A(n) (a)symmetric perspective towards task-technology-performance fit in mobile app industry

Abstract

Purpose- This study aims to examine (a)symmetric features of task-technology-performance characteristics that are most relevant to fit, satisfaction, and continuance intention of using apps in mobile banking transactions.

Design/methodology/approach- Exploratory factor analysis was used with maximum likelihood extraction and Varimax rotation on a separate sample of 183 mobile banking apps users prior to the main data collection. The theoretical model was tested applying a factor-based structural equation modelling approach to a sample of 250 experienced mobile banking apps users.

Findings- The study unveiled that the task and performance characteristics are more relevant compared to technology characteristics when doing transactions via apps. In addition, the findings uncovered that user satisfaction and continuous intention to use apps stem from the degree of fit in online transactions. The findings of moderation analysis highlighted that users in the lower income group are more concerned about the performance characteristics of banking apps, and there are no differences across age and gender groups. Surprisingly, technology characteristic has a nonlinear nature and this study shows potential boundary conditions of technology characteristics in degree of fit, user satisfaction, and continuance intention to use apps.

Practical implications- Findings from the conditional probabilistic queries reveal that with 83.3 percent of probability, user satisfaction is high when using apps for banking transactions, if the levels of fit, task, performance, and technology characteristics are high. Furthermore, with 72 percent of probability, continuance intention to use apps is high, if the levels of performance and task characteristics are high.

Originality/value- Contributing to task-technology fit theory, this study shows that performance characteristics need to be aligned with task and technology characteristics in order to have better fit when using apps for online banking transactions.

Keywords: Technology characteristics, task characteristics, performance characteristics, task technology fit theory, mobile banking apps, online transactions

1. Introduction

Thanks to Web 2.0 technologies, more and more smarter and smaller electronic devices which have facilitated the use of various applications are emerging (David and Kai, 2015). In recent years, the emerging markets have witnessed the development of smartphone online shopping and mobile payment (Dawei and Weiwei, 2017). To no longer lagging behind competitors, improving the services has been a critical step for many companies. As a recent channel, using mobile application has gained popularity over recent years and it has become an indispensable part of many users (Rezaei and Valaei, 2017a). More recently, a greater orientation to online banking by consumers is observed. By considering the necessity of using different channels of financial and banking companies, a study by Sangle and Awasthi (2011) highlighted the significant role of mobile banking. To clarify this, mobile banking is favoured by many customers due to faster and easier banking activities, such as transactions, transferring funds, paying the bills, as well as viewing their statements 'on the go'(Wannemacher and L'Hostis, 2015) besides a 24/7 banking service.

Mobile banking refers to conducting financial transactions via a smartphone or other cellular devices. Growing use of mobile banking has considerably influenced consumer behaviour (Taghavi-Fard and Torabi, 2010). Rahmani *et al.* (2012) suggested that wireless communication methods and affordable Internet data policies offered by telecommunication companies are the main reasons for customers' attraction to mobile banking. In addition to the advantage of retaining the customers, as indicated by (Laukkanen *et al.*, 2008), mobile banking reduce the costs and foster competitiveness.

Anticipating the trajectories of new technologies is critical to the investment strategies of governments and banks (Alcaide–Muñoz *et al.*, 2017). Banks have been investing in IT infrastructure on a large scale, but they are still failing (Osborne, 2014) and the user experience is not improving, as the banking apps are still unpopular (e.g., "Barclays, HSBC, Lloyds, NatWest and Santander") and they receive negative electronic word-of-mouth communication over the web, according to a research by Adaptive Lab in 2015 (Finextra Research, 2015). Maybank and CIMB group, the biggest banks in Malaysia (with a total asset of 164 and 106 billion dollars, respectively), are also facing the same issues, even though they have invested hugely in mobile banking apps, says HSBC (New Straits Times, 2017). By banking

transactions, this study refers to those online payments made for transferring money, top up, QR code pay, and bill payments.

Robi Ganguly, the CEO of Apptentive, stated that dealing with desktop and mobile apps in the same way is one of the biggest mistakes in mobile app marketing (Ganguly, 2013). In fact, researchers need to consider mobile apps differently, as the research findings on desktop/ website apps may not be applicable to the mobile apps' context. Nevertheless, empirical research in the adoption and use of mobile banking apps is still limited. As banks advance their apps and most of their services are offered online, investigating essential prerequisites for using mobile apps for banking transactions by customers is of paramount importance, yet overlooked by prior studies. To address this gap, examining task-technology fit theory in the banking apps context is very essential. This study argues that performance characteristic is one of the missing components that need to be aligned with task-technology characteristics to have better fit in the app industry. Therefore, the main objectives of this research are:

- To examine what aspects of task-technology-performance fit impacts on satisfaction and continuance intention in using mobile banking apps.
- To examine the effect of demographic factors on the structural relationships.
- To examine under what conditions high satisfaction and patronage intention will be achieved when using mobile banking apps.

This study is organized as follows. Subsequent section gives a rigorous review of literature on task-technology-performance fit along with hypothesis development. Section four provides information on the steps taken before and after data analysis. The results of measurement and structural models are tabulated and schematically shown in section five followed by the findings of moderation analysis, conditional probabilistic queries, and nonlinearity test. The final sections provide insights into discussion of findings, theoretical and managerial implications followed by outlining the future study and limitations of the research.

2. Literature review

Focusing on the description of predicaments and tasks which must have a proper fit to solve a problem, task-technology fit theory is used to determine the intersection between the precise technological device and the requisite task (Goodhue and

Thompson, 1995). As proposed by Goodhue and Thompson (1995), there are three crucial components in task-technology fit model, where "task characteristics" and "technology characteristics" will fit together to form the "task-technology fit". Previous studies integrated task-technology fit with several models and variables such as social motivation (Khan *et al.*, 2017), information quality (Aljukhadar *et al.*, 2014), social characteristics (Lu and Yang, 2014), technology acceptance model (Wu and Chen, 2017), perceived risk (Hsin Chang, 2010, Chen and Huang, 2017), self-efficacy (Mpekoa and Bere, 2015, Vannoy and Chen, 2012), input and problem complexity (Erskine *et al.*, 2018), knowledge internalisation (Wipawayangkool and Teng, 2016), expectation-confirmation model (Yuan *et al.*, 2016), technology quality and accessibility (Zhang *et al.*, 2017), and cognitive styles (ChienHsing *et al.*, 2018).

Previous studies explored mobile banking adoption grounding in "theory of reasoned action" (Carter and Yeo, 2016), "technology acceptance model" (Teo *et al.*, 2012, Choudrie *et al.*, 2018, Malaquias and Hwang, 2019, Zhang *et al.*, 2018, Changchit *et al.*, 2017), and "unified theory of acceptance and use of technology" (Hew *et al.*, 2015, Owusu Kwateng *et al.*, 2018). Using a sample of experienced Finnish users, Karjaluoto *et al.* (2018) found that high perceived value is conducive to users' commitment and their overall satisfaction towards banking app services. Surveying users from US, India, and Brazil, Sampaio *et al.* (2017) also found that mobile adoption will result in more customer loyalty and trust.

Research is scarce on the integration of task-technology fit theory in online banking studies in general and app-based banking in particular. For instance, Malaquias and Hwang (2016) studied the mobile banking adoption in Brazil by developing a trust model on a sample of undergraduate students. In their study, they only investigated the positive impact of task characteristics on trust and omitted to hypothesise the impact of technology characteristics and level of fit on trust. Drawing on a sample of students, Tam and Oliveira (2016) used task-technology fit theory to investigate the antecedents of mobile banking in Portugal. Their study revealed that both task and technology characteristics are related to degree of fit.

Studying task-technology fit in the context of social networking sites, Lu and Yang (2014, p. 323) quoted that "it is unreasonable to expect that a simple model would explain behaviour fully across a wide range of technologies and adoption situations". While researches studied the implications of task-technology fit theory in information systems (Wu and Chen, 2017), little is known about its application in app

industry. Goodhue and Thompson (1995, p. 213) mentioned that "if task-technology fit is decomposed into more detailed components, it could be a basis for a strong diagnostic tool to evaluate whether IS and services are meeting user needs". The task-technology fit model does not include the performance characteristics of technology (trustworthy, time saving, payment efficiency, and payment convenience), which may curb its predictive ability and it is not yet known if a good task-technology-performance fit has positive effect on satisfaction and continuance intention of users to use banking apps. Therefore, this study develops a new model for banking apps (see Figure 1) by extending task-technology fit to performance characteristics.

Former researches mainly focused on studying latent moderating variables such as perceived risk (Chen and Huang, 2017), technology characteristics (Teo and Men, 2008), self-efficacy (Strong *et al.*, 2006), fit (Strong and Volkoff, 2010, Teo and Men, 2008, Cane and McCarthy, 2009), and course difficulty (Huang *et al.*, 2017) on the relationship between task-technology fit and target constructs, i.e. attitude and purchase intention. Therefore, further investigation is required to examine the impact of demographic characteristics on task-technology fit in mobile banking context.

Studying customer satisfaction should include supplementary determinants, moderation effects, and test of nonlinearity, as mentioned by Kumar *et al.* (2013). Further, there are inconsistencies on the customer satisfaction conceptualizations and the findings are divergent (Ahrholdt *et al.*, 2019). To address this limitation, this study provides more advanced analyses (in terms of test of nonlinearity and moderation analysis) to broaden our knowledge of customer satisfaction and re-patronage intention.

Finally, one of the pitfalls in data driven IS researches is interpreting p-values on studies with high sample sizes where the p-value is forced to "0" (Müller *et al.*, 2016). Even though the results are statistically significant, but they have little practical implications. However, it is noteworthy to draw conclusions based on other approaches such as probabilities and this study is aimed to extend our understanding through the results of conditional probabilistic queries.

3. Hypothesis development

Behaviour carried out by individuals to satisfy their information needs by shifting from inputs to outputs is known as 'task characteristics' (Goodhue and Thompson, 1995). According to Schrier *et al.* (2010), the accomplishment of a task is associated

with the individual's performance, where increasing the task can enhance the effectiveness and efficiency. Wu and Chen (2017) found a positive link between task-technology fit and perceived usefulness and ease of use of online learning platform. Drawn on a sample of 256 online banking users, the results of the study by Carlos and Tiago (2016) indicated that task characteristics impacts on the degree of fit. The positive association between task characteristics and fit is also proven in studies by Khan *et al.* (2017) and Lu and Yang (2014).

H1: Task characteristic is positively related to level of fit in financial transactions via mobile banking apps.

Based on task-technology fit theory, the information system will be adopted by customers when the task and customer needs fit together (Gebauer *et al.*, 2010). Technology characteristics are the elements of the tools, such as support services, hardware, and software that users apply when performing particular tasks (Goodhue and Thompson, 1995). When technology is applied, having a good fit is possible (Schrier *et al.*, 2010). Previous findings also suggested a positive association between technology characteristics and fit in MOOC adoption (Khan *et al.*, 2017) as well as in the usage of social networking sites (Lu and Yang, 2014). Carlos and Tiago (2016) also found that technology characteristics is associated with the degree of fit in online banking context. However, applying this scenario to app channels is also promising.

H2: Technology characteristic is positively related to level of fit in financial transactions via mobile banking apps.

Performance characteristic is defined as the extent to which an information system will provide benefit to the users (Venkatesh *et al.*, 2003). The roots of this component, in the context of online transactions through apps, are apps' level of trustworthiness, time saving, and payment convenience, and payment efficiency. Study shows that trust is an important factor for user acknowledgement and it is substantial for being successful in m-commerce (Min *et al.*, 2008). In addition, trust is a fundamental component to enhance satisfaction and intention of customers in using m-commerce (Lu *et al.*, 2008, Jinnan *et al.*, 2017). Kim and Park (2013) also indicate that trust and performance are intertwined in online retailing.

In a seminal paper in MIS Quarterly, Hamilton and Chervany (1981) mentioned that convenience is a part of performance measures for the MIS use process. Further, perceived convenience is explained as accessibility, availability, and the ability of services in a pay-as-you-go model (Okazaki and Mendez, 2013). There

is so little research on the relevant aspects of convenience such as the availability for urgent payment requirement (Dinh *et al.*, 2018), speed of transaction (Bi *et al.*, 2017), and convenience of the transaction (Mahapatra, 2017). Mobile commerce can bring more convenience as users could spend less time and effort to achieve more services during usage (Lu *et al.*, 2015). Previous research considered task and technology characteristics as determinants of fit. It is surmised that performance characteristics can also be another factor conducive to degree of fit in transactions via apps.

H3: Performance characteristic is positively associated with the level of fit in financial transactions via mobile banking apps.

Customer satisfaction is defined as the "fit" between the benefit of applying a system and customers' needs (Goodhue, 1998). As suggested by Goodhue (1998), satisfaction is the most proper method to analyse the effectiveness of systems. Furthermore, the most suitable approach to examine "task-technology fit" would be to study the users' understanding of the systems and identifying how the system satisfaction satisfy the task's needs (Goodhue, 1998).

Financial organizations are developing fast and have advanced their outdated systems to embrace a more digital method. This is significant as the nature of the link between customers, products, and services is a noteworthy component of the banking industry (Mohsan *et al.*, 2011). Investigating the implications of mobile banking in China, Yuan *et al.* (2016) found no association between task-technology fit and satisfaction of users. However, further investigation is required to examine this relationship.

There is a positive relationship between **H4:** task characteristics; **H5:** technology characteristics; **H6:** performance characteristics; and user satisfaction in financial transactions via mobile banking apps.

As claimed by Goodhue and Thompson (1995), user needs will be more effectively met by performance if a good fit is achieved by the technology. Using a sample of 259 respondents in a knowledge sharing environment, the results of a research by Wipawayangkool and Teng (2016) exposed that task-technology fit is relevant to expert power. When the functionality of technology and the needs of customers fit together, task-technology fit will be greater. Further, Carlos and Tiago (2016) found that degree of fit is conducive to individual performance of online bank users. According to Lin and Wang (2006), a vital component to determine the constant intention of customers in technology usage is customer satisfaction.

Customers will be satisfied and carry on with the apps if the apps meet their needs (Rezaei and Valaei, 2017b).

H7: The higher the degree of fit, the higher the user satisfaction in financial transactions via mobile banking apps.

Constant use of the Internet by customers can be determined by the evaluation of quality perceptions and services (Ribbink *et al.*, 2004). In the meanwhile, the success of IT products and services are influenced by the constant intention of users (Parthasarathy and Bhattacherjee, 1998, Karahanna *et al.*, 1999). The positive association between fit and behavioural intention of MOOC usage was identified in a research conducted by Khan *et al.* (2017) . Contrary to previous researches, the results of study by Aljukhadar *et al.* (2014) indicate that task-technology fit is not conducive to behavioural intention. This calls for further investigation and it is hypothesised that:

There is a positive association between **H8:** task characteristics, **H9:** technology characteristics, and **H10:** performance characteristics, and continuance intention of using apps in mobile banking.

Surveying 258 respondents, the association between task-technology fit and ICT use and knowledge creation performance was proven in a study by ChienHsing *et al.* (2018). They also found that cognitive styles (intuitive and analytical) moderate these relationships. Bhattacherjee (2001) indicated that customers will not give up using the information system if the information system's expectations are satisfied, Reddick and Zheng (2017) found that future use of government mobile apps is strongly predicted by customers' satisfaction. However, customers continue using an app once loyalty towards an app is developed. All the research hypotheses are shown schematically in figure 1.

H11: The higher the degree of fit, the higher the continuance intention of using apps in mobile banking.

H12: Satisfied users will continue using the apps in online banking transactions.

Few studies have investigated the structural differences of demographic characteristics in mobile banking and there is a discrepancy between the results. For instance, in one hand, Owusu Kwateng *et al.* (2018) found user experience, age, education, and gender as significant moderating variables in mobile banking acceptance of Ghanaians. Arning and Ziefle (2007) also found age and gender as

moderators to PDA acceptance in TAM model. Sampling 468 social software users, Wu *et al.* (2015) found gender as a moderator to the relationships between social technology-fit constructs and online social network value development. Studying consumer preferences in banking technology, Harris *et al.* (2016) found that young users are attached to new technologies compared to older consumers who are more interested in traditional banking. The results of the study by Tam and Oliveira (2016) also indicated a significant differences across age groups where degree of use was more important to older users in mobile banking adoption in Portugal.

On the other hand, studying antecedents of user behaviour towards mobile banking, the results of a research by Hew *et al.* (2015) implied that education and gender are insignificant moderators. In addition, investigating mobile banking adoption and use in both US and Brazil in a cross-cultural setting, the outcomes of the research by Malaquias and Hwang (2019) disclosed that there were no significant differences across gender and age groups among undergraduate students. Similarly, no significant differences across gender groups in mobile banking adoption was found in a study by Tam and Oliveira (2016)

The findings of previous studies showed discrepancies between the impacts of demographic characteristics and mobile banking use. Furthermore, little is known on the demographic factors' role on the association between task-technology fit and target constructs. More research is required in different cultural settings to examine the level of mobile banking adoption in both developed and developing countries. It is also important to understand which demographic groups have higher satisfaction and higher tendency to continue using mobile banking apps. Therefore, it is hypothesised that:

H13: Gender, **H14:** age, and **H15:** income, moderates the relationships between the extended task-technology-performance fit, user satisfaction, and continuance intention to use apps in online banking transactions.

Figure 1: Research model (Insert here)

4. Method

As a standard in determining latent variables, all measurement items (see Appendix A), excluding performance characteristics (self-developed), are adopted from prior established studies in order to evaluate the variables (Westland, 2015). The items of

task characteristics, technology characteristics, and fit constructs are adopted from Schrier *et al.* (2010). Items of performance characteristics are developed for this research using exploratory factor analysis with maximum likelihood extraction and Varimax rotation on a separate sample of 183 users prior to the main data collection.

User satisfaction and continuance intention were measured by items adopted from (Rezaei and Valaei, 2017b, Valaei and Baroto, 2017). Avoiding any possible bias before conducting data analysis was ensured. For instance, For example, Harman's one factor test (Podsakoff *et al.*, 2003) shows that there is no common method bias (CMB), as no single factor accounts for more than 50% of the total variance (the outcome of principal component analysis with no-rotation show a total variance of 45.3%). Following the (Bagozzi *et al.*, 1991), ground rule the CMB exist if the intercorrelation among the predictor and outcome variables exceed from the threshold of 0.85. Since the correlation among the variables are not greater than 0.85, therefore the CMB is not a concern in the present study.

258 responses were recorded. The missing values through an "expectation-maximization algorithm" (EMA) (Little, 1988) by using SPSS software (Version 20) were addressed. Eight responses were excluded from the collected data and 250 acceptable responses as the final sample size was used for data analysis. To estimate the efficiency of sample size and conduct a power analysis calculation, the "inverse square root" and "gamma-exponential" methods (Kock and Hadaya, 2018) are applied. Following the guidelines provided by Kock and Hadaya (2018) for "minimum sample size in PLS-SEM", with the minimum absolute significant path coefficient in the proposed model B=0.152 and the significance level of P-value=0.05, we need a sample size of N=244 (inverse square root method: see Appendix B) or N= 230 (gamma-exponential method) to have high power level of 82%, which is satisfactory. This research also utilized "a-priori sample size software for SEM" (Soper, 2018). The results showed that the required number of sample size is 161 and 246 for "high effect size of 0.35" and "medium-high effect size of 0.25" respectively. This criterion is achieved as the sample size of this research is 250.

Each item is rated on a 7-point Likert scale where 1 represents "strongly disagree" and 7 represents "strongly agree". The sample information is depicted in Table 1. As a fully-fledged SEM method, PLS is an appropriate technique for theory testing (Henseler *et al.*, 2016a, Hair Jr *et al.*, 2014). To analyse the models, SmartPLS software version 3.2.4 (Ringle *et al.*, 2015) and WarpPLS version 6.0 (Kock, 2017)

are used by applying consistent PLS (PLSc) algorithm. Since the estimates of PLSc algorithm are similar for both software, this research followed a synergistic PLS approach (Valaei and Baroto, 2017) to have the most rigorous analysis. SmartPLS software is used to test the measurement model (in terms of reliability and validity) and structural model (in terms of bootstrapping, predictive relevancy, and multi-group analysis). WarpPLS is applied to test the model fit, conditional probabilistic queries as well as nonlinearity. PLS-SEM is a "suitable method for analysing models with moderation effects and nonlinear terms" (Ahrholdt *et al.*, 2019, p. 22) and it facilitates the estimation for complex models. In addition, this method provides advanced analyses which are not available through the estimates of co-variance based SEM (Hair Jr *et al.*, 2017).

Dissimilar to the conventional quantitative methods in social sciences (such as first-generation statistics, causality, and multi-variate analysis), that are mainly about the consistency and frequency thresholds (Valaei *et al.*, 2019), the asymmetric methods such as fuzzy sets (e.g., fuzzy-set qualitative comparative analysis, crisp-set qualitative comparative analysis) and conditional probabilities provide more advanced inferences.

In relation to the Bayes' theorem, conditional probabilities, as an asymmetric method, fill the void of the deficiency of the traditional approaches where the causal conditions are independent constructs with linear impact. In addition, the asymmetric approach goes beyond the assessments through path coefficients and it uses a combination of causal conditions for an optimal juxtaposition (Woodside, 2014) that are dissimilar to merely one causal condition.

Table 1: Sample information (*N*= 250) (Insert here)

5. Results

5.1 Measurement model assessment

Making sure to have a good model fit, validity and reliability before analysing the structural model is very essential. As indicated in Appendix C, the model fit of Structural Equation Modelling is satisfactory. Furthermore, reliability test (Cronbach's alpha), composite reliability (CR), Average variance Extracted (AVE) as well as discriminant validity are examined to assess the suitability of the measurement model. As indicated in Table 2, the factor loading of all measurement models are

greater than 0.70 and AVEs are above 0.5 which both are above the suggested threshold of 0.70 and 0.5 respectively. As shown in Figure 2, the measurement model within which the Task characteristic → Continuance intention to use apps has the lowest path coefficient (B= 0.002). The results showed that the Fornell-Larcker and cross-loading criteria are also met. The Heterotrait-monotrait ratio (shown in table 3) indicate that the discriminant validity amongst the variables are established (all values are below 0.9).

Table 2: Reliability and validity (Insert here)

Figure 2: Results of measurement model (Insert here)

Table 3: Heterotrait-monotrait ratio (Insert here)

5.2 Structural model assessment

As the results presented in Table 4 show, the model has high predictive relevancy and the R^2 and Q^2 values demonstrated large effect sizes. The results of hypothesis testing (tabulated in Table 5) show that all hypotheses are supported except H8 (Task characteristics → Continuance intention to use apps) as it generated a weak path coefficient of 0.002 and insignificant T-value of 0.025. The highest significant path coefficients are received for the Fit → User satisfaction and Task characteristics → Fit relationships with beta values of 0.45 and 0.41, respectively.

Table 4: R^2 and Q^2 values (Insert here)

Table 5: Results of hypothesis testing (Insert here)

5.2.1 Moderation analysis

According to Becker *et al.* (2013), several researchers failed to address heterogeneity in data, which leads to incorrect interpretations. PLS-Multi Group Analysis (PLS-MGA) is used to assess moderating hypotheses. Prior to PLS-MGA, researchers need to make sure that there is no measurement invariance across groups. Following the procedures proposed by Hair Jr *et al.* (2017) and Henseler *et al.* (2016b), permutation test is performed between each two-groups of investigation and the results show that the measurement invariance are established. Since the

measurement invariance is met across groups, we also tabulated the results of parametric test. The results of Welch-Satterthwait *t* test are very similar to the parametric test as well (See Tables 6a, 6b, and 6c). Similar results across multimethods (parametric test, PLS-MGA, and Welch-Satterthwait *t* test) provide high confidence in the final results (Hair Jr *et al.*, 2017). To avoid singular matrix error (huge gap between group sizes), some demographic subgroups are discarded. Taking gender, age, and income as categorical moderating variables, and using factor weighting scheme and percentile bootstrapping, Tables 6a, 6b, and 6c show the results of PLS-MGA for examining H13, H14, and H15, respectively.

The results shown in Tables 6a and 6b show that there are no significant differences (all P-values are greater than 0.05 and lower than 0.95) across gender and age groups, however, H13 and H14 are rejected. Further, Table 6c shows that the relationships between Performance characteristics → User satisfaction and Performance characteristics → Continuance intention to apply apps are higher for "below RM2000" income group. The association between technology characteristics and user satisfaction is also higher for the income group "between RM2001 and 4000". Therefore, H15 is substantiated.

Table 6a: PLS-MGA Results (assessing moderating effect of gender) (Insert here)

Table 6b: PLS-MGA Results (assessing moderating effects of age) (Insert here)

Table 6c: PLS-MGA Results (assessing moderating effect of income) (Insert here)

5.2.2 Results of conditional probabilistic queries

Nowadays, apart from the symmetric view of the interpretations (causality and multi-variate analysis), researchers are moving towards the asymmetric analysis of the reaped data (Valaei *et al.*, 2017). Fuzzy sets and conditional probabilities are two asymmetric approaches which provide more advanced inferences.

With reference to Bayes' theorem, this study also computes complex probabilities through conditional probabilistic queries using combinations of latent constructs, and relational and logical operators. It should be noted that conditional probabilities cannot be assessed via path coefficients (Kock, 2017), and appraising such probabilities will shed more light on our understanding towards mobile app users. In this study, after estimating several queries to find the highest probabilities,

two queries showed the highest percentage: 1. What is the probability that user satisfaction is high when using apps for banking transactions (>1), if the level of fit, task, performance, and technology characteristics are high (>1) and 2. What is the probability that continuance intention to use apps is high, if the levels of performance and task characteristics are high? Interestingly, as tabulated in Table 7, the results of conditional probabilistic queries show that the conditional probabilities of first and second queries are 83.3 and 72 percent, respectively.

Table 7: Results of conditional probabilistic query

5.2.3 Results of nonlinear relationships

According to Kaiser and Messer (2011), most relationships in behavioural studies have nonlinear nature and the majority of "multivariate statistical analysis" methods have linear assumptions (Kock, 2015b). Applying a nonlinear variance-based SEM software, WarpPLS 6.0 (Kock, 2017), this study also investigates which proposed relationships are nonlinear. Warp3 algorithm is used to examine which relationships are "warped". This algorithm diminishes the occurrence of Simpson's paradox as well (Kock, 2015a).

Surprisingly, apart from the significant linear associations between technology characteristics and fit, user satisfaction, and continuance intention to use apps (see Table 5), the results also suggest that these associations are warped (curvilinear), as shown in Figures 3, 4, and 5. For instance, to examine the nonlinear relationship between technology characteristics and fit (see Figure 3), the S-curve (which is an amalgamation of two U-curves) indicates that the inflection point is placed at around -0.695 standard deviations (SD) from the "TechChs" mean. The first U-curve goes from -3.42 to -2.33 SD from the mean, at which point the lowest level of technology characteristics is reached for the U-curve. It can be construed that an increase in technology characteristics results in a decrease in the degree of fit. In the second U-curve, an increase in technology characteristics leads to an increase in degree of fit. The S-curve of the Technology characteristics → User satisfaction relationship (Figure 4) illustrates that the first U-curve goes from -2.33 to -1.24 SD from the mean, at which point the lowest degree of user satisfaction is achieved for the U-curve. In addition, the second U-curve illustrates that a growth in technology characteristics results in a rise in user satisfaction. The results of nonlinear

relationship in Figure 5 can be interpreted likewise. These findings imply the potential boundary conditions of technology characteristics in degree of fit, user satisfaction, and continuance intention to use apps.

Figure 3: Nonlinear relationship between technology characteristics and fit

Figure 4: Nonlinear relationship between technology characteristics and satisfaction

Figure 5: Nonlinear relationship between technology characteristics and continuance intention

6. Discussion

Nowadays, banks are interested in practicing multichannel banking and be omnipresence without studying users' experience and feeling. They merely develop their apps in different platforms to not lag behind competitors. This is one of the main issues in digital marketing strategy initiatives, as managers ignore spotting different digital media touch points and "understanding online customer journey map" (Chaffey and Ellis-Chadwick, 2016). Therefore, appreciating the behavioural studies, assessing different touch points, and examining factors associated with app channel usage is imperative for mobile banking.

Task-technology fit theory has significant contributions to research on online user and IT design (Aljukhadar *et al.*, 2014). Research on the banking apps' adoption for performing transactions is very scarce. Contributing to the task-technology fit theory, the findings imply that performance characteristics need to be aligned with technology and task characteristics to have a better fit when using apps for online banking transactions.

The link between task characteristics and the fit is supported by prior studies (Hollingsworth, 2015). Combining relevant task characteristics can establish a suitable fit for the technology device-specific activity. The outcomes of this study unravelled the higher relevance of task and performance characteristics of transaction-based apps (path coefficients of 0.41 and 0.26, respectively) as compared with technology characteristics. The outcomes of PLS-MGA also imply that those users in the lower income group are more concerned about the performance characteristics of banking apps and that there are no differences across age and gender groups. In line with Tam and Oliveira (2016), Hew *et al.* (2015), and Malaquias and Hwang (2019), the results of moderation analysis complements the previous findings of insignificant

role of gender in mobile banking context. Interestingly, even though Harris *et al.* (2016) found that young users are more attached to new technologies, our results indicated that there was no significant differences across age groups in mobile banking, being in line with Malaquias and Hwang (2019). Perhaps, elder people are becoming more tech-savvy and the mobile penetration ratio is increasing rapidly.

The technology functionality can impact on task-technology fit. Similarly, the fit between technologies can affect an app's performance (Trice and Treacy, 1988).
The degree of fit becomes important, thanks to the accessibility that mobile devices offer. The results propose that degree of fit and user satisfaction of mobile apps are greatly related to each other (path coefficient of 0.45).

The desire to adopt a new technology can be reduced by a poor fit (Lee *et al.*, 2005, Liang *et al.*, 2007). The results revealed that the greater the degree of fit, the greater the continuance intention to use apps for online transactions (path coefficient of 0.27). Moreover, consumers' satisfaction determines continuous intention of using information systems (Larsen *et al.*, 2009). As stated by Delone and McLean (2003), customer satisfaction in IS success model can predict the determination of net advantage and customer loyalty. In line with previous research (Zeithaml *et al.*, 1996, Szymanski and Henard, 2001, Heitmann *et al.*, 2007, Reddick and Zheng, 2017), a positive association between customer satisfaction and continuous intention in using apps was found in the current study.

6.1 Implications

Behavioural studies aid app developers and IT managers in their decision making and development of user-friendly apps (Unal *et al.*, 2017, Palomba *et al.*, 2018). It is difficult for IT managers and developers to appraise the performance of apps without considering the users' experiential value. For instance, CIMB Bank, 2nd largest bank in Malaysia, developed its app (CIMBClicks) for both iOS and Android operating systems and its early versions turned out to be a failure, as it received several negative reviews over social media and app review websites. What IT managers were neglecting was acknowledging different touch points in digital media and change of customer behaviour which could cause bounce rate. The CIMB Bank managers did not realise that a bad experience with the app could trigger switching behaviour as most of Malaysians are two-account holders and they could easily switch to the online services of the main competitor. It is likely that CIMB Bank lost a

lot of customers due to the bad app perceived experience, even though its website was a success.

While apps in today's business world are increasing ubiquitously, they are used not only for pleasure, entertainment, and games, but also for simplifying access to organizational amenities (Reddick and Zheng, 2017) as well as facilitating techniques of resident contribution (Wilson *et al.*, 2017). As apps are mobile and convenient, banks initiated to use apps in enhancing their services. Our findings show that combining the performance characteristic construct with task-technology fit provides a better explanation for the variance in using banking apps and the proposed model has a high predictive relevancy, as R^2 and Q^2 measures show large effect sizes.

Unexpectedly, the outcomes revealed the irrelevance of task characteristics to continuous intention in using apps for online transactions. This is congruent with the findings of Aljukhadar *et al.* (2014) in online environment. Nevertheless, banks should take into consideration that the degree of fit, technology and performance characteristics of apps encourage continuance intention of users. Thus, policy makers and administrators should pay particular attention to the technology and performance characteristics of banking apps related to trustworthiness, ease of control, usefulness, pleasure experience, payment easiness, time saving, safety, and customisation. The banking app developers should consider these performance characteristics when designing the apps.

In addition, comprehending nonlinear effects is important for adequate resource allocation (Masiero *et al.*, 2016) when seeking to boost user satisfaction and continuance intention. In a mobile service context, this study found negative cubic relationships between technology characteristics → level of fit, technology characteristics → user satisfaction, and technology characteristics → continuance intention to use apps in online banking transactions, where these relationships showed s-shaped curves. According to the results (shown in figures 3, 4, and 5), technology characteristics unfold its high effects at lower levels, but only when a threshold degree is surpassed. Further, the impacts of technology characteristics get saturated at higher levels.

These nonlinear effects imply that users have a reference-dependent assessment, based on the prospect theory of Kahneman and Tversky (1979), of technology characteristics when forming their degree of fit, level of satisfaction and continuance intention. The flat effect on the middle of s-curves indicate that users set

a reference point for degree of risk, reliability, usability, experience, and customisation (facets of technology characteristics) and their behaviour is shaped when a certain extent of value is met. The incremental effect of these facets (gains, according to the prospect theory) will result in better fit, higher level of satisfaction, and eventually continuance intention. The opposite occurs for lower bound of the s-curves with increasing distance below the reference point, where lower value (losses, according to the prospect theory) is perceived by users.

Moreover, the nonlinear nature of technology characteristics shed more light on our understanding in such a way that an overemphasis on the technology perspective of apps may result negatively. Therefore, CTOs, managers, and app developers should consider the potential boundary conditions of technology characteristics in degree of fit, user satisfaction, and continuance intention to use banking apps.

As an asymmetric investigation, calculating several complex probabilistic queries, two conditions generated the highest conditional probability. The results of conditional probabilistic query are useful for managers, practitioners and researchers (Kock, 2017). The conditional probabilistic queries found by this research empower the decision makers to examine under what circumstances (conditions) an outcome solution is reached (for example, user satisfaction), regardless of the results of causal linear relationships between independent variables and dependant variable. No previous study had an asymmetric perspective towards the task-technology fit theory and the findings of this research shed more light on the complex probabilistic queries, as solutions, that lead to outcome conditions. This research also provides methodological guidance for future research in IS discipline to include both symmetric and asymmetric perspectives in their study design.

Finally, user satisfaction and continuance intention are two decisive factors in IS success or failure (Wang *et al.*, 2019). More research is required to find out under what circumstances users continue using mobile services (Kim *et al.*, 2019). This research showed that with 72 percent of probability, continuance intention to use apps is high, if the levels of performance and task characteristics are high. To be more specific, continuance intention to use apps as an outcome solution can be achieved if users perceive higher performance in terms of their online payment convenience, efficiency, trustworthy as well as fulfilling the utilitarian value of using mobile banking (task characteristics). Therefore, developers and other decision makers

should consider these characteristics to have higher number of app downloads and increased mobile banking transactions. Finally, with 83.3 percent of probability, user satisfaction as an abstract outcome solution can be attained if all the task-technology-performance-fit conditions are integrated.

7. Conclusions

The proposed model has a high predictive relevancy with large effect size. The findings imply that performance characteristics need to be aligned with technology and task characteristics to have a better fit when using apps for online banking transactions. In addition, task and performance characteristics of transaction-based apps are more relevant than technology characteristics. The results of PLS-MGA showed that those users in the lower income group are more concerned about the performance characteristics of banking apps and that there are no differences across age and gender groups.

The findings suggest that degree of fit is highly associated with mobile apps' user satisfaction and the higher the degree of fit, the higher the continuance intention to use apps for online transactions. The nonlinear nature of technology characteristics indicated that an overemphasis on the technology perspective of apps may result negatively. Finally, the results of complex probabilistic queries showed that two conditions generated the highest conditional probability.

7.1 Future directions and limitations

With rapid technology advancements in the service industry, user preferences change, quickly. The casual and every-day use of smartphones makes it easier for users to switch between service providers or ditch an app. It is likely that banks would have lost their customers because of their failure to keep pace with the rapid changes. Considering the dramatic number of smartphone users (Lin *et al.*, 2017) and since a lot of people are two-bank account holders (Schaner, 2017), chances are that if the users are unhappy with the app or view the negative comments, they would not hesitate to switch to other banks for the sake of better online banking experience. Therefore, every online presence (website/ desktop/ app) needs to be monitored and further study should investigate other factors to extend this study's proposed model.

Recently, several banks have invested billions of dollars to take the initiatives and investigate the implications of blockchain in the banking industry (Underwood,

2016). Researchers forecast that blockchain platform will be the future of this industry (Tapscott and Tapscott, 2016, Lee and Pilkington, 2017) due to its peer-to-peer nature. Supplementary research is essential to scrutinize factors related to the level of fit in the blockchain and the degree to which they may influence user satisfaction and continuous intention in using this technology for digital transactions.

The sample size of this research might have some limitations in terms of generalisability. More research with larger sample sizes are required for higher power level. Furthermore, it is likely that there are other factors associated with degree of fit in mobile app industry. As Goodhue and Thompson (1995, p. 213) put it: "if task-technology fit is decomposed into more detailed components, it could be a basis for a strong diagnostic tool to evaluate whether IS and services are meeting user needs". Therefore, more in-depth researches are required to decompose task-technology-performance elements of fit. Finally, since this study introduced the performance characteristics as a new construct to task-technology fit theory, the proposed model of this research should be validated in other contexts. This research merely proposed the task-technology-performance fit model for banking apps, and further study is required to examine this model across other forms of apps.

Appendix A: Measurement items

Appendix B: Sample size adequacy

Appendix C: Model fit and quality indices

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