Shahid Bahonar University of Kerman

Journal of New Studies in Sport Management

Online ISSN: 2717 - 4069

Homepage: https://jnssm.uk.ac.ir

Iranian Scientific Association of Sport Management

The Role of Perceived Risk in the Adoption of Internet of Things Technology in Sports

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ARTICLE INFO

Article type:
Original article

Article history:
Received: 21 April, 2023
Received in revised form: 24 May, 2023
Accepted: 29 May, 2023
Publish online: 5 August, 2023

Keywords:
Intention to use
Iranian Athletes
Perceived Risk
Technology acceptance model

ABSTRACT

The Internet of Things (IoT) is one technology that can revolutionize traditional methods and transform sports infrastructure. To promote the adoption of IoT effectively, it's vital for sports manager to understand the factors that positively and negatively affect it. The aim of this study was to investigate how perceived risk impacts people's willingness to use IoT technology in sports. This quantitative study used a survey method and applied a descriptive approach. The statistical population included Iranian athletes, and 394 individuals completed questionnaires using a non-probability sampling method. Data analysis was performed using Smart PLS3 software. Results showed that perceived risk has a direct and negative impact on perceived ease of use, willingness to use, and perceived usefulness. However, its effect on attitude towards use was insignificant. The study also confirmed the positive impact of perceived ease of use on perceived usefulness and attitude towards use. Perceived usefulness had a greater effect on the latter variable. Additionally, perceived usefulness had a significant positive impact on willingness to use IoT technology in sports, as did attitude towards use. Attitude towards use also had a significant positive impact on willingness to use IoT technology in sports. The study recommends implementing strategies to enhance and improve perceived usefulness, ease of use, and attitude towards use while reducing perceived risk to increase acceptance and willingness to use IoT technology in sports.

Introduction

Economies that prioritize innovation have highlighted its importance in the business ecosystem. The discussion surrounding technology's role in promoting innovation has been a subject of intense

How to Cite: Nazemi Bidgoli, A., Mohamadi Turkmani, E., & Irani, H. R. (2023). The Role of Perceived Risk in The Adoption of Internet of Things Technology in Sports. Journal of New Studies in Sport Management, 4(3), 846-856. doi: 10.22103/jnssm.2023.21381.1185

 Publisher: Shahid Bahonar University of Kerman
DOI: 10.22103/jnssm.2023.21381.1185

debate. New technologies can improve the efficacy of efforts towards innovation by eliminating inefficient processes and reallocating resources. In light of these benefits, countries should strive to enhance their competitiveness by transitioning from a factor-driven economy to an efficiency-driven one, ultimately culminating in an innovative economy (Kamali Mohammadzadeh et al., 2018). Iran is a country that is currently transitioning from a factor-based economy to an efficiency-driven one, as indicated by its ranking on the global competitiveness index (GCI) (Zarei, Mohammadian, & Ghasemi, 2016). Focusing on emerging technologies that are expected to significantly contribute to competitiveness in the future is critical for policy-making. The Internet of Things (IoT) is one of these technologies (Zohrabi, Karimi, & Mohebi, 2020).

The Internet of Things is a network that facilitates communication between physical objects through the use of tags (Ansari, Mohammadian, & Nevisande, 2017). It is not just a single technology, but rather a collection of complementary technologies that bridge the gap between the virtual and real world. By enabling physical objects, entities, data, and virtual environments to interact in the same place and time, the Internet of Things creates a seamless experience (Balaji & Roy, 2017). With this technology, anything can connect to the internet at any time and from anywhere, providing various services to anyone (Aldowah, Rehman, Ghazal, & Umar, 2017). The IoT has a significant impact on various industries, including construction and manufacturing. However, it is especially noteworthy in the realm of sports (Vermesan et al., 2022).

The field of IoT applications has demonstrated that this technology has a significant impact on the sports industry (Kunz & Santomier, 2019). Sports wearable gadgets are increasingly becoming a crucial component of IoT technology, with their development evolving from simple accessories to specialized appliances (Dian, Vahidnia, & Rahmati, 2020). The combination of IoT with analysis methods can enhance athlete safety by identifying risk factors (Catarinucci et al., 2017; Wilkerson, Gupta, & Colston, 2018) and could even surpass the science of coaching in the future by improving athletic performance (Kos, Wei, Tomaži“, & Umek, 2018). Research exploring smart technologies to aid referees' decision-making processes indicates that many sports can use various techniques to promote fairer performances (Leveaux, 2010). The widespread adoption and collection of IoT data (Zhan, 2021) has raised concerns about potential attacks, threats, and abuses (Asad, Moustafa, & Yu, 2020; Bansal, Chana, & Clarke, 2020; Duan & Guo, 2021), leading to doubts about the adoption of IoT technology.

To make significant strides in the adoption of Internet of Things (IoT) technology, it's crucial to understand both the positive and negative factors influencing it. While several theories exist, the Technology Acceptance Model (TAM) is considered the most appropriate framework for research (Capasa, Zulauf, & Wagner, 2022; Rondan-Cataluña, Arenas-Gaitán, & Ramírez-Correa, 2015). This model is derived from the theory of reasoned action (TRA) (T. G. Kim, Lee, & Law, 2008), which has been used to determine behavioral tendencies and the usefulness of technology adoption (H.-F. Lin, 2007). According to TRA, individuals consider the consequences of their actions before deciding whether or not to engage in a certain behavior. Their intention is the main determinant of behavior (Fishbein & Ajzen, 1975). However, the technology acceptance model (TAM) assumes that an individual's behavioral intention to accept and use technology is determined by two constructs: perceived usefulness and perceived ease of use (Davis, 1989).

Several studies have used the technology acceptance model (TAM) in the field of sports (qolamian et al., 2022; Shekari, Mosuavi, & Gholami Chenarestan Olya, 2020). However, it is important to recognize that TAM has been criticized for its limitations in fully capturing the unique effects of technological factors and the context of use, which can influence user acceptance (El-Qirem, 2013). The current studies have incorporated both internal and external variables, such as trust, risk, return, policy, and perceived behavioral control conditions (Mutahar, Aldholay, Isaac, Jalal, & Kamaruddin, 2022). This integration has helped to validate and improve the explanatory power of the model (Koksalmis, Arpacı, & Koksalmis, 2022). Additionally, researchers have applied this model to other areas, including technology adoption and consumer willingness to purchase behavior (Yu, 2022). One of the most commonly studied variables is perceived risk (AlHadid et al., 2022; Patel, Parida, & Tran, 2022)

Perceived risk refers to the psychological cost associated with customers' purchasing behavior, which indicates a sense of uncertainty about the future. This uncertainty directly impacts consumers'

purchase intentions (W.-B. Lin, 2008). It should be noted that people aim to avoid losses as much as possible when making decisions in different situations (hosseininia, Moghaddas Farimani, & Marefat Gharehbaba, 2022). The importance of perceived risk on decision-making and acceptance has been established by various studies (Girish, Kim, Sharma, & Lee, 2022; Soto-Beltrán, Robayo-Pinzón, & Rojas-Berrio, 2022). Therefore, any increase in consumer-perceived risk can unfavorably impact technology acceptance (golshan, Athena, & Roudbane, 2020; Shambiati, Shafii Nikabadi, Khatami Firouzabadi, Rahmani Manesh, & Saberi, 2022).

This model incorporates the relationship between intention to use, attitude, perceived usefulness, and perceived ease of use from the Technology Acceptance Model (TAM). Additionally, the variable of perceived risk, which has been shown to have an impact on consumer behavior in past studies (Dowling & Staelin, 1994), is included in the model. Therefore, the following hypotheses have been proposed:

H1: Perceived risk significantly affects the willingness to use IoT technology in sports.

H2: Perceived risk significantly affects the attitude towards the use of IoT technology in sports.

H3: Perceived risk significantly affects perceived ease of use.

H4: Perceived risk significantly affects perceived usefulness.

H5: Perceived ease of use significantly affects perceived usefulness.

H6: Perceived ease of use significantly affects the attitude towards the use of IoT technology in sports.

H7: Perceived usefulness significantly affects the attitude towards the use of IoT technology in sports.

H8: Perceived usefulness significantly affects the willingness to use IoT technology in sports.

H9: Attitude significantly affects the willingness to use IoT technology in sports.

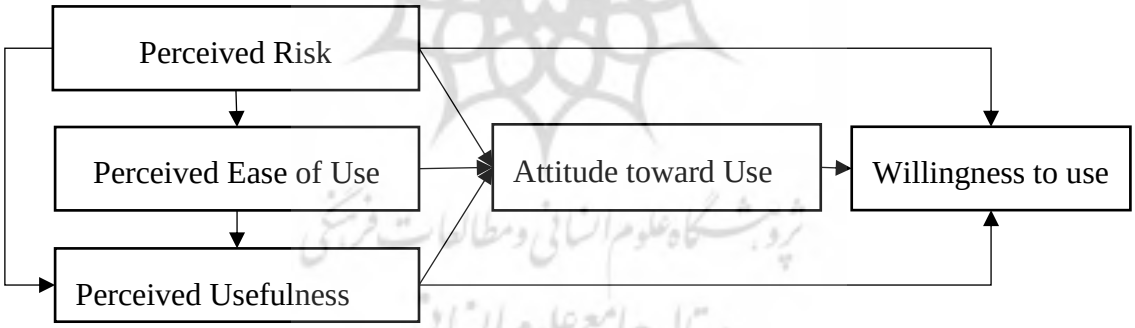

Figure 1. The proposed research model

Methodology

This study utilized applied research with a correlational research design and relied on structural equation modeling for data analysis to examine Iranian athletes, trainers, and sports practitioners who were registered and insured in the sports federation system in 2023. The researchers employed a non-probability sampling method to gather data from 394 participants using questionnaires adapted from (Cavdar Aksoy, Kocak Alan, Tumer Kabadayi, & Aksoy, 2020; Shin & Lee, 2014), and (Tan, Ooi, Chong, & Hew, 2014). These questionnaires consisted of 18 items across five variables: perceived usefulness (four items), perceived ease of use (three items), perceived risk (three items), attitude (four items), and willingness to use (four items). Participants rated these items on a five-point Likert scale ranging from 1 (very low) to 5 (very high). The face and content validity of the questionnaires were confirmed by ten experts in sport management. In a preliminary study, 40 participants completed the questionnaires digitally to determine the internal reliability coefficient (Cronbach's alpha) of the

scales, which were found to be acceptable with values of 0.839, 0.747, 0.899, 0.840, and 0.927 for perceived usefulness, perceived ease of use, perceived risk, attitude, and willingness to use, respectively. Finally, PLS3 software was used to analyze the data, conduct structural equation modeling (SEM), test hypotheses, and draw conclusions.

Results

In this research, 394 questionnaires were evaluated; 60.9% are women and 39.1% are men, 46.4% are people up to 20 years old, 24.4% are 21-30 years old, 18.3% are 31-40 years old and 7.9% are the percentage of people aged 41 to 50 years and 0.3% of people over 51 years old. The frequency distribution related to the education of the research sample also shows that out of 394 people in the research sample, 94 people (23.9 percent) have less than a diploma, 92 people (23.4 percent) have a diploma, 94 people (23.9 percent) have a bachelor's degree, 95 people have a bachelor's degree. (24.1 percent) had a master's degree and 19 people (4.8 percent) had a doctorate degree. Table 1 shows the demographic of participants.

Table 1. The demographic characteristics of participants

Demographic variables of the research		Frequency	Relative Frequency percentage	Cumulative frequency percentage
Gender	Men	154	39.1	39.1
	Women	240	60.9	100
Age	Up to 20 years	183	46.4	46.4
	21 to 30 years	96	24.4	70.8
	31 to 40 years	72	18.3	89.1
	41 to 50 years	31	7.9	97.0
	Over 51 years old	12	3.0	100
Education	less than a diplom	92	23.4	23.4
	Diploma	94	23.9	47.3
	Bachelor's degree	94	23.9	71.2
	Master's degree	95	24.1	95.3
	Doctorate degree	19	4.8	100

In this research, the values of skewness and kurtosis have been used for the normality and non-normality of the data. Table 2 presents the results of this research, indicating that the data collected was normal.

Table 2. Assessing the normality or non-normality of data distribution

Variable	Mean	S.D	Skewness	S.D of Skewness	Kurtosis	S.D of Kurtosis
Perceived usefulness	1.770	0.587	0.249	0.123	-0.649	0.245
Perceived ease of use	2.165	0.627	-0.115	0.123	-0.017	0.245
Attitude	1.890	0.609	0.402	0.123	0.100	0.245

Perceived risk	2.147	0.832	0.411	0.123	0.929	0.245
Willingness to use	2.147	0.707	0.402	0.123	0.100	0.245

To ensure the internal consistency of the questionnaire constructs, Cronbach's alpha index and composite reliability were used. Additionally, the extracted mean variance index was utilized to check for convergent validity. Table 3 displays the results of these analyses, demonstrating that the variables hold sufficient utility.

Table 3. Reliability and convergent validity coefficients of research variables

Variable	Cronbach's alpha	Composite reliability	Average Variance Extracted
Perceived usefulness	0.808	0.874	0.635
Perceived ease of use	0.630	0.798	0.570
Attitude	0.821	0.882	0.651
Perceived risk	0.842	0.872	0.757
Willingness to use	0.845	0.896	0.684

Furthermore, the Fornell-Locker index was used to check for divergent validity. The results of this analysis are shown in Table 4, confirming the divergent validity of the research variables.

Table 4. Divergent validity of research variables

Variable	(1)	(2)	(3)	(4)	(5)
Willingness to use (1)	0.827	-	-	-	-
Attitude (2)	0.523	0.807	-	-	-
Perceived ease of use (3)	0.503	0.539	0.750	-	-
Perceived risk (4)	-0.361	-0.184	-0.300	0.871	-
Perceived usefulness (5)	0.565	0.579	0.450	-0.281	0.797

The researchers consider a measurement model to be homogeneous if the absolute value of factor loadings for observable variables is at least 0.7, while others suggest a minimum threshold of 0.4 and recommend removing variables with lower factor loadings. Table 5 displays the favorable condition of factor loadings for all research variables.

Table 5. Factor loadings of variables

Abbreviation	Variable name	Questions	Factor load amount
PU	Perceived usefulness	Q1	0.770
		Q2	0.848
		Q3	0.805
		Q4	0.761
PEOU	Perceived ease of use	Q5	0.804
		Q6	0.718
		Q7	0.740
PR	Perceived risk	Q8	0.854
		Q9	0.826
		Q10	0.927

AT	Attitude to use	Q11	0.829
		Q12	0.770
		Q13	0.843
		Q14	0.783
AI	Willingness to use	Q15	0.809
		Q16	0.824
		Q17	0.865
		Q18	0.809

The coefficient of determination is the fundamental value used to evaluate endogenous variables. Values of 0.25, 0.5, and 0.75 indicate the small, medium, and large size of one structure over another, respectively. In this study, the values of the coefficient of determination for willingness to use, attitude to use, perceived ease of use, and perceived usefulness are 0.418, 0.431, 0.094, and 0.22, respectively. These values indicate an appropriate fit of the structural model.

Another quality index that examines the predictive ability of the structural model is Q2 values. If a model has a Q2 value greater than zero, it indicates predictive ability. The Q2 values obtained in this research for willingness to use, attitude to use, perceived ease of use, and perceived usefulness are 0.266, 0.259, 0.050, and 0.127, respectively. These results suggest an appropriate quality of the structural model in predicting outcomes.

Table 6. Evaluation indices for the structural model

Variable	R Square	Q2
Willingness to Use	0.418	0.266
Attitude to Use	0.431	0.259
Perceived Ease of Use	0.094	0.050
Perceived Usefulness	0.220	0.127

Table 7 presents the results of the path coefficient analysis and significance levels in this research.

Table 7. Evaluation indices for the structural model

Direction	Original Sample	Standard Deviation	T Value	P Value
Perceived risk → Willingness to use IoT technology in sports	-0.213	0.047	4.444	0.000
Perceived risk →Attitude towards use	0.046	0.045	1.034	0.306
Perceived risk → Perceived ease of use	-0.306	0.050	6.179	0.000
Perceived risk → Perceived usefulness	-0.161	0.044	3.612	0.000
Perceived ease of use →Perceived usefulness	0.394	0.047	8.819	0.000
Perceived ease of use → Attitude towards use	0.352	0.042	8.483	0.000
Perceived usefulness → Attitude towards use	0.435	0.043	10.234	0.000
Perceived usefulness → Willingness to use IoTo technology in sports	0.338	0.050	6.799	0.000
Attitude to use → Willingness to4use4technologyR in sports	0.287	0.054	5.391	0.000

Based on the results presented in Table 7, it can be concluded that the perceived risk variable has a direct and negative effect on the perceived ease of use variable (==0.00, .. -0.306), willingness to use variable (β=-0.00, P=0.00) and perceived usefulness (==0.00, .. -0.161). However, its effect on the attitude towards using IoT technology in sports did not reach an acceptable level of significance (P=0.045).

Furthermore, the positive effect of the perceived ease of use variable on perceived usefulness (P=0.00, .. 04344)and attitude towards use (==0.00, ==05352)was confirmed. Its impact on perceived usefulness was found to be greater. Additionally, perceived usefulness had a positive and significant effect on the willingness to use IoT technology in sports (==08338, 8n0o000)o rhe study also

confirmed the positive and significant relationship between perceived usefulness and attitude towards use (==0.000, .. 0qq3q)qMoreover, the attitude towards use had a positive and significant effect on the willingness to use IoT technology in sports (P=0=00, =-0=2==)

Figure 2 displays the research hypotheses' test results and the structural relationships among the research model's variables.

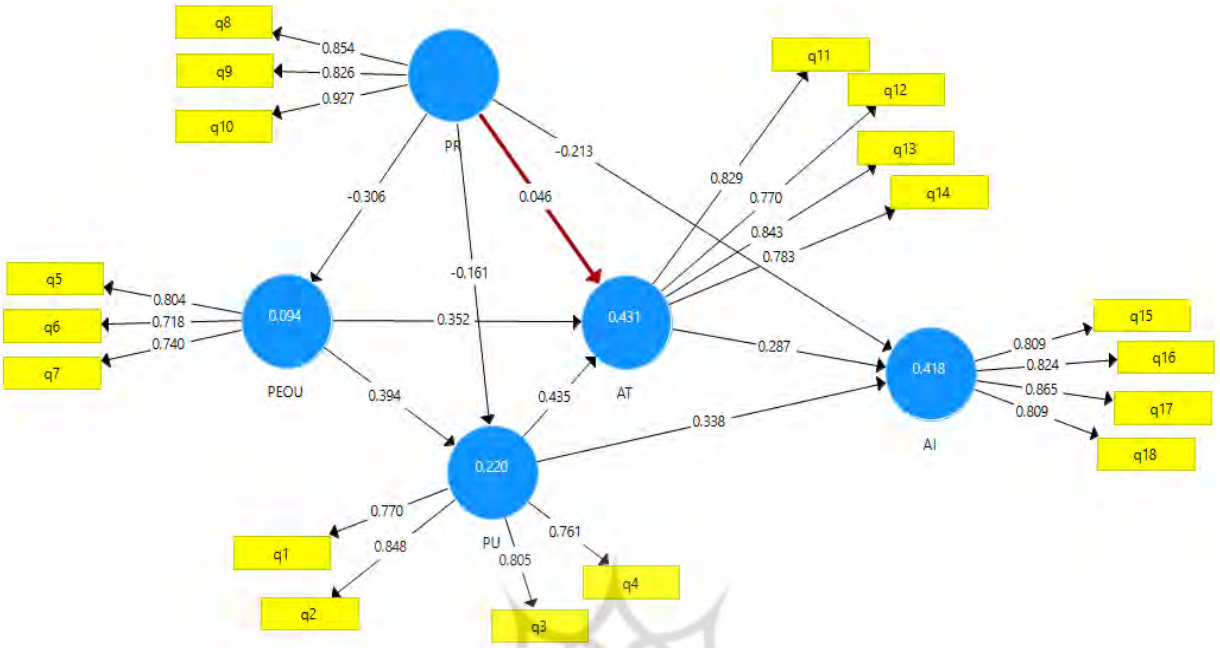

Figure 2. Standardized coefficients of the factor loadings

Discussion and Conclusion

The Internet of Things is a revolutionary concept in the world of technology that enables advanced services through the physical and virtual connection of things. As such, it has the potential to bring about significant changes to every sport, from coaching to holding sporting events. In this research, we examined the role of perceived risk in the adoption of Internet of Things technology in sports. Our proposed model was based on the technology acceptance model, with the addition of the perceived risk variable for a more comprehensive review. This allowed our model to cover both positive and negative aspects of IoT technology adoption. Our findings indicate that the proposed model has good explanatory power and confirms its strength in predicting consumers' willingness to use such services.

We also found that attitude can have a positive and direct effect on the willingness to use this technology, which is consistent with previous research by (Lunney, Cunningham, & Eastin, 2016; Tan et al., 2014), and (Cavdar Aksoy et al., 2020). Based on these results, advertising, training, and introducing the capabilities of this technology can be effective in encouraging individuals to adopt and use IoT technology in sports.

The results indicate that the perceived usefulness of IoT technology in sports has a significantly positive impact on both attitude and willingness to use, with a coefficient of 0.435 and 0.338 respectively. This suggests that a one-unit increase in perceived usefulness leads to a 0.435 unit increase in attitude towards IoT technology. Additionally, the indirect effect of perceived usefulness on willingness to use was found to be 0.125. These findings align with those of (Sukendro et al., 2020). It's worth noting that an individual's perception of usefulness is strongly linked to their belief in how much a system can enhance their efficiency. Therefore, highlighting the benefits of IoT technology in improving performance and efficiency for athletes, coaches, and sports practitioners through effective marketing (Javani & Karimivand, 2022) and providing samples can be a crucial step in promoting its adoption. Furthermore, the study found that perceived ease of use has a significant positive direct effect on perceived usefulness. This finding is consistent with prior studies by (T. G. Kim et al., 2008) ,(Shin & Lee, 2014), and (Cavdar Aksoy et al., 2020) which also confirm that perceived ease of use predicts perceived usefulness. Perceived ease of use refers to the extent to

which people perceive a technology as easy to learn and use without any physical or mental strain (Venkatesh, Morris, Davis, & Davis, 2003). Enhancing user-friendliness and designing IoT technology for easy setup and learning in various sensitive sports situations can help promote its benefits (Sahebkaran, Khoshbakhti, & Kariminejad, 2022) and ultimately increase its acceptance among consumers.

Moreover, the results also indicate that perceived ease of use has a positive direct effect on attitude, which aligns with (Sukendro et al., 2020) findings but contradicts the results of (K. J. Kim & Shin, 2015). This suggests that the easier athletes, coaches, and sports practitioners perceive using IoT technology, the more positive their attitude towards it, leading to increased acceptance of this technology.

The research results indicate that the variable of perceived risk has a negative and significant impact on both the perceived usefulness and willingness to use IoT technology in sports, consistent with (Lu, Hsu, & Hsu, 2005). Previous studies have shown that perceived risk of using Internet-connected devices affects decision-making and ultimately, behavioral intentions. An increase in consumer perceived risk can negatively impact consumer behavior, as observed by (golshan et al., 2020) and (Shambiati et al., 2022), which aligns with this research's findings.

However, the impact of perceived risk on attitude did not attain a significant level, consistent with the outcomes of (Hajisalim & Badizadeh, 2018). On the contrary, (bandari, Saidi, Sohail, & Ghasemi, 2021) and (Ebrahimi, Jafarzadeh, & Bozorgi, 2012) discovered that perceived risk had a positive effect with acceptable significance levels, which contradicts the findings of this research. Additionally, the study indicates that the variable of perceived risk has the most substantial negative influence on perceived ease of use, aligning with the research discoveries of (Lu et al., 2005).

Based on (Bauer R, 1960) Consumer behavior is closely associated with risk, as their purchasing decisions carry unpredictable consequences that can lead to dissatisfaction . As stated by (Gharahkhani & Pourhashemi, 2021), consumers frequently employ risk-reducing strategies, such as gathering information before making a purchase. Effective measures to reduce perceived risk include compensation policies, information about security, privacy and existing laws that protect consumer rights, preparation of necessary instructions for use, and distribution of suitable educational packages.

The study found that perceived risk has an impact on the adoption of IoT technology in sports. However, it is vital to consider cultural and national limitations that can affect research results. According to (Bontempo, Bottom, & Weber, 1997), cultural differences can shape people's perceptions and reactions to risks, indirectly influencing coaches, athletes, and practitioners' acceptance. Thus, conducting this study on a larger scale with diverse cultures is necessary to generalize the findings. Additionally, people's attitudes towards sports may also influence these results. Therefore, it is recommended to conduct this research in various societies, taking into account different attitudes towards sports.

Acknowledgment

We express our gratitude to the participants and reviewers who contributed to this research. Thank you for devoting your time and expertise to advance scientific knowledge.

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