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Evaluation of the intergenerational relationship of IoT awareness in businesses

Şükrü Mustafa Kaya *
Department of Computer Technologies
Istanbul Aydin University
Istanbul
Turkiye

Vildan Bayram †
Istanbul Aydin University
Anadolu BİL MYO
Istanbul
Turkiye

Mustafa Özkan §
Faculty of Economics and Administrative Sciences
Giresun University
Giresun
Turkiye

Abstract

This study aimed to examine the Internet of Things (IoT) awareness levels of generations with different demographic characteristics of society. In the research, sample selection was made from production, agriculture and service sectors. In the research, the relationship between IoT awareness was examined according to the demographic characteristics of the participants such as generation, gender, line of business, education level and social media usage intensity. The research was analysed using AMOS for path analysis for the model assumption and SPSS 24.0 for other analyses. Parametric and nonparametric hypothesis tests performed at the 0.05 significance level showed that there was no significant difference in IoT

* *ORCID-ID:* 0000-0003-2710-0063
† *ORCID-ID:* 0000-0001-7526-6485
§ *ORCID-ID:* 0009-0009-1664-2351

* *E-mail:* mustafakaya@aydin.edu.tr (Corresponding Author)
† *E-mail:* vildanbayram@aydin.edu.tr
§ *E-mail:* mustafa.ozkan@giresun.edu.tr

awareness levels depending on demographic characteristics. These results show that, despite the common belief that Generation Z is different from previous generations, there is no significant separation in IoT awareness compared to other generations. The research results support that the level of IoT awareness is not determined by the demographic characteristics examined and is generally widespread in society. These findings show that IoT technology is becoming increasingly widespread and reaching every segment of society.

Subject Classification: *68-02, 68Q11, 94-02, 94A16.*

Keywords: *IoT, IoT awareness, Digitalization, Generations, Intergenerational change.*

1. Introduction

The Internet of Things (IoT) is a network of interconnected devices, sensors, and software that aims to make the world around us smarter and more efficient by collecting, analysing, and sharing data [1]. IoT devices can connect to the Internet and communicate with each other and exchange data without human intervention [2]. IoT emerges as a technology that makes our daily lives easier, optimizes business processes and creates new opportunities.

IoT allows businesses to increase their efficiency and automate their processes. With smart sensors and security systems, IoT increases personal and business security. Also, it provides sustainable solutions on issues such as energy saving, resource management and waste reduction by offering services and products customized according to personal preferences [3]. In addition, it finds application in many different sectors by entering every area of social life. Moreover, smart home systems developed using IoT also enable remote control of lighting, heating, security and home appliances [4]. Again, wearable devices with IoT are used to track patients' health data and provide remote healthcare services [5]. Intelligent traffic management systems optimize traffic flow and shorten travel times [6]. Smart agricultural practices increase productivity by optimizing irrigation and fertilization [7]. With the use of IoT, businesses increase efficiency by automating production processes and produce high quality products by reducing error rates [8].

The aim of our study is to investigate whether there is a significant difference in IoT awareness between generations and demographic characteristics. It is thought that IoT has reached every segment of society today and has a widespread level of knowledge across generations [9]. It can be said that generations from Baby Boomers to Generation Z have a basic understanding of what IoT is and realize how it can affect their daily lives. As technology becomes more and more prevalent in all segments of social life, it is anticipated that IoT will attract the attention of people of all ages and their awareness levels will increase [10].

Each generation may have a different way of interacting with IoT. While Baby Boomers use more traditional uses of technology, Generation Z may use IoT in a more integrated way into their daily lives [11]. For example, Generation Z may be more interested in new trends such as smart home systems and wearable technologies [12]. However, rather than creating a significant divide in IoT awareness, these different experiences indicate that the technology is being adopted across society and affecting people of all ages.

2. Conceptual Framework

2.1 *The Concept of Generation*

The word "generation" is of Greek origin and means "getting out of the best possible presence." Generation refers not only to biological/ conceptual birth, but also to continuous change over time in terms of origin. In other words, it describes the development of something new in the societies [13; 14]. The concept of generation is defined as a group that exists by sharing and being influenced by important historical events, cultural developments or trends and important developments within them in the same birth year. [15]. A generation that covers the same period in terms of their birth years and has experienced similar political and social events refers to a group of individuals who have developed values and belief systems that appear different from the masses born before or after them, and who display similar personality traits compared to other generations. Critical developments and events encountered during the said period; political events or threats, socio-economic change processes, industry trends, unemployment levels, dominant ideas about concepts such as security or famine [16].

Although the generational types defined in the literature have been classified based on different starting and ending dates, the general scientific consensus can be categorized as follows [17; 18; 19].

- Silent Generation (1925-1944)
- Baby Boomer (1945-1964)
- Generation X (1965-1979)

- Generation Y (1980-2000)
- Generation Z (Those born in 2000 and later)

There is no consensus in the literature regarding the starting point of Generation Z. Some researchers propose different starting years for this generation, which include 1990 and onwards, 1995 and onwards, and 2000 and onwards. In addition to Generation Z, there is also discussion about a hybrid generation frequently mentioned across various platforms, although not scientifically validated or widely accepted. This generation is referred to as the "Alpha Generation" [18]. While there is no scientific evidence supporting the derivation of the term "Alpha Generation," it holds significant importance for generational segmentation. It is also suggested that this sub-generation tends to be less personally connected to society but is socially interconnected [19]. Consequently, this generation is neither entirely part of Generation Z nor a completely independent new generation. It may need to be considered as an intersection set between Generation Z and the subsequent generation that might eventually gain acceptance in the scientific community [20].

3. Materials & Methods

3.1 *Purpose of the research*

The basis of this study is to investigate the factors affecting IoT awareness in businesses and reveal them together with the intergenerational relationship. The aim of this research is to examine the demographic factors affecting the level of IoT awareness within society.

3.2 *Research Model & Hypotheses*

The research model created to reveal the intergenerational relationship of IoT awareness in businesses is given in below.

The hypotheses established for the study are as follows:

H_1: There is no statistically significant difference between generations and IoT awareness.

H_2: There is no statistically significant difference between gender, generation and IoT awareness.

H_3: There is no statistically significant difference between the sector in which an individual works and IoT awareness.

H_4: There is no statistically significant difference between education level and IoT awareness.

H_5: There is no statistically significant difference between social media usage duration and IoT awareness sub-dimensions.

3.3 *Universe and Sample*

All studies within the scope of this research comply with the ethical standards set forth in the 1964 Declaration of Helsinki and its subsequent amendments. Ethical approval for this study was obtained from the Social and Humanities Ethics Committee of Istanbul Aydın University, with the decision numbered 2024/06, dated June 27, 2024.

The sample for the research was selected from employees working in the manufacturing, agriculture, and service sectors. The aim was to assess the level of IoT awareness in these sectors considering the advancements in digitalization. The reason for not focusing on a single sector was to test the hypothesis that there is no significant difference in IoT awareness across different sectors.

Using a questionnaire based on the scale, a convenience sampling method was employed to reach 416 participants between June 27, 2024, and July 30, 2024. The normality of the scale items related to IoT awareness was tested using the collected data. Twenty-three responses classified as "extreme" cases, which disrupted the normal distribution, were excluded from the analysis. Consequently, the analysis was conducted using data from 393 survey forms, utilizing the SPSS software package. Table 1 presents the analysis results concerning the demographic characteristics of the participants.

Table 1

Demographic Characteristics of Participants

Gender					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Male	279	71,0	71,0	71,0
	Female	114	29,0	29,0	100,0
	Total	393	100,0	100,0	

Maritual Status					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Married	98	24,9	24,9	24,9
	Single	295	75,1	75,1	100,0
	Total	393	100,0	100,0	

Generation					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Generation X	32	8,1	8,1	8,1
	Generation Y	93	23,7	23,7	31,8
	Generation Z	268	68,2	68,2	100,0
	Total	393	100,0	100,0	

Income Rate					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Between 17000-25000 ₺	199	50,6	50,6	50,6
	Between 25001-35000 ₺	39	9,9	9,9	60,6
	Between 35001-45000 ₺	47	12,0	12,0	72,5
	45001 ₺ and more	108	27,5	27,5	100,0
	Total	393	100,0	100,0	

Kurumda Çalışma Süresi					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	201	51,1	51,1	51,1
	Between 1-5 years	67	17,0	17,0	68,2
	Between 6-10 years	51	13,0	13,0	81,2
	10 years and more	74	18,8	18,8	100,0
	Total	393	100,0	100,0	

Education Level					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High school	33	8,4	8,4	8,4
	Vocational High School	219	55,7	55,7	64,1
	Undergraduate	89	22,6	22,6	86,8
	Graduate	52	13,2	13,2	100,0
	Total	393	100,0	100,0	

Social Media Usage					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Yes	375	95,4	95,4	95,4
	No	18	4,6	4,6	100,0
	Total	393	100,0	100,0	

Social Media Usage Times					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Less than 4 hours	296	75,3	75,3	75,3
	Between 4-9 hours	87	22,1	22,1	97,5
	Between 9-14 hours	8	2,0	2,0	99,5
	More than 14 hours	2	,5	,5	100,0
	Total	393	100,0	100,0	

Line of Work					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Manifacture	11	2,8	2,8	2,8
	Agriculture	19	4,8	4,8	7,6
	Service	363	92,4	92,4	100,0
	Total	393	100,0	100,0	

A total of 393 survey responses were used for the analysis. As shown in Table 1, 71% (279 individuals) of the participants are male, while 29% (114 individuals) are female. Among the participants, 24.9% (95 individuals) are married, and 75.1% (295 individuals) are single. Regarding generational affiliation, 8.1% (32 individuals) belong to Generation X, 23.7% (93 individuals) to Generation Y, and 68.2% (268 individuals) to Generation Z.

Moreover, 95.4% (375 individuals) of the participants reported that they are social media users, while 4.6% (18 individuals) stated that they are not. When examining the duration of social media usage, 75.3% (296 individuals) spend less than 4 hours per day on social media, 22.1% (87 individuals) spend 4-9 hours daily, 2% (8 individuals) spend 9-14 hours, and 0.5% (2 individuals) spend over 14 hours per day on social media. Lastly, 2.8% (11 individuals) work in the manufacturing sector, 4.8% (19 individuals) in the agriculture sector, and 92.4% (363 individuals) in the service sector.

3.4. *Data Collection Tools of the Research*

The survey used in the research consists of two sections. The first section includes questions related to demographic characteristics. This part contains inquiries aimed at gathering information about the participants' demographic features, such as gender, marital status, year of birth, income level, duration of employment in the organization, education level, social media usage, and the number of hours spent on social media each day.

The second section of the survey utilizes questions from the "Internet of Things (IoT) Awareness Scale in Businesses," developed by [20; 21]. Which consists of 15 items designed to measure participants' IoT awareness. The scale comprises two sub-dimensions: "Activity Dimension," which includes 7 items, and "Benefit Dimension," which includes 8 items. The Cronbach's Alpha values for the scale were found to be 0.912 in a pilot study conducted in the energy sector, 0.917 in the health sector, and 0.873 in the aviation sector. These values indicate that the scale is reliable.

The scale assessment was conducted using a 5-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). An example item from the scale is: "Business activities are transferred to digital environments with the help of sensors."

Table 2 below shows the Reliability Statistics results of the "Internet of Things (IoT) Awareness Scale in Businesses".

Table 2

Reliability Statistics

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
,967	,968	15

Before applying the scale to the sample, a pilot study was conducted with 70 individuals. According to Table 2, the Cronbach's Alpha value of the scale was measured at 0.967. This indicates that there is a high level of internal consistency among the items created for the scale.

3.5 *Methods*

Parametric analysis techniques were employed to compare the scores obtained by participants on the relevant scales with demographic variables using the independent samples t-test. Prior to the use of parametric analysis techniques, the necessary assumptions were checked. Skewness and kurtosis coefficients of the data were calculated to examine the normality assumption, and multiple normality tests were also conducted. A skewness and kurtosis coefficient within the range of ±2 is considered sufficient to accept the normal distribution assumption [22; 23]. In this context, when examining the totals of the scales and their dimensions, it was determined that all of them accepted the normal distribution assumption. Since normal distribution was confirmed, the Pearson correlation coefficient was utilized. For the path analysis related to the model assumption of the research, AMOS was used, while SPSS was employed for other analyses. The analysis results were evaluated at a 95% confidence level [24; 25; 26; 27].

4. Findings

The analysis results and findings regarding the hypotheses developed in the research are as follows:

*"**H_1**: For the hypothesis stating that "there is no statistically significant difference in IoT awareness among generations," the data was first examined to determine whether it followed a normal distribution, as shown in Table 4.*

Table 3

IoT awareness normality test by generations

Descriptives				
			Statistic	**Std. Error**
IoTAwaness	Generation X	Mean	3,9125	,08129
		Skewness	,348	,414
		Kurtosis	-,035	,809
	Generation Y	Mean	4,1369	,04991
		Skewness	-,174	,250
		Kurtosis	,033	,495
	Generation Z	Mean	4,0878	,03055
		Skewness	-,010	,149
		Kurtosis	-,077	,297

As seen in Table 3, the data show a normal distribution. When the average of the answers is examined, it is seen that the skewness and kurtosis coefficients for all generations are within ideal limits. Since there are more than two groups in the answers to the statements, H_1 was tested with One-Way ANOVA. The ANOVA results of the relationship between generations and IoT awareness are presented in Table 4 below.

Table 4

Relationship between generations and IoT awareness

ANOVA					
IoT Awaness					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1,205	2	,602	2,482	,085
Within Groups	94,665	390	,243		
Total	95,870	392			

According to the ANOVA results shown in Table 4, it was concluded that there was no statistically significant difference between the group means at the 0.05 significance level (p=0.085). Thus, it can be said that there is no statistically significant difference between IoT awareness and generations. It can be said that the level of IoT awareness in different generations is almost the same. When the analysis results are evaluated, it is seen that H_1 is accepted.

For the hypothesis established as "H_2: There is no statistically significant difference between gender, generation and IoT awareness.", normality analysis was first performed for the sub-dimensions of gender, generation and IoT awareness. The analysis results are shown in Table 5.

Table 5

Normality test of gender, generation and IoT awareness

	Descriptives				
				Statistic	**Std. Error**
IoTAwaness	Male	Generation X	Mean	3,8410	,08490
			Skewness	,507	,456
			Kurtosis	1,051	,887
		Genaration Y	Mean	4,0900	,06636

Contd...

			Skewness	-,046	,309
			Kurtosis	-,234	,608
		Generation Z	Mean	4,0966	,03766
			Skewness	,014	,179
			Kurtosis	-,127	,355
	Female	Generation X	Mean	4,2222	,19676
			Skewness	-,563	,845
			Kurtosis	-1,874	1,741
		Genaration Y	Mean	4,2602	,08338
			Skewness	-,137	,421
			Kurtosis	,207	,821
		Generation Z	Mean	4,0923	,05645
			Skewness	,158	,272
			Kurtosis	-,239	,538

When the analysis results in Table 5 are examined, it is seen that the data conform to a normal distribution. H_2 was tested with Two-Way ANOVA, one of the parametric methods. In addition, the Levene test was performed to test whether the error variances in the two-way ANOVA were equal. The results of the Levene test are presented in Table 6 below.

Table 6

Levene test results

Levene's Test of Equality of Error Variances[a,b]					
		Levene Statistic	**df1**	**df2**	**Sig.**
IoT Awaness	Based on Mean	,300	5	380	,913
	Based on Median	,179	5	380	,970
	Basel on Median and with adjusted df	,179	5	372, 647	,970
	Based on trimmed mean	,317	5	380	,903
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.					
a. Dependent variable: IoT Awaness					
b. Design: Intercept + D1 + D3 + D1 * D3					

As seen in Table 6, p=0.913 was calculated. According to these results, it was seen that the error variances were distributed homogeneously. The Two-Way ANOVA results performed to test the relationship between gender and generation variables and IoT awareness are shown in Table 7.

Table 7

Relationship between gender, generation and IoT awareness

Tests of Between-Subjects Effects							
Dependent Variable: IoTAwaness							
Source		**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Intercept	Hypothesis	2222,999	1	2222,999	8684,122	,000	,999
	Error	1,411	5,512	,256[a]			
D1	Hypothesis	1,099	1	1,099	2,806	,176	,434
	Error	1,431	3,652	,392[b]			
D3	Hypothesis	,519	2	,260	,531	,653	,347
	Error	,977	2	,488[c]			
D1 * D3	Hypothesis	,977	2	,488	1,947	,144	,010
	Error	95,316	380	,251[d]			
a. ,593 MS(D3) + ,407 MS(Error)							
b. ,593 MS(D1 * D3) + ,407 MS(Error)							
c. MS(D1 * D3)							
d. MS(Error)							

Upon examining Table 7, it can be concluded that there is no statistical interaction between the variables of gender and generation concerning IoT awareness at the 0.05 significance level (p= 0.144). When gender and generation are assessed concurrently, it is observed that they do not influence IoT awareness. The analysis results indicate that H_2 is accepted.

For the hypothesis expressed as "H_3: There is no statistically significant difference between the averages of individuals' sectors and IoT awareness," a normality analysis was conducted for IoT awareness. The relevant analysis results can be found in Table 8.

When Table 8 is examined, it is seen that the skewness and kurtosis coefficients are not within ideal limits. For this reason, it was determined that the data did not conform to normal distribution. H_3 was tested with

Kruskal Wallis, one of the nonparametric methods, and the results are presented in Table 9.

Table 8

Normality analysis of sector and IoT awareness

Descriptives				
			Statistic	**Std. Error**
IoTAwaness	Manifacture Industy	Mean	3,8000	,18641
		Skewness	-,158	,661
		Kurtosis	-1,409	1,279
	Agricultural Industry	Mean	3,9018	,09515
		Skewness	,048	,524
		Kurtosis	,976	1,014
	Service Industry	Mean	4,1034	,02577
		Skewness	,000	,128
		Kurtosis	-,125	,255

Table 9

Relationship between industry and IoT awareness

Ranks			
	Generation	N	Mean Rank
IoTAwaness	Generation X	32	150,25
	Generation Y	93	210,48
	Generation Z	268	197,90
	Total	393	

Test Statistics[a,b]	
	IoTAwaness
Kruskal-Wallis H	4,546
df	2
Asymp. Sig.	,103
a. Kruskal Wallis Test	
b. Grouping Variable: Generation	

According to Table 9, it is seen that there is no statistically significant difference between the sector in which the individual works and IoT awareness at the 0.05 significance level (p=0.103). In other words, there is no relationship between the sector in which the individual works and IoT awareness. When the analysis results are evaluated, it is seen that H_3 is accepted.

"H_4: There is no statistically significant difference between education level and IoT awareness." In the hypothesis established as follows, first, normality analysis was performed. The results of education level and IoT awareness normality analysis are shown in Table 10 below.

Table 10

Education level and IoT awareness normality analysis

Descriptives				
			Statistic	**Std. Error**
IoTAwaness	High School	Mean	4,0869	,11494
		Skewness	-,298	,409
		Kurtosis	-1,068	,798
	Vocational School	Mean	4,0770	,03196
		Skewness	,020	,164
		Kurtosis	,178	,327
	Undergraduate	Mean	4,0674	,05071
		Skewness	,121	,255
		Kurtosis	,109	,506
	Graduate	Mean	4,1487	,06939
		Skewness	-,013	,330
		Kurtosis	-,525	,650

In Table 10, it can be said that the skewness and kurtosis coefficients for all education levels are within ideal limits and the data are normally distributed. Since the data are normally distributed, H_4 was tested with One-Way ANOVA, which is appropriate for the data structure. The One-Way ANOVA results are shown in Table 11.

Table 11

Relationship between education level and IoT awareness

ANOVA					
IoT Awaness					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	,253	3	,084	,343	,794
Within Groups	95,617	389	,246		
Total	95,870	392			

According to the ANOVA results shown in Table 11, it is concluded that there is no statistically significant difference between the group means at the 0.05 significance level (p=0.794). Thus, it can be said that there is no statistically significant difference between the participants' education levels and IoT awareness. High or low education levels do not affect IoT awareness. When the analysis results are evaluated, it is seen that H_4 is accepted.

"H_5: There is no statistically significant difference between the social media usage time and IoT awareness sub-dimensions." For the hypothesis established as follows, firstly, normality analysis was carried out. Since the frequency of the group using social media for 15 or more hours is 2 among the groups, the normality of the relevant group cannot be calculated. For this purpose, these extreme values were censored, and normality measurement was performed. The relevant analysis results are shown in Table 12 below.

Table 12

Social media usage duration and IoT awareness normality analysis

Descriptive				
			Statistic	**Std. Error**
IoT Awaness	4 hours and below	Mean	4,0633	,02795
		Skewness	-,014	,142
		Kurtosis	-,027	,282
	Between 4-9 hours	Mean	4,1211	,05705
		Skewness	-,082	,258

Contd...

		Kurtosis	-,289	,511
	Between 9-15 hours	Mean	4,3833	,16415
		Skewness	,400	,752
		Kurtosis	-1,799	1,481

Since the skewness and kurtosis values of the data are not within normal limits, it is understood that the data is not normally distributed. H_5 is analyzed with the Kruskal Wallis test, one of the nonparametric methods. The analysis results are shown in Table 13.

Table 13

Relationship between social media usage time and IoT awareness Ranks

	Social Media Usage Times	**N**	**Mean Rank**
IoT Awaness	4 hours and below	296	192,34
	Between 5-9 hours	87	202,40
	Between 10-14 hours	8	261,63
	Total	391	
Test Statistics[a,b]			
	IoT Awaness		
Kruskal-Wallis H	3,309		
df	2		
Asymp. Sig.	,191		
a. Kruskal Wallis Test			
b. Grouping Variable: Social Media Usage Times			

According to the Kruskal Wallis test results shown in Table 13; at the 0.05 significance level, it is concluded that there is no statistically significant difference between the group means (p=0.191). Thus, it can be said that there is no statistically significant difference between the participants' social media usage time and IoT awareness. Whether individuals use social media more or less does not change their IoT awareness. When the analysis results are evaluated, it is seen that H_5 is accepted.

5. Conclusion and Discussion

The analysis shows that although the participants have different generations (0.085), genders (0.144), sectors (0.103), education levels (0.794) and different social media usage levels (0.191), these factors do not lead to significant differences in their IoT awareness. The literature frequently suggests that Generation Z differs significantly from previous generations in many respects. However, it is observed at the 0.95 significance level that IoT awareness is not one of these differences. According to the analysis results, the research hypotheses were accepted. These findings indicate that, despite the common belief that Generation Z is distinct from earlier generations, there is no significant divergence in IoT awareness compared to other generations. The results of the study support the idea that IoT awareness levels are not determined by the demographic characteristics examined and are generally widespread in society. These findings demonstrate that IoT technology is becoming increasingly prevalent and reaching all segments of society. According to the findings of the research, it can be stated that there is a significant level of IoT awareness in society. IoT should be recognized as a technology that captures the interest of all generations, not just the younger ones, and strategies should be developed accordingly. As a continuously evolving technology, IoT is anticipated to become even more widespread and play an increasingly significant role in society in the future. Integrated with technologies such as artificial intelligence, cloud computing, and 5G, IoT is expected to make social and economic life smarter, more connected, and more efficient.

Future studies conducted in different geographical areas and with larger sample sizes may help the results gain broader acceptance. By utilizing various variables and different scales to measure IoT awareness levels, the validity and reliability of the results can be enhanced. Additionally, incorporating questions that examine participants' experiences and usage habits related to IoT technologies would provide a more comprehensive perspective. Considering the continuous development of IoT technologies, long-term studies could better elucidate the impact of these technologies on awareness levels. These suggestions will assist future researchers in gaining deeper insights into IoT awareness and advancing understanding of the topic.

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