IMPROVING USER SATISFACTION OF FUTURE TELECOM BILLING AND REVENUE MANAGEMENT SYSTEMS

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ABSTRACT

With hyper-growth in demand for connectivity, the telecoms sector is now fiercely competitive. Operators are engaged in: i) a 'battle' for subscriber retention and growth by rolling tuning of their promotion, campaign and service portfolios; ii) infrastructure overhauls necessary for the Internet of Things led transformation of business; and iii) realizing government strategies aimed at complete economic transformation, epitomized, for example, by Thailand 4.0.

Billing and Revenue Management Systems (BRMS) are needed to support all of the above. And yet no studies into ways of improving user satisfaction currently exist, despite it being acknowledged as a measure of information systems success generally. According to a renowned and widely cited conceptual model, user satisfaction is influenced by information, system and service quality respectively. To test this theory for BRMS we applied structural equation modelling to investigate which of these dimensions has the most affect.

Ninety two users from Thai telecom operators were consulted. Findings showed a positive relationship between all three quality dimensions and user satisfaction, although service quality was found to have the largest impact. Measures of service quality range from extent of knowledge of the IT user support team, to confidence in the application vendor. The implications of these results indicate that operators should focus on these measures in future rather than over emphasising system quality and BRMS features.

Keywords: 1) Information Systems Success 2) Billing and Revenue Management Systems 3) User Satisfaction Measures

1. Introduction

A recent report on the future of telecoms referred to them as the "enabler of digitization and disruptor-in-chief of everything, from business and operating models across converging industries, to the global economy (Pati, et al., 2017)". The Thai government for one is vigorously pursuing a new economic model - 'Thailand 4.0' - that aims to elevate the country from a middle-income industrial nation, to a high-income economy anchored in science, technology and digital innovation. Pivotal to its success is a program to develop so-called smart cities that will improve the life quality of urbanites (Jin and et al., 2014); one hundred in all are slated over the next twenty years, with connectivity acknowledged as key to realizing this ideal.

Thus, with demands on connectivity growing exponentially the telecoms sector is now fiercely competitive with providers 'battling' on three fronts. First consolidation and expansion, mainly by baited hook tuning of promotions and services tempting subscribers

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into consuming more data cap draining content, thereby increasing revenues which in turn, jack up stock prices. Second, reinvesting (some of) this revenue by rolling out massive infrastructure overhauls that connect the diverse technologies necessary to make happen the Internet of Things (IoT) – the next generation internet and next telecoms cash cow. And finally on a related point, competing to construct long range IoT networks needed to make happen smart city initiatives such as those in Dubai, Honk Kong and (as previously mentioned) now taking seed in Thailand (4.0).

The upshot is that telecom providers are being jolted into upgrading their assets, part of which involves migrating from ageing business support systems to state of the art modular platforms in order to reduce costs, improve consumer experience and enhance their ability to launch new services. Examples include Customer Relationship Management (CRM) and Billing and Revenue Management Systems (BRMS). BRMS are one of several mandatory (non-volitional) enterprise applications used in the sector; a form of credit, providers deliver a service and subscribers later pay for that service, period. In contrast, other system types – e.g. Enterprise Resource Planning – may seem 'optional extras' (especially) when resources are limited, even if they can yield efficiency benefits.

Understanding the determinants of BRMS success, in particular improving levels of user satisfaction, would help companies leverage such factors on future implementations. However, a lack of work investigating BRMS success currently exists. One solution is to apply the highly influential success model by DeLone andMcLean (2003), determine whether that model can (or needs to) be extended/ modified for BRMS, and then evaluate which factors have most bearing on user satisfaction. The model itself provides an excellent theoretical basis for understanding IS success generally by considering interrelationships among six critical dimensions. Therefore, in this study we investigate which dimensions have the strongest effect on BRMS user satisfaction.

Section 2 of the paper reviews related literature; Sections 3, 4 and describe our research hypotheses, methodology and findings respectively; Section 6 offers our conclusions.

2. Literature Reviewand Theoretical Foundations

Telecom operators face a dilemma; pricing strategies rooted in reduced minute rates and unlimited data caps doubtless attract new subscribers (and thus bolster market share) but can be counter-productive; more calls from more subscribers increases network infrastructure stress levels, leading to higher congestion rates, reduced quality of service and with it greater churn rates (Hassoun, et al., 2015). Annual churn averages up to 67 percent in some countries, while the cost of acquiring new customers can be as much as 20 times higher than keeping them (Ascarva, 2018); so when they bale, companies lose not only future revenue, but also resources spent luring them in the first place (Hughes, 2007).

Thus, business models are being reconfigured while product offerings grow ever more complex as operators vie to offer customers the most attractive 'service bundles'. Ergo, IT agendas are in a constant flux to realize these services, both to entice new subscribers and to better manage and leverage those they already have (Niebuhr et al. 2010).

Moreover, today's network services greatly surpass basic voice and SMS; streaming, navigation and location sharing among others demand both extra bandwidth and improved IT platforms in order to quickly develop, launch and charge for new offerings, while keeping the 'customer experience' positive. Retention surveys show that while price and product are important, subscribers mostly leave because of displeasure with their treatment (Hughes, ibid.). There fore systems such as CRM and BRMS are critical to remaining competitive.

2.1 Telecom Billing Systems Overview

Integrated modular billing systems are now prevalent throughout the industry; a form of distributed enterprise application (He and Da Xu, 2014) they support various business processes including collecting consumption data, credit control, calculating charges, producing customer bills, processing payments and managing debt (Hunter and Thiebaud, 2003). Nowadays the generic term 'billing system' is often refined thus: Post-paid, Prepaid and Convergent (Goldman, 2012). Post-paid billing supports subscribers using products and services on a monthly basis (Lin et al., 2016). Prepaid meanwhile describes a mechanism where customers pay in advance for services (Lin et al., ibid.) and so do not receive an invoice but instead are charged in real-time. Finally, convergent billing refers to generating a unified view of all subscribed service charges (Mobile, Fixed, IP, etc.) within a single invoice (Ali and Alhinai, 2015).

Billing system success, to the consumer, implies continued correctness! As such the TM Forum (TMF), a global industry association that fosters collaboration to maximize success among telecoms providers, developed a framework and metrics by which companies can benchmark their existing operations. The framework proposes measurement of billing systems under 3 domains; revenue and profit, customer experience and operational efficiency (TM Forum, 2014) - similar in fact to constructs in the DeLone and McLean model employed here. TMF also recommended tangible measurements under the 3 domains such as average revenue per user, revenue unbilled, revenue overbilled, and churn rate. Another study into cloud-hosted billing systems (Park et al., 2013) based success on such factors as integrity and non-repudiation capabilities, as well as non-obstructive and minimal computation costs. Further papers on BRMS success measures include Amdocs (2009) and Joshi et al. (2014).

2.1.1 The Billing System Process

The billing system process (or more precisely, group of processes) varies depending on providers' choice of system software and how in turn, it interfaces with their network infrastructure. However a simple process overview starts with activation of a new subscriber through an order management and fulfillment system which in turn, interfaces with the billing system; the billing system itself then interfaces with a network inventory system that adds new phone numbers and IP addresses, etc. Hunter and Thiebaud (ibid.) outlined the stepwise billing system process flow as follows: Firstly, usage for customers activated on a network is passed to the billing system; next, usage data sent from several network elements are transformed into a common format. The rating engine then rates this data according to a pre-defined price. Following that, the calculation system collects all usage prices per customer and computes any applicable discounts or promotions applicable. A bill presentation module then creates the presentation format showing charges for that customer who receives their invoice in soft or hard copy. The process is completed by a function for managing accounts receivable payments. Thus, the system provides a module supporting payment and adjusts the balance accordingly. Where a payment is overdue, the system provides a function to handle outstanding balances; e.g. by blocking usage. BRMS can also support balance or usage adjustments in cases where the operator would like to compensate a customer for any reason.

2.1.2 Billing System Software

When choosing BRMS software, service providers can either purchase an off-the-shelf application tailored to their individual needs, or else developing a completely new system in house. Unsurprisingly most companies opt for off-the-shelf solutions as they can deliver all necessary functionality (due to the modular architectures mentioned previously), combined with proven levels of dependability (Avienzis et al., 2004).

Providers opting for in-house development face many challenges in terms of scalability, performance and determining their future system road map. Since BRMS are non-volitional, they carry an enormous implementation risk (a point underscored by the collapse of Australian company OneTel as described in Avision and Wilson (2002)). Poor quality systems can also negatively affect customer experiences, for example through unexpected changes in products, bill shock and disruptions to service (Friedrich et al, 2015). In keeping with similar studies, Bloch et al, 2012 showed that large software projects - including BRMS – finish up challenged or failed (based on schedule, cost and scope), running as much as 66 percent over budget and 33 percent behind schedule.

Regardless of whether built in house, bespoke, or off-the-shelf/ vendor adapted, billing systems represent a major investment. Typically they have a lifespan of around ten years (minimum) from deployment to decommissioning during which they are integral to strategic positioning of any telecoms service provider (Tam andTomala, 2001). The interesting point here is that unlike many other types of system, relatively few new BRMS are deployed each year (Katz, 2008) thereby limiting opportunities to learn from past mistakes.

2.2 Theoretical Foundation: DeLone and McLean Model of Information Systems Success

Our theoretical foundation here is a conceptual model by DeLone and McLean (1992). That particular model built on an existing taxonomy by Mason (1978), itself a modification of Shannon and Weaver's Information Theory (1949). Working from Mason's taxonomy, DeLone and McLean proposed six IS success dimensions: system quality, information quality, use, user satisfaction, individual impact, and organizational impact. For each dimension, the authors identify, categorize and analyze appropriate success measures.

DeLone and McLean's model was subsequently evaluated in several domains to validate and contribute to its refinement, with nearly 300 peer-reviewed articles reporting on their findings. However many such works only represent partial evaluations, using cherry-picked subsets of relationships between the IS success dimensions (often leading to corollary misconceptions that subsequent works propagated). In fact, only a brace of publications (Seddon and Kiew, 1994 and Rai et al., 2002) actually sought to validate the entire model, both conducted at individual level.

Despite these caveats and some criticism (cf. Seddon, 1997; and Pitt et al., 1995), the overwhelming weight of literature backed the DeLone and McLean model. That said, Myers, et al. (1997) and Peter et al. (1999) observed how while individual and organizational benefits feature in the model, wider benefits, for example to industry or society at large, do not. Consider how dynamic pricing engines are profiting the airline industry by enhancing revenue generating capabilities (Wittman and Belobaba, 2018). Or the benefits technology has brought to mankind, e.g. in health care, education and communication, while revolutionizing productivity, entertainment and avenues for political engagement (Turkle, 2017).

Following ten years validation, DeLone and McLean (2003) published an updated model incorporating feedback received. The revised model again defines six dimensions: system quality, information quality, service quality, use, user satisfaction, and perceived net benefits. While very similar, the revised model featured two significant changes. The first revision, acknowledging Pitt et al. (ibid.), saw inclusion of a 'service quality' dimension. Secondly, incorporating Seddon's (ibid.) suggestion, DeLone and McLean generalize the individual and organizational impact measures into a single dimension termed 'net benefits', thereby enabling benefits to be considered at individual, organizational, industry and societal levels.

A meta-analysis by Petter et al. (2008) later evaluated the state of DeLone and Mclean's model including the strength of relationships between dimensions. The authors proposed fourteen hypotheses covering empirical research published between 1992 and 2007. Results show support for the majority of hypotheses implied at the individual level of analysis for net benefits, but only one relationship at the organizational level (which are markedly different in comparison). In addition, few studies were found to measure and account for multiple dimensions of success (and interrelationships among them); hence our motivation in this paper where we empirically test for net benefits at organization level.

Several studies specifically consider levels of effect between user satisfaction and system, service and information quality. Among them, a study on e-Government systems by Wang and Laiu (2008) found that information quality has the strongest effect on user satisfaction followed by service quality. A further review of knowledge management systems (Wang and Yang, 2016) identified service quality as impacting strongest on user satisfaction, with system quality having least impact. Montesdioca and Maçada (2015) meanwhile showed that only information quality is positively associated with user satisfaction in an information security context. In a study of e-Learning systems in Pakistan, Kanwal and Rehman (2016) demonstrated that system quality contributes most to user satisfaction followed closely by information quality. Finally the findings of a study by Alshibly (2014) evaluating e-HRM systems showed that information quality and system quality respectively have the highest effect on user satisfaction. When viewed collectively, it is evident information quality is frequently either the most significant or subsequent influencer of user satisfaction.

As previously indicated, this paper assesses BRMS success using the 2003 manifestation of DeLone and McLean's model. However while further validation may seem unnecessary, our belief is that there are areas still to be explored. We touched on certain aspects of this during the introduction. Certainly to date and to the best of our knowledge, no application considered in the literature qualifies as either non-volitional or business critical, at least not enough to trigger the demise of an entire company (cf. OneTel).

3. Research Hypotheses

Figure 1 illustrates the research model developed for this study to measure and explain BRMS success by user satisfaction. It defines success in terms of 4 dimensions - information quality, system quality, and service quality and user satisfaction - each having multiple success indicators.

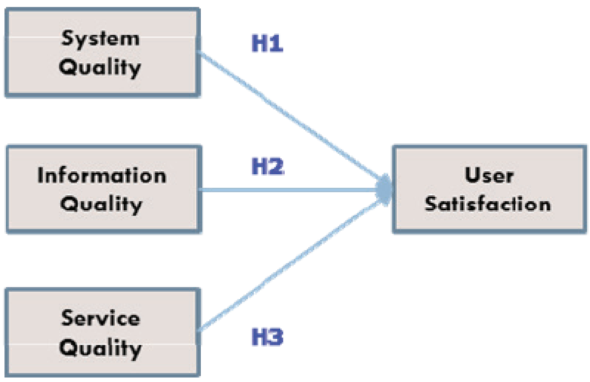

Figure 1: Proposed Model for User Satisfaction of BRMS

Hypothesis 1 (H1: Information quality focuses on quality of output generated by BRMS. Examples include amount charged in a bill, billing reports and other financial information. Inputs meanwhile feature a mechanism to verify call detail records before allowing data into the system. A previous study showed solid support for the association between information quality and user satisfaction (Schppers et al., 2006). We therefore proposed that this study also tests whether the same is true for BRMS.

Hypothesis 2 (H2): Service quality considers overall system support provided by an organization's IT department and the BRMS product owner, as well as items facilitating ease of use including such aspects as responsiveness of product owner, reliability of billing vendor service, and empathy and competence of IT staff. An earlier study indicated that service expectancy has a positive influence on user satisfaction (Thong et al., 1996). Again, therefore this study also tests whether the same is true for BRMS.

Hypothesis 3 (H3): Finally, system quality alludes to desired characteristics of BRMS including performance and functionality geared towards saving user effort. Quality embodies aspects such as system turnaround time and system features, including, real-time rating and accuracy. An earlier study investigating information systems success demonstrated a positive impact of system quality on user satisfaction (Schppers, et al., ibid.). So once again, this study also tests whether the same is true for BRMS.

4. Research Methodology

This section describes the construct measurement, sampling, data collection and data analysis methods applied in our work. Construct measurement seeks to identify appropriate measures for each model construct. Once identified, they were used to develop a questionnaire in order to farm data from various BRMS stakeholders. Next, structural equation modeling (SEM) was used to test the data we obtained.

Previously validated indicators from existing literature were employed as means of developing measurement indicators for each dimension in our proposed model. These indicators are summarized in Table 1 and were subsequently used to develop a questionnaire using a five-point Likert scale, ranging from "strongly disagree" (1) to "strongly agree" (5).

Table 1: Indicators for Each Dimension

Dimension	Measures	References
Information Quality (IQ)	Correct Output from System (IQ1)	Iivari (2005); Bailey and Pearson (1983)
	Sufficient Data (IQ2)	McKinney, et al., (2002)
	Timeliness of Data (IQ3)	Iivari (2005); Bailey and Pearson (1983); Gable, et al. (2008)
	Consistency Data Output (IQ4)	Iivari (2005)
	Correct Input to System (IQ5)	Iivari (2005); Bailey and Pearson (1983)
System Quality (SY)	System Accuracy (SY2)	Gable, et al. (2008); Sedera and Gable (2004)
	System Performance (SY5)	Gable, et al. (2008)
	Sufficient Features to Replace Existing System (SY6)	Gable, et al. (2008); Sederaand Gable (2004)
	Customization Capability (SY7)	Gable, et al. (2008); Sederaand Gable (2004)

Dimension	Measures	References
Service Quality (SV)	Accountability (SV1)	Chang and King (2005)
	Knowledge Capability (SV2)	Pitt et al. (1995)
	Assurance to Support (SV3)	Pitt et al. (1995)
	Assurance to Fix Issue (SV4)	Pitt et al. (1995)
	Meet the Standard Policy Defined by the Operator (SV5)	Chang and King (2005)
	Training Users to be Ready (SV6)	Norris (1998)
User Satisfaction (US)	Fast response time (US1)	Almutairi and Subramanian (2005)
	Bill Shock or Incorrect Bill (US2)	Joshi (2014)
	Defects (US3)	Gable et al. (2008)
	Function Correctly as Requirements (US4)	Gable et al. (2008)

In a primer on the topic, Hair, et al. (2013) advocate use of component-based (Structured Equation Modeling (SEM) or Partial Least Squares (PLS) modeling for exploratory research where the objectives include estimating complex cause-effect relationship among latent variables; this aligns with the objectives of this paper making it an obvious choice. PLS-SEM is a structured equation modeling technique capable of analyzing models involving multiple-item dimensions, with direct and indirect paths. It can simultaneously evaluate both the measurement model and the structural model with the aim to minimize error variance (Hair et al., ibid).

A PLS-SEM consists of two elements; firstly, the structural model represents the constructs and relationships or paths between these constructs. Secondly, the measurement models of the constructs display the relationships between constructs or dimensions and indicator variables. In this study there are four measurement models and one structural model linking our four dimensions. For the purpose of our investigation, SmartPLS professional software was used to analyze and estimate the parameters in the measurement models and structural model.

Westland and Lower (2010) recommend as the minimum sample size, using ten times the largest number of formative indicators to measure a single dimension; in this case, forty was the target minimum sample size. Participants in our survey comprised IT workers, marketing personnel and business users from seven telecom operators in Thailand whose market share collectively exceeds 98% of all subscribers throughout the country.

We validated our questionnaire by using the index of Item-Objective Congruence (IOC) developed by Rovinelli and Hambleton (1977), a procedure used in test development for evaluating content validity at the item development stage. This measure is limited to assessment of one-dimensional items or items that measure specified composites of skills. After validation, the questionnaire was launched as an online survey to target participants. BRMS experts and representatives from the telecom operators joined the IOC test in order to ensure clarity of the questions and hence overall quality of the questionnaire. Rovinelli and Hambleton (ibid.) advise an IOC score greater than or equal to 0.5 is appropriate.

Next, we sought permission to contact their staff from directors of the service providers involved conducting the survey. Results were assessed for both the measurement models and structural model. Following Hair et al. (ibid.) the statistical values from the analysis were then compared with the recommended values as shown in Figure 2 in order to conclude the validity of measures and model.

Assessment	Criterion	Value	References
Indicator reliability	Outer loading	> 0.708	(Hair et al, 2013)
Internal consistency reliability	Composite reliability	> 0.7	(Hair et al, 2013)
Convergence validity	Average variance extracted	> 0.5	(Hair et al, 2013)
Discriminant validity	Square root of AVE	> correlations of latent variables	(Fornell and Larcker, 1981)
Significance and relevance of model relationship	Significant of path coefficients	> 1.96 (0.05 level with two-tailed test)	(Hair et al, 2013)
Level of coefficient of determination	Level of R^2 value	>.67 substantial, >.33 average, >.19 weak	(Chin, 1998)

Figure 2: Criteria of Statistical Model Assessment

5. Research Findings

This subsection presents the findings from our research, including IOC questionnaire testing, results of data collection, assessment of the measurement models, structural model proposition testing and overall effect of the three quality dimensions on user satisfaction.

5.1 Questionnaire Validation

Five experts in the area of BRMS were used in conducting our Item-Objective Congruence questionnaire validation, with seven users involved in our pilot survey test. The experts performed IOC testing to affirm clarity of questions featured in the questionnaire. Results clearly showed that all IOC test scores for all questions were above 0.5. Thus, those questions were deemed suitable to use for the survey. After completing the IOC test, a pilot survey was conducted involving seven selected users. Feedback from the pilot revealed a need to remove ambiguities from three questions. After modifying those questions, the results of our questionnaire validation, including IOC and pilot survey test, proved the questionnaire was now of sufficiently good quality to perform a detailed survey.

5.2 Data Collection Results

The questionnaire was sent to 120 BRMS stakeholders in order to ascertain views on BRMS success inside their respective organizations. For each question, participants were asked to select the response which best described their level of agreement. All participants partook on an entirely voluntarily basis. Ninety two samples were returned with an effective ratio of 72%. Results showed that 30% of respondents had seven years or more experience,49% between(49%) between three and seven years, with just 21% having less than three years. In addition, they were working for three distinct types of telecom operator: mobile service only, fixed line and broadband services, or fixed line, broadband and mobile services. This covers all categories of telecom operator in Thailand.

5.3 Assessment of Measurement Models

The measurement model consisted of the constructs, indicators and relationships between indicators and constructs. As stated previously, in this study there were four measurement models. Firstly, we tested the reliability of all indicators in each dimension by using outer loading. The indicator's outer loadings should be higher than 0.5 (Hair, et al., 2013). Results were higher than its highest correlation with any other models. Thus, there is discriminant validity between all the measurement models. In conclusion therefore, it can be said all four measurement models were acceptable given the assessment criteria were met.

5.4 Structural Model Proposition Testing

We then evaluated the structural model to test our hypotheses. Two measures were used: statistical significance (t-tests) of the estimated path coefficients and the ability of the model to explain variance in the dependent variables R squared (R^2). To test the significance of our hypotheses, the rule proposed by Hair et al. (ibid.) was followed; namely that a t-value > 1.96 is significant at the 95% confidence level. The results showed that information quality had a t-value of 5.616, system quality a t-value of 3.456, and service quality a t-value of 5.734. Therefore all quality dimensions were found to have a significant impact on user satisfaction. R^2 attempts to measure the explained variance of the dependent variable relative to its total variance. Chin (1998) contends that an R^2 value > .67 implies substantial, .67 > R^2 value >.33 implies average, and .33> R^2 value >.19 implies weak. The coefficient of determination values for user satisfaction was 0.791.

5.5 Effect between the Three Quality Dimensions and User Satisfaction

After examining the significance of the relationships, it was important to assess the relevance of those relationships. Structural model path coefficients can be interpreted relative to one another. If one path coefficient is larger than another path, its effect on the endogenous latent variable is greater; this is known as the 'total effect'. The results shown in Table 2 revealed that total effect of service quality on user satisfaction was 0.405 which was the highest number compared to the other constructs. Thus, service quality exhibited a stronger effect on user satisfaction than both information quality and system quality.

Table 2: Total Effect between Constructs

Quality Dimension	User Satisfaction
Information Quality	0.357
Service Quality	0.405
System Quality	0.251

6. Conclusions and Future Work

The results indicate that information quality, system quality, service quality and user satisfaction are all valid measures of BRMS success. Hypothesized relationships between the four success dimensions were significantly substantiated. This corresponds with results of other studies (DeLone and McLean, 2003; Urbach and Müller, 2011). The study also identified five measures of information quality, four measures of system quality, four measures of service quality and four measures of user satisfaction. The measures for information quality were correct output, sufficient data, timeliness of data, consistency of output and correct input to (the) system. The four measures of system quality were system accuracy, system performance, sufficient features to replace (an) existing system and customization capability. Measures of service quality were accountability, knowledge capability, assurance to support, assurance to fix issue, meet standard policy and training of users. And finally, the four measures of user satisfaction were fast response time, (extent of) bill shock, defects, and (system) functioning correctly.

Once the proposed model had been successfully validated, we tested the level of significance among user satisfaction and the three quality dimensions. Results showed that service quality had the strongest influence on user satisfaction, with information quality second. This finding is quite different from other applications found in our literature review which mostly have information quality as having the strongest impact (knowledge management systems apart). It means that level of effect between user satisfaction and the three dimensions depends on type of application. One expects that complex system like BRMS require better service quality than other, easier to use application.

Our main research contribution in this paper is further empirical testing of the DeLone and McLean IS success model in respect of user satisfaction for BRMS. This study is also, to the best of our knowledge, the first to empirically validate a comprehensive success model for BRMS as well as contributing fresh knowledge relating to success measurement for enterprise systems in the Telecoms sector generally. Thus, our study advances theoretical development of such systems (thereby yielding more effective use of time and other resources), also serving as a basis for future research in this field.

From a practical point of view, our findings highlight a need for organizations to focus on the service aspect of BRMS towards enhancing user satisfaction. The study may be extended to cover a complete DandM model evaluation covering areas such as intention to use and net benefits to an organization in order to understand which factor(s) have the strongest effect on the success of telecom service providers. Further, and perhaps more significantly, the experiments could be extended to other countries, with results compared to those for Thailand, while the impact on the telecoms industry as a global entity and also impact on society at large could also be explored.

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