Acceptance of RFID Toll Payment Method by Highway Users in Malaysia

Tan Owee Kowang[1*], Vilasini Thevasekamanai[2], Ong Choon Hee[3], Goh Chin Fei[4], Mohd Saiful Izwaan Saadon[5]

Abstract

Radio frequency identification (RFID) is a wireless tracking technology for data identification, capturing and analysis. It is used in numerous business applications to overcome the drawback of collecting data manually, such as data errors, time delay and high labour cost. RFID was introduced as an alternate toll charge payment method in Malaysia highways in 2018, and the government of Malaysia aims for a full implementation by end 2023. However, up to January 2022, only 10% of highway users switched to RFID. Hence, this study aims to assess highway users' intention level on using RFID as toll payment mode. Additionally, the study also aims to evaluate the causal relationship between users' perception on RFID payment mode and users' intention to use RFID. The study views users' perception based on modified TAM theory, which consist of perceived ease of use, perceived usefulness, perceived culture's influence and perceived privacy and security. The study is quantitative based, structured questionnaire adopted from prior studies was distributed to the targeted population, which is class 1 highway users, and 176 responded. Data collected is normally distributed and statistically reliable. Hence, data was processed further with descriptive analysis and Pearson correlation test to address the research objectives. Finding from the research reveals that users' intention to migrate to RFID payment mode is low, which suggested additional effort is required for the full implementation of RFID by end 2023. Additionally. Result of correlation test discloses that users' perception on the ease of use and the usefulness are significantly associated with the intention to use RFID. However, the correlation of perceived culture's influence, privacy and security with intention is weak and insignificant. The finding implies that highway operator should focus on addressing users' anxieties and hesitation of using RFID in order to encourage more users to migrate to RFID. Additionally, the study also contributes to the domain new technology acceptance by the introduction of users' acceptance model for RFID based on modified TAM theory.

Key Words: Acceptance of RFID, Perceived Convenience, Culture's Influence, Prevention of Privacy Risk, Technology Acceptance Model.

DOI Number: 10.14704/nq.2022.20.1.NQ22296 **NeuroQuantology 2022; 20(1):291-298**

Introduction

Creating a sustainable competitive advantage is important to business success. Hence, business need to continuously improve their business system's performances such as the speed and accuracy of data identification, capturing and analysis. Besides focus on people and procedure, leveraging technology for business system enhancement is one of the viable approaches for competitive advantage (Lee and Yoo, 2019). Within the domain of business data capturing and analysis, Automated Identification and Data Capture (AIDC) technology is the most common technology used to overcome the drawback that associated with the manual data collection method, such as data errors, time delay and high labor cost (Nysveen and Pedersen, 2016).

Corresponding author: Tan Owee Kowang
Address: [1*,2,3,4]Azman Hashim International Business School, Universiti Teknologi Malaysia, Johor Bahru, Johor, Malaysia; [5]Faculty of Maritime Studies, Universiti Malaysia Terengganu, Terengganu, Malaysia.
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 20 December 2021 **Accepted:** 10 January 2022

AIDC technology makes data identification, capturing and analysis process easier, convenience, speediness, improve data accessibility and accuracy. One of the examples of AIDC technology is Radio Frequency Identification (RFID). RFID technology is applied in many consumer applications by global enterprises to identify and track goods, objects or people via an automated passive process that uses RFID tag (Hossain and Quaddus, 2011).

RFID is a wireless tracking technology that allows a data reader to activate a transponder attached to or embedded in a radio frequency tag (RFID tag), and allow the reader to remotely read and/or write data to the RFID tag. (Li et al., 2010). RFID was first introduced on Malaysia highways in 2018 as an alternative toll payment method to the old payment system that used infrared (IR) technology. One of the limitations of IR technology's is short transmission range, hence highway users need to stop their vehicles at the toll booth for payment. To speed up the traffic flow, the highway concessionary (or the build-operate-transfer operator company) had decided to gradually replace IR technology with RFID along one of the main highways in Malaysia, namely North-South Highway (PLUS). On January 2022, the highway concessionary announced that with effect from 15th January, RFID would be made available as the main payment method in all toll station along PLUS highway. The government of Malaysia targets 60% RFID usage by end 2022, and 100% by end 2023. However, following the introduction of RFID on the 15th of January 2022, it was reported that only 10% of highway users migrated to RFID (NST, 2022). Users resistance to technological change is one of the main reasons of failure for any new technology (Shalini, 2020). Hence, the purpose of the study is to assess highway users' intention level on using RFID as toll payment mode. Additionally, the study also aims to evaluate the causal relationship between users' perception on RFID payment mode and users' intention to use RFID based on a modified Technology Acceptance Model (TAM). As such, the study aims to achieve two objectives (RO)

RO1: To assess the intention level to used RFID toll payment mode that perceived by highway users in Malaysia.

RO2: To evaluate the causal relationship between users' perception on RFID payment mode (i.e. perceived ease of use, perceived usefulness, perceived culture's influence and perceived privacy and security) and users' intention to use RFID

Literature Review

1. Radio Frequency Identification (RFID)

RFID serves as a fundamental technology for automated data identification and data capturing system, it provides greater visibility on data analysis and management, hence, it has been applied widely in the modern businesses system of inventory and logistics management, manufacturing, supply chain, transportation, healthcare and retail store to streamline business operations (Ramanathan, Ramanathan & Ko, 2016). In this globalization era, RFID is successfully being implemented across a variety of fields and the application is rapidly expanding (Tesoriero et al., 2008). Hence, RFID is one of the greatest opportunities in information technology that will change the world broadly and intensely (Jia et al., 2012). RFID systems consist of three main components: RFID tags, reader and application system as shown in Figure 1.

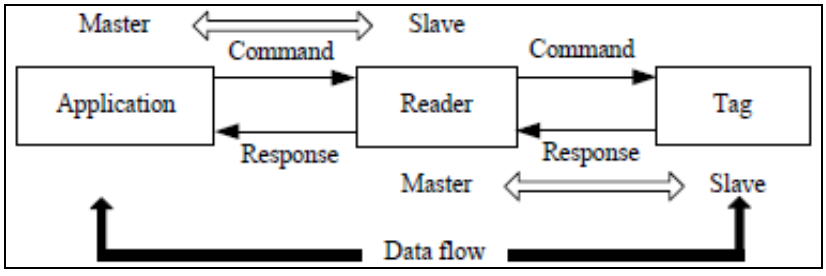

Figure 1. The components of a RFID system (Adapted from Jia et. al., 2012)

RFID tag is a transponder (transmitter/responder) that connects to the objects for automatic identification. RFID tag contains coiled antenna and microchip mainly to store and retrieve data (Jia et al., 2012). While RFID reader is recognized as transceiver (transmitter/receiver) that consists of a radio frequency interface (RFI) module and control unit. It mainly serves the purpose of activating the

tags, constructing the communication arrangement with the tags and transferring data between the application software and tags (Jia et al., 2012). Meantime, applications is a data processing system that entails with application or database relating on the application function. All the activities of RFID readers and tags will be originated from the application software. RFID serves a rapid, flexible and consistent techniques to detect, track and manage various objects in a wink of an eye (Jia et al., 2012). RFID system facilitates automatic data management, it automatically perform the processes of data identification, capturing, analysis, monitoring, validation and alerting through the data exchange between RFID tag and reader. Hence. RFID system is also viewed by prior scholars as an enterprise application system for data processing to improve the efficiency of business activities (Ramanathan, Ramanathan & Ko, 2014).

2. RFID Toll Payment Mode

Most of the highways in Malaysia are built under privatization or public-private partnership (PPP) concept, whereby a contractual agreement between the government and private firm, namely a toll concession is contracted for the private firm or the toll concessionaire to design, build, finance, operate and maintain the highway. Within the concession period, tolls will be charged to the highway users as the funding source of highway development and maintenance cost.

RFID was first introduced on Malaysia highways in 2018 as an alternative toll payment method to the current infrared (IR) based payment system. Due to the short transmission range of IR based payment system, users need to stop their vehicles at the toll booth for payment which caused traffic congestion at toll station especially during peak hour. As such, RFID based payment method is introduced by the highway concessionaire in order to speed up the traffic flow at toll station. Highway users who intend to switch to RFID payment method are required to purchase a RFID tag from RFID fitment centers or purchase online. To activate the RFID tag, users are required to installed an online payment application, namely eWallet and link the RFID tag to the eWallet application. RFID tag that is activated need to be stick or placed on the vehicle's windscreen or headlamp, when a vehicle is approaching the RFID toll booth, RFID reader that installed at the toll both will transmit a payment enquiry signal to the RFID tag. Subsequently, toll charge will be debited from the eWallet via the RFID tag with a return signa send to the RFID reader. This process is done without stopping the vehicle. However, the available credit amount in eWallet must be sufficient in order to complete the payment process.

3. Technology Acceptance Model (TAM) and Research Framework

Technology acceptance model (TAM) is one of the common theoretical foundation used to study consumer's acceptance of new technology (Hamed, 2018). TAM speculates that perceived usefulness and perceived ease of use decide the user's intention to use the new technology (Hossain and Quaddus, 2011) (refer to Figure 2). The basic assumption of the TAM is the "actual use" of a new technology depends on the "intention" to exploit the technology. Additionally, the "intention" depends on individual "attitudes" toward the new technology, and its perceived usefulness and perceived ease of use (Shalini, 2020). TAM is chosen as the research model in this study because it is a robust model of technology acceptance behaviors in wide variety of new information systems or technology usages (Lee, 2009).

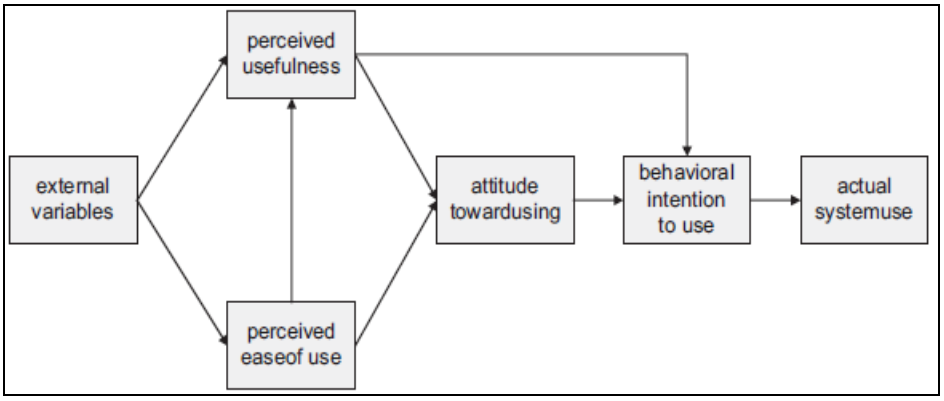

Figure 2. Technology Acceptance Model

According Hamed (2018), perceived usefulness is described as the extent which an individual believes that his or her job performance could be enhanced by using the new technology, and perceived ease of use is described as the extent to which an individual believes that using a particular system could be free of effort. Based on TAM, Users' perceived usefulness and perceived ease of use of a new technology have impact on the users attitude toward using the new technology, which in turn affect the users' intention to use the new technology (Lee, 2009; Ramanathan, Ramanathan & Ko, 2016).

Hossain and Quaddus (2011) investigated the factors that affect consumer acceptance of RFID technology in general application based on TAM model. Finding from Hossain and Quaddus (2011) suggested the research on the acceptance of RFID should not confined within the perceived of usefulness and perceived ease of use. Instead, it should expand beyond TAM model to include the impacts or factors from the perspective of cultural, regulations, privacy and security as complementary to TAM model. Additionally, Hossain and Quaddus (2011) also recommended due the nature of RFID which is easy to use, both perceived usefulness and perceived ease of use should be combined as perceived convenience of use. As such, the RFID technology acceptance model proposed by Hossain and Quaddus (2011) consist of five factors, which are perceived convenience, culture's influence, privacy, regulations' influence and security.

The research framework for this study contextualizes TAM theory and the model proposal by Hossain and Quaddus (2011) into the context of intention to use RFID technology application as highway's toll payment method. As discussed in section 2.2, to switch to RFID payment mode, users need to purchase RFID tag online, install and link to the RFID tag to the eWallet application. The process involved is more complicated when compared with Hossain and Quaddus (2011)'s research, which was focusing on the general application of RFID technology. As such, this research views perceived ease of use and perceived of usefulness as two separated constructs, which is in line with TAM theory. Additionally, due to there is no specific law that covering the use of RFID payment method in Malaysia, the perceived regulations' influence construct that used in Hossain and Quaddus's model is excluded from the research framework. Furthermore, the perceived privacy and security are combined into one construct because both are close related. Hence, there are 4 independent variables used in this research, which are perceived ease of use, perceived usefulness, perceived culture's influence and perceived privacy & security as shown in Figure 3.

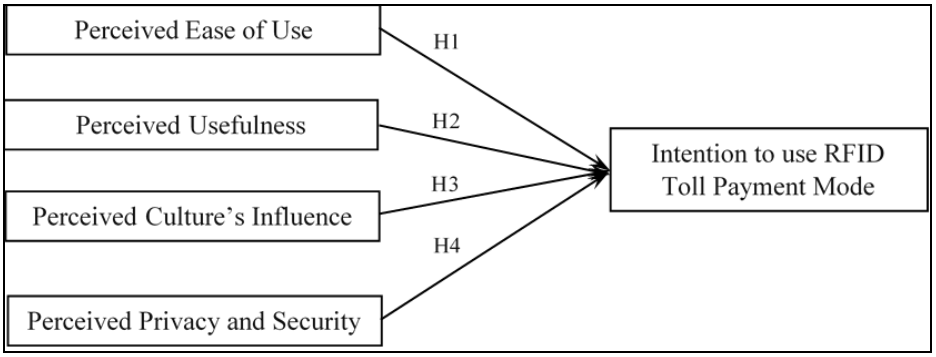

Figure 3. Research Framework

4. Hypotheses Development

- *Perceived Ease of Use and Intention to Use RFID*

The perceived ease of using RFID payment mode refers to the degree to which highway users believe that using RFID payment method is easy, effortless and hassle-free (Zailanie et al., 2015). One of the major causes of users' resistance toward new technology is users feel uncomfortable on learning a new way to adopt with the new technology (Shalini et. al., 2020). It would be worse if the technology appear more complicated and difficult to use. Finding from prior studies shared consensus that if an individual believe that the use of the new technology is easy to learn and convenient to use, the behavioral intention of the individual to adopt the new technology will be boosted. Hence, the it is hypothesized that

H1: Perceived ease of use is positively associated with the intention to use RFID toll payment among PLUS highway users.

- *Perceived Usefulness and Intention to use RFID*

Performance improvement involves change, however not every change will lead to improvement (Salleh, 2014). Changes seen by users that guarantee performance improvements will be more likely to be accepted by users (Jia et. al., 2012). Hence, the RFID users' perception on how the RFID technology improve their convenience on making toll payment is another construct that drive the behavioral intention of the users to use the RFID payment method. Zailani et. al. (2015) stated that people more likely prefer to use a technology if they perceive that the technology is convenient to use and make their life easier in enhancing their job performance and productivity better. Therefore, it is hypothesized that

H2: Perceived usefulness is positively associated with the intention to use RFID toll payment among PLUS highway users.

- *Perceived Culture's Influence*

Perceived culture's influence refers to the extent to which an individual view that the society's culture that influence the behavioral intention of the individual to use RFID payment method (Nysveen and Pedersen, 2016). Hossain and Quaddus (2011) and Jahner et al. (2008) defined society's culture as value, norm beliefs and behaviors that an individual learned from the society, which will affect how the individuals assess and intervene changes. Empirical review suggested that the influence of culture on the way an individual views new technology has significant impact on an individual's intention to use the technology. Hence, the it is hypothesized that

H3: Perceived culture's influence is positively associated with the intention to use RFID technology among PLUS highway users.

- *Perceived Privacy and Security*

Privacy refers to users' concern on the protection of their personal data associated with RFID tag and eWallet, while security relates to the security of performing toll charge payment transaction via eWallet. Research by Renata and Zeljko (2012) on online service reveals that privacy and security are the two main reasons that create users' suspicion and hesitate to use online service. Excellent security practice guarantee privacy protection (Salleh, 2014), both security and privacy are close related practices. Hence, factors that influence users' privacy and security concerns should not be viewed and studied separately. Jia et. al., (2012) argued that users might hesitate to use RFID technology due to their suspicions on the level of protection and security offered by the service. Hence, the it is hypothesized that

H4: Perceived privacy and security has a positive impact on the intention to use RFID technology among PLUS highway users.

Research Methodology

This research is quantitative based, the following sections summarize the research methodology adopted in this study.

1. Population and Sampling

The targeted population for this study is PLUS highway class 1 users. PLUS defined class 1 users as vehicles with 2 axles and 3 or 4 wheels excluding taxis. Class 1 users were selected as they are the main highway users and was the targeted group for RFID implementation. The total number of populations is unknow, therefore, sample size is derived based on the statistical analysis method used in this study. The four hypotheses of this study are tested via Pearson correlation test, to ensure that the analysis result meet the minimum correlation coefficient value of 0.2 (Mohamad and Nurakmal, 2016) with sufficient power at significant level of 0.05 (Mohamad and Nurakmal, 2016), the estimated sample size is 194. Respondents were selected randomly at one of the biggest PLUS Rest and Service (R&R) point, i.e. Pagoh R&R.

2. Research Instrument

The study used structured questionnaire as research instrument. The questionnaire assess users perceived level on the ease of use (5 items), usefulness (5 items), cultural influence (5 items), privacy & security influence (5 items) and the level of intention to use RFID (6 items). The measurement items are adopted from Hossain and Quaddus (2011), Lee (2008), Cazier et al. (2008) and modified to suit the research scope (i.e. RFID). Respondents were asked to assess to perceived level based on 5 points Likert scale, from (1) strongly disagree to (5) strongly agree.

3. Analysis Tool

Data normality is assessed via data's Skewness and Kurtosis value, with threshold value of +/-3 (Hair et al., 2015). Whereas data reliability is tested via Cronbach Alpha coefficient, with accepted level of minimum 0.7 (Hair et al., 2015), Additionally, descriptive analysis in term of mean score is used to address RO1, to assess the perceived intention level to used RFID toll payment mode. While Pearson correlation test is applied to test the four hypotheses of RO2, i.e. to assess the causal relationship that influence highway users' intention of using RFID. Correlation test is done at significant level of 0.05.

Analysis Results and Discussion

1. Normality and Reliability Test

The researcher approached 387 PLUS users at Pagoh R&R, 200 of them agreed to participate in the survey. However, 24 of the return questionnaires were incomplete or missing value, Data from the 176 usable questionnaires were processed with normality and reliability test. Skewness and Kurtosis value of the 176 data were ranged from -0.766 to +0.494, which is within the threshold of +/-3, hence, data collected is normally distributed. Additionally, reliability value for all the dependent and independent variables are all above 0.70, ranged from 0.786 to 0.902, which suggested data collected can be proceed to further analysis.

2. Addressing RO1

To address RO1, i.e. to assess the intention level of using RFID toll payment method that perceived by highway users in Malaysia. The means score of the perceived intention level is calculated with the average of 3.2173. Based on the interpretation method proposed by Lucero (2011), mean score between 2.5 to 3.5 represents a neutral agreement level, this suggested that respondents placed a neutral stand on the perception on the intention of using RFID toll payment method. This finding is in line with prior study (Nysveen and Pedersen, 2016) which reveals that the process of accepting a new innovation and technology involve observation, evaluation, and decision stages. At the beginning stage, consumers or users observes and review feedback by other users, and the finding from the observation stage influence they intention to try or use the new technology, i.e. the acceptance or rejection on the new technology. Hence, a neutral stand reflects low intention but yet to the stage of resistance (Nysveen and Pedersen, 2016).

Hence, the finding of respondents' neutral stand also suggests that perhaps highway users are yet to reach the decision of acceptance or rejection, hence highway concessionaire should view this as opportunity to influence the users' perception on the benefits of using RFID payment mode, which will subsequently promote users attitude toward using the new technology.

3. Addressing RO2

RO2 is to evaluate the causal relationship between users' perception on RFID payment mode (i.e. perceived ease of use, perceived usefulness, perceived culture's influence and perceived privacy and security) and users' intention to use RFID. To address RO2, Pearson correlation analysis is used to test the 4 hypotheses at significant level of 0.05. Additionally. The strength of correlation is interpreted based on method proposed by Evan (1996) by referring to the coefficient of correlation (r). The result of correlation test is summarized in Table 1.

Table 1. Result of Correlation Test

		Correlation with Intention to use RFID			Hypo Test Result
Hypo	**Users' Preceiption**	**Coefficient (r)**	**Strength***	**p-value**	
H1	Perceived Ease of Use	0.816	Very strong	0.000	Supported
H2	Perceived Usefulness	0.754	Strong	0.000	Supported
H3	Perceived Culture's Influence	0.238	Weak	0.067	Rejected
H4	Perceived Privacy & Security	0.297	Weak	0.054	Rejected

As refer to Table 1, the significant value (p-value) of H1 and H2 are below the threshold of 0.05, this suggested that hypothesis 1 and 2 are supported. While p-value for H3 and H4 are above 0.05 which revealed that both hypotheses 3 and 4 are rejected. Result from the hypotheses test suggested that the perceived ease of use and the perceived usefulness of RFID are significantly and positively associated with the intention to use RFID toll payment among PLUS highway users. However, the relation

between the perceived culture, privacy and security with intention of using RFID are weak and insignificant.

The coefficient for perceived ease of use is the higher at 0.816, which suggested a very strong correlation. Additionally, perceived usefulness is also strongly correlated with intention to use RFID, with coefficient value of 0.754. This finding echo research by Zailanie et. al. (2015) which suggested the degree to which users believe that using the new technology is easy, effortless and hassle-free, and users' perception on how the new technology improve their convenience are highly correlated or influence user's intention to use the new technology. As discussed in section 2.2, there are number of steps involved for highway users to switch to RFID payment mode, start from the purchase a RFID tag online, install eWallet application, links RFID tag to eWallet, stick the tag on the vehicle windscreen and monitoring eWallet credit balance. The process seems complicated, and might hesitate users, especially the elderly group who are unfamiliar with online purchase and application installation from migrate to RFID. Hence, finding from this research implies that the process should be stream-lined to encourage more highway users to migrate to RFID.

Additionally, the finding on the insignificant correlation of perceived culture, privacy and security with intention to use RFID suggested that the culture's value and norm did not affect how the individuals assess the acceptance of RFID. Meantime, users also viewed that the personal data associated with RFID tag and eWallet are secured and safe. Perhaps, this is due since eWallet concept has been launched in Malaysia since 2018, eWallet is now one of popular payment method in Malaysia without any major security or privacy concerns.

Conclusion and Future Research

Analysis result of users' intention to use RFID suggested that users are yet to reach the decision of acceptance or resistance, instead, they are observing and assessing the benefit of using RFID Additionally, finding from hypotheses test reveals that the acceptance of RFID toll payment mode is associated or relies on highway users' perception on the ease of use and the usefulness of the RFID payment mode. Hence, finding from this study implies that the understanding on why users felt anxieties and hesitation of using RFID is crucial in order to encourage more users to migrate to RFID. Individual accept change at different rates, hence, as implication, the highway concessionaire should review users' anxieties or concerns, and develop an extension user communication scheme or program to clear users' hesitation or doubt of using RFID. In conjunctions with the implication, future research can be conducted qualitatively to identify users' anxieties and concern of migrating to RFID. Additionally, experts opinion assessment also could be carried out to explore the best approach to addressed users' hesitation of switching to RFID payment mode.

Acknowledgements

This work was supported/funded by the Ministry of Higher Education under Fundamental Research Grant Scheme (FRGS/1/2019/SS03/UTM/02/8).

References

Cazier, J.A., Jensen, A.S., & Dave, D.S. (2008). The impact of consumer perceptions of information privacy and security risks on the adoption of residual RFID technologies. Communications of the Association for Information Systems, 23(1), 14.

Evans, J.D. (1996). Straightforward statistics for the behavioural sciences. Pacific Grove, CA: Brooks/Cole Publishing.

Hair, J.F., Ringle, C.M., & Sarstedt, M. (2015). PLS-SEM: Indeed a silver bullet. Journal of Marketing theory and Practice, 19(2), 139-152.

Hamed T., (2018) A review of technology acceptance and adoption models and theories, Procedia Manufacturing, 22, 2018, 960-967.

Hossain, M., & Quaddus, M. (2011). The adoption and continued usage intention of RFID: an integrated framework. Information Technology & People, 24(3), 236-256.

Jahner, S., Leimeister, J.M., Knebel, U., & Krcmar, H. (2008). A cross-cultural comparison of perceived strategic importance of RFID for CIOs. In Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008), 405-405.

Jia, X., Feng, Q., Fan, T., & Lei, Q. (2012). RFID technology and its applications in Internet of Things (IoT). In 2012 2nd international conference on consumer electronics, communications and networks (CECNet), 1282-1285.

Lee K, Yoo J (2019) How does open innovation lead competitive advantage? A dynamic capability view perspective. PLoS ONE, 14(11): e0223405. https://doi.org/10.1371/journal.pone.0223405

Lee, M.S. (2009). An empirical study about RFID acceptance—focus on the employees in Korea. International Journal of Human and Social Sciences, 4(14), 997-1006.

Li, J., Wang, Y.F., Zhang, Z.M., & Chu, C.H. (2010). Investigating acceptance of RFID in Chinese firms: The technology-organization-environment framework. In 2010 IEEE International Conference on RFID-Technology and Applications, 263-268.

Mohamad A.B. and Nurakmal B. (2016), Sample Size Guideline for Correlation Analysis, World Journal of Social Science Research, 3(1), 37-46.

Nysveen, H., and Pedersen, P.E. (2016). Consumer adoption of RFID-enabled services. Applying an extended UTAUT model. Information Systems Frontiers, 18(2), 293-314.

Ramanathan, R., Ramanathan, U., & Ko, L.W.L. (2016). Some lessons for promoting RFID by applying TAM theory. In Encyclopedia of e-commerce development, implementation, and management, 1900-1912.

Renata M. and Zeljko H (2012), The role of perceived privacy and perceived security in online market, Conference: MIPRO, 2012 Proceedings of the 35th International Convention, 1-6.

Salleh, A., Hashim, N.M.Z., Mohamad, N.R., Hadi, N.A.A., & Ab Aziz, M.Z.A. (2014). Development of High Performance and Low Cost Automatic Toll Payment System using RFID Technology for Malaysia Environment. International journal for advance research in engineering and technology, 2(10), 01-07.

Shalini T, Manish T, Puneet K, Amandeep D (2020), Consumers' resistance to digital innovations: A systematic review and framework development, Australasian Marketing Journal, 28(4), 286-299.

Tesoriero, R., Gallud, J.A., Lozano, M., & Penichet, V.M.R. (2008). Using active and passive RFID technology to support indoor location-aware systems. IEEE Transactions on Consumer Electronics, 54(2), 578-583.

Zailani, S., Iranmanesh, M., Nikbin, D., & Beng, J.K.C. (2015). Determinants of RFID adoption in Malaysia's healthcare industry: occupational level as a moderator. Journal of medical systems, 39(1), 172.