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ICT Usage Characteristics and Web Security

Atila Bostan, İbrahim Akman

Abstract— **In assuring the security in information and communication technologies, user awareness and acquired-user habits are inevitable components, yet they may be qualified as the feeblest ones. As the information technology tries to put its best in providing maximum security, user awareness plays the key-role. The relation in between the demographic factors, usage frequency and issues related web security not to be known yet. Therefore, this study investigates demographic factors, information and communication technology usage characteristics of users on providing secure web usage. For this purpose, a survey was conducted among 466 citizens from different layers of the society. The results indicated existence of significant relations between various socio-demographic factors, reason and frequency of ICT usage factors and web-security issues.**

Index Terms— **computer security, demographic factors, ICT usage frequency**

I. INTRODUCTION

THE world has witnessed the rapid development in information and communication technologies in the last two decades. Today almost all of the communication and business transactions have been moved onto digital networks. An abundant amount of communication and e-commerce services are running on the Internet with about 2.5 billion of current user count [1]. Among all other digital techniques on the Internet, web is the most common one as a user interface for a variety of services. With user satisfaction and service performance in mind the initial design of web technology did not include any mechanism to stipulate security in transactions. But great demand from baking and e-commerce domains, forced web service to incorporate security mechanisms in time. Unfortunately, whereas the technology tries its best to improve security mechanisms, web based security breaches are proven to be on a constant rise in recent years [2,3]. As it is in other security mechanisms, the key component is almost always pointed as end users in web based security services either. Users, while taking part as administrators, technicians or users in web services are inevitable and weakest rings in security-chain. Uncertainty in human behaviors is generally deemed as the grounds for the weakness of user component. Thus, it is usually hard to predict the expected response of a user when (s)he is exposed to a security related experimental setting. Yet security-responses of two users would most likely be different than each other when they face similar settings although they were subject to the same education and directions. The factors effective in human decision-making process are fuzzy.

Most preferred behavioral practices, habits, of any web user play an important role in predicting user responses towards a security challenge. In one of their scientific studies D'archy and Hovay pointed out; the success in information security greatly depends on user security habits and awareness [4]. In another one, Adams and Sase indicate "Since security mechanisms are designed, implemented, applied and breached by people, human factors should be considered in their design" [5]. Appropriate and constructive behavior by end users, system administrators, and others can enhance the effectiveness of information security while inappropriate and destructive behaviors can substantially inhibit its effectiveness [6]. In his interpretation on information security behaviors of human, Secrets and Lies, Schneier asserts ''Mathematics is logical; people are erratic, capricious, and barely comprehensible.''[7]. Security mechanism need to be user friendly otherwise they are most likely laid off. Witten and Tygar highlighted the user discontent in PGP e-mail encryption [8]. Freidman et al. investigated user's perception of security in web-based interactions and noted that problems arise how people assess the security of settings they encounter [9]. Furthermore in one of our previous studies we examined user behavior characteristics in SSL/TLS web applications [10] and found that users do not always pay attention to web security indicators. End user security related behaviors would suggest several instruments to improve observed practices. Most of the academic publications refer to user training on security as a possible cure to develop user behaviors. But, there are scientific studies which prove that user practices are not always in parallel with their beliefs [11,12]. Secure ways of web usage must be practiced and internalized [12]. In addition, age and experience are shown to be correlated with attitudes towards security [13].

An improvement in web usage behavior calls for a change in every day practices of users. Training, user intentions and experiences are factors known to induce behavioral changes. Researchers go along with the need to focus on user motivations and usage habits in designing web security mechanisms [14,15,16].

In this research study we examined the effect of user ICT experience on secure web usage. In order to scrutinize the problem in focus an 14-question survey was carried out in shopping malls on 433 randomly selected participants. Interpretations and conclusions in this study are derived from the results of the survey.

The rest of this paper is organized as follows: In the next chapter research methodology used in the study is presented along with the hypotheses scrutinized. Following the research design and test method, we state the results found in the study. In the final chapter, conclusion is submitted.

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II. RESEARCH METHODOLOGY AND HYPOTHESES

The literature reported existence of digital divide within countries [17]. Some studies investigated the attitude of individuals toward using ICT and the relationships between ICT issues and socio-demographic factors (see for example [18-22]).

For the citizens, ICT technologies can offer a huge range of services and the internet is probably the most important one of these services. The literature provides evidences stating that there are many people who do not or can not access to computers and/or internet due to the gap between citizens' attributes including gender, education, income, age, households, business and geographic areas at different socio-economic levels with re1"gard to their use of the internet for a wide variety of activities. Of these attributes, gender, age, education and experience have attracted special interest. Additionally, organizational characteristics play an important role in shaping individuals' attitudes towards the use of IT [23]. Some studies reported significant differences between the types of IT applications among organizations from public and private sectors [24,25]. Lau and Gupta et al. reported significant differences between the types of IT applications among organizations from different sectors. On the other hand, in their study Tan et al. [26] considered security to be a major barrier in using ICT and reported it to be a significant factor influencing internet-based ICT adoption. This research focuses only on small and medium sized enterprises. Maslin and Zuraini [27] examined the influence of demographic factors on awareness for computer-use and security. They reported that age and education level influence awareness for computer use and security.
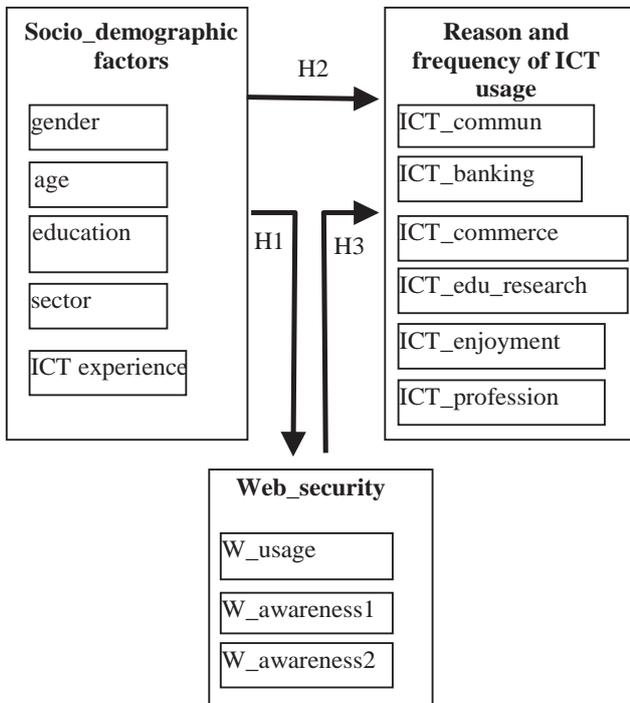

Fig. 1. Research model

This research used data collected from computer science students. Finally, Choi [28] examined how demographic variables are statistically associated with the level of equipping the computer security and reported that demographic factors differentially contribute to computer security issues. All these studies point the need for further research since findings may offer valuable insights to policy makers in general.

The concerns on the internet security have grown in parallel to the increase in the reliance on the Internet [29]. Symantec [30] reported that there are over one million viruses, worms, Trojan horses and other malicious code on the Internet. Therefore, the research on inadequate Internet security has increased gradually during the last decade.

With this backdrop, present study performs a systematic analysis to investigate the impact of independent (decision) variable socio-demographic factors on web security and reason and frequency of ICT usage. Whereas the impact of web security on reason and frequency of ICT usage is also scrutinized. The research model was developed to find an answer to the following main questions:

- Do socio-demographic factors have impact on web security?
- Do socio-demographic factors have impact on reason and frequency of ICT usage?
- Do web security factors have impact on reason and frequency of ICT usage?

For this purpose, three empirical factors are used as follows: (i) Socio-Demographic, (ii) web security and (iii) ICT usage. The justification for empirical factors and their corresponding hypotheses are provided below.

Hyp.	Definition
$H1_{ij}$	web_security factor$_i$ (i=1,2,3) is related to socio-demographic factor$_j$ (j=1,2...,5)
$H2_{ij}$	reason and frequency of ICT_usage factor$_i$ (i=1,2,..,6) is related to socio-demographic factor$_j$ (j=1,2...,5).
$H3_{ij}$	web_security factor$_i$ (i=1,2,3) is related to reason and frequency of ICT_usage factor$_j$ (j=1,2,..,6).

III. RESEARCH DESIGN

The respondents were ordinary citizens belonging to different groups in the society, since the survey was conducted in big shopping malls in different cities in different days of the week by the young members of Turkish Chamber of Electrical Engineers. The sampling method was selected to be "judgment sampling" and the respondents participated in the study voluntarily. A total of 466 completed survey questionnaires were received. Thirty three responses were discarded due to the existence of unqualified data, which means 433 responses included in the analysis. Thus, the approximate response rate was approximately 93 percent which can be considered acceptable for the purpose of this study [31,32]. The research questions and variables are given in Table 1 below.

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TABLE 1
RESEARCH QUESTIONS AND VARIABLES

Q	Variable	Definition	Range of values
1	gender	What is your gender?	male, female
2	age	What is your age?	<21, 21-30, 31-40, 41-50, 51-
3	education	What is your education level?	graduate/under graduate/others
4	sector	What is the sector of your organization?	private, public, not working
5	experience	What is the level of your ICT experience (years)	0, 1-5, 6-10, 11-15, 16-20, >20
6	W_usage	Do you visit/use web pages on Internet?	yes/no
7	W_awareness1	What is the level of your awareness on web security?	very high, high, average, little, very little
8	W_awareness2	Do you have awareness on web	Yes/no
9	ICT_commun	How much do you use ICT for communication?	very high, high, average, little, very little
10	ICT_banking	How much do you use ICT for electronic banking?	very high, high, average, little, very little
11	ICT_commerce	How much do you use ICT for electronic commerce?	very high, high, average, little, very little
12	ICT_edu_resrch	How much do you use ICT for education and research?	very high, high, average, little, very little
13	ICT_enjoyment	How much do you use ICT for enjoyment?	very high, high, average, little, very little
14	ICT_profession	How much do you use ICT for your professional activities?	very high, high, average, little, very little

IV. TEST METHOD

Testing of hypotheses concerning the impact of socio-demographic factors on web security ($H1_{ij}$), the impact of socio-demographic factors on reason and frequency of ICT usage ($H2_{ij}$) and the impact of web security factors on reason and frequency of ICT usage ($H3_{ij}$) were conducted using multivariate regression. Regression Analysis is a powerful statistical tool and is used in a wide variety of applications. It has the advantage that no assumption is made about the nature of the relationship between dependent and independent variables. Additionally, it can handle categorical data better. Therefore, is normally preferred when the independent variables are categorical [33]. The chi-square test method [33] is used whenever there is a need to examine the relationship between the dependent and independent variables.

V. RESULTS

The results of the present survey are presented in the following sequence. Initially, the results of the survey are presented using descriptive analysis. As it was mentioned earlier, Chi-square test method was also used whenever there was a need to have a better insight to the respondents' profile in this part. This is followed by the results of regression analysis for each demographic factor.

A. DESCRIPTIVE RESULTS

The background profile of respondents is provided in Table 2.

TABLE 2
PROFILE OF RESPONDENTS

Variable	Turkish graduate students	
	Number	**%**
Gender	433	100
Male	239	55
Female	188	44
Unknown	6	1
Age	433	100
<21	91	21
21-30	204	47
31-40	89	21
41-50	40	9
>50	9	2
Sector	433	100
Private	93	21
Public	76	18
Not working	238	55
Unknown	26	6

The respondents were observed to be almost equal in terms of gender (male: 55%; female: 44%) in this survey. This is expected since it was conducted in shopping malls where there is no reason for dominancy of any gender. Of the males in the sample, 14% reported their awareness on web security is above average and this percentage for females is 5%. Chi-square test results indicate that there is significant relation between gender and awareness on web security (Chi-Square = 14.622; DF = 5; P-Value = 0.012).

The age distribution showed a high percentage for the group of less than 30 years of age (68%) whereas this percentage for elder people, who are greater than 40 years is only 11%. This should be considered normal because the percentage of young people visiting shopping malls every day is observed to be high and young people show more interest in responding surveys. Of the young respondents (<30 years of age), 14% reported their awareness on web security to be above average and this percentage for elder people (>40 years of age) is 0%. Chi-square test results indicates significant relationship between age and web security (Chi-Square = 97.110; DF = 12; P-Value = 0.000).

Regarding respondents from private sector organizations 10% reported their security awareness is above average for web services. This percentage for public sector employees is observed to be 5%. Public sector employees seem to be less security-aware on web services and Chi-square test result shows significant relationship between sector and web security awareness (Chi-Square = 33.557; DF = 12; P-Value = 0.001).

B. TEST RESULTS

Regression test results of socio-demographics against web security are shown in Table 3. P-values in last column of Table 3 indicate that except for the hypotheses $H1_{12}$ and $H1_{15}$, the remaining ones are not supported by the survey results at 5% significance level for W_usage. This means $H1_{11}$, $H1_{13}$ and $H1_{14}$ are rejected at 5 percent significance level since their p-values are 0.469, 0.158 and 0.263 respectively. This can also be interpreted as the socio-demographic factors age and experience have impact on the web usage for different purposes. Interestingly, the work sector does not have any impact. Regarding the dependent variable w_awareness1, it is observed from inspection of p-values that $H1_{21}$ (p_value=0.020), $H1_{22}$(p_value=0.000), $H1_{23}$ (p_value=0.000) and $H1_{25}$ (p_value=0.000) are all accepted. This can also be interpreted as gender, age, education and experience are related to w_awareness1. In other words, they have impact on the level of web security awareness. The work sector is the only factor in this category that does not have any effect and $H1_{24}$ is rejected (p_value=0.253). Inspection of the last column of Table 3 states that, except for the hypothesis $H1_{31}$ (p_value=0.986), all the others are accepted at 5 percent significance level for the dependent variable w_awareness2. This means the independent variables age, education, sector and experience have impact on the awareness level for web certificate error. Surprisingly, gender does not have this effect.

TABLE 3
REGRESSION TEST RESULTS OF SOCIO-DEMOGRAPHICS AGAINST WEB SECURITY

Dep.var.	Indep. var.	Hyp.	alpha	p*
W_usage	gender	$H1_{11}$	0.02606	0.469
	age	$H1_{12}$	-0.06764	0.000*
	education	$H1_{13}$	-0.02111	0.158
	sector	$H1_{14}$	0.02673	0.263
	experience	$H1_{15}$	0.15509	0.000*
W_awareness1	gender	$H1_{21}$	-0.36032	0.020*
	age	$H1_{22}$	-0.36032	0.000*
	education	$H1_{23}$	0.16711	0.000*
	sector	$H1_{24}$	-0.06998	0.253
	experience	$H1_{25}$	0.44513	0.000*
W_awareness2	gender	$H1_{31}$	-0.00116	0.986
	age	$H1_{32}$	-0.24484	0.000*
	education	$H1_{33}$	0.07600	0.006*
	sector	$H1_{34}$	0.07600	0.011*
	experience	$H1_{35}$	0.07600	0.000*

*indicates statistically significant at 5 per cent significance level.

Regression test results of socio-demographics against reason and frequency of ICT usage are shown in Table 4. Interestingly, inspection of p-values in the last column of Table 4 indicate acceptance of $H2_{15}$, $H2_{25}$, $H2_{35}$, $H2_{45}$, $H2_{55}$ and $H2_{65}$. This means, that the socio-demographic factor experience has significant impact on all of the dependent factors, ICT_commun, ICT_banking, ICT_commerce, ICT_edu_research, ICT_enjoyment and ICT_profession since p-values are all 0.000. It can also be interpreted as with the increasing level of experience the usage of ICT is increasing in different fields such as communication, banking, commerce, education and research, enjoyment and professional usage.

TABLE 4
REGRESSION TEST RESULTS OF SOCIO-DEMOGRAPHICS AGAINST REASON AND FREQUENCY OF ICT USAGE

Dep. var.	Indep. var.	Hyp.	alpha	p*
ICT_commun	gender	$H2_{11}$	- 0.003	0.975
	age	$H2_{12}$	- 0.548	0.000*
	education	$H2_{13}$	0.085	0.024*
	sector	$H2_{14}$	0.037	0.536
	experience	$H2_{15}$	0.696	0.000*
ICT_banking	gender	$H2_{21}$	- 0.247	0.026*
	age	$H2_{22}$	- 0.045	0.425
	education	$H2_{23}$	0.193	0.000*
	sector	$H2_{24}$	0.067	0.361
	experience	$H2_{25}$	0.593	0.000*
ICT_commerce	gender	$H2_{31}$	- 0.218	0.052*
	age	$H2_{32}$	- 0.130	0023*
	education	$H2_{33}$	0.125	0.008*
	sector	$H2_{34}$	- 0.194	0.009*
	experience	$H2_{35}$	0.436	0.000*
ICT_edu_research	gender	$H2_{41}$	- 0.011	0.924
	age	$H2_{42}$	- 0.447	0.000*
	education	$H2_{43}$	0.196	0.000*
	sector	$H2_{44}$	- 0.364	0.000*
	experience	$H2_{45}$	0.683	0.000*
ICT_enjoyment	gender	$H2_{51}$	- 0.213	0.040*
	age	$H2_{52}$	- 0.602	0.000*
	education	$H2_{53}$	0.066	0.125
	sector	$H2_{54}$	- 0.238	0.001*
	experience	$H2_{55}$	0.649	0.000*
ICT_profession	gender	$H2_{61}$	- 0.259	0.039
	age	$H2_{62}$	- 0.048	0.449
	education	$H2_{63}$	0.242	0.000*
	sector	$H2_{64}$	0.236	0.005*
	experience	$H2_{65}$	0.627	0.000*

*indicates statistically significant at 5 per cent significance level.

On the other hand, p-values indicate acceptance of $H2_{21}$, $H2_{31}$, $H2_{51}$ and $H2_{61}$. In other words, gender is found to have impact on ICT_banking, ICT_commerce, ICT_enjoyment and ICT_profession. This means, there is a significant relationship between gender and usage of ICT for banking, commerce, enjoyment and professional purposes. But the relationship between gender and ICT usage for education and research is strongly rejected with a p-value of 0,924. Regarding the socio-demographic variable age, $H2_{12}$, $H2_{32}$, $H2_{42}$ and $H2_{52}$ are supported by the survey results and, therefore, we accept them. This implies that age has significant impact on usage of ICT for communication, commerce, education and enjoyment purposes. Whereas, the

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findings indicate that the relationships between age and ICT usage for banking or profession are insignificant. For the hypotheses $H2_{13}$, $H2_{23}$, $H2_{33}$, $H2_{43}$, and $H2_{63}$, p-values were found to be 0.024, 0.000, 0.008, 0.000, and 0.000 respectively. Therefore, we again accept $H2_{13}$, $H2_{23}$, $H2_{33}$, $H2_{43}$ and $H2_{63}$ at 5% significance level in this empirical category. This also means that for the variables ICT_banking, ICT_commerce, ICT_edu_research and ICT_profession the variable "level of education" has significant influence on ICT usage. In other words, level of education category does not show identical behavior in their populations for ICT usage frequency in communication and enjoyment. Finally, inspection of p-values indicate that the variable sector is in favor of $H2_{34}$, $H2_{44}$, $H2_{54}$ and H264, which leads to their acceptance. A plausible explanation for this finding is that sector of the respondent's work sector has significant impact on the frequency of ICT usage for commerce, education and research, enjoyment and professional usage.

TABLE 5
REGRESSION TEST RESULTS OF WEB SECURITY AGAINST REASON AND FREQUENCY OF ICT USAGE

Dep. var.	Indep.var.	Hyp.	alpha	p*
ICT_commun	w_usage	$H3_{11}$	1.3472	0.000*
	w_awareness1	$H3_{12}$	0.53630	0.000*
	w_awareness2	$H3_{13}$	0.18729	0.014*
ICT_banking	w_usage	$H3_{21}$	0.7415	0.000*
	w_awareness1	$H3_{22}$	0.60200	0.000*
	w_awareness2	$H3_{23}$	-0.25227	0.008*
ICT_commerce	w_usage	$H3_{31}$	0.61780	0.000*
	w_awareness1	$H3_{32}$	0.6178	0.000*
	w_awareness2	$H3_{33}$	-0.29296	0.001*
ICT_edu_research	w_usage	$H3_{41}$	0.5397	0.000*
	w_awareness1	$H3_{42}$	0.78040	0.000*
	w_awareness2	$H3_{43}$	-0.2466	0.014*
ICT_enjoyment	w_usage	$H3_{51}$	1.0013	0.000*
	w_awareness1	$H3_{52}$	0.55697	0.000*
	w_awareness2	$H3_{53}$	0.00563	0.952
ICT_profession	w_usage	$H3_{61}$	0.2445	0.138
	w_awareness1	$H3_{62}$	0.58922	0.000*
	w_awareness2	$H3_{63}$	-0.0006	0.996

*indicates statistically significant at 5 per cent significance level.

The regression test results for the relationship between web security and, reason and frequency of ICT usage are given in Table 5. Interestingly, the inspection of p-values in the last column of Table 5 indicate similar trend for the dependent variables ICT_commun, ICT_banking, ICT_commerce and ICT_edu_research. In other words, $H3_{11}$, $H3_{12}$ and $H3_{13}$ for ICT_commun; $H3_{21}$, $H3_{22}$ and $H3_{23}$ for C_banking; $H3_{31}$, $H3_{32}$ and $H3_{33}$ for C_commerce and $H3_{41}$, $H1_{42}$ and $H1_{43}$ for ICT_edu_research are all accepted at 5 percent significance level. This means the independent variables w_usage, w_awareness1 and w_awareness2 have impact on the dependent variables ICT_commun, ICT_banking, ICT_commerce and ICT_edu_research. In other words, behavior towards usage of web, web security awareness level and certificate error awareness level influence the usage and frequency of ICT usage for communication, banking, commerce and education/research purposes. On the other hand, inspection of p-values on the last column of Table 5 leads to the acceptance of $H3_{51}$ (p_value=0.000) and $H3_{52}$ (p_value=0.000) and rejection of $H3_{53}$ (p_value=0.952). This means there is significant relationship between the behavior towards using ICT for enjoyment and web usage and also between using ICT for enjoyment and level of web security awareness. Level of awareness about certificate error does not have any impact in this category. Finally, depending on p-values for the usage of ICT for professional purposes, the only factor having significant impact appears to be the level of web security awareness (p_value=0.000). Therefore, we accept $H3_{62}$ and reject $H3_{61}$ (p_value=0.138) and $H3_{63}$ (p_value=0.996).

VI. CONCLUSIONS

The paper presents the findings of a survey conducted among the citizens in Ankara. The results show in general that socio-demographic factors are significantly important in reason and frequency of ICT usage and awareness on web security. Our results may provide important insight for companies that are developing web security products and solutions. The findings in this study may also direct academic researchers in conducting and designing of new studies in the field. Furthermore, web security educators and trainers may benefit from the results as well.

The multivariate regression analysis method is used for tests in this study. The results observed in this study supports the existence of significant relationships between socio-demographic factors, factors related to reason/frequency of ICT usage and web security issues at different levels.

There are some limitations to the present study. The sample is composed basically of ordinary citizens, which may not be representative of different layers in the society. Therefore, an extension to consider different groups in the society such as professionals may provide interesting results. Other socio-economic factors such as income should also be investigated. Another important limitation may be based on the studies of Calhoun et al. [34], Chirkov et al. [35] and other researchers which concluded that culture affects the use of ICT in significant way. Furthermore the effect of culture on ICT usage among organizations may be studied from an organizational perspective among different countries in the future.

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