e-HTAM: A Technology Acceptance Model for Electronic Health

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***Abstract*— Serving citizens through an integrated e-Health system requires an understanding of the behaviour of the population as well as the factors that influence their acceptance and usage of technology, such as technology design and sociocultural factors. This has been called e- Health acceptance.**

The research reported in this paper employed the well-established Technology Acceptance Model (TAM) to empirically assess the validity of its constructs, namely 'perceived usefulness', 'perceived ease of use' and 'intention to use e-Health services'. Other sociocultural factors affecting e-Health acceptance, such as 'trust', 'subjective norms' and 'tangibility' have also been investigated.

The proposed e-Health Technology Acceptance Model (e-HTAM) assessed the influence of 'perceived usefulness', 'perceived ease of use' as independent variables on 'intention to use e-Health services' as dependent variable; the correlation found to be positive between the three constructs, which indicate that TAM is suitable to evaluate e-Health services acceptance.

Other sociocultural factors such as 'tangibility', 'trust', 'masculinity', 'uncertainty avoidance', and 'power distance' also showed significant positive Correlations with the reported 'intention to use e-Health services'.

Keywords: Technology acceptance, perceived ease of use, perceived usefulness, health technology acceptance model.

I. INTRODUCTION

It is noticeable that the majority of e-Health services are focused on providing people with comprehensive electronic resources to respond to individuals' queries and routine concerns [22]. Researchers [24,25] have pointed out that in many countries provision of e-Health is still far from reaching full effectiveness. Governments will still be dependent on the traditional channels to provide services, as not all mandatory services are available electronically.

As new Information system (IS) infiltrate workplaces, home, and classrooms, research on user acceptance of new technologies has started to receive more attention from professionals as well as academic researchers. Developers and software industries are beginning to realise that lack of user acceptance of technology can lead to loss of money and resources [22].

Studies on information technology continuously report that user attitudes are important factors affecting the success of the produced system [3, 4]. For the past several decades, many definitions of attitude have been proposed. However, all theories consider attitude to be a relationship between a person and an object [4]. In the context of IS theories [3, 4], these suggest users formulate a positive attitude toward the technology when they perceive the technology to be useful and easy to use [2].

In studying user acceptance and use of technology, the Technology Acceptance Model (TAM) is one of the most cited models [1]. TAM (figure 1) was developed by Davis and jointly extended with Venkatesh [4] to explain computer-usage behaviour.

TAM [2,3,4] is an Information System theory that models how users come to accept and use a technology; the model suggests that when users are presented with a new software package, a number of factors influence their decision about how and when they will use it, notably Perceived Usefulness (PU) and Perceived Ease of Use (PEU). Technology with a high level of PU and PEU is more likely to induce positive perceptions. The relation between PU and PEU is that PU mediates the effect of PEU on attitude and intended use.

TAM [2,3,4] has generally been seen as a prudent and well-tolerated model that predicts acceptance of an information technology. TAM has mostly been tested (as well as developed) within the US which is by far the earliest and most extensive user of what we still think of as "new technology".

The applications of TAM in e-Health research could be read as a means to assess and determine the role of sociocultural and technological factors affecting the adoption and dissemination of e-Health.

The Technology Acceptance Model (TAM) specifies the causal relationships between system design features, perceived usefulness, perceived ease of use, attitude toward using, and actual usage behaviour [2,3,4,5]. Overall, the TAM provides an informative representation of the mechanisms by which design choices influence user acceptance, and should therefore be helpful in applied contexts for forecasting and evaluating user acceptance of information technology (IT), as shown in Figure 1.

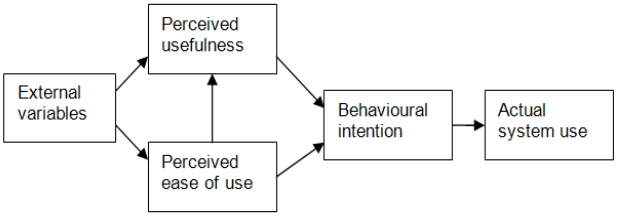

Figure 1: Technology Acceptance Model (Davis, 1989)

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The motives to conduct this research were to establish empirical validation and assess the position of current factors affecting e-Health acceptance. The researcher employed Davis' TAM [5], namely 'perceived usefulness', 'perceived ease of use' and 'intention to use' for the purpose of evaluating e-Health acceptance from a technology viewpoint. Other factors such as trust, subjective norms and tangibility were also assessed. This research work also took into consideration Hofstede's [12,13] cultural dimensions, namely power distance, masculinity and uncertainty to investigate socio-cultural factors that might affect the acceptance of e-Health services.

II. Related Work

In a related work, Park et al [26] examined the factors that influenced lecturers' acceptance and use of Virtual Learning Environment (VLE) in a university and tested the applicability of TAM. Their research indicated that there is a significant positive relationship between PEU and PU; they argued that PEU of the system had significant impacts on PU. They concluded that the indirect effect of PU on actual system use was directed not through behavioural intention to use the system but through evaluation of the actual system. Their study also indicated that motivation to use the system had a significant role in affecting PU, evaluation, and actual system use.

Peker [27] investigated factors that might have strong relations with the acceptance of the technology within a Hospital IS management context. Peker added 12 external constructs to Davis' original TAM. In order to verify the reliability of the model compared to Davis' TAM, both models were analysed. Peker's extended model explained the intention to use with r= .54 while Davis' TAM had r= .45. This finding showed that the modified model in Peker's study would be more meaningful in explaining the users' intentions while using the technology in a hospital IS.

Although the findings can be considered statistically significant in the above related works, however, Peker's study did not evaluate and confirm the effects of behavioural intention to use the VLE on actual use of that system. The fact that the study was conducted within a single university might raise external validity issues, and the exploration of sociocultural factors influence has not been considered.

III. The Proposed Model Hypothesis

This study proposes a new Technology Acceptance Model specifically developed for the e-Health context (e-HTAM). The aim is to test how the TAM [2,3,4] applies to the use of e-Health services. This experiment adapted the standard constructs of Davis' TAM [2,3,4] to test and investigate the applicability and viability of TAM in the field of e-Health. The proposed model incorporated technological factors (computer skills and e-Health technology design) factors, and sociocultural cultural constructs to the model, as they were expected to have a significant role on Intention of use.

e-HTAM suggests that intention to use (I2U) or acceptance of e-Health web based services is formed by the user perceptions of e-Health technology design adequacy and relevancy, especially its navigation-ability, quality, validity and usefulness of its information. Davis' original TAM [2,3,4] constructs namely 'perceived usefulness' (PU) and 'perceived ease of use' (PEU), along with other sociocultural constructs such as 'power distance' (PD), 'trust', 'subjective norm (SN), 'tangibility' (Tang), 'uncertainty avoidance' (UA) and 'masculinity' (Mascul) were all taken into consideration.

e-HTAM proposes several hypotheses as a base of developing the proposed model/framework:

Hypothesis PEU1: Perceived ease of use of e-Health services will have a positive effect on perceived usefulness of e-Health acceptance.

Hypothesis PEU2: Perceived ease of use of e-Health services will have a positive effect on behavioural intention to use e-Health services.

Hypothesis PU1: Perceived usefulness of e-Health services will have a positive effect on behavioural intention to use e-Health services.

Hypothesis PU2: Perceived usefulness of e-Health services will have a positive effect on e-Health acceptance.

IV. Result Analysis

In order to test the proposed model empirically, a pilot study was conducted in UAE and UK1. The participants were randomly selected with no prior preferences. The data was collected through online questionnaire facility 'questback.com' during a two month period. 35 were people asked to participate in UK of whom 27 responded. 35 people were asked to participate in the UAE of whom 25 responded.

N = 50		I2U	eH	PEU	PU	SN	Tang	Trust	UA	MasculL	PD	skills
I2U	Correlation	1	.275*	.438**	.420**	.240*	.407**	.403**	-.320*	-.108	-.055	.429**
*. Correlation is significant at the 0.05 level (1-tailed).												
**. Correlation is significant at the 0.01 level (1-tailed).												

Table 1: e-HTAM constructs correlation

The study employed Likert attitude scale [9], the scale has five points scale ranging from 'strongly agree' to 'strongly disagree', Likert's scale can be interpreted as "1" stands for "strongly disagree" and "5" stands for "strongly agree". For the purpose of this study an additional response category: 'I have not used it' item has been added to the scale, as not everyone is expected to have used or experienced e-Health web based services.

The gathered data were statistically analysed to test the hypothesis. Pearson's correlation coefficient was used to measure relationships between the e-HTAM constructs.

Cronbach Alpha test [29] was performed to test the stability and consistency of the e-HTAM constructs.

PEU (Cronbach's α=0.640) measured the level of the respondents' agreement with the following statements:

I can access the internet based health information easily.

[1] This Research is a part of the PMI2 project funded by the UK Department for Innovation, Universities and Skills (DIUS) for the benefit of the Dubai Higher Education Sector and the UK Higher Education Sector.

The internet based health information or services websites that I have used were easy to use.

I can search the internet for health information or services.

PU (Cronbach's α=0.610) measured the level of the respondents' agreement with the following statements:

The health information presented on the internet website that I have used was useful.

The internet based health information is useful at work.

The internet based health information is useful for me.

The internet based health information is useful for my family.

The National Health Services websites that I have visited are useful.

Using internet based health information or services would improve my life.

Using internet based health information would increase my productivity at work.

Using internet based health information would increase my productivity at study.

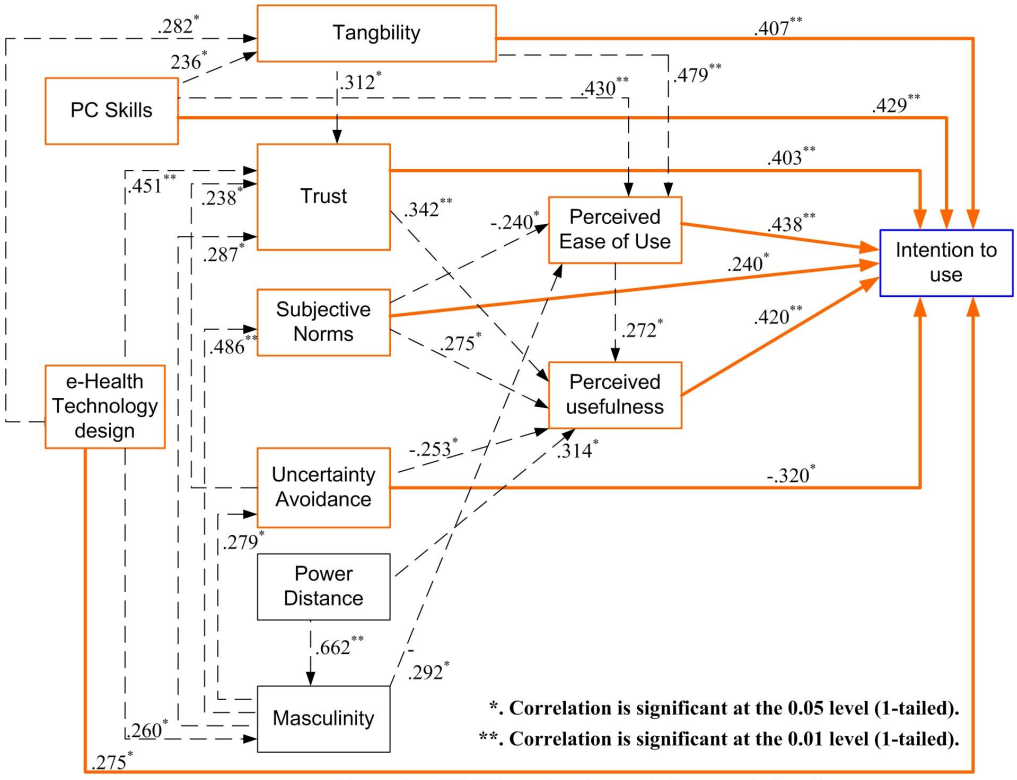

Figure 2: e-HTAM constructs correlation association diagram

In this experiment, the Pearson product-moment correlation coefficient analysis was used to study the correlation between the e-HTAM constructs and intention to use, as can be seen from Table 1. Significant correlations were obtained for the major constructs except PD and Masculinity.

The statistical analysis confirmed the existence of correlations between e-HTAM constructs (Table 1 & Figure 2). Table 1 results indicate that there is a significant positive relationship between intention to use and PU, PEU, Tang, Trust, and skills. Significant negative correlations were shown between intention to use and UA. These are shown in Figure 2,

The results indicates that PEU (r= .438, p=.001 at 0.01 level 1-tailed), PU (r= .420, p=.001 at 0.01 level 1-tailed), all positively influence I2U. The results confirm those previous studies conduct by Davis and Venkatish [18].

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of PEU is normal with mean 13 and standard deviation 2.548.	One-Sample Kolmogorov-Smirnov Test	.122	Retain the null hypothesis.
2	The distribution of Tang is normal with mean 11.76 and standard deviation 2.861.	One-Sample Kolmogorov-Smirnov Test	.099	Retain the null hypothesis.
3	The distribution of I2U is normal with mean 8.14 and standard deviation 2.01.	One-Sample Kolmogorov-Smirnov Test	.240	Retain the null hypothesis.
4	The distribution of Trust is normal with mean 15.64 and standard deviation 2.961.	One-Sample Kolmogorov-Smirnov Test	.857	Retain the null hypothesis.
5	The distribution of UA is normal with mean 6.94 and standard deviation 2.113.	One-Sample Kolmogorov-Smirnov Test	.348	Retain the null hypothesis.

Table 2: Summary of hypothesis test

The results presented in Table 1 indicate that trust is associated with I2U (r = 0.403) which suggests that trust has a high influence on sample population intention to use e-Health services. In other words, increasing an individual's trust may lead to an increase in an individual's intention to use e-Health services. These results are consistent with the previous research that examined trust and use of internet based services [11,15].

Gefen et al [3] stated that cultures with high collectivism prefer to use tangible media (e.g. face-to-face meeting) to enhance social presence rather than email, for example which leads to minimal social interaction.

The results in Table 1 indicate that tangibility (Tang) is a significant factor. Tangibility positively relates to individuals' intention to use e-Health services, with r = 0.407, p< 0.01) the analysis results indicate that both PD and Masculinity have a negative relationship with I2U, but this is not statistically significant. Since the e-Health services acceptance in this study is of a voluntary nature, this finding is in agreement with Venkatesh and Davis' [17] findings. The results of a negative correlation between PD Masculinity and intention to use provides some slight evidence to support the suggestion that the direct compliance impact of masculinity on I2U does not work in a voluntary cases [18] Hypothesis PEU1, PEU2, PU1 and PU2 were all tested using

the Kolmogorov-Smirnov Test (K-S) [28], the hypothesis test results are reported in Table 2, where most of the hypotheses were confirmed and retained.

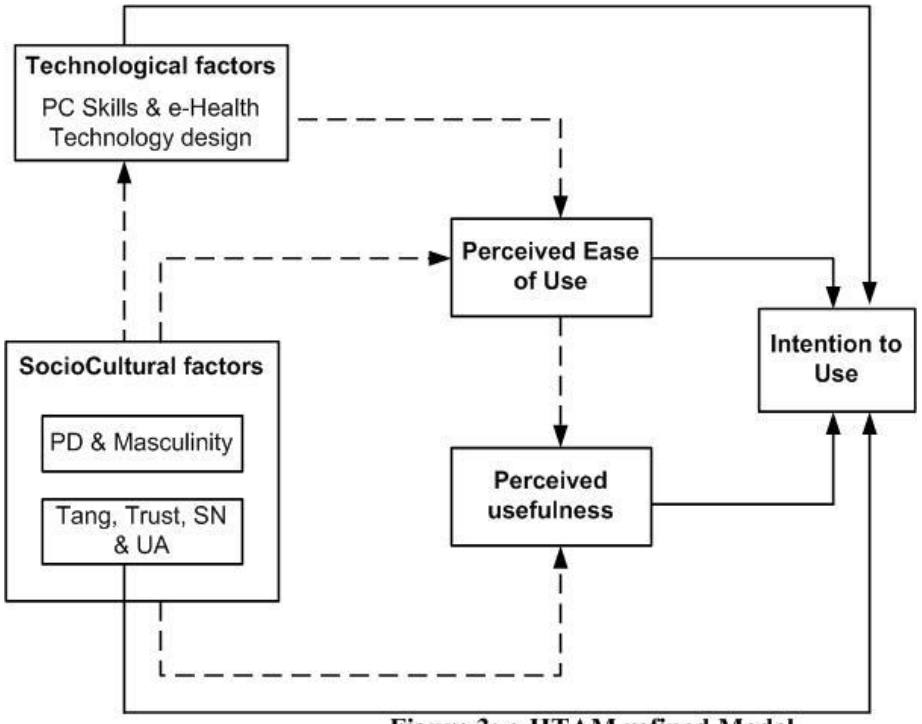

Figure 3: e-HTAM refined Model

According to Hair et al [27] a good Cranach alpha (α) reliability test should produce at least a coefficient value of 0.60 to 0.70. Although e-HTAM's reliability tested scored .651, which indicate that the scales can therefore be considered reliable, however, it is the researcher's intention to further refine these constructs in the future development of the scale, but for the purpose of this pilot study it was considered to be acceptable to proceed.

The Correlation analysis and hypothesis test conclusion has been represented graphically as a refined model in Figure 3.

The refined model grouped the technological and the sociocultural factors into two constructs. The direct relationship between the constructs and the intention to use e-Health services has been represented with solid lines arrows, while the indirect relationship with the intention to use has been represented in dashed arrows.

V. CONCLUSION

This study intends to construct and test a model that adequately explains the e-Health services acceptance within UK and UAE. e-HTAM constructs exist within a technological and sociocultural environment, which exerts influence over how the characteristics are perceived by users and how the perceived characteristics contribute or lead to the ultimate intention to accept or reject e-Health services.

Results of this study offer some important implications for future studies; e-HTAM has been shown to be a reasonably reliable and consistent framework to explain the factors that affect users' behavioural intention to use e-Health services. e-HTAM incorporated additional factors to the original TAM to make the theory building process of technology use more fruitful. Factors such as technology design and sociocultural variables will help to further study the gap between intention to use e-Health services and the actual use of e-Health services

Pearson's correlation analysis was used to determine the relationships between e-HTAM constructs. Significant relationships were found for most constructs. The refined model confirmed through rigorous analytical testing that there is a direct relationship between technological, sociocultural constructs and intention to use e-Health services. In addition, the model also confirmed the direct relationship between PU and PEU and intention to use. The model has shown many interesting relationships which need to be further tested and the model refined but what this research has shown is that sociocultural variables should be taken into account alongside of technological variables, when investigating how ready people are to use e-Helath systems. There is a further need to examine the gap between e-Health technology design and actual e-Health services acceptance; nevertheless, the effects of behavioural intention to use of the e-Health services on actual need to be tested as well.

REFERENCES

[1] Chuttur M.Y. (2009). "Overview of the Technology Acceptance Model: Origins, Developments and Future Directions", Indiana University, USA.

[2] Davis, F.D. (1989). "Perceived usefulness, perceived ease of use, and user acceptance of information technology". MIS Quarterly, 13 (3).

[3] Davis, F.D. (1993). "User acceptance of information technology: system characteristics, user perceptions and behavioural impacts". International Journal of Man-Machine Studies 38.

[4] Davis, F.D. and Venkatesh, V. (2004). "Toward Preprototype User Acceptance Testing of New Information Systems: Implications for Software Project Management". IEEE Transactions on Engineering Management, 51 (1).

[5] Davis F.D., Bagozzi, R.P. and Warshaw, P.R. (1989). "User Acceptance of Computer Technology. A Comparison of Two Theoretical Models". Management Science, 35 (8).

[6] G.S. Hubona and A. Burton-Jones, (2006), The mediation of external constructs in the technology acceptance model, Information & Management 43 (6) (2006), pp. 706–717.

[7] S. Khushman, A. Todman, S. Amin (2009). "The Relationship between Culture and E-business Acceptance in Arab Countries," DeSE2009, pp.454-459, IEEE Computer Society, The Second International Conference on Developments in eSystems Engineering, Abu Dhabi.

[8] Venkatesh, V. and Davis, F.D. (2000). "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies". Management Science, 46 (2).

[9] Dawes, John (2008). "Do Data Characteristics Change According to the number of scale points used? An experiment using 5-point, 7-point and 10-point scales". International Journal of Market Research 50 (1): pp. 61–77.

[10] Gefen, D. and Straub, D. (1997), Gender Differences in the Perception and Use of e-mail: An extension of the Technology Acceptance Model. MIS Quarterly, Vol.21.No.4, pp. 389-400.

[11] Gefen, D., Karahanna, E. and Straub, D. W., (2003), Trust and TAM in Online Shopping: An Integrated Model, MIS Quarterly, Vol.27 No.1, pp. 51-90.

[12] Hofstede, G (1980), "Culture's Consequences; International Differences in work related values", Sage, Beverly Hills.

[13] Hofstede, G. (2001), Culture's Consequences: Comparing Values, Behaviours, Institutions and Organizations across Nations, 2nd Ed., Sage Publication, Thousand Oaks, CA.

[14] Kong, W.C., Hung, Y.T. (2006), "Modeling Initial and Repeat Online Trust in B2C E Commerce", Proceedings of the 39th Hawaii International Conference on System Sciences, Big Island, HI .

[15] Laroche M., Bergeron J. and Goutaland C. (2001), A Three-Dimensional Scale of the Intangibility, Journal of Service Research, Vol.4, No.1, pp. 26-38.

[16] Schumacker, R. E. and Lomax R. G. (2004) A Beginner's Guide To Structural Equation Modeling. 2nd Ed, New Jersey: Lawrence Erlbaum.

[17] Venkatesh, V. and Davis F. D. (2000). "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies", Management Science, Vol. 46. No. 2, pp. 186-204.

[18] Venkatesh, V. and Morris, M. G. (2000) "Why Don't Men Ever Stop to Ask for Directions? Gender, Social Influence, and Their Role in Technology Acceptance and Usage Behavior," MIS Quarterly Vol. 24.No.1, pp. 115-139.

[19] Venkatesh, V., and Morris, M.G., Davis, G., and Davis, F. (2003) User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly, pp. 425-478.

[20] Pallant, J. (2007). SPSS Survival Manual. A step by step guide to data analysis using SPSS for Windows third edition. Maidenhead, Berkshire: Open University Press.

[21] Glasgow, R. E. (2007). eHealth evaluation and dissemination research. Am J Prev Med, 32(5 Suppl), S119-126.

[22] Hossain, L. and DE Silva, A. (2009) Exploring user acceptance of technology using social networks. Journal of High Technology Management Research 20(1), 1.

[23] Pan American Health Organization (1999), Setting up Healthcare Services Information Systems: A Guide for Requirement Analysis, Application Specification, and Procurement. Essential Drugs and Technology Program, Division of Health Systems and Services Development, PAHO/WHO, Washington, DC.

[24] Oh, H., Rizo, C., Enkin, M., Jadad, A. (2005), "What is e-health? A systematic review of published definitions", Journal of Medical Internet Research, (published online February 24, 2005), Vol. 24.

[25] Park, N., Lee, K. M., & Cheong, P. H. (2007). User acceptance of e-learning in higher education: An application of the technology acceptance model. Journal of Computer-Mediated Communication, 13 (1), article 9.

[26] Peker, C. (2010) An Analysis of The Main Critical Factors that affect the acceptance of Technology In Hospital Management systems, The Middle East Technical University.

[27] Hair, JF, Bush, RP and Ortinau, DJ, (2003) Marketing Research: Within A Changing Information Environment, 2nd Ed. McGraw-Hill/ Irwin, New York.

[28] Corder, G.W., Foreman, D.I. (2009).Nonparametric Statistics for Non-Statisticians: A Step-by-Step Approach Wiley.

[29] Gliem, J. and Gliem, R. (2003). Calculating, Interpreting, and Reporting Cronbach's Alpha Reliability Coefficient for Likert-Type Scales. In 2003 Midwest Research to Practice Conference in Adult, Continuing and Community Education. Columbus, OH.

N = 50		I2U	eH	PEU	PU	SN	Tang	Trust	UA	MascuL	PD	skills
I2U	Pearson Correlation	1	.275*	.438**	.420**	.240*	.407**	.403**	-.320*	-.108	-.055	.429**
	Sig. (1-tailed)		**.027**	**.001**	**.001**	**.046**	**.002**	**.002**	**.012**	.227	.351	**.001**
eH	Pearson Correlation	*	1	.026	.189	.149	.282*	.451**	.164	.260*	.064	-.183
	Sig. (1-tailed)			.429	.095	.151	**.024**	**.001**	.127	**.034**	.329	.102
PEU	Pearson Correlation			1	.272*	-.240*	.479**	.143	.057	-.292*	-.070	.430**
	Sig. (1-tailed)				**.028**	**.047**	**.000**	.160	.347	**.020**	.315	**.001**
PU	Pearson Correlation				1	.275*	.100	.342**	-.253*	.191	.314*	.207
	Sig. (1-tailed)					**.027**	.245	**.008**	**.038**	.092	**.013**	.074
SN	Pearson Correlation					1	-.041	.202	.062	.486**	.212	.084
	Sig. (1-tailed)						.389	.080	.334	**.000**	.069	.280
Tang	Pearson Correlation						1	.312*	-.006	-.180	-.125	.236*
	Sig. (1-tailed)							**.014**	.484	.106	.194	**.049**
Trust	Pearson Correlation							1	.238*	.287*	.218	.001
	Sig. (1-tailed)								**.048**	**.022**	.064	.498
UA	Pearson Correlation								1	.279*	.150	-.008
	Sig. (1-tailed)									**.025**	.150	.479
MascuL	Pearson Correlation									1	.662**	-.127
	Sig. (1-tailed)										**.000**	.189
PD	Pearson Correlation										1	.031
	Sig. (1-tailed)											.415
skills	Pearson Correlation											1
***. Correlation is significant at the 0.05 level (1-tailed).**												
****. Correlation is significant at the 0.01 level (1-tailed).**												

Table 3: Pearson Correlations significance matrix