improve the athlete's performance to positively influence their intention to use it [6]. Ease of use has a positive influence on intention to use but was found not to have a significant difference outside a sports-related context [6]. Thus, as a result we hypothesize that:

H3: Perceived Usefulness (PU) has a positive influence on the Attitude Towards Usage (ATU)

The perceived ease of use when interacting with technology-based products plays a crucial role in cultivating interest in their utilization [7]. This importance stems from the fact that the ease of use is a fundamental component within the decision-making process. If an individual possesses confidence in the system's user-friendliness, they are more inclined to engage with it, and on the other hand, a lack of confidence may prevent usage. Concurrently, the attitude towards using technology is characterized by users' evaluations, encompassing both positive and negative sentiments, reflecting their overall interest in engaging with

technology [7]. Thus, we hypothesize that:

H4: Perceived Ease of Use (PEOU) has a positive influence on the Attitude Towards Usage (ATU)

The impact of social support on the intention to use health technologies in sports is not consistent across different studies [6]. Gamification and data sharing through health technologies is considered a social activity, thus promoting intention to use [6]. The social influence concerning technology has a positive influence on an individual's attitude towards usage [8]. Individuals may not have the desire to use technology until they are influenced by important individuals such as family, friends, and even higher-ups at work. Moreover, the support of these individuals further influences the utilization and attitude towards the usage of individuals. Thus, we hypothesize that:

H5: Social Influence (SI) has a positive influence on the Attitude Towards Usage (ATU)

It was observed that attitude towards usage had the strongest impact and influence on behavioral intention [9]. When individuals have a positive attitude towards technology, they are more likely to have intentions to use technology. Thus, we hypothesize that:

H6: Attitude Towards Usage (ATU) has a positive influence towards Behavioral Intention (BI)

When an individual can easily access technology, they are then more likely to utilize it. Such findings were identified [10]. Following the technology acceptance model, it was found that accessibility positively affected behavioral intention to use technology. Thus, we hypothesize that:

H7: Accessibility (ACC) has a positive influence on the Behavioral Intention (BI)

This research will follow a quantitative approach. Through this approach, the technology acceptance model of student athletes in using smartwatches will be explored. To be more specific, the relationship between the variables, Behavioral Intention (BI), Attitude Towards Usage (ATU), Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Prior Experience (PE), Tech-Related Anxiety (TRA), Convenience (C), Social Influence (SS), and Accessibility (ACC).

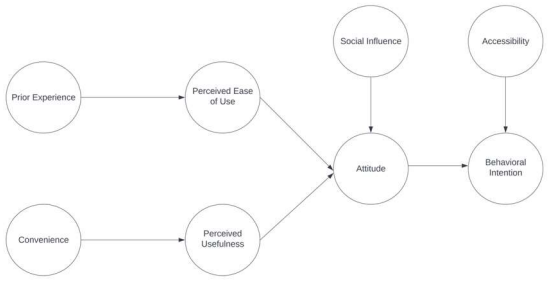

Fig. 1. The proposed acceptance model for smartwatch adoption among gen Z student athletes.

Fig. 1 depicts the relationship between variables of the proposed acceptance model for smartwatch adoption among Gen Z student athletes. These are in line with the hypotheses to be explored in this research as shown in Table 1.

Table 1. Summary of hypotheses

Hypothesis	Statement
H1	Convenience (C) has a positive influence on the Perceived Usefulness (PU)
H2	Prior Experience (PE) has a positive influence on the Perceived Ease of Use (PEOU)
H3	Perceived Usefulness (PU) has a positive influence on the Attitude Towards Usage (ATU)
H4	Perceived Ease of Use (PEOU) has a positive influence on the Attitude Towards Usage (ATU)
H5	Social Influence (SI) has a positive influence on the Attitude Towards Usage (ATU)
H6	Attitude Towards Usage (ATU) has a positive influence towards Behavioural Intention (BI)
H7	Accessibility (ACC) has a positive influence on the Behavioural Intention (BI)

III. Methodology

This chapter describes the methodology of study. The chapter includes the population and sampling, instrumentation, data gathering procedures, data analysis, limitations, and ethical guidelines.

A. Population and Sampling

The population of the study are student athletes in the Gen Z age bracket, specifically those eligible to compete in university-level competitions (18–25 years old). Thirty athletes were selected for the pilot test of the research instrument. Upon verification of the instrument, 161 student athletes participated in the final survey. Purposive sampling was utilized by the researchers to select the participants of the study.

B. Instrumentation

To perform data gathering, the researchers created a survey instrument. This was published using Google Forms and shared with the target population. The instrument has 10 sections: namely, General, Convenience, Social Influence (SI), Perceived Ease of Use (PEOU), Prior Experience (PE), Attitude Toward Usage (ATU), Perceived Usefulness (PU), Accessibility (ACC), and Behavioral Intention (BI).

Convenience (C), refers to the comfort experienced by technology users. On the other hand, Social Influence (SI) is a construct that represents the influence exerted by the social circles of athletes that may influence the decision to use smartwatches. Perceived Ease of Use (PEOU) is the perception of individuals to use smartwatches because it is easy to use and understand. Another construct is Prior Experience (PE) which posits that previous experience with the same technology is a significant predictor of its adoption. Attitude Toward Usage (ATU) is the positive or negative feelings of athletes towards the use of smartwatches. Perceived Usefulness (PU) captures the beliefs of athletes that smartwatches offer various benefits in their daily physical activities. Accessibility (ACC) refers to the attainability of smartwatches to athletes. Lastly, Behavioral Intention (BI) is the projected future behavior of student athletes towards the use of smartwatches. These variables are represented in Fig. 1.

C. Data Gathering Procedures

A convenient sample was used for this exploratory survey. A total of 30 respondents were invited for the instrument validation phase using PLS-SEM algorithm of smartPLS to ensure the validity of the hypothesis and variables identified. After validation, 161 respondents were selected for the structural model test.

Table 2. PLS-SEM pilot instrument results

Construct	Cronbach's Alpha	Composite Reliability (rho a)	Composite Reliability (rho c)	Average Variance Extracted
Accessibility	0.897	0.901	0.936	0.829
Attitude Towards Usage	0.928	0.929	0.954	0.874
Behavioral Intention	0.884	0.887	0.928	0.811
Convenience	0.929	0.931	0.949	0.824
Perceived Ease of Use	0.815	0.817	0.878	0.642
Perceived Usefulness	0.868	0.894	0.904	0.655
Prior Experience	0.822	0.941	0.915	0.843
Social Influence	0.779	0.776	0.859	0.607

The results of the PLS-SEM validation test as shown in Table 2 showed that all variables in the proposed acceptance model for the smartwatch adoption among Gen Z athletes explored through the pilot survey instrument are valid and reliable [11, 12]. To ensure reliability, Cronbach's alpha and Composite reliability must be above 0.7 [11, 12]. Based on the table, it can be concluded that all variables included in the survey have Cronbach's alpha and a Composite reliability of above 0.7 which means that they are all reliable. Moreover, the validity, accuracy, and truthfulness in measurements of tests are indicated by the Average Variance Extracted which should be at least 0.5 [11, 12]. Based on the table below, all figures from the variables have an Average Variance Extracted (AVE) values of above 0.5 which means that the instrument is able to accurately measure the results from each of the variables.

D. Methodological Limitations

There are several methodological limitations that may affect the results of the research. These include limitations in contact between researchers and respondents and limitations with regards to the variety of respondents.

IV. Results

The respondents comprise a diverse group of student athletes aged 18 to 25, from various universities, with a notable representation from De La Salle University (DLSU). The total number of respondents is 161, distributed across different age groups. Most participants (61.49%) fall within the 18 to 23 age range, with 10.6% (17/161) aged 18, 9.9% (16/161) aged 19, 8.1% (13/161) aged 20, and 12.4% (20/161) aged 21. Additionally, 11.2% (18/161) are aged 22, 9.3% (15/161) aged 23, 4.3% (7/161) aged 24, and 1.9% (3/161) aged 25. Significantly, 72.67% (117/161) of respondents are varsity players, highlighting the prevalence of competitive athletes in the study.

The bootstrapping technique using SmartPLS was applied to the data collected to test the hypotheses of the study. Following the minimum t-value threshold [13] of 1.96, we found that four of our hypotheses were supported. H1 where Convenience has a positive influence on the Perceived Usefulness with a t-value of 2.402, H2 where Prior Experience has a positive influence on the Perceived Ease of Use with a t-value of 2.812, H3 where Perceived Usefulness has a positive influence on the Attitude Towards Usage with a t-value of 2.740, and H6 where Attitude Towards Usage has a positive influence towards Behavioral Intention with a t-value of 3.116 as shown in Table 3.

Table 3. Results

Hypothesis	Path Coefficient	T Statistics	*p*-values	Decision
H1: Convenience (C) has a positive influence on the Perceived Usefulness (PU)	0.507	2.402	0.016	Supported
H2: Prior Experience (PE) has a positive influence on the Perceived Ease of Use (PEOU)	0.417	2.812	0.005	Supported
H3: Perceived Usefulness (PU) has a positive influence on the Attitude Towards Usage (ATU)	0.555	2.740	0.006	Supported
H4: Perceived Ease of Use (PEOU) has a positive influence on the Attitude Towards Usage (ATU)	0.338	0.377	1.573	Not Supported
H5: Social Influence (SI) has a positive influence on the Attitude Towards Usage	−0.269	1.636	0.102	Not Supported
H6: Attitude Towards Usage (ATU) has a positive influence towards Behavioral Intention (BI)	0.452	3.116	0.002	Supported
H7: Accessibility (ACC) has a positive influence on Behavioral Intention (BI)	0.246	1.087	0.277	Not Supported

The results show that convenience has a positive influence to perceived usefulness (H1), prior experience has a positive influence on the perceived ease of use (H2), perceived usefulness has a positive influence on the attitude towards usage (H3), and that attitude towards usage has a positive influence towards behavioral intention (H6). These findings have been consistent with other studies that follow the TAM model in different contexts.

A previous study conducted by Wardana *et al.* [14] found that convenience had a positive influence on perceived usefulness, such that the greater the convenience was for the user, the more they found the technology to be useful. Additionally, it was found that perceived usefulness had a positive influence on the user's attitude towards using the said technology [15].

It was found that prior experience had a positive influence on the user's perceived ease of use of technology [16], however, perceived ease of use was not seen to be significant when it comes to affecting the user's attitude towards using the technology. Previous studies highlight the significant relationship between perceived ease of use and attitude [17, 18]. However, in a study done by Calisir *et al*. [18], they found that this relationship was not significant, stating that children are growing up in the digital age and find it fun to learn more about new technologies. Another variable the researchers thought that would influence the user's

attitude towards was social influence, however, this was found to not have an influence. This was also found to be true by a study done [13].

With regards to the variables affecting behavioral intention, it was found that attitude towards had a significant effect as supported by another study [19]. However, accessibility was not found to be significant, which had a similar result as the other study done [20]. The researchers think that the reason for this is the increased accessibility of smartwatches in the current years such that there were over 400 million units sold in 2020 [8]. Additionally, there are many different models that are within various price ranges which give the users various options and choose a model that can easily fit their budget.

V. Conclusion

This study, guided by the Technology Acceptance Model (TAM), investigated athletes' acceptance of using smartwatches for health and performance monitoring. Various factors, including convenience, prior experience, perceived usefulness, and attitude towards usage have proven to positively impact athletes' attitudes towards the usage of smartwatches. On the other hand, the results do not support social influence and accessibility.

This study is constrained by several limitations that can be addressed in future research. First, the mode of survey conduction is online. This limits the contact between researchers and respondents which may affect the results due to the lack of connection. Moreover, given that the survey is lengthy, the respondents may get distracted. The researchers would not be able to monitor and mitigate this due to the lack of contact. Second, the population of the respondents is limited to the student athletes that the researchers are in contact with. This may affect the results of the research as student athletes from different backgrounds may have different experiences.

Aside from highlighting key factors that influence the integration of smartwatches into athletes' routines, the implications of this study are significant for efforts to optimize health and performance among various athletes from different types of sports, including varsity players and coaches in enhancing output and productivity. It will also be relevant for technology developers' better understanding of smartwatches' acceptance and usability.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

TS, EM, NN, ND, JC and DO equally contributed to the research design, collection of data and statistical analysis. RJM recruited additional respondents and assisted RE in the finalization of the manuscript. All authors had approved the final version.

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