

Environmental & Green IT Practices' Awareness Role on Driving Users Towards Adopting SaaS Cloud Computing Services: A Malaysian University Context

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Abstract—The technology has brought innovative ideas into practice. However, negative aspects emerged that triggered research on environment-friendly technology. Consequently, SaaS Cloud Computing (SaaS CC) emerged to meet these expectations. However, the connectedness between Green IT and SaaS CC has been overlooked in the academia. Therefore, this gap is further investigated and empirically tested. Also, the objective is to highlight the connectedness between two concepts and examine the role of Environmental Concern (EC) and Perceived Environmental Responsibility (PER) jointly with the Level of Awareness (LA) that respondents possess to drive users' attention to adopt SaaS CC. Results revealed appropriateness of the model and hoped to open a new area of research.

Index Terms—Green IT; SaaS Cloud Computing; Awareness; Adoption.

I. INTRODUCTION

Technology surprises us with innovations every day that facilitates our life and increases productivity, revenue, and performance. Nevertheless, it has side effects that veil in silence [1]. The issues of global warming, CO₂ emission, toxic materials, E-waste, and energy crisis are some negative aspects of technology advancement [1] that increased to a warning level. Moreover, ICT is responsible for almost 2% (i.e., 0.86 metric Gigatons) of the global carbon emission [1], [2]. Green technology, therefore, became a crucial element to solve these escalating issues. Further, Cloud Computing with its core technology of virtualisation brought efficiency to IT equipment [3] and appeared to be among the solutions to overcome the negative aspects of technology. Green IT research still have a scarcity of empirical studies that warrants further investigation [4], [5] and has not been investigated thoroughly at the micro-level. Likewise, Cloud Computing is still in the infancy that needs further exploration [6]. Hence, this study attempts to shed more light on the connectedness between SaaS CC and Green IT practices from the perception of the individuals at the University level at Malaysian context. Besides, this study aims to investigate the influential factors on adopting SaaS CC and pays special attention to the effect of Green IT & User Environmental Predisposition (GIT) on the Level of Awareness (LA) that individuals possess to drive them to embrace SaaS Cloud Computing Technology as a means of Green IT practices. The following sections are organised as follows. Firstly, the literature review

gives an overview of Green IT and Cloud Computing concept; then the constructs of the model were delineated. After that, the methodology, findings and discussions were presented. Finally, the conclusion is addressed and highlights the main findings of the study.

II. LITERATURE REVIEW

A. Green IT and Cloud Computing

Technology is moving at a rapid pace that infiltrates every aspect of our daily errands. It has brought many benefits to our life. However, there are side effects that shed their shadows in nature and made harmful and hazardous effects on the human-life, the plants, water, and air as an outcome of this advancement. The global warming, CO₂ high emissions, climate change, and increased e-waste lead organisations, practitioners, researchers, and countries to look for solutions to these escalated issues. Therefore, Green IT has become the mantra in academia, business, and international conferences, with focus on the main aspects of reducing, reuse, and recycle [7].

Besides, the recent trend of manufacturers is to drive users to use Cloud services to make them be acquainted with this novel technology. This new paradigm shift to go for SaaS CC services make customers familiar with this novel technology and to practice it from any device, any place, and at any time in a way to Green their practices in using technology. SaaS Cloud Computing Services (or a Software as a Service) are the applications of the Cloud Computing (CC) infrastructure that the service provider offers to consumers [8] over the internet in which it has a variety of software packages that can be accessed based on the customer needs [9].

In sum, moving businesses processes, government transactions, and Universities academic activities to clouds can reduce carbon footprint emissions immensely up to 90 percent when using Cloud Services (i.e., Large corporations can save 30-60 percent and mid-size businesses 60-90 percent) [10]. Yet, there is a scarcity in conducting empirical studies to investigate the connectedness between SaaS Cloud Computing and Green IT in a single study in general and at Higher Education (HE) sector represented by Universities in specific. Hence, this article presents the study conducted to investigate the perception of using, accepting or adopting SaaS CC as a means toward Green IT. The conceptual framework is depicted in Figure 1 based on TPB by Ajzen [11].

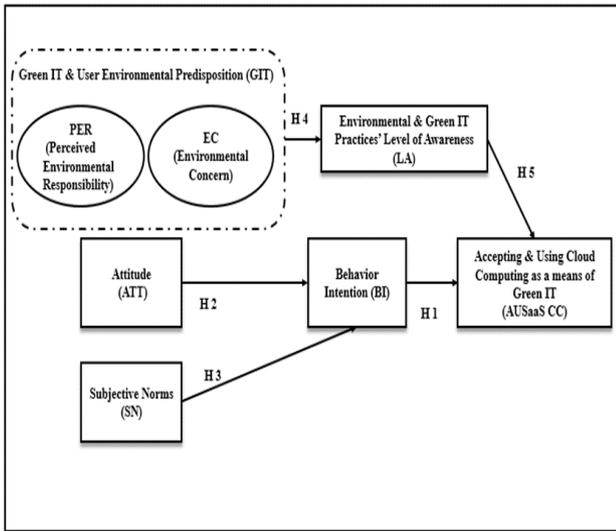


Figure 1: SaaS Cloud Computing Acceptance as a Means of Green IT (AUSaaS CC)

B. SaaS Cloud Computing Acceptance as a Means of Green IT (AUSaaS CC)

The adoption, usage, or acceptance is referred to as the implementation, usage, acceptance, utilisation, and actual behaviour or use [12]. Usage, acceptance or adoption behaviour toward technology is defined as the process that has many phases and need to extend over time and under the individual's will to perform/not to perform it [13]. Consequently, the usage, acceptance, or adoption of SaaS CC services as a means of Green IT (AUSaaS) by individuals is defined as a process with many phases that extends over time and under individual's will to use or not SaaS CC services. It is noteworthy that adoption is found in literature as an outcome of BI and is supported theoretically by Decomposed Theory of Planned Behavior (DTPB) by Taylor & Todd [14], Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, Morris, Davis & Davis [15], TPB by Ajzen [11] among others, and empirically in using and adopting technologies in different contexts [16].

C. Behaviour Intention (BI)

Behaviour intention was found to be the primary driver of actual behaviour or adoption process. The way that people react to any task can be referred as the behaviour intention [17]. Many theories and studies supported the role of BI on the actual behaviour or acceptance of technology, such as The Theory of Reasoned Action (TRA) by Fishbein and Ajzen [18], TPB by Ajzen [11], and DTPB by Taylor and Todd [14]. Hence, the following hypothesis is postulated:

H1. Behaviour intention has a direct and significant relationship with the adoption of SaaS CC services as a means toward Green IT.

D. Attitude (ATT)

Attitude (ATT) is defined as “the degree to which a person has a favourable or unfavourable evaluation of the behaviour in question.” [19, p. 454]. Lining with the above definitions, and in the context of the study, ATT is defined as the degree of favorability or unfavorability felt by the individual in Higher Education (HE) in relation to the adoption, acceptance, or usage of SaaS CC as a means of Green IT. In the context of SaaS CC online services, the 24-hour access to applications, storage, and variety of SaaS CC services

regardless of location, time, or device, make it advantageous when compared with other conventional methods such as: using computers at office hours inside the University, accessing data using USB drives, or the use of limited sharing capabilities at premises. Therefore, these tangible benefits of SaaS services presumed to affect ATT of an individual and, thus, influence his/her intention to perform the behaviour in question. Following this, a hypothesis is considered:

H2. Attitude has an empirically significant relationship with BI in using SaaS CC as a facility towards Green IT.

E. Subjective Norms

Subjective norms (SN) gained a special attention in the academia. It is defined as “the perception that the significant referent desire the individual to perform a behaviour or not” [14, p. 149]. In the context of this study, SN is defined as the extent in which the SaaS CC services' users expect, desire, and urge others to use/accept or not to SaaS CC services as a means of Green IT, combined with the motivation that those others would comply with them. Hence, the following hypothesis is presumed:

H3. Subjective norms have an empirically significant relationship with BI to accept, adapt, or use SaaS CC as a means towards Green IT.

F. Green IT & User Environmental Predisposition (GIT) & its Dimensions

Green IT (GIT) has become an important topic in recent decades to overcome side effects of technology. It aims to increase benefits such as: reduce cost, increase sustainability, and better usage of IT devices. A recent definition is prescribed by [20, p. 1733] as, “any device, tool (software or hardware), or practices using information technology as a basic element of its components that produce usefulness and is not harmful to the environment for the sake to facilitate life and conserve natural resources”. Therefore, SaaS CC services, as a crucial component of Cloud service model, is considered as a means of Green IT that can not only increase revenue but also has less impact on nature that Green IT is aiming to [21]. Thus, the study suggests including two-second order latent constructs of Green IT & User Environmental Predisposition (GIT) (i.e., composed of User Environmental Concern (EC) and Perceived Environmental Responsibility (PER)). The following sections delineate these two dimensions.

G. User Environmental Concern (EC)

The User Environmental Concern (EC) is the type of concern that one has on the environment. It is, “the extent to which the individual believes that s/he is part of nature” [22, p. 1]. Based on this definition, the environmental concern can be regarded as the degree of emotional involvement in environmental issues that will lead to an effective response of adopting or using SaaS CC services as a means towards Green IT and eventually leading to a sense of connectedness with nature and protection of the environment. This implies that when the environmental concern is perceived, the level of awareness increases and a positive feeling is created that in turn motivates the person to act positively towards the environment. Based on the above, the study suggests adding EC as a dimension of GIT.

H. Perceived Environmental Responsibilities (PER)

Based on the theory of efficacy expectation, Perceived

Environmental Responsibilities (PER) is defined as the prediction of, "People's process, weigh and integrate several different sources of information with regard to their abilities and the outcomes of a behavior, and then use this information to guide their behavior and efforts" [23, p. 582]. For the purpose of this research, PER is defined as the prediction of people's process, weigh and integrate different sources of information (i.e., of the harmful effects of technology) according to their abilities and the outcome of their behavior, and then this perceived information influences their awareness to drive their positive behavior to adopt/use SaaS CC services as a means toward Green IT to protect the environment. Based on the above, the study postulates the inclusion of REP as a dimension of GIT construct to investigate the perception of individuals on the adoption of SaaS CC through the level of awareness that they possess (LA). Thus, the hypothesis is postulated:

H4. Green IT & User Environmental Predisposition (GIT) is expected to be a significant driver towards the use, acceptance, or adoption of SaaS CC as a means of Green IT through LA that individuals possess.

I. Environmental & Green IT Practices' Level of Awareness (LA)

Awareness has different definitions in different contexts in literature. In the context of this research, level of awareness (LA) is defined as the degree of the perception of the environmental issues within a volume of time and space, the comprehension of its effect on nature, and the understanding of the effects that would deteriorate nature. The awareness then eventually will lead to act positively toward adopting or using SaaS CC services as a means of Green IT to improve the quality of the environment. Ismail [24] in his research in Malaysia, affirms the importance of environmental awareness in changing ATT and behaviour of people to maintain a good quality of the environment. Based on the above, LA is added to the model as a driver towards AUSaaS CC; hence, the hypothesis is postulated:

H5. User Environmental & Green IT practices Level of Awareness (LA) has a significant impact on AUSaaS CC facility towards Green IT.

III. METHODOLOGY

The respondents of the study are students and lecturers at public Universities in Northern Malaysia. Based on the total number of the populations obtained, a minimum sample size of 384 chosen based on Cohen's statistical table [24]. The total distributed number of questionnaires exceeded the 384 using the self-administered technique. Items were adapted from previous literature, with four items for each construct & acceptable reliability with a total number of 20 items. They were anchored with five-point Likert scale [25]. After initial screening and outliers' elimination, the valid responses were 507 from different University levels, different races, and age. Smart PLS 3 software was used as a main analytical tool.

IV. FINDINGS AND DISCUSSIONS

A. Respondents' Profile

The valid number of responses of the current study is 507, showing a majority of females (65.9%) over males (33.9%). About half of the respondents are having a bachelor's degree (57%), followed by Master degree (16.4%), the PhD (22.9%),

and finally Diploma (2.2%). The age is categorized into five groups, (18-26) has a percentage of (61.5%), followed by (27-35) with (10.3%), then (36-44) with percentage of (18.3%), next (45-53) achieved (5.9%), and finally (age above 53) with percentage of (3.9%).

B. Structural Model

The first step is to check the collinearity for the structural model, to examine that no issues related to it, for the exogenous constructs on the endogenous constructs [26]. The second step is to investigate the strength and significance of the relationships. As shown in Table 1, the results reveal that ATT exert a significant and positive relationship with BI and provides empirical evidence of their crucial importance towards BI. While inspecting the 95% Confidence Interval (CI), the results speak in favour of the significant relationship between ATT and SN, from one side, and BI, from the other side; thus, H2 & H3 are supported. This gives an additional value of both constructs in the area of Cloud Computing and Green IT in Malaysian and Higher Education context. Besides, both constructs explained 56% (R²) of BI variance. Next, the effect size f^2 of ATT and SN on BI revealed that ATT has a larger effect size ($f^2 = 0.86$), while SN has a smaller effect size (0.03) on BI. This lends further support for the above results. Besides, GIT ($\beta = 0.51$, $t = 10.85$, $P < 0.00$, CI does not include zero in its range) has a positive and significant relationship with LA; thereby, hypothesis H4 is supported. GIT, also, explains 26% (R²) of the variance of LA, which gives support of our explorative study. Moreover, the effect size f^2 of GIT is large ($f^2 = 0.35$) on LA, which confirms hypothesis H4 and gives further support of the researchers' postulation in combining EC and PER in one composite construct of GIT. More importantly, the high correlation between EC with LA ($\beta = 0.90$) and PER with LA ($\beta = 0.91$) combined with high reliability of both constructs (squaring β values of both constructs yields a value > 0.7) implies that GIT is correctly postulated and empirically proven to form two LOCs (Low Order Constructs) as its dimensions [27]. Also, the results imply that the correlation between GIT and LA is large and suggests that the perceived environmental concern of the respondents and their perceived responsibility toward accepting or adopting a friendly technology, such as SaaS CC, is reflected on the high level of awareness of respondents. Consequently, the high LA influence the users of SaaS CC services to use or embrace Greener practices by using SaaS CC services and applications. The testing of hypothesis H1 & H5 show that BI ($\beta = 0.53$, $t = 11.47$, $P < 0.00$, CI does not include zero) and LA ($\beta = 0.18$, $t = 4.89$, $P < 0.00$, CI does not include zero) have significant and positive relationship with AUSaaS, whereby the two hypotheses are supported.

Based on Table 1, BI shows a strong influence AUSaaS CC. In addition, LA found to be appropriately correlated with AUSaaS. This result is not surprising as the individual at HE sector is having an awareness of the negative consequences of technology on nature, and this creates a motivation to drive his/her attention to look for Green technologies that meet the expectations of performance and safeguard the environment. Furthermore, both constructs (LA and BI) explain 38% of the variance of AUSaaS CC, in which this value is considered moderate according to Chin [28]. Also, the effect size f^2 of BI ($f^2 = 0.40$) and LA (0.05) on AUSaaS CC give more support of the appropriateness of the constructs on the model postulated, and that BI is an essential factor.

Table 1
Path Coefficients Significance of the Relationships

Path	Path Coefficients	t Statistics	p Values	Confidence Interval at 2.50%	Confidence Interval at 97.50%
ATT -> BI	0.68	23.07	0.00	0.63	0.74
SN -> BI	0.12	3.41	0.00	0.05	0.19
BI -> AUSaaS	0.53	11.47	0.00	0.43	0.61
GIT -> LA	0.51	10.85	0.00	0.42	0.60
LA -> AUSaaS	0.18	4.89	0.00	0.11	0.26
GIT -> EC	0.90	93.09	0.00	0.88	0.92
GIT -> PER	0.91	87.84	0.00	0.88	0.93

V. CONCLUSION

Cloud Computing and Green IT are two nascent research areas that have captured the attention of researchers recently. However, the research focused on the business side and not the individual side, who is the end user of the technology and affected by its side effects. This study contributes to the knowledge and literature by combining the two concepts in a single study and provides empirical support of the role of EC & PER on the respondent's LA to embrace SaaS CC as a Green practice. Besides, the results revealed that LA is an appropriate influencer of the adoption process of SaaS CC. Additionally, GIT proved to be a strong driver of LA. However, limitation resides on, not including private universities or analysis of heterogeneity among respondents so generalisation of the applicability of the model at Malaysian HE sector is not fulfilled. Further, the model can be tested in different contexts with different groups to give more insight into the adoption process of SaaS CC with regard to Green IT concept. Lastly, constructs of GIT and LA can be added to different models in various contexts to study its applicability/suitability in studying human behaviour towards innovative technology such as SaaS Cloud Computing.

REFERENCES

- [1] T. B. Ahmad, A. Bello, and M. S. Nordin, "Exploring Malaysian university students' awareness of green computing," *GSTF Int J Educ*, vol. 1, no. 2, pp. 1–9, Nov. 2013.
- [2] R. Bose and X. Luo, "Integrative framework for assessing firms' potential to undertake Green IT initiatives via virtualisation – A theoretical perspective," *J Strateg Inf Syst*, vol. 20, no. 1, pp. 38–54, Mar. 2011.
- [3] D. Durkee, "Why cloud computing will never be free?," *Commun ACM*, vol. 53, no. 5, p. 62, May 2010.
- [4] R. E. Abdul Rahim and A. Abdul Rahman, "Green IT capability and sustainable development," in *Proc. first Int. Conf. Green Comput. Technol. Innov. (ICGCTI 2013)*, 2013, pp. 80–88.
- [5] B. T. Tushi, D. Sedera, and J. Recker, "Green IT segment analysis: An academic literature review," in *Proc. 20th Am. Conf. Inf. Syst. (AMCIS 2014)*, 2014, pp. 1–15.
- [6] A. Saedi and N. A. Iahad, "Developing an instrument for cloud computing adoption by small and medium-sized enterprises," in *Proc. 2013 Int. Conf. Res. Innov. Inf. Syst. (ICRIIS)*, 2013, pp. 481–486.
- [7] T. Velte, A. Velte, and R. C. Elsenpeter, *Green IT: Reduce your information system's environmental impact while adding to the bottom line*. New York, NY: McGraw-Hill, Inc., 2009.
- [8] P. Mell and T. Grance, "The NIST definition of cloud computing. Recommendations of the National Institute of Standards and Technology," vol. 145, p. 7, 2011.
- [9] S. G. Lee, S. H. Chae, and K. M. Cho, "Drivers and inhibitors of SaaS adoption in Korea," *Int J Inf Manage*, vol. 33, no. 3, pp. 429–440, 2013.
- [10] S. Kumar and R. Buyya, "Green cloud computing and environmental sustainability," in *Harnessing green IT*, S. Murugesan and G. R. Gangadharan, Eds. Chichester, UK: John Wiley & Sons, Ltd, 2012, pp. 315–339.
- [11] I. Ajzen, "The Theory of Planned Behavior," *Organ Behav Hum Decis Process*, vol. 50, pp. 179–211, 1991.
- [12] Ibrahim M. Al-Jabri and M. S. Sohail, "Mobile banking adoption: Application of diffusion of innovation theory," *J Electron Commer Res*, vol. 13, no. 4, pp. 379–391, 2012.
- [13] E. M. Rogers, *Diffusion of Innovations*, 3rd ed. New York, NY: Free Press A division of Macmillan Publishing Co., Inc, 1983.
- [14] S. Taylor and P. A. Todd, "Understanding information technology usage: A test of competing models," *Inf Syst Res*, vol. 6, no. 2, pp. 144–176, Jun. 1995.
- [15] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User acceptance of information technology: Toward a unified view," *MIS Q*, vol. 27, no. 3, pp. 425–478, 2003.
- [16] P. Pinheiro, M. Aparicio, and C. Costa, "Adoption of cloud computing systems," in *Proc. Int. Conf. Inf. Syst. Des. Commun. (ISDOC '14)*, 2014, pp. 127–131.
- [17] A. Al Shikhy, Z. M. Makhbul, K. A. M. Ali, and A. A. Mazari, "Modeling the impact of resistance to change within the context of human resources information systems adoption. 1–5," in the *11th Asian Academy of Management International Conference on Embracing Innovation and Creativity: Towards Sustainability and Inclusive Growth*, 2014, pp. 1–5.
- [18] M. Fishbein and I. Ajzen, *Belief, attitude, intention and behavior: An introduction to theory of research*. Reading, MA: Addison-Wesley, 1975.
- [19] I. Ajzen and T. J. Madden, "Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control," *J Exp Soc Psychol*, vol. 22, no. 5, pp. 453–474, 1986.
- [20] T. H. G. Al-Madhagy, S. A. M. Yusof, K. F. Hashim, and W. Alaswadi, "Exploring the underlying factors of individual's perception and behaviour towards Green IT in Malaysia," *Adv Sci Lett*, vol. 21, no. 16, pp. 1729–1733, 2015.
- [21] A. Molla and A. Abareshi, "Green IT adoption: A motivational perspective," in *Proc. Pacific Asia Conf. Inf. Syst. (PACIS 2011)*, 2011, pp. 1–14.
- [22] P. W. Schultz, C. Shriver, J. J. Tabanico, and A. M. Khazian, "Implicit connections with nature," *J Env. Psychol*, vol. 24, no. 1, pp. 31–42, Mar. 2004.
- [23] K. Lee, "Opportunities for green marketing: Young consumers," *Mark Intell Plan*, vol. 26, no. 6, pp. 573–586, Sep. 2008.
- [24] M. H. S. Ismail, "Intention to use green products among consumers," Unpublished Master's thesis, Universiti Utara Malaysia, Kedah, Malaysia, 2014.
- [25] R. A. Likert, "A technique for the measurement of attitudes," vol. 140, pp. 4–53.
- [26] M. Sarstedt, C. M. Ringle, D. Smith, R. Reams, and J. F. Hair, "Partial least squares structural equation modeling (PLS-SEM): A useful tool for family business researchers," *J Fam Bus Strateg*, vol. 5, no. 1, pp. 105–115, 2014.
- [27] J. F. Hair, G. T. M. Hult, C. M. Ringle, and M. Sarstedt, *A primer on partial least squares structural equation modeling (PLS-SEM)*. London, England: SAGE Publications, Inc., 2014.
- [28] W. W. Chin, "The Partial Least Squares Approach to Structural Equation Modeling," in *Mod. methods Bus. Res.*, G. A. Marcoulides, Ed. New Jersey, NJ: Lawrence Erlbaum Associates, 1998, pp. 295–336.