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Sojen Pradhan

Elina Amatya

Yijun Ma

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P22: Manipulation of Online Reviews: Analysis of Negative Reviews for Healthcare Providers

Sojen Pradhan
The University of Technology
Sojen.Pradhan@uts.edu.au

Elina Amatya
eHealth NSW
sojelina@gmail.com

Yijun Ma
Ikea Australia
myj.mark@gmail.com

Abstract

There is a growing reliance on online reviews in today's digital world. As the influence of online reviews amplified in the competitive marketplace, so did the manipulation of reviews and evolution of fake reviews on these platforms. Like other consumer-oriented businesses, the healthcare industry has also succumbed to this phenomenon. However, health issues are much more personal, sensitive, complicated in nature requiring knowledge of medical terminologies and often coupled with myriad of interdependencies. In this study, we collated the literature on manipulation of online reviews, identified the gaps and proposed an approach, including validation of negative reviews of the 500 doctors from three different states: New York and Arizona in USA and New South Wales in Australia from the RateMDs website. The reviews of doctors was collected, which includes both numerical star ratings (1-low to 5-high) and textual feedback/comments. Compared to other existing research, this study will analyse the textual feedback which corresponds to the clinical quality of doctors (helpfulness and knowledge criteria) rather than process quality experiences. Our study will explore pathways to validate the negative reviews for platform provider and rank the doctors accordingly to minimise the risks in healthcare.

Keywords: Online reviews; healthcare providers, fake reviews, Web 2.0, Crowdturfing

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1. Introduction

Web 2.0 systems such as online forums, blogs, and reviews sites became popular as they enhanced interactions between online users. This phenomenon reversed the direction of information flow from 'providers to consumers' to 'consumers to providers'. Modern lives increasingly revolve around the use of the Internet to interact with others and share and make online purchasing decisions. Users increasingly rely on user-generated content (UGC) such as online reviews, while making purchasing decisions (Barbu et al. 2019; Motyka et al. 2018; Mayzlin et al. 2014; Ma & Lee 2014; Ott et al. 2012; Jurca et al. 2010). Never have we had a significant amount of reviews for products and services so readily available online, to assist us in making decisions to purchase. These reviews offer a vantage point for consumers to voice their opinions and influence future potential customers (Fayazi et al. 2015). A study by Podium revealed that 93% of its participants stated that purchasing decisions had been impacted by online reviews (Fullerton 2017). With an incredible power to persuade consumers, online reviews help build, establish and maintain business credibility and trust.

Online reviews are popularly used across many industries but have mainly impacted the hospitality industry such as hotels, restaurants, bars, the entertainment industry (movies and video games) and others like buying items online and hiring tradesmen. In general, when consumers are buying online through e-commerce sites, online reviews are considered to be very helpful because they show previous buyers' opinions on products or services. The healthcare industry is not immune to the phenomenon of using online reviews to assess service provided by health professionals. Patients research the doctors online and begin to form perceptions based on those reviews, before making an appointment.

Companies are aware of the popularity and dependency of online reviews, and therefore, some of them actively recruit consumers to write online reviews and share their positive experiences and opinions online (Motyka et al. 2018; Malbon 2013). This is in line with the manipulation theory (McCornack 1992), wherein a false perception is generated. One of the common practices of generating biased reviews is incentivising consumers to get positive reviews (Motyka et al. 2018; Fayazi et al. 2015; Yang & Kwok 2013). Thus, fake reviews are growing at an alarming rate making the review systems unreliable (Yao et al. 2017). This phenomenon has raised the question of the legitimacy of the online reviews and threatens the consumers' trust. The study (Ott et al. 2012) showed the use of human annotators is helpful to differentiate truthful (real) or deceptive (fake) reviews, however it has also shown that it is difficult for human readers to identify the differences. Therefore, there is a tendency to use fake reviews writing services to attract more revenues by companies.

With increasing dependency of consumers on online reviews, there is an ever growing urgency to ensure the presence of genuine responses by reviewers (Dohse 2014), especially in the case of the healthcare industry. Misinformation in the healthcare industry can have a large effect on consumers and can lead to misadventures, compared to other industries. It is important to investigate the malpractices in the healthcare industry and protect the patients/consumers from potential risks. This research-in-progress paper briefly outlines the prevalence of online review manipulation in the next section. It is followed by a research approach and results in the following two sections. Future research direction and conclusion is drawn in the end.

2. Online review manipulation

Web 2.0 has made searching for products and services easier with an additional assurance from reviews provided by previous consumers. Nevertheless, several issues and concerns have risen about the truthfulness of reviews online. Information manipulation theory (McCornack 1992) recognises the deceitful nature of communication and motivation for those violations. The falsification of user-generated content for various purposes, such as nefarious monetary gain or deliberately compromising genuine products and services, has become a significant problem (Malbon 2013; Shukla et al. 2019). Since online reviews have been recognised as a powerful marketing tool to attract new customers, falsified online reviews have been promoted by some companies, either by providing discounts to consumers or recruiting dummy consumers to write positive reviews for money, also known as crowdurfing. It is a form of malicious crowdsourcing, which is based on generating deceptive information by optimising the power of the crowd. Businesses can solicit fake or deceptive reviews to boost business reviews from malicious crowdsourcing marketplaces (Hajek et al. 2020; Yao et al. 2017). Instead of creating economic and societal values through genuine user experiences and opinions, crowdurfing creates false digital impressions (Rinta-Kahila & Soliman 2017) and poses a major threat to the accuracy of online reviews. For

example, a recent study shows that one in three reviews in the world's largest travel platform, TripAdvisor, is fake (Hajek et al. 2020).

With an aim to maintain credibility and create digital impression, business owners are fabricating positive reviews, seeking web services and utilising paid writers to produce trustworthy comments which replicates a genuine consumer user experience and opinion (Shukla et al. 2019; Dohse 2014). Consumers are unable to differentiate these inauthentic online behaviours (Rinta-Kahila & Soliman 2017; Dohse 2014). These malicious practices exist in different forms like 'undercover promotion', 'astroturfing', and 'opinion spam' (Dohse 2014). For example; a number of companies offer their services to help build business credibility by boosting positive reviews, and preventing or hiding negative reviews. They advertise saying "If you have existing bad reviews, no worries. We will ensure that your customers see your good content on Google first." (Wood 2018). In addition, businesses have a choice to buy legitimate reviews from other providers selling the same products, this is referred to as 'review brokerage'

2.1 Existing relevant algorithms to detect fake reviews

There are multiple computational models to detect the prevalence of fake reviews online, and they are classified into two broad approaches: behavioural and linguistic approaches (Shukla et al. 2019) however 'relatively little is known about the actual prevalence, or rate, of deception in online review communities' (Ott et al. 2012). Despite several types of fake review detection models, there is not a perfect detection system as the fraudsters are gaming the system (Hunt 2015). Malbon (2013) posed the presence of two information risks – honesty of the seller, and honesty of the review. It is important to note that there is 'no definitive evidence' as to how to prevent and differentiate fake content from the genuine ones, based on a text review and a simple star rating; it is a pervasive problem (Hunt 2015) and problematic to diagnose.

Review spam is difficult to detect as spammers can easily disguise themselves in a plaintext situation (Wang et al. 2012). Malbon (2013) identified a number of factors affecting the authenticity of online consumer reviews: the creation of false identities for the purpose of writing reviews 'stealth campaign'; seller incentive 'buzz marketing'; search engine rank ordering of information, for example, buying better search result visibility; astroturfing - fake grassroots marketing where the seller or a seller's associate poses as a consumer; and spam reviews, including 'sockpuppeting' where a single user creates multiple accounts to generate more reviews. The pursuit of detecting manipulated reviews started as discussions over the internet forums were manipulated by interested parties. Jindal and Liu (2007) scrutinised review spam through the similarity of reviews and product features. Hu et al. (2012) examined sentiments and readability of reviews. Verbal features and non-verbal behavioural features such as review posting behavior and social interaction with other reviewers were analysed to detect fake reviews (Hu et al. 2016). Deep neural network combining with word embeddings and lexicon-based emotion indicators, used in another study (Hajek et al. 2020).

2.2 Legislative implications from fake reviews

This is not only a theoretical concern, but has legislative implications, although cases against fake reviews have been difficult to prosecute (Hunt 2015), there are some cases, for example a 2015 case against Yelp in which plaintiffs unsuccessfully sought to sue for the presence of fake reviews as security frauds (Goldman 2015); a 2014 case about a British budget hotel reviews in TripAdvisor (Hunt 2015); a lawsuit filed by Amazon in 2016 against fraudulent reviewers who wrote fake reviews in exchange for cash (Tech Crunch 2016); and in 2017, the

Australian Competition and Consumer Commission (ACCC), a consumer watchdog, has taken Perth-based building company Aveling Holmes to court for allegedly creating fake review websites for their products (Powell & Trigger 2017). This sort of activity continues for hotel price comparison site 'Trivago.com' as the site prioritised and ranked first for those who were willing to pay the highest cost per click fee (ACCC 2018). When the similar practice was detected in healthcare providers' advertisement through Chinese Search Engine Baidu, a 21 year old student passed away in Shaanxi Province, China (Wikipedia).

2.3 Reviews in Healthcare

With the imminent rise in online platforms and social media to help decide how to choose products and services, the healthcare industry has also seen a rise in the use of online reviews. Increase in the user-generated content also increases the burden on the healthcare providers, including public health authorities to constantly analyse and maintain their online presence within the social media health networks (Tang et al 2018). Patient expectations of the service and experience from a physician is not dissimilar to any other customer-oriented businesses like restaurants, hotels or retail outlets. A 2019 Survey Report by PatientPop about online reputation and patient perception indicates how online reviews are playing a crucial role in shaping patients' perspectives (Cheney 2019). The survey showed that 74.6% of people searched online to find a suitable healthcare provider and 69.9% consider a positive online reputation, whether it is a dentist, doctor or medical care. Another interesting finding was that there was an increase in the patient satisfaction rate (99%), when the negative feedback was addressed by the practice.

During the course of attaining a treatment from a doctor, there are two primary and distinct elements of quality a patient experiences, namely clinical and process quality (James et al. 2017). Clinical quality related to components like medical procedures, tests, diagnosis and quality of care whereas the process quality is specific to the service delivery like bedside manners, waiting time, staff aptitude etc. (James et al. 2017; Marley et al. 2004). Both these experiences are a major force in influencing a patient's healthcare quality perception. Misleading information on clinical quality through manipulated information may have a significant negative implication on patient's health. The scale of impact in healthcare risk is substantially bigger, complex and debilitating in comparison to other industry sectors.

3. Research approach

For reviews to reflect genuine user experiences and opinions as well as the reviews platform to gain consumers' trust and reputation, spam and fake reviews should be detected. However, despite several attempts to detect the authenticity of those reviews, it is difficult to assure the detection with a higher accuracy (Shukla et al. 2019). This study explores an alternative approach to provide a fair view to consumers by analysing negative reviews for healthcare providers. Our approach to detecting fake reviews only makes use of negative reviews for doctors which to our knowledge, is the first study conducted with this aspect. For this study, we selected one of the most popular review sites, RateMDs.com, which allows patients to rate with four separate criteria 'staff', 'punctuality', 'helpfulness' and 'knowledge' to provide feedback. The first two criteria impose process quality of the clinic and the latter two determine the clinical quality or describe the quality of the healthcare provider.

We selected the top 500 doctors from three different states: New York (NY) and Arizona in USA and New South Wales (NSW) in Australia from the RateMDs website. The reviews of doctors was scraped, which includes both numerical star ratings (1-low to 5-high) for the above mentioned criteria and textual feedback/comments. We aim to examine the negative

reviews to find out which criteria the reviewer corresponds to. As the majority of negative reviews corresponds to the process quality, this study will analyse the textual feedback which corresponds to the clinical quality of doctors. Based on the reviews which correspond to the latter two criteria (helpfulness and knowledge), we will propose a new method to validate the negative reviews for the platform provider and rank the doctors accordingly. Since the positive reviews could have been generated through biased and dedicated companies (crowdturfing), we propose to analyse negative reviews to determine the accurate rankings of doctors by the review platform.

4. Preliminary Results

RateMDs.com is one of the popular reviews sites for healthcare providers. This platform allows users to read reviews and submit reviews anonymously. Users can review their doctors across four criteria: staff, ‘punctuality’, ‘helpfulness’ and ‘knowledge’ and write free textual message as a comment or feedback. There are more than 2 million reviews in this platform around the world. Table 1 below shows the number of negative reviews and percentage of negative reviews among the best 500 doctors in the selected locations for this study.

Location	No. of Reviews for the best 500 Doctors	Total no. of -ve reviews	% of -ve reviews	No. of doctors with -ve reviews	Total no. of reviews for doctors with -ve reviews	% of -ve reviews for these doctors	Average -ve reviews per doctor	Std. Dev.
NY	23,345	871	3.73%	256/500	15,884	5.48%	3.4%	3.73
Arizona	10,876	757	6.96%	265/500	8,077	9.37%	2.86%	2.93
NSW	9,882	1048	10.6%	252/500	7,494	13.98%	4.16%	6.87

Table 1: Basic statistics of reviews for the best 500 doctors in RateMDs.com

The number of doctors who had negative reviews among the best 500 doctors in three separate locations: 256 (NY), 265 (Arizona) and 252 (NSW), are very similar. Although there are many reviews for the best 500 doctors in NY, negative reviews for them are comparatively low, 3.73% versus 6.96% in Arizona, and 10.6% in NSW respectively. The actual number of negative reviews is high in NY (15,884) in comparison to 8,077 in Arizona and 7,494 in NSW. Most prevalent negative issues are non-clinical in nature and relate to service delivery experiences like long waiting times, difficulty making appointments, billing, staff behaviour and healthcare professionals manners, therefore it is important to scrutinise the clinical or technical expertise of doctors which correspond to the latter two criteria in RateMDs site (helpfulness and knowledge) before ranking the doctors.

5. Conclusion and Future Direction

Online review platforms represent the digital word of mouth and has become an integral part of consumerism. Online reviews equip new potential consumers with knowledge and experiences of other fellow users, increase transparency and provide space for grievances; and opportunity for improvement. They also provide valuable insight to the healthcare consumers, providers and regulatory authorities to progress towards achieving patient-centered care. However, inauthentic reviews promote misinformation, mistrust and tarnish the reputation. To rectify the problem of increasing use of fake reviews, we are working towards proposing a model for platform providers of review systems which can be used to investigate the negative reviews further and provide a more accurate ranking of doctors. The model will follow the following steps:

- Extract negative reviews (star rating of 3 or less) for doctors. Include star ratings and comments for doctors who have more than one negative review.
- Conduct text mining analysis of the review to verify whether the comments/feedback correspond to the third (helpfulness) and fourth (knowledge) criteria of the RateMDs site.
- If the negative review does not correspond to the third or/and fourth criteria, but the negative comment is about ‘queueing time’ or ‘payment difficulty’ etc. this review should not affect the ranking of the doctor.
- In contrast, if it does, we will conduct cross-validation with other similar negative reviews for the same doctor to classify the doctor. The review platform needs to verify this with another source, e.g., as discussed in Gao et al. (2015) and rank doctors.

We propose that negative reviews can be scrutinized and analysed to find the accurate representation of doctors as positive reviews could have been generated from malicious intentions. Review platforms can consider this to provide helpful independent recommendations of doctors as the number of reviews continues to grow, to protect potential risks to both patients and doctors in the future. We will continue to work on this study to present some kind of results in the future.

References

- ACCC (Australian Competition and Consumer Commission) (2018, August 23). ACCC takes action against Trivago over hotel price advertisements.
- Barbu, C. M., Carbonell, G., & Ziegler, J. (2019, April). The influence of trust cues on the trustworthiness of online reviews for recommendations. In Proceedings of the 34th ACM/SIGAPP Symposium on Applied Computing (pp. 1687-1689). ACM.
- Cheney, C. (2019, April 29), 70% of Patients call Online Reviews crucial in selecting Healthcare Providers, *Health Leaders*.
- Dohse, K. A. (2013). Fabricating feedback: Blurring the line between brand management and bogus reviews. *U. Ill. J.L Tech. & Policy*, 363.
- Fayazi, A., Lee, K., Caverlee, J., & Squicciarini, A. (2015, August). Uncovering crowdsourced manipulation of online reviews. The 38th international ACM SIGIR conference on research and development in information retrieval (pp. 233-242). ACM.
- Fullerton, L. (2017), Online reviews impact purchasing decisions for over 93% of consumers, report suggest, *The Drum*. Marketing can change the world.
- Gao, G. G., Greenwood, B. N., Agarwal, R., & McCullough, J. (2015). Vocal minority and silent majority: How do online ratings reflect population perceptions of quality? *MIS Quarterly*, 39(3), 565-589.
- Hajek, P., Barushka, A., & Munk, M. (2020). Fake consumer review detection using deep neural networks integrating word embeddings and emotion mining. *Neural Computing and Applications*, 1-16.
- Hong, Y. A., Liang, C., Radcliff, T. A., Wigfall, L. T., & Street, R. L. (2019). What Do Patients Say About Doctors Online? A Systematic Review of Studies on Patient Online Reviews. *Journal of Medical Internet Research*, 21(4), e12521.
- Hu, N., Bose, I., Koh, N. S., & Liu, L. (2012). Manipulation of online reviews: An analysis of ratings, readability, and sentiments. *Decision support systems*, 52(3), 674-684.
- Hunt, K. M. (2015). Gaming the system: Fake online reviews v. consumer law. *Computer Law & Security Review*, 31(1), 3-25.
- James, T. L., Calderon, E. D. V., & Cook, D. F. (2017). Exploring patient perceptions of healthcare service quality through analysis of unstructured feedback. *Expert Systems with Applications*, 71, 479-492.

- Jindal, N., & Liu, B. (2007, October). Analyzing and detecting review spam. In Seventh IEEE International Conference on Data Mining (ICDM 2007) (pp. 547-552). IEEE.
- Jurca, R., Garcin, F., Talwar, A., & Faltings, B. (2010). Reporting incentives and biases in online review forums. *ACM Transactions on the Web (TWEB)*, 4(2), 5.
- Ma, Y., & Lee, H. H. (2014). Consumer responses toward online review manipulation. *Journal of Research in Interactive Marketing*, 8(3), 224-244.
- Malbon, J. (2013). Taking fake online consumer reviews seriously. *Journal of Consumer Policy*, 36(2), 139-157.
- Mayzlin, D., Dover, Y., & Chevalier, J. (2014). Promotional reviews: An empirical investigation of online review manipulation. *American Economic Review*, 104(8), 2421-55.
- Menon, A. V. (2017). Do online reviews diminish physician authority? The case of cosmetic surgery in the US. *Social Science & Medicine*, 181, 1-8.
- Motyka, S., Grewal, D., Aguirre, E., Mahr, D., De Ruyter, K., & Wetzels, M. (2018). The emotional review–reward effect: how do reviews increase impulsivity? *Journal of the Academy of Marketing Science*, 46(6), 1032-1051.
- Ott, M., Cardie, C., & Hancock, J. (2012, April). Estimating the prevalence of deception in online review communities. The 21st international conference on WWW (pp. 201-210).
- Powell, G. & Trigger, R. (2017, Nov 27). Aveling Holmes taken to court over ‘misleading’ review websites, *ABC News*.
- Rinta-Kahila, T., & Soliman, W. (2017). Understanding crowdturfing: the different ethical logics behind the clandestine industry of deception. In *European Conference On Information Systems. Association For Information System (AIS)*.
- Shukla, A., Wang, W., Gao, G. G., & Agarwal, R. (2019). Catch Me If You Can—Detecting Fraudulent Online Reviews of Doctors Using Deep Learning.
- Tang, W., Ren, J., & Zhang, Y. (2018). Enabling trusted and privacy-preserving healthcare services in social media health networks. *IEEE Transactions on Multimedia*, 21(3), 579-590.
- Wang, G., Xie, S., Liu, B. and Yu, P.S., 2012. Identify online store review spammers via social review graph. *ACM Transactions on Intelligent Systems and Technology (TIST)*, 3(4), p.61.
- Wood, P. (2018), Read online review sites? Here are all the ways they’re faked and manipulated.
- Yang, W., & Kwok, L. (2013, December). Detecting Frauds in Restaurant Reviews. In 2013 International Conference on Computer Sciences and Applications (pp. 123-129). IEEE.
- Yao, Y., Viswanath, B., Cryan, J., Zheng, H., & Zhao, B. Y. (2017, October). Automated crowdturfing attacks and defenses in online review systems. In *Proceedings of the 2017 ACM SIGSAC Conference on Computer and Communications Security* (pp. 1143-1158).
- Zhang, D., Zhou, L., Kehoe, J. L., & Kilic, I. Y. (2016). What online reviewer behaviors really matter? Effects of verbal and nonverbal behaviors on detection of fake online reviews. *Journal of Management Information Systems*, 33(2), 456-481.

P23: Mobile Money and Financial Inclusion for the Unbanked – A Choice Analysis

Batloung Hlabeli
University of Cape Town
hlbbat001@myuct.ac.za

Pitso Tsibolane
University of Cape Town
pitso.tsibolane@uct.ac.za

Malcolm Garbutt
University of Cape Town
grbmal002@myuct.ac.za

Abstract

This study explored the impact of mobile money on financial inclusion and development from Kleine's Choice perspective in the lives of entrepreneurs of a least developed country (LDC). A thematic analysis of data gathered from in-depth semi-structured interviews of twenty-three micro and small enterprise entrepreneurs based in Lesotho's capital city Maseru suggested a variety of primary outcomes that result when the entrepreneurs exercise their choice to use mobile money technology. These include achieving a higher quality of life through increased revenue and profits due to the transactional convenience, financial management capabilities and improved access to banking services (financial inclusion) provided by the mobile money technology. For the entrepreneurs to achieve these primary outcomes, a choice must exist and be accompanied by an awareness of the available choices that can be made. Furthermore, the entrepreneurs must possess the agency to make a choice and actively make a choice before an outcome can be achieved. Mobile money is not without limitations such as withdrawal limits, network failures and safety issues which limit the entrepreneurs' agency to exercise choice. This study proposes a practical model based on Kleine's Choice Framework for assessing development that is based on a rich and contextualised understanding of choice, agency and structure.

Keywords: Mobile Money, MPESA, Choice Framework, ICT4D, Financial Inclusion.

1. Introduction

Mobile money has been promoted to assist the estimated 30% of the world's population denied financial inclusion through banking the unbanked (Finmark, 2018; Hughes & Lonie, 2007; Schwittay, 2011). Over the past decade, mobile money has delivered exceptional benefits to the micro and small enterprise (MSE) sector in developing countries (Adaba, Ayoung & Abbott, 2019). In Lesotho, many people are not only unbanked but also lack financial access (FinMark, 2016). Simultaneously, Lesotho suffers from unemployment issues in a vicious cycle of unemployment, further increasing unemployment (Damane & Sekantsi, 2018). Each unemployment shock can result in increased unemployment for eight years after such an event (Damane & Sekantsi, 2018). Productivity shocks can increase unemployment for the following three years, which led to Damane and Sekantsi (2018) recommending government intervention in increasing both productivity and employment. Sekantsi and Motelle (2016) recommend developing closer relationships between mobile money operators and commercial banks which could lead to greater access to banking services and an expansion of financial inclusion.

The underlying assumption of these authors is that mobile money provides developmental outcomes for MSE entrepreneurs through financial inclusion and overall improvement of their financial wellbeing. However, before government and commercial intervention is undertaken, it is advisable to consider if the citizens want and would make use of the proposed interventions. This has led authors such as Dube, Chitakunye and Chummun (2014) to conclude that there is a need to understand customer choices for financial inclusion better and that governments be sensitive to consumer choices.

Sekantsi and Motelle (2016) recommend the use of mobile money supported by education and improved network infrastructure in rural areas. They also recommend that Lesotho use Chinese businesses for the diffusion of mobile money due to their existing reach into rural communities. Nevertheless, both Damane and Sekantsi (2018) as well as Sekantsi and Motelle (2016) take a collective view which discounts the views of individual entrepreneurs.

Mobile money falls in the ambit of information and communications technology (ICT) which is promoted as a solution to assist in improving both individual and collective lives in developing economies. When used for developmental purpose, ICT is commonly referred to as ICT4D which seeks to better understand two challenges: the provision of access to ICT that people wish to use; and the implementation of technologies that improve value in their individual and collective lives of the citizens (Kleine, Light & Montero, 2012).

Drawing on a study amongst MSE entrepreneurs in Maseru, Lesotho, we use dimensions of choice from the Choice Framework (Kleine, 2010) to assess the awareness and use of mobile money in an emerging economy. ICT4D, financial inclusion and development are complex issues, and we need to acknowledge both for- and against points of view. Through an exploration of the connections between mobile money and well-being, this study aims to contribute empirical evidence and insights to the under-explored role of choice in the broadening of individual developmental outcomes through mobile money use.

The paper progresses as follows. In the next section, a background to financial inclusion and mobile money is provided. Mobile money is contextualised in the developing economy of Lesotho, and the Choice Framework is described as a theoretical framework for the research. The third section describes the research approach, which provided the findings in section four. The paper ends with a discussion and conclusion in section five.

2. Related Work

The relationship of mobile money in providing financial inclusion is described in the following sections and related to the context of Lesotho. An overview of MSE entrepreneurs in Lesotho is provided, followed by the dimensions of choice and developmental outcomes from the Choice Framework as a theoretical framework for our research.

2.1 Financial Inclusion

Mobile money has led to financial inclusion with substantive economic benefits in developing countries (Suri & Jack, 2016). Financial inclusion is the availability, accessibility and affordability of financial services and products for all people (FinMark, 2016). The FinMark view is more comprehensive than the naive definition of “banked” versus “unbanked” which erroneously assumes that the mere provision of a banking account will meet individual needs. Financial inclusion is multi-dimensional with access to financial services as one dimension to which FinMark (2016) add usage and quality.

Access - Access must be both available and appropriate to the community. Without access, financial products and services are not able to provide financial inclusion.

Usage - Usage of financial products and services serves as a proxy to determine access and uptake of the products or services.

Quality - Quality of financial products and services has a direct influence on usage but is challenging to measure. Poor quality will reduce usage over time. FinMark (2016) recommends four ways of understanding quality: product fit; value-add; convenience; and risk.

The financial products must be appropriate and tailored to the needs of clients while adding value to their financial situation. The products must be accessible and user-friendly and not increase the financial risk of the client. Consequently, Schwittay (2011) proposes a more complicated system of global financial inclusion assemblages which combines people, equipment and organisations from various nationalities.

Moreover, existing clients want the ability to move money over time – using instruments like savings, insurance, and access to credit (Donovan, 2012). Thus, in addition to purely banking products, financial products and services must incorporate micro-finance services, including loans products, savings mechanisms, and insurance policies. These requirements render financial inclusion, both a development problem and a market opportunity (Schwittay, 2011). Financial inclusion rests on the materialistic assumption that financially poor people desire financial inclusion. The potential that this is not the case threatens the foundation of the financial inclusion assemblage (Schwittay, 2011). Nevertheless, the complexity of the financial inclusion assemblage is challenging to research in the context of financially excluded individuals. Fortunately, the increasing access and usage of mobile money, which has been seen to have a positive bearing on financial inclusion (Dube, Chitakunye & Chummun, 2014) provided a proxy for research purposes.

2.2 Mobile Money

Mobile money uses mobile wallet apps on mobile phones to provide unbanked people to ability to pay for goods and services from merchants using mobile phones (Ntale & Bosire, 2018). Mobile money replaces physical cash when paying for goods and services or when receiving payments from customers (Kemal, 2016) and provides convenience for other micro banking services such as payment of bills, money transfers and savings (Gichuki & Mulu-Mutuku, 2018). Mobile money originated in Africa in Kenya through M-Pesa by Safaricom in 2007 (Ezeh & Nwankwo, 2018). M-Pesa has been accompanied by numerous benefits, including the emergence of a mobile banking ecosystem which has provided socio-technical transformation (Lepoutre & Oguntoye, 2018). Research indicates that the presence of M-Pesa has benefited both rural and urban communities because it is regarded as a safe way to transfer and save monies. The attraction of mobile money is the ability to increase productivity, reduce transaction costs, and create employment opportunities and growth for businesses (Donovan, 2012).

Mobile money attracts investment and spurs revenue growth; supports the sustainability of businesses; formalises the informal sector; enables efficiencies through digitisation, and reduces frictions associated with cash usage (Gencer, 2011). The mobile money technology is considered to be transformational (Donovan, 2012), bringing about a positive impact on financial wellbeing (Gencer, 2011). Mobile money serves to improve business efficiencies as traders make payments to suppliers (Ng'weno & Ignacio, 2010; Plyler et al., 2010) through a

secure means of transferring money between the unbanked and the banked (Ntale & Bosire, 2018).

Mobile money can reduce transport costs, improve manageable cash flow and reduce customers' credit exposure while saving time, such as by avoiding long queues at banks (Perekwa, Prinsloo & Venter, 2016). Supporting shortened supply chains and delivery times, mobile money can improve an enterprise's growth (Perekwa et al., 2016) which is associated with the creation of employment opportunities (Gencer, 2011) resulting in economic development (Kushnir, 2010). The ease of use of mobile money has resulted in mobile money technology being adopted by small firms to conduct their business transactions (Mbiti & Weil, 2011).

Although the literature on mobile money in Lesotho discusses the context of agency, financial exclusion and inclusion, it takes a collectivist stance (Sekantsi & Lechesa, 2018; Sekantsi & Motelle, 2016; FinMark, 2016; Jefferis & Manje, 2014; Tsemame 2015) and neglects the individualistic contexts. Moreover, extant literature does not theoretically stress mobile money phenomena from an ICT4D perspective. Thus, the gap in ICT4D and mobile money literature in Lesotho calls for more research.

2.3 Mobile Payments in Lesotho

As of 2014 subscribers to Lesotho mobile money providers, M-Pesa and EcoCash, numbered more than the registered bank account holders (Anderson & Reynolds, 2015) with Lesotho receiving 29% of GDP through M-Pesa. Six months after the inception of M-Pesa in Lesotho, the adoption and use of mobile money rose to 62% of all money savings and transfers (Central Bank of Lesotho, 2013). During the 2018-2019 financial year, M-Pesa revenues grew by 32.2% and accounted for USD2,8 billion in transactions from 13,5 million customers across all of Africa (Vodacom, 2019).

M-Pesa services are accessible across the entire country through retail shops who act as M-Pesa agents. Both withdrawals and fund deposits can be processed at M-Pesa agents. Services associated with M-Pesa include sending and receiving money across mobile networks; paying electricity and water bills; buying goods and services from shops where mobile money is allowed as a mode of payment; paying for television subscriptions; paying monthly insurance premiums; and transferring airtime to M-Pesa (Tsemame, 2015).

2.4 Micro and Small Enterprises (MSEs) in Lesotho

MSEs in Lesotho employ less than nine employees and generate annual turnover less than the equivalent of USD65 000 (Mokoatleng, 2014). MSEs have begun to be recognised by the Government of Lesotho for their contribution to job creation, poverty alleviation and economic development (Maliehe, 2018; Workman, 2019). However, MSEs face challenges that hinder their operation in the business ecosystem, including lack of funding, lack of business skills, lack of ICT expertise, and limited business connections (Renny, 2011). Mokoatleng (2014) observed that due to the lack of access to banking services and financial assistance, the growth of the MSE sector in Lesotho is negatively impacted, resulting in further unemployment and poverty.

Business funding is predominantly from personal funds with few entrepreneurs acquiring funding from financial institutions (Khoase, 2015; Mokoatleng, 2014; Siringi, 2011). Frequently cited reasons for lack of funding by financial institutions are a lack of collateral, lack of a business plan, lack of information required by financial institutions, lack of financial

literacy, and high-interest rates for loans (Mokoatleng, 2014; Mazanai & Fatoki, 2012). Mots'oene (2014) pointed out that financial institutions do not provide financial credit to people from disadvantaged economies as they are not considered financially viable. Mobile money platforms which provide accounting services such as financial history over a specific period may deliver an affordable, accessible and acceptable solution for the financial institution (Mramba et al., 2017).

Donovan (2012) recognised a need for time-based movement of money in the form of savings, insurance and loans. However, Dube, Chitakunye and Chummun (2014) observed that savings and loan facilities were not popular despite mobile money service having a positive bearing on financial inclusion. This led Dube, Chitakunye and Chummun (2014) to conclude that there is a need to understand customer choices for financial inclusion better. They support this with a further conclusion that the impact of financial inclusion initiatives could be increased if, amongst regulatory and infrastructure concerns, governments were sensitive to consumer choices.

2.5 Choice Framework

The Choice Framework (Kleine, 2010) is a theoretical framework built on Sen's Capabilities Approach to assess the contribution of ICT to development. Sen's Capabilities Approach posits that development is a process of expanding the real freedom that people enjoy that leads to the lives they desire (Sen, 1999). The objective of the Capabilities Approach is to measure an individual's economic well-being in terms of capabilities and functionings (Kuklys & Robeyns, 2005). Sen (1999) explains that development is the freedom to make choices from personal, social, economic, and political perspectives.

In Sen's broader scope, economic well-being is the leading indicator of development. Sen stresses the significance of social, cultural and political dimensions of development. Thus, the Capabilities Approach is a paradigm that provides crucial information about a person's well-being and social engagement (Yousefzadeh et al., 2019). However, Robeyns (2003) argued that the Capabilities Approach does not adequately explain or describe the social structures and how individuals use ICTs to make choices. While ICT4D authors have used the Capabilities Approach to understand the impact of mobile money on development (Adaba, Young & Abbott, 2019; Donovan, 2012), our study employs the Kleine Choice Framework (2010), as shown in Figure 1. The Choice Framework places the focus on choice, including the choice of an ICT such as mobile money, as the principal developmental outcome that determines all subsequent development outcomes.

The Choice Framework uses qualitative research methods to gain in-depth information about an individual's choices based on the life they desire (Kleine, 2010). The Choice Framework is geared to ICT4D studies but is equally applicable to other development areas (Kleine, 2010). To maintain the holistic and systemic richness of the Choice Framework, it must be operationalised appropriately, for which Kleine (2010) recommends working systematically backwards from development outcomes through dimensions of choice (degrees of empowerment) to agency and structure.

Development outcomes require the capability to make decisions and are influenced by a person's choice of what they value as part of their life (Kleine, 2010). There are two parts to development outcomes, namely primary outcomes and secondary outcomes. The current study is limited to the primary outcome, which according to Kleine (2010) is the individual's choice. As depicted in Figure 1, Dimensions of Choice result from combinations of agency

and structure (Kleine, 2010). Dimensions of Choice are attained when an individual utilises ICT to enhance their lives. Choice comprises two subcategories: Dimension of Sense of Choice, which comprises the existence and sense of choice; and Dimension of Use of Choice which comprises the use and achievement derived from the use of choice. Sense of choice relates to an individual’s awareness of a choice while the use of choice is the operationalisation of the identified choice.

Freedom to make a choice may be considered in a given social context relative to a person’s resources (Kleine, 2010). Resources refer to material resources, financial resources, natural resources, geographical resources, psychological resources, cultural resources, social resources, education and skills resources, health resources, as well as information as a resource (Kleine, 2010). Structure in the Choice Framework includes formal and informal laws, regulatory policies, norms and customs that frame the empowerment process (Kleine, 2010). However, we restrict the current study to the primary outcome of choice and the relevant dimensions of choice.

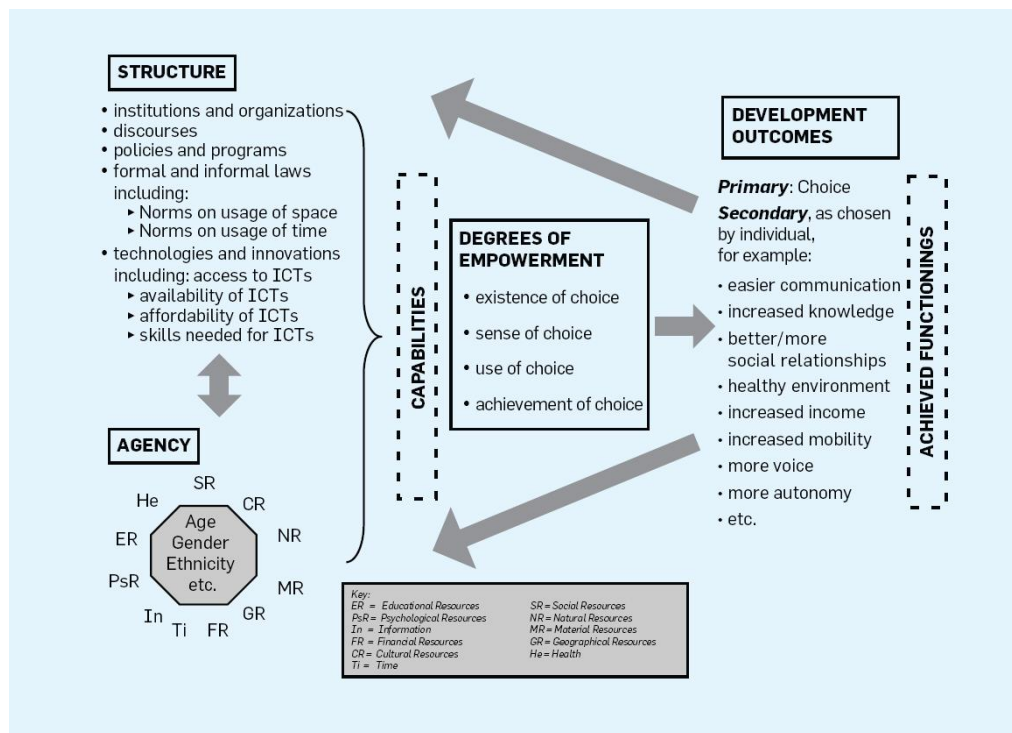


Figure 1. Illustration of Choice Framework (Kleine et al., 2012)

2.6 Research Aim and Research Questions

To meet the objective of this study of assessing the use of choice in using mobile money towards the outcome of financial inclusion, we posed the following questions: What mobile money usage choices do MSE entrepreneurs make? And, What dimensions of choice – existence, sense, use and achievement – do MSE entrepreneurs engage in when making mobile money choices?

3 Research Approach

Guided by the Choice Framework (Kleine, 2010), the current study made use of qualitative semi-structured interviews. Interviews were considered an appropriate approach to collect data and provided the ability to engage socially with the respondents who were identified through a purposive-snowballing technique. This sampling method provided referrals from

interviewees. The study targeted MSE entrepreneurs from multiple trading industries – food, clothing, health, ICT, hairdressing and saloons. All the interviews were conducted in Maseru, where it was convenient to obtain a sample due to constraints of time and logistics. The respondents were all enterprise owners. Some of the interviews were conducted in English, but most were conducted in Sesotho (Lesotho’s national language) and translated into English by the first author. After completion of each interview, the recordings were saved in a .mp3 format, translated and transcribed into text and analysed thematically. Braun and Clarke (2006) hold that thematic analysis is an appropriate method for analysing qualitative data pertaining to well-being. The process consists of six phases, as shown in Table 1. Phase 1 familiarises researchers with the data from which initial codes are generated in phase 2. Phase 3 collates the initial codes into themes which are reviewed in phase 4. Phase 5 refines that themes through an iterative process from which the final output of 3 to 8 concepts is produced (Phase 6).

Phase	Description of Process
1. Familiarising yourself with your data	Transcribing data (if necessary), reading and rereading the data, noting down initial ideas.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes	Checking in the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic map of the analysis.
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells; generating clear definitions and names for each theme.
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, the final analysis of selected extracts, relating back to the analysis to the research question and literature, producing a scholarly report of the analysis.

Table 1. Thematic Approach Process (Braun & Clarke, 2006).

A pilot study to evaluate the feasibility of the study was undertaken. Based on the pilot study, minor changes were made to the interview guide and the acquisition of a better quality recording device. A total of 23 interviews were undertaken and thematically analysed from which a summary of findings is presented in the next section. The interviews for the pilot project and the main study were all conducted by the first author. All ethical guidelines (dignity, privacy, confidentiality, anonymity, informed consent) were duly approved by the academic institution and were observed by the researchers.

4 Findings

Interviews were conducted with 23 MSE entrepreneurs in Maseru, Lesotho. The respondents represented a range of businesses, as shown in Table 2. The majority of interviewees operated clothing businesses (n=5, 22%) followed by pharmacies and salons (n=3, 13% respectively).

Business	Count	Average Years	Business	Count	Average Years
Clothing	5	8.8	IT and Office Equipment	2	8.5
Pharmacy	3	10.0	Stationery and Printing	2	14.0
Salon	3	4.3	Not Specified	2	11.0

General Dealer	2	1.0	Cigarette Vendor	1	5.0
Herbal Products	2	7.0	Cleaning Services	1	4.0
			Total	23	7.3

Table 2. Business Type and Average Years of Operation.

The respondents had collectively traded for an average of 7.3 years. Stationery and printing businesses showed the highest average number of years of trading (average=14 years), followed by pharmacies (average=10 years) and clothing operations (average=8,8 years).

Nine respondents (39%) situated their businesses for accessibility to their market, while three (13%) were located their business based on the availability of space. One respondent (4%) did not have a fixed business location, and another (4%) operated online. The balance of 9 (39%) did not reveal any reasons for the location of their businesses.

The respondent businesses employed between one and eleven staff with an average headcount of 3.5 staff. Skill acquisition by the respondents stemmed predominantly from experience (n=13, 57%) while three (13%) had specialised training. Three respondents (13%) suggested that they require financial skills and one respondent (4%) showed an interest in acquiring marketing skills.

The majority of businesses were registered (n=15, 65%) and four (17%) were not registered. The balance of the respondents did not indicate their registration status. Half of the respondent businesses (n=12, 52%) were explicitly self-funded with one respondent acknowledging the use of bridging loans. The balance of the respondents was implicitly self-funded. For example, respondent four used deposits for funding “... *you just deposit it into my M-Pesa account, and I withdraw money. That money I buy t-shirts with it and then print them*”.

4.1 Primary outcome

The primary outcome occurred when MSE entrepreneurs chose to use mobile money. For the MSE entrepreneurs, outcomes primarily revolved around achieving a higher quality of life associated with successful enterprises. Mobile money increased revenue and profits, often generating income from commissions on mobile money transactions.

Three primary outcome themes were observed: (1) convenient transacting with improved business outcomes; (2) financial management activities; and (3) financial inclusion and financial information access. The first outcome, having convenient access to financial information, was a goal stated by most of the entrepreneurs. Mobile money provided outcomes of time-saving, empowerment of economically disadvantaged individuals, financial management skills and cost reductions. Respondents found mobile money convenient for transacting. “*I know that when I have deposited money today, tomorrow I can find it at my convenience.*” (Res 13). Mobile money made it convenient to process bill payments and to save, transfer and receive funds. “*It has improved my life, like all the money that I have goes to M-Pesa. Whenever I want it, I just go get it. It is just makes my business easy.*” (Res 2). Mobile money was more convenient than handling cash. “*It is the easiest way of handling cash.*” (Res 23). Mobile money led to improved business performance and increased turnover. “*...but since M-Pesa came in the business flows quite easy*” (Res 2). “*it helps me get increased turnover*” (Res 7). At the same time, mobile money helped the respondents to reduce costs. “*it cut my transportation costs such as putting fuel into my car...*” (Res 12). Overall, mobile money improved respondents’ well-being and quality of life. “*It has*

improved my life like ehh all the money that I have goes to M-Pesa. Whenever I want it, I just go get it. It is just makes my business easy.” (Res 2). *“M-Pesa plays a huge part in my life.”* (Res 6).

The second outcome of financial management was observed. Respondents considered mobile money as enabling them to manage money. *“I am able to manage money... Therefore, that enables me to save it.”* (Res 4). Respondents also benefitted from more accurate transactions compared to handling cash. *“And while dealing with hard cash that might make a person to miss numbers during calculations. As well as misplacement of cash.”* (Res 17).

Thirdly, the respondents pointed out that the use of M-Pesa made them have a feeling of accessing commercial bank services, *“It forms something like a bank where a person can keep money because its fees are quite low as compared to bank fees”* (Res 6). Respondents showed appreciation for financial equality. *“On M-Pesa, there is not platinum members or gold cardholders. All people are the same”* (Res 19). *“I do allow them to use M-Pesa to transfer money to me. Especially those people from the rural areas.”* (Res 21).

4.2 Dimensions of Choice

For entrepreneurs to achieve the primary outcomes, choices must exist, and entrepreneurs must be aware of them. The entrepreneurs must also make use of the choices and have the ability to achieve the taking of choice before achieving an outcome. MSE entrepreneurs were observed to identify possible choices. The majority of respondents indicated that cost and access to mobile phones, the usability of mobile money services, education and geographic locations were not barriers for choosing an M-Payment platform. *“M-PESA provider officials came in here and asked me to join so I joined from that time,”* (Res 16) *“they gave me a phone and I didn’t pay,”* (Res 16). MSE entrepreneurs guided customers through the purchasing process, especially customers who were not familiar with mobile money platforms.

The respondents knew about the opportunities that M-Pesa would bring into their businesses. They noted that using M-Pesa could enable them to improve their lives and enterprises’ performance - both financial and non-financial performance. It was evident that MSE entrepreneurs knew the opportunities provided to their businesses by M-Pesa. Moreover, the telecoms provider made an initiative of offering free mobile phones to MSE entrepreneurs; hence, it was up to them how they used the resources and opportunities to achieve their desired outcomes. *“...I want to see myself having a better life ... I know that when I have deposited money today, tomorrow I can find it at my convenience.”* (Res 13). *“...but since M-Pesa came in the business flows quite easy ... to get more customers...”* (Res 2). *“it helps me get increased turnover”* (Res 7). Respondents used mobile money for business purposes and to transfer and receive money to and from relatives and friends. *“When someone came in to buy a laptop and then payment processing becomes easy through M-Pesa.”* (Res 2). *“...M-Pesa helps me transfer money to friends and relatives”* (Res 14). *“Things such as business’s water bills and electricity bills can be covered with M-Pesa money.”* (Res 22). *“I do pay my employees through M-Pesa. Especially those ones who are working at home.”* (Res 11).

Achievement of choice related directly to the primary outcome whereby the use of mobile money combined a convenient method of transacting with financial inclusion and the ability to manage finances. Respondents were impressed with the role that mobile money played in their lives. Most respondents indicated that mobile money influenced their lives significantly. *“We have a lot of customers. So M-Pesa, just like you are eager to know about it, it is one of*

the technological innovations that helps us a lot ... Through M-Pesa my business was able to broaden its market.” (Res 12). “That contributed significantly to an increase in customers because today not everyone goes around holding cash. People use M-Pesa or bank cards ... The reason why I am living today it’s because of this business.” (Res 10). “I am now able to help my family as well as myself financially.” (Res 9).

4.3 Limitations Affecting Choice

The respondents pointed out that although mobile money benefited them, they encountered challenges in using the technology. Withdrawal limit, network failures and safety issues were observed. M-Pesa restricted withdrawal amounts for business accounts as well as personal accounts. These restrictions limited access to the MSE entrepreneur limited to their financial information. *“Since I have a lot of customers, even before the end of the month I will be told that I have reached the limit.” (Res 60). “Limit is a major problem because I often withdraw money from M-Pesa and find that I even exceed a monthly limit.” (Res 4). Network outages were seen to restrict business operations. “Problems arise when there is no network connectivity. So in that case when a customer has paid we don’t get a notification...” (Res 19). Security issues were a cause for concern. “I want to use M-Pesa as my bank. So such things need us to have a tight security especially towards late hours. Even when I am walking on streets I know that people already know that I am a bank and there is money with me.” (Res 13).*

5 Discussion and Conclusion

This study set out to explore MSE entrepreneurs choice to use mobile money in a developing economy. Using the setting of Lesotho, the current study observed MSE entrepreneurs being aware of the choice to use mobile money. MSE entrepreneurs were shown to choose to use mobile money and achieved positive outcomes from their choices. The findings confirmed that the use of mobile money within the MSE sector enabled micro-entrepreneurs to access financial information conveniently which led to lives that they value (Donovan, 2012). Consequently, calls for additional government and financial institution interventions could be justified from an individual perspective (Aker et al., 2013; Duncombe & Boateng, 2009). Nevertheless, the entrepreneurs faced several issues while using mobile money, including network disruptions, withdrawal amount limits and security risks. Thus, although mobile money provided capabilities for choices to be made, limitations to capabilities hamper development outcomes and achieved functionings as depicted in Figure 2.

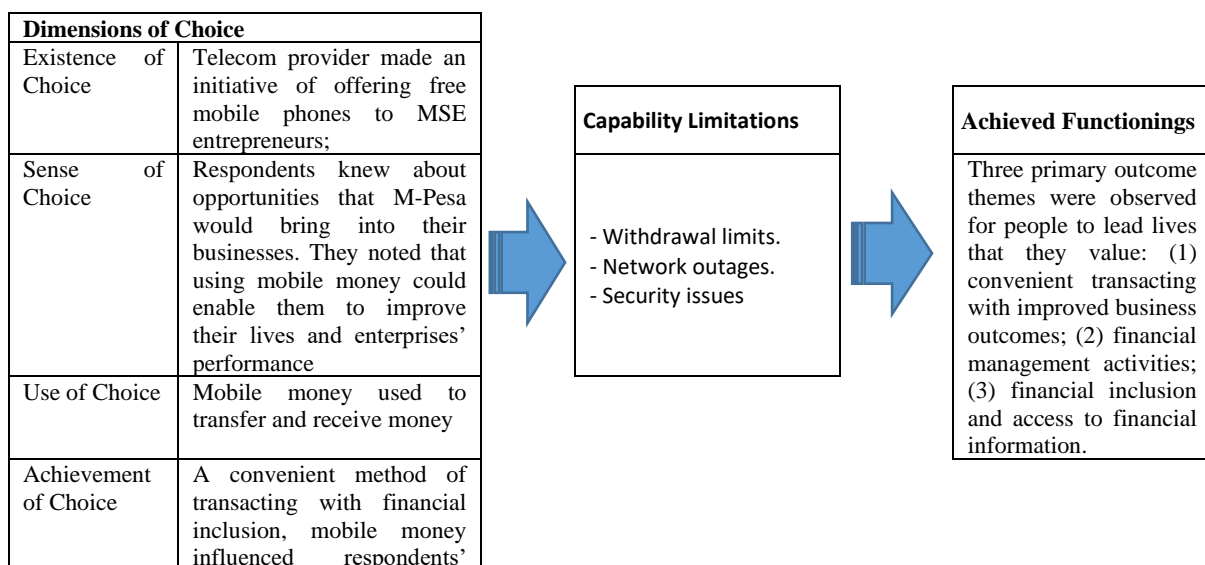


Figure 2. Dimensions of Choice Capability Limitations and Achieved Functionings.

Financial exclusion in the global South, particularly in the context of extremely impoverished countries such as Lesotho, remains a significant challenge that ICT4D researchers should seek to understand from various perspectives (Adaba et al., 2019; Tsibolane, 2016). Using Kleine's Choice Framework (Kleine, 2010), this paper highlights the need to align personal choice and its enablers and impediments in order to gain better insights about the role of ICTs in affording all humans the power to live the lives they desire to live. The implication of this study for state institutions and policymakers is that the creation of enabling structural conditions as well as the diffusion of mobile money products among micro-enterprises can help alleviate the sense of financial exclusion while promoting a culture of savings (Aker & Wilson, 2013). The study had a few limitations. It is a cross-sectional view of the entrepreneurs' experiences located in one city of a developing country where access to technology is superior compared to the majority of the country. Furthermore, the sample of 23 entrepreneurs from the business section of Maseru could be broadened to cover a broader population of entrepreneurs across more sectors of Lesotho life for a more generalisable study.

References

- Adaba, G. B., Ayoun, D. A., & Abbott, P. (2019). Exploring the contribution of mobile money to well-being from a capability perspective. *The Electronic Journal of Information Systems in Developing Countries*, e12079.
- Aker, J., Boumijel, R., McClelland, A., & Tierney, N. (2013). How do electronic transfers compare? Evidence from a mobile money cash transfer experiment in Niger. Tufts University. Retrieved from http://sites.tufts.edu/jennyaker/files/2010/02/Zap-it-to-Me_12sept2013_No-Appendices.pdf
- Aker, J. C., & Wilson, K. (2013). Can mobile money be used to promote savings? Evidence from Northern Ghana (SSRN scholarly paper no. ID 2217554). Rochester, NY: Social Science Research Network.
- Anderson, C. L., & Reynolds, T. (2015). Review of Interoperability and Regulations of Mobile Money Pierre Biscaye, Caitlin Aylward. Evans School Policy Analysis and Research. University of Washington.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101.
- Central Bank of Lesotho. (2013). Annual Report. Central Bank of Lesotho, Maseru. CGAP. Technology Program Country Note, pp.1-14. Available online at <http://www.cgap.org/sites/default/files/CGAP-Technology-Program-Country-Note-GhanaJun-2011.pdf>.
- Damane, M., Sekantsi, L., & Molapo S. (2018). Testing the stability of money demand function in Lesotho. *International Journal of Sustainable Economy*, 10(4)
- De Koker, L. & Jentsch, N. (2013). Financial Inclusion and Financial Integrity: Aligned Incentives?, *World Development*, 44 (1), pp. 267–280.
- Donovan, K. (2012). Mobile money for financial inclusion. *Information and Communications for development*, 61(1), 61-73.

- Dube, T., Chitakunye, P. & Chummun, B. Z. (2014). Mobile Money as a Strategy for Financial Inclusion in Rural Communities, *Mediterranean Journal of Social Sciences*, 5(25), pp. 216-224.
- Duncombe, R., & Boateng, R. (2009). Mobile phones and financial services in developing countries: A review of concepts, methods, issues, evidence and future research directions. *Third World Quarterly*, 30(7), 1237–1258. <https://doi.org/10.1080/01436590903134882>
- Ezeh, P.C., & Nwankwo, N. (2018). Factors that Influence the Acceptance of Mobile Money in Nigeria. *Journal of Research in Marketing*, 8(2), 669-682.
- Finmark. (2018). Research Report on Mobile Money in South Africa. Available Online: http://www.finmark.org.za/wp-content/uploads/2017/12/Final-Report-on-Mobile-Money-in-South-Africa-v11.1_clean_digital_CB.pdf. Last accessed: 05 December 2019.
- Finmark. (2016). New facts and figures from Finscope MSME survey Lesotho. Available Online: <http://www.finmark.org.za/new-facts-and-figures-from-finscope-msme-survey-lesotho-2016/>. Last Accessed: 11 December 2019.
- Gencer, M. (2011). Mobile Money Movement: Catalyst to Jump-Start Emerging Markets. *Innovations: Technology, Governance, Globalization*, 6(1), 101-117.
- Gichuki, C. N., & Mulu-Mutuku, M. (2018). Determinants of awareness and adoption of mobile money technologies: Evidence from women micro entrepreneurs in Kenya. In *Women's Studies International Forum* (Vol. 67, pp. 18-22). Pergamon.
- Hughes, N., & Lonie, S. (2007). M-PESA: mobile money for the “unbanked” turning cellphones into 24-hour tellers in Kenya. *Innovations: technology, governance, globalisation*, 2(1-2), 63-81.
- Ignacio, M., & Ng'weno, A. (2010). Three keys to M-PESA's success: Branding, channel management and pricing. *Journal of Payments Strategy & Systems*, 4(4), 352-370.
- Jefferis, K., & Manje, L. (2014). Making Access Possible: Lesotho Country Diagnostic Report. A Report Commissioned by Finmark Trust, Centre for Financial Regulation and United National Capital Development Fund. Available online at http://www.finmark.org.za/wpcontent/uploads/pubs/MAP-Lesotho_Diagnostic-report_final_2014.pdf.
- Kemal, N.I.V. (2016). Mobile Payment System: Theory and Cases of Services Modularity. PhD thesis, The London School of Economics and Political Science (LSE).
- Kleine, D. Light, A., & Montero, J. (2012) Signifiers of the life we value? – considering human development, technologies and Fair Trade from the perspective of the capabilities approach, *Information Technology for Development*, 18:1, 42-60.
- Kleine, D. (2010). ICT4WHAT?—Using the choice framework to operationalise the capability approach to development. *Journal of International Development*, 22(5), 674-692.
- Khoase, R. (2015). The influence of public and private supporting institutions on small, medium and micro enterprise development: a comparative study between Lesotho and SA. PhD Thesis. http://ukzn-dspace.ukzn.ac.za/bitstream/handle/10413/15147/Khoase_Refiloe_Gladys_2015.pdf
- Kuklys, W., & Robeyns, I. (2005). Sen's capability approach to welfare economics. In *Amartya Sen's Capability Approach* (pp. 9-30). Springer, Berlin, Heidelberg.
- Kushnir, K. (2010). How Do Economies Define Micro, Small and Medium Enterprises (MSMEs)? Companion Note for the MSME Country Indicators. World Bank/IFC.
- Lepoutre, J., & Oguntoye, A. (2018). The (non-)emergence of mobile money systems in Sub-Saharan Africa: A comparative multilevel perspective of Kenya and Nigeria, 131, 262-275.
- Mazanai, M., & Fatoki, O. (2012). Access to Finance in the SME Sector: A South African Perspective. *Asian Journal of Business Management*, 4(1), 58 – 67.

- Mbiti, I., & Weil, D.N. (2011). Mobile Banking: The Impact of M-Pesa in Kenya. African Successes, Volume III: Modernisation and Development
- Mokoatleng, M. (2014). Small and Medium Size Enterprises' Access to External Finance in Lesotho. Master's Thesis. <http://scholar.ufs.ac.za:8080/xmlui/handle/11660/679>
- Mots' oene, K. A. (2014). The informal sector and human capacity building for sustainable development in MASERU. *Journal of Emerging Trends in Economics and Management Sciences*, 5(7), 109-114.
- Mramba, N., Rumanyika, J., Apiola, A., & Suhonen, J. (2017). ICT for Informal Workers in Sub-Saharan Africa: Systematic Review and Analysis. Retrieved from <https://ieeexplore.ieee.org/abstract/document/8095530/>
- Ntale, J.F., & Bosire, J.M. (2018). Effect of Mobile Money Transfer Services on the Growth of Small and Medium Enterprises in Informal Sector of Nairobi County, Kenya. *International Journal of Information Research and Review*, 5(3), 5326-5333.
- Perekwa, G.B., Prinsloo, T., & van Deventer, J.P. (2016). The Impact of Mobile Technology on Micro and Small Enterprises in Zimbabwe in the Post-Hyperinflation Economic Era. *The African Journal of Information Systems*, 8(3).
- Robeyns, I. (2003). The capability approach: an interdisciplinary introduction. In *Training course preceding the Third International Conference on the Capability Approach*, Pavia, Italy (p. 29).
- Schwittay, A. F. (2011). The financial inclusion assemblage: Subjects, technics, rationalities. *Critique of Anthropology*, 31(4), 381-401. (<https://www.imtfi.uci.edu/resources/recommended.php>)
- Sekantsi, L. P., & Lechesa, M. E. (2018). The national payment system in Lesotho, 2000–2016. *Journal of Payments Strategy & Systems*, 12(1), 74-88.
- Sekantsi, L.P., & Motelle, S.I. (July, 2016). The Financial Inclusion Conundrum In Lesotho: Is Mobile Money The Missing Piece In The Puzzle? Accessed from https://www.centralbank.org.ls/images/Publications/Research/Papers/Working/THE_FINANCIAL_INCLUSION_CONUNDRUM_IN_LESOTHO.pdf
- Sen, A. (1999). Development as freedom. *The globalisation and development reader: Perspectives on development and global change*, 525.
- Siringi, E. (2011). Women's small and medium enterprises for poverty alleviation in Sub-Saharan Africa: Lessons from Kenya. *Management Research Review*, 34(2), 186-206.
- Suri, T., & Jack, W. (2016). The long-run poverty and gender impacts of mobile money. *Science*, 354(6317), 1288-1292.
- Tsemame, A. (2015). The Impact of Mobile Money on Financial Inclusion in Lesotho. Retrieved from <http://scholar.ufs.ac.za:8080/xmlui/bitstream/handle/11660/4615/TsemameA.pdf>
- Tsibolane, P. (2016). Towards a Conceptual Framework for Social Wellbeing through Inclusive Frugal ICT Innovation in Postcolonial Collectivist contexts. *Conference on Information Resources Management 2016 Proceedings*, 8.
- Vodacom. (2019). Vodacom Group Limited Preliminary Results for 2019. Available online: <https://www.vodacom.com/pdf/annual-results/2019/vodacom-fy19-results-booklet.pdf>. Last Accessed 20 December 2019
- Yousefzadeh, S., Biggeri, M., Arciprete, c., & Haisma, H. (2019). A Capability Approach to Child Growth. *Child Indicators Research*, 12(2), 711–731.

P24: Open Government Data Initiatives: Open by Default or Publishing with Purpose

Novy NRA Mokobombang
Auckland University of Technology &
Universitas Hasanuddin
novynra.mokobombang@aut.ac.nz

Jairo Gutierrez
Auckland University of Technology
jairo.gutierrez@aut.ac.nz

Krassie Petrova
Auckland University of Technology
krassie.petrova@aut.ac.nz

Abstract

Over the last decade, after a set of Open Government Data (OGD) principles were developed, governments around the world started to radically change their culture on data governance. However, at the implementation stage of OGD initiatives governments needed to consider whether publishing the massive quantities of open datasets did meet public needs for use and re-use, in view of the enormous investment and resources put into the production of publishable OGD. This research-in-progress adopts an exploratory case study approach combining it with a narrative literature review to investigate how the “Open by default” principle and the “Publishing with purpose” strategy were involved in facilitating OGD usage and public participation. The study’s goal is to overview the current implementation of OGD initiatives and to explore best practices when working with open data. We expect to present a new logic model or to show the modification of existing government organisational logic models by analysing the findings on the nature of the New Zealand government effort in opening data up relates with the possible advantage experienced by the government and the public at large.

Keywords: Open Government Data initiatives, open data, Open by Default, Publishing with Purpose, organisational logic model.

1. Introduction

The concept of open data is introduced in the Open Data handbook by The Open Knowledge Foundation (O. K. Foundation, 2009) as “*Open data is data that can be freely used, reused and redistributed by anyone – subject only, at most, to the requirement to attribute and share alike*”. The goal is not only to promote transparency, efficiency and public participation but also to gain social and economic benefits. In an executive order issued by the USA President in 2013 (White House, 2013), it is postulated that the most significant benefit of open data is the provision of information resources that are freely available, easy to find and accessible as open data has high value when shared, and little or no value when locked (Janssen, Charalabidis, & Zuiderwijk, 2012). Furthermore, the value enhancement of open data based on their granularity, accuracy and congruence may contribute to creating new product and service offerings, coupled with a higher level of accountability (McKinsey, 2014). Of specific importance in the last years has been the demand for Open Government Data (OGD). As per the definition found in the OECD working paper (Ubaldi, 2013) OGD are produced by governments with public funding as a set of policies that aim to boost transparency,

accountability and value creation. However, there have also been concerns about how to open government-produced data in order to maximise the benefits of their usage. All levels of government agencies ought to develop policies and processes to unharness relevant, accessible, and beneficial open data to encourage innovation, foster a better-informed public, and build economic opportunities. Moreover, OGD will create a crucial distinction in promoting business innovation and the development of innovative services both within and outside the government that provide and use the data.

The six principles below were elaborated upon by governments, experts, and community stakeholders in order to derive an agreed set of global standards about how to publish OGD (Charter, 2015):

1. **Open by Default:** All government agencies establish a culture of data openness. Data should be readily available to the greatest extent possible.
2. **Timely and Comprehensive:** Release data without undue delay in order to keep their relevance.
3. **Accessible and Usable:** Publish data in a machine-readable format in order to facilitate easy public access for analysis and reuse.
4. **Comparable and Interoperable:** Meeting the agreed data standards will ensure the quality of the open data sets and will increase their value potential.
5. **Improved Governance and Citizen Engagement:** Open data promote information sharing between governments and the public, increase public trust in governments, and promote public participation in decision making.
6. **Inclusive Development and Innovation:** Open data can allow users to innovate and create new social and economic value by integrating OGD with other data.

Following government adoption of the six charter principles, the Open Data Charter was reviewed in 2018. There was a consideration of the core principle “Open by default”; concerns were expressed that adhering to the principle may put too much pressure on governments to open all their data without considering data quality, and disregarding security considerations. It was also suggested that it could be more useful to publish data targeting specific problem domains, or aiming to provide specific public benefits. These reflections resulted in the Open Data Charter 2018 Strategy (Charter, 2018b) that emphasised on “Publishing with purpose”, by driving open data efforts towards delivering an impact. However, the strategy of “Publishing with purpose” raised questions about the approaches towards identifying what data were needed, who might use the data, and why (ODI, 2019).

Current research has investigated to a significant degree how governments shaped their OGD initiatives, focusing on their purpose, and the implementation of data openness. However, less attention has been paid to the causal connection between the effectiveness of the government approach to the OGD principles, and the outcomes achieved by governments (as the data providers) and citizens/organisations/communities as (the data users). The study presented in this paper is part of an ongoing research that explores the process of opening and publishing OGD that involves the internal systems of the government agencies and aims to fulfil public needs. More specifically, this paper investigates how the “Open by default” principle and the “Publishing with purpose” strategy were adopted in various OGD initiatives.

2. Research background and objectives

The nature of the ongoing research study is exploratory as it focuses on current OGD initiatives, rather than on drawing inferences from the findings of prior research. More

specifically, the study’s research question is how the “Open by default” and the “Publishing with purpose” strategies were involved in facilitating New Zealand OGD usage and in attracting public participation aligned with social-economic motivation. It investigates New Zealand OGD initiatives through a case study approach. In particular, rather than evaluate in detail the performance of the New Zealand OGD initiatives, it looks into how the current OGD initiatives adopted the open data publishing principles in order to provide best practice guidance. As a result, we aim to propose a new organisational logic model or a modification of the existing organisational logic model related to the OGD initiative.

3. Related work

3.1 Open Government Data initiatives

The Open Data Charter proposed the Open data framework (Charter, 2018a) in figure 1 as a means to underpin government effort in developing OGD programs. The framework highlights two overarching premises: (1) High-quality production and management of data are required for data sharing, and (2) To enhance benefits, the public as users need to be able to process, use and re-use published data.

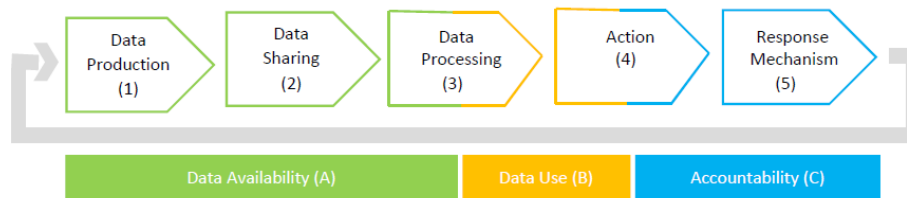


Figure 1. The framework of open data use and impact. Adapted from (Charter, 2018a)

Based on Verhulst and Young (2017), figure 2 presents the six characteristics of open data that are especially relevant in the context of developing economies. Scrutiny, for instance, refers to the provision of details that enhance data quality while flexibility refers to providing a data format that allows repurposing and reusing data in a different context. Another feature, trust, can bring higher levels of accountability and transparency.

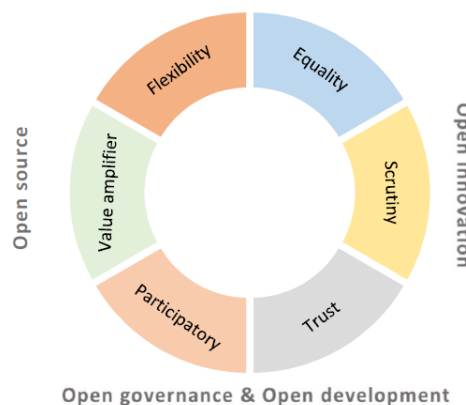


Figure 2. The characteristics of Open Data. Adapted from (Verhulst & Young, 2017)

The implementation of OGD by different government agencies with regards to sharing public data internally and externally presents challenges in terms of work culture transformation and promoting systemic and structural reforms (Matheus & Janssen, 2019). Focusing on the “Open by default “ principle, The Open Data Barometer Leader report (World Wide Web Foundation, 2018) posited that having an open government data initiative and an “open by default” policy was not enough to bring open data up to the point of stimulating creative use.

It involves complex shifts to both government culture and systems to adopt the “open data by default” principle. Furthermore, to ensure that the principle can be well adopted, these indicators are needed: sufficient resources, appropriate government policies, and a Right to Information (RTI) and protection framework.

Considerations about applying the “Publishing with purpose” strategy start with the monitoring of how the six Charter principles have been adopted globally (Charter, 2018b). After several decades, governments implemented OGD initiatives; however, organisations advocating the OGD initiatives realised that most of the open data implementations were not driven by user demand, and often ended up with merely opening data up without considering other factors such as data timeliness, accessibility, and comparability.

Taking in all implications, a paper by Crusoe, Simonofski, Clarinval, and Gebka (2019) concluded that most open data published today are hugely underused. Some scholars (Styrin, Luna-Reyes, & Harrison, 2017) compared three country open data ecosystems and found that the potential impact of the OGD initiatives highly depended on the political leadership (W.W.W. Foundation, 2019), on the active OGD initiative promotion, and on the incentives offered by the government. A recently published paper (Wang & Shepherd, 2020) examined in detail information about the United Kingdom Open data - a leader in OGD movement. Sampling the most popular dataset offerings, they found that only 15% were open from the perspective of the ordinary citizen, equating to 0.05% of the population of all datasets available at the UK OGD portal (data.gov.uk). Moreover, approximately 6 out of 10 datasets did not contain granular data, while 4 out of 10 data sets were significantly aged (more than 30 months old). The investigation revealed that the UK OGD initiative did not meet the open data charter principles 2, 3 and 4.

3.2 New Zealand Open Government Data

The data portal data.govt.nz was launched in 2009. The site acts both as a portal and as a citizen engagement platform, to make non-personal government-held information more discoverable, usable and relevant (NZDIA, 2009). The portal is not a data repository rather it is a catalogue of existing government agency websites. Based on interviews, a web survey, literature sources, and comparisons with other government portals, an independent review published in 2011 (Stott, 2011) concluded that although the portal was well designed and was professionally ran, the datasets were still under-used, and were insufficiently well known internally and externally. Responding to the recommendations provided in the review report, the New Zealand government set up a regularly updated open data action plan supported by an implementation plan then was monitored by conducting a quarterly assessment. The main challenges for the New Zealand government in implementing the open data action plan were the shift to a sustainable open data culture and the reluctance to support and use open data, the lack of appropriate government agencies and user capabilities, and the difficulties related to delivering data from different sources and in different formats (StatsNZ, 2018).

To ensure high-quality open data, the principles for managing New Zealand government data and information were approved by the New Zealand cabinet on 8 August 2011 (Cabinet, 2011). It was postulated that data should be open, protected, readily available, trusted, well-managed, reasonably priced (preferably free) and reusable. The commitment was reaffirmed in the National Action Plan 2018-2020 (NZSSC, 2018).

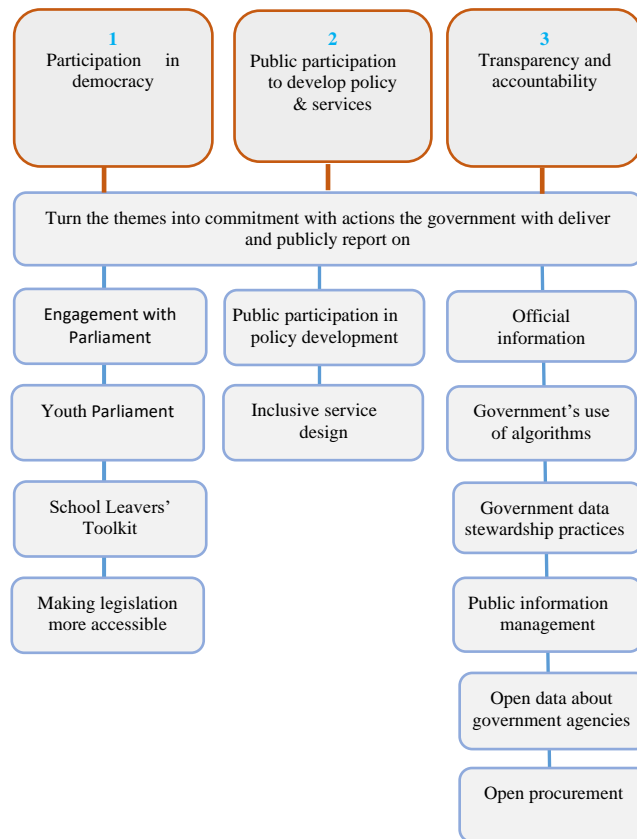


Figure 3. The National Action plans 2018-2020 themes. Adapted from (NZSSC, 2018)

Figure 3 depicts the three themes of the plan (NZSSC, 2018), including government commitment. The plan was developed with the input of engaging citizens and community groups; the comprehensive discussions resulted in 449 ideas which were incorporated into these three themes.

4. Study methodology

The ongoing study follows an exploratory case study approach that allows to present multiple perspectives on OGD actors, activities, policies, and documents. The issues identified are the results of interpreting the data gathered from study participants, in the light of the information gathered from OGD related policies and other documents. The study was designed to include a two-stage data collection process. At the first stage (in 2019), data were collected by semi-structured interviews with participants from 10 government agencies and organisations in New Zealand. The second stage involved collecting data from the New Zealand OGD reports. To address the research question (see section 2), semi-structured interviews employing open-ended questions were used; these interviews were often accompanied by follow-up “why” or “how” questions. The interviews were conducted with one participant at a time for about 40 – 50 minutes at their office premises or using virtual sessions.

The participants were either government officers or employees in organisations that collaborate in OGD programs. The participants were selected for their expertise and experience about OGD implementation and use in New Zealand. All participants had technical skills related to OGD and were knowledgeable about the ways the data were used within their respective organisations.

Overall, the research design was iterative and began with a review of the literature in order to understand what was previously investigated and currently implemented, followed by the interviews with experts in OGD; the data from those interviews are currently being coded. To increase the accuracy in interpreting the qualitative data, a thematic analysis approach including the inductive coding will be applied (Boyatzis, 1998; Saldaña, 2015).

5. Summary and expected results

In this paper, we review the literature in order to analyse current research in OGD initiatives and the implementation of the New Zealand OGD plan. We expect that the study will contribute essential insights on how OGD initiatives can best move forward, by exploring the case study of the New Zealand OGD initiatives, and proposing a new organisational logic model (or a modification of the existing one). More specifically, the study will identify and compare the factors influencing the adoption of “Open by default” or “Publishing with purpose” principles, and the expected outcomes of each strategy. Currently, we are analysing the qualitative information gathered from the case study findings and the narrative literature review in order to obtain comprehensive answers to the research questions. The continuing analysis that will lead to the development a business model of organisations using OGD is part of our future work.

6. References

- Boyatzis, R. E. (1998). *Transforming qualitative information : thematic analysis and code development* USA: SAGE Publication.
- Cabinet, N. Z. (2011). *Cabinet decision: Open government* Wellington: New Zealand Department of Internal Affairs Retrieved from <https://www.data.govt.nz/assets/Uploads/cab-min-11-29-12-8-august-2011.pdf>
- Charter, O. D. (2015). *The six charter principles of publishing Open Government Data*. Retrieved 10 January, 2019, from <https://opendatacharter.net/principles/>
- Charter, O. D. (2018a). *Open Up Field Guides: Methodology*. Retrieved from <https://drive.google.com/drive/u/0/folders/1iUNitYoiPOoU4a9fE5PVyRE3T5LQRJ8I>
- Charter, O. D. (2018b). *Publishing with Purpose- Open Data Charter 2018 Strategy*. Retrieved from <https://drive.google.com/file/d/1hYmoTZTDgFe9E8CtxAW6qfbjfj5W93DL/view>
- Crusoe, J., Simonofski, A., Clarinval, A., & Gebka, E. (2019). The impact of impediments on open government data use: Insights from users Retrieved from <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074367708&doi=10.1109%2fRCIS.2019.8877055&partnerID=40&md5=eb7ab58a7b73601ba114d7eccd72c538> <https://doi.org/10.1109/RCIS.2019.8877055>
- Foundation, O. K. (2009). *Open data handbook*. Retrieved 10 January, 2020, from <https://opendatahandbook.org/guide/en/what-is-open-data/>
- Foundation, W. W. W. (2018). *Open Data Barometer - Leaders Edition*. Washington DC: World Wide Web Foundation. Retrieved from <https://opendatabarometer.org/doc/leadersEdition/ODB-leadersEdition-Report.pdf>
- Foundation, W. W. W. (2019). *Open Data Barometer - African edition report* Retrieved from <https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/57855/57924.pdf?sequence=1>
- Janssen, M., Charalabidis, Y., & Zuiderwijk, A. (2012). Benefits, Adoption Barriers and Myths of Open Data and Open Government. *Information Systems Management*, 29(4), 258-268. <https://doi.org/10.1080/10580530.2012.716740>
- Matheus, R., & Janssen, M. (2019). A Systematic Literature Study to Unravel Transparency Enabled by Open Government Data: The Window Theory. *Public Performance and Management Review*. <https://doi.org/10.1080/15309576.2019.1691025>

- McKinsey. (2014). *How government can promote open data and help unleash over \$3 Trillion in economic value*. USA: McKinsey & Company. Retrieved from [https://www.mckinsey.com/~media/mckinsey/industries/public%20sector/our%20insights/how%20government%20can%20promote%20open%20data/how_govt_can_promote_open_data_and_help_unleash_over_\\$3_trillion_in_economic_value.ashx](https://www.mckinsey.com/~media/mckinsey/industries/public%20sector/our%20insights/how%20government%20can%20promote%20open%20data/how_govt_can_promote_open_data_and_help_unleash_over_$3_trillion_in_economic_value.ashx)
- NZDIA. (2009). Government takes steps to demystify data. Wellington: Beehive.govt.nz.
- NZSSC. (2018). *New Zealand's Open Government Partnership National Action Plan 2018-2020*. New Zealand: The NZ State Services Commission. Retrieved from <https://ogp.org.nz/assets/Publications/91b28db98b/OGP-National-Action-Plan-2018-2020.pdf>
- ODI. (2019). *Publishing data with purpose in Serbia*. Retrieved 20 January, 2020, from <https://theodi.org/article/publishing-data-with-purpose-in-serbia/>
- Saldaña, J. (2015). *The coding manual for qualitative researchers*: Sage.
- StatsNZ. (2018). *New Zealand Open data action plan*. Wellington: StatsNZ. Retrieved from <https://www.data.govt.nz/assets/Uploads/NZ-open-data-action-plan-Nov2018.pdf>
- Stott, A. (2011). *data.govt.nz: An independent review*. Wellington: Department of Internal Affairs NZ. Retrieved from <https://www.data.govt.nz/assets/Uploads/data-govt-nz-2011-independent-review.pdf>
- Styrin, E., Luna-Reyes, L. F., & Harrison, T. M. (2017). Open data ecosystems: an international comparison. *Transforming Government: People, Process and Policy*, 11(1), 132-156. <https://doi.org/10.1108/TG-01-2017-0006>
- Ubaldi, B. (2013). Open Government Data. <https://doi.org/doi:https://doi.org/10.1787/5k46bj4f03s7-en>
- Verhulst, S., & Young, A. (2017). Open Data in Developing Economies: Toward Building an Evidence Base on What Works and How. In *Open Data in Developing Economies: Toward Building an Evidence Base on What Works and How* (pp. 206-224). Retrieved from <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85058351981&partnerID=40&md5=5d7ba57e034cfca4b35d3abf4ffbbf18>
- Wang, V., & Shepherd, D. (2020). Exploring the extent of openness of open government data – A critique of open government datasets in the UK. *Government Information Quarterly*, 37(1). <https://doi.org/10.1016/j.giq.2019.101405>
- White House, T. (2013). *Executive Order -- Making Open and Machine Readable the New Default for Government Information*. Retrieved 10 March, 2018, from <https://obamawhitehouse.archives.gov/the-press-office/2013/05/09/executive-order-making-open-and-machine-readable-new-default-government>

P25: Problems Associated with Older Adults' Adoption of Robo Advisors: An Empirical Study

Shangjun Wang
Florida International University
swang067@fiu.edu

Abstract

In the recent years, Robo Advisor, a digital platform that provides automated, algorithm-driven financial planning services, has increasingly received attention from users of different demographics. Many users have taken advantage of its features to automate their saving and investing activities. However, users in an older age group, specifically, those aged fifty or above, have been seen with low adoption of the robo-advisory services. This empirical study is designed to explore the problems associated with older adults' adoption of robo advisors. Specifically, this study intends to examine whether mental health of aging adults affects their intention to use robo advisors. In addition, I hypothesize that perceived usefulness may mediate the effect of mental health on behavioral intention towards using robo advisors, such that it serves to explain why various levels of mental health would result in differences in intention to use (i.e. approach or avoid robo advisors). To explore solutions for non-adoption, I identify three external variables (i.e. social influences, accessibility, and learning support) that could possibly moderate the main effects of mental health hypothesized in the study, so that when either of these variables is present and strengthened, it will enhance likelihood of using robo advisors.

Keywords: Robo Advisor, Technology Adoption, Mental Health, Older Adult, Financial Service.

1. Introduction

Robo advisor is an artificial intelligence software that automates and assists management of investment (Belanche et al., 2019). In contrast to traditional human advisory services, robo advisory services reduce fees and provide 24/7 access to finance (Park et al., 2016). Comparing to traditional financial services, several functionalities that make robo advisors uniquely attractive to users are: lower minimum balance to maintain the account, automation of money managing and investing activities, trading fractional shares of securities (low barrier of entry), and sometimes automatically minimizing tax on selling or transferring of investment. The top robo advisory services on the market today are registered investment advisors, therefore, are subject to fiduciary standards. In other words, robo advisors must act in the best interest of their users.

While robo advisors are continuously attracting attention from users with various demographic and socioeconomic backgrounds, not much is known about factors that lead to the adoption and the use of robo advisors. Specifically, studies that dig into how robo advisors are adopted and used among older users do not exist. According to a report released by the Center for Disease Control and Prevention (CDC, 2008), three mental health issues are becoming prevalent among older adults: anxiety, cognitive decline, and depression, and they are influencing older adults' behaviors and decisions in their daily life. In addition, a big challenge faced by older adults today is a financial one, that is, the challenge in personal finance and retirement planning (Stanford Center on Longevity, 2018; Loibl, 2017; Sixsmith

et al., 2014). A book recently published in the University of Pennsylvania Wharton School Pension Research Council series (Agnew & Mitchell, 2019), found that older adults' mental health issues affect their abilities to cope with financial stress. A robo advisor, due to its financial expertise and automation, appears to be a viable solution to assist older adults in dealing with this kind of stress. However, the process of getting comfortable with new technology is a steep learning curve for older adults. This is especially true for those who have mental health problems. Therefore, it is possible that having mental problems could result in negative attitudes of older adults towards using robo advisors.

Furthermore, although older adults with mental health problems may refrain from using robo advisors, the reason why is unknown. One possible explanation is that low mental health level contributes to negative beliefs that robo advisors are actually not useful. Prior studies have found that, the perceived usefulness of the technology is one important factor to determine whether older adults would adopt a technology (Zhou et al., 2014; Braun, 2013; Dear et al., 2013). In addition, other external factors that can be considered in affecting older adults' adoption of robo advisors are: social influences, accessibility, and learning support. Social influences mean that elders change their behaviors according to the standards of the society they live in. It has been suggested that older adults will use a new technology just to "keep up with society" (Kuerbis et al., 2017). Therefore, it is interesting to look into whether social influences could make older adults more likely to use robo advisors when they may be unable to see the usefulness of this type of technology due to having lower mental health. Moreover, accessibility simply means that robo advisors are easy to use to the elderly (Czaja, 2006). They should be able to navigate the interface and interact with features without a hassle; learning support is an environment in which necessary help is provided to users so that they can adequately use the technology to complete tasks. It is possible accessibility and learning support can potentially alter the effect of mental health conditions of elders on their perceived usefulness of robo advisors. For instance, when mental health is low, they may still be able to see the usefulness, and therefore become inclined to use the application, if greater accessibility is integrated in the app and help is given.

In summary, this research study is interested in knowing whether older adults' mental health conditions can impact perceived usefulness of robo advisors, and therefore influencing them to approach or avoid this type of technology. One purpose of this study is to examine whether perceived usefulness can explain why different levels of mental health can induce older adults' to adopt or avoid robo advisors. The other purpose is to determine whether the effect of mental health on intention to use robo advisors differs in dependence of social influences, as well as whether higher or lower mental health affects older adults' beliefs of usefulness to be different in dependence of accessibility of the application and learning support resources available to them. Older adults are particularly of interest to the research because, compared to a younger demographic, older adults have a very different attitude and learning culture in connection with the use of technology (Arning & Ziefle, 2007). The results of this research study will provide insights for financial advisory services, brokerage firms, financial institutions, as well as their technology providers to develop and configure robo advisors that are elder-friendly. Especially, for those with mental health conditions, enabling older adults to overcome the impact of mental problems to utilize new technology and build wealth as they are aging. Meanwhile, the successful introduction of robo advisors to older age groups can bring a competitive advantage for many firms in the finance sector (Park et al., 2016).

2. Theoretical Development and Hypotheses

Studies found that people age 55 years or older experience some type of mental health condition. The most common conditions are anxiety, cognitive decline, and depression (CDC, 2008). Mental health influences older adults' motivation to engage in technology. For example, one study found that among Medicare beneficiaries 65 years or older, "depression and anxiety were negatively related to internet use" (Kuerbis et al., 2017; Choi & DiNitto, 2013). Cognitive change may potentially impact older adults' ability to engage with technology. Research have found that cognitive abilities such as visual-spatial ability, memorizing, and problem solving decline with age, making the technology more difficult to use. (Chevalier et al., 2013; Pak et al., 2009; Juvina & Taatgen, 2009). In Kuerbis et al.'s review of related literature (2017), cognitive decline leading to slower learning processes of the older age groups is found in several empirical studies (Chevalier et al., 2013; Hanson, 2011; Czaja et al., 2006). As evidently shown, when mental health problems are present, learning a new technology becomes less straightforward to older adults. As a result, they are more likely to avoid it. Therefore, when concerning robo advisors, it can be argued that:

H₁: Mental health levels of older adults have a significantly positive effect on their intention to use robo advisors.

In the context of this study, the mental health level is a variable that represents an older adult's perceived mental healthiness of themselves. And, mental health is reduced by three common conditions (i.e. anxiety, depression, and cognitive decline). Not to mention, it is possible that when mental problems prevent older adults from properly operating robo advisors, they will unlikely be able to complete the intended task. As a result, they will unlikely view the technology to be useful (Agnew & Mitchell, 2019). It can be further argued that, lower mental health level leads to lower perceived usefulness of robo advisors.

H₂: Mental health levels of older adults have a significantly positive effect on perceived usefulness of robo advisors.

Perceived usefulness can also be seen as a fundamental determinant of the adoption of various types of technology (Davis, 1989). Studies also found that, among older users, when benefits of utilization are not clear, they are more likely to choose not to engage in that technology (Chen & Chan 2013; Mitzner et al., 2010; Czaja et al., 2006). This could also be true when older adults evaluate the usefulness of robo advisors.

H₃: Perceived usefulness has a significantly positive effect on older adults' intention to use robo advisors.

Social influences refer to situations in which people change their behaviors to agree with others in society. A number of studies have reported that older adults see using technology as a "basic skill" and a way of "keeping up with society" (Kuerbis et al., 2017; Damodaran et al., 2014; Chen & Chan, 2013). For that reason, it is possible to argue that when social influences are strong, older adults with lower levels of mental health may still be willing to use robo advisors. Consequently, it can be hypothesized that:

H₄: Social influences moderates the effect of mental health levels of older adults on their intention to use robo advisors.

Accessibility is the robo advisor's quality of being able to be used by an older age group. This factor is especially important to older adults during the time of retirement because

retirement planning is a very complicated process and can hardly be automated by machine (Agnew & Mitchell, 2019). Therefore, it is critical that robo advisors are designed in keeping with financial needs associated with aging. Accessibility could potentially moderate the effect of perceived mental health on perceived usefulness such that when higher accessibility is integrated in the robo advisor, an older adult with a lower level of mental health may still be able to realize its usefulness (Kuerbis et al., 2017). Therefore, it can be argued that:

H₅: Accessibility moderates the effect of mental health levels of older adults on perceived usefulness of robo advisors.

The context of learning is important to older adults who want to learn to use technology. For them, there are primarily three ways of learning regarding utilization of technology: reading a manual, receiving instruction from other people who have the know-how, and “trial and error” (Barnard et al., 2013). In a supportive environment, older adults are able to quickly learn to perform basic tasks (Barnard et al., 2013; Broady et al., 2010; McLeod, 2009). In the adoption of robo advisors, when substantial learning support is provided, elders with mental health conditions may be able to overcome the impact of the mental condition and understand how to use robo advisors properly, resulting in believing “robots” to be useful.

H₆: Learning support moderates the effect of mental health levels of older adults on perceived usefulness of robo advisors.

Finally, considering that whether mental health level is high or low may affect perceived usefulness of a robo advisor, which in turn may influence an older adult’s intention to use it. It can be hypothesized that:

H₇: The effect of mental health levels of older adults on their intention to use robo advisors is mediated through perceived usefulness.

Figure 1 illustrates the research model:

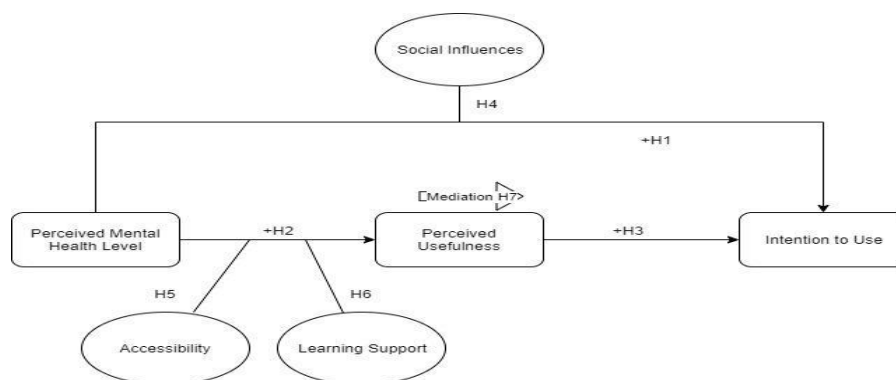


Figure 1: Research Model

3. Research Methodology Overview

3.1 Research Design

Based on findings from related research studies, a conceptual research model (Figure 1) is developed to describe relationships hypothesized in the section above. Surveys will be developed and distributed to participants to measure each construct specified in the model.

Measuring items will be selected from prior related studies, but will be redefined to fit the current context. This study focuses on the individual older adult as the unit of analysis. 7-point Likert scales will be provided for participants to respond to each question (from “1” – “Strongly Disagree” to “7” – “Strongly Agree”). “Older adult” refers to persons who are 50 or above in age because cognitive changes begin to take place at the age of fifty, interfering with technology engagement (Hanson, 2011). These participants will be assessed for their mental health state, and data will be collected from a balanced mix of mentally healthy individuals and those with some signs of mental conditions (i.e. anxiety, depression, and cognitive decline). For each participant, an average score will be computed to represent their overall mental health level. An additional assessment will be conducted prior to the study, to ensure that participants have similar levels of knowledge and experience about technology. Those who have substantial experiences of using robo advisors will not be selected for this study. The assessment also ensures that participants have similar levels of financial experience and knowledge. An introductory video will be sent to inform participants what a robo advisor is, its basic functions, and how to use it. Each survey will be accompanied with a questionnaire to collect demographic and socioeconomic information about participants.

3.2 Data Collection and Analysis

The survey will be conducted in the United States, and responses will be collected from a sample of 300 adults aged 50 or above. The participation is limited to this age group as they are of interest in this study. To ensure that the sample represents a diverse population and an even split in terms of demographic and socioeconomic variables (i.e. gender, marital status, education, and income), the study will administer data collection online using Qualtrics survey software. Before distributing surveys, to check content validity, faculty at the author’s institution who have expertise in the topic of interest will be invited to evaluate the appropriateness of language and content of each measuring item. Pilot tests will be conducted with smaller samples and exploratory/confirmatory factor analysis and reliability analysis will be used to ensure construct validity and reliability of measuring items (Straub, 1989). Data analysis will be conducted in SPSS. All hypotheses except H₇ will be tested using multiple regression while controlling participants’ gender, marital status, education, and income. The testing of H₇ will be conducted by using PROCESS Macro, which facilitates mediation analysis. Preferably, bootstrapping will be used as it is a robust analysis in testing the significance of indirect effects (Hayes, 2018).

4. Contribution

This research intends to validate a research model that can effectively provide explanation to some key issues associated with the technology adoption of an older age demographic. First, the research finds that various mental health conditions may prevent older adults from using robo advisors. Second, the research identifies external variables that may aid in the development of solutions to mitigate older adults’ non-adoption of robo advisors. Financial planning for older adults need to be thought carefully through as they are a vulnerable group that hardly recovers if significant financial loss occurs due to poor planning strategies. Therefore, their mental process of adopting robo advisors should be understood for development and improvement of financial services technology to minimize risk of financial loss and maximize benefit of planning. Theoretically, this research sheds additional light on the process of technology adoption by focusing on a unique age group and a novel technology for a specific purpose. Practically, financial services firms and their technology providers can consider the insights provided in this study when developing and implementing robo advisory services to better serve the needs of older clients. This will create a win-win situation that both firms and clients can benefit from cutting-edge technology.

References

- Agnew, J. and Mitchell, O. S. (2019). *The Disruptive Impact of Fintech on Retirement Systems*. Oxford University Press, United Kingdom.
- Arning K. and Ziefle M. (2007). "Understanding Age Differences in PDA Acceptance and Performance." *Computers in Human Behavior*, 23, 2904-2927.
- Barnard Y, Bradley M. D., Hodgson F., and Lloyd A. D. (2013). "Learning to Use New Technologies by Older Adults: Perceived Difficulties, Experimentation Behaviour and Usability." *Computers in Human Behavior*, 29, 1715-1724.
- Belanche, D., Casalo, L. V., and Flavián, C. (2019). "Artificial Intelligence in FinTech: Understanding Robo-Advisors Adoption among Customers." *Industrial Management & Data Systems*, 7, 1411.
- Braun, M.T. (2013). "Obstacles to Social Networking Website Use among Older Adults." *Computers in Human Behavior*, 29, 673-680.
- Broady T., Chan A., and Caputi P. (2010). "Comparison of Older and Younger Adults' Attitudes towards and Abilities with Computers: Implications for Training and Learning." *British Journal of Educational Technology*, 41, 473-485.
- Centers for Disease Control and Prevention and National Association of Chronic Disease Directors. (2008). "The State of Mental Health and Aging in America Issue Brief 1: What Do the Data Tell Us?" Atlanta, GA: National Association of Chronic Disease Directors.
- Chen K. and Chan A. H. (2013). "Use or Non-Use of Gerontechnology-A Qualitative Study." *International Journal of Environmental Research and Public Health*, 10, 4645-4666.
- Chevalier A., Dommès A., and Martins D. (2013). "The Effects of Ageing and Website Ergonomic Quality on Internet Information Searching." *Ageing and Society*, 33, 1009-1035.
- Choi N.G. and DiNitto D.M. (2013). "Internet Use among Older Adults: Association with Health Needs, Psychological Capital, and Social Capital." *Journal of Medical Internet Research*, 15(5).
- Czaja, S. J. (2006). "Technology and older adults: designing for accessibility and usability." *In Proceedings of the 8th international ACM SIGACCESS conference on computers and accessibility* (pp. 1-1).
- Czaja S. J., Charness N, Fisk A. D., Hertzog C, Nair S. N., Rogers W. A., and Sharit J. (2006). "Factors Predicting the Use of Technology: Findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE)." *Psychology and Aging*, 21, 333-352.
- Damodaran L., Olphert C., and Sandhu J. (2014). "Falling off the Bandwagon? Exploring the Challenges to Sustained Digital Engagement by Older People." *Gerontology*, 60, 163-173.
- Davis F. (1989). "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology." *MIS Quarterly*, 13(3), 319-340.
- Dear B. F., Zou J., Titov N., Lorian C., Johnston L., Spence J., Anderson T., Sachdev P., Brodaty H., and Knight R. G. (2013). "Internet-Delivered Cognitive Behavioural Therapy for Depression: a Feasibility Open Trial for Older Adults." *Australian and New Zealand Journal of Psychiatry*, 47, 169-176.
- Hanson V. L. (2011). "Technology Skill and Age: What Will be the Same 20 Years from Now?" *Universal Access in the Information Society*, 10, 443-452.
- Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: a regression-based approach, 2nd Edition*, New York: Guilford Press.
- Jovina I. and Taatgen N. A. (2009). "A Repetition-Suppression Account of Between-Trial Effects in a Modified Stroop Paradigm." *Acta Psychologica (Amst)*, 131, 72-84.

- Kuerbis, A., Mulliken, A., Muench, F., Moore, A. A., and Gardner, D. (2017). "Older Adults and Mobile Technology: Factors that Enhance and Inhibit Utilization in the Context of Behavioral Health." *Mental Health and Addiction Research*, 2(2), 1-11.
- Loibl, C. (2017). "Living in Poverty: Understanding the Financial Behaviour of Vulnerable Groups." In R. Ranyard (ed.), *Economic Psychology*, Hoboken, NJ: John Wiley & Sons, Inc. 421-434.
- McLeod E. (2009). "The Use (and Disuse) of Mobile Phones by Baby Boomers." *Australian Journal of Emerging Technologies and Society*, 7, 28-38.
- Mitzner T. L., Boron J. B., Fausset C. B., Adams A. E., Charness N., Czaja S. J., Dijkstra K., Fisk A. D., Rogers W. A., and Sharit J. (2010). "Older Adults Talk Technology: Technology Usage and Attitudes." *Computers in Human Behavior*, 26(6), 1710-1721.
- Pak R., Price M. M., and Thatcher J. (2009). "Age-Sensitive Design of Online Health Information: Comparative Usability Study." *Journal of Medical Internet Research* 11(4).
- Park, J. Y., Ryu, J. P., and Shin, H. J. (2016). "Robo Advisors for Portfolio Management." *Advanced Science and Technology Letters*, 141, 104-108.
- Sixsmith, J., Sixsmith, A., Fänge, A. M., Naumann, D., Kucsera, C., Tomsone, S., Haak, M., Dahlin-Ivanoff, S., and Woolrych, R. (2014). "Healthy Ageing and Home: The Perspectives of Very Old People in Five European Countries." *Social Science & Medicine*, 106, 1-9.
- Stanford Center on Longevity. (2018). "Special Report: Seeing Our Way to Financial Security in the Age of Increased Longevity." The Sightlines Project. Longevity.stanford.edu.
- Straub, D. W. (1989). "Validating Instruments in MIS Research." *MIS Quarterly*, 13(2), 147-169.
- Zhou J., Rau P. L. P., and Salvendy G. (2014). "Age-Related Difference in the Use of Mobile Phones." *Universal Access in the Information Society*, 13, 401-413.

P27: Solutions to Increase Mobile Merchant Payment Applications Value, Customers' Continued Intention to Use, and Loyalty

Karlene Cousins
Florida International University
kcousins@fiu.edu

Pouyan Esmailzadeh
Florida International University
pesmaeil@fiu.edu

Shangjun Wang
Florida International University
swang067@fiu.edu

Abstract

The use of mobile payment applications is on the rise. There are a variety of mobile payment applications that attempt to offer value to increase the market share of merchants that provide them. However, many users are likely to stop using apps if optimal utility and customized services are not correctly delivered. This study proposes that offering context-based services that indicate customization and personalization of services will improve the perceived utility of mobile merchant payment applications and in turn, increase continued intention to use it and customer loyalty to the merchant. Our results also show that the reputation of mobile vendors significantly enhances the perceived utility of mobile merchant payment applications. The findings of this study can be valuable to researcher, merchants and mobile application developers.

Keywords: Context Awareness, Calculus Theory, Mobile Application, Mobile Payment, Utility, Personalization, Privacy, Technology Adoption.

1. Introduction

Technology has long been recognized as an enabler of competitive advantage. In fact, competing brands often gain a competitive advantage by using technology to connect to customers to offer products and services, build loyalty and retention, lock in customers, and increase switching costs (Faulds et al., 2018). However, it is difficult to understand how customers choose to use one information system (IS) over the other to procure products and services. In the IS research community, system use is often predicted by measures of perceived ease of use and perceived usefulness. However, these IS theoretical models are commonly used to predict system use by employees within organizations. One possible way of increasing our understanding of customer behavior as they interact with IS in hyper-competitive environments, is to include the perceived value construct in IS theoretical models. The marketing literature recognizes the perceived value construct as one of the most critical measures for gaining competitive advantage (Petrick, 2002). Particularly when IS is used by external customers, in-depth learning about what customers value about IS may help guide managers on how to respond. Further, because a customer finds an IS useful or easy to use, it does not necessarily mean that the IS provides excellent value. It is quite possible that a customer who finds an IS easy to use or useful may consider it poor value if the costs of using the IS outweigh the benefits (Manis & Choi, 2019). One case of note is that of mobile payments. Mobile payments service providers in the United States face significant challenges in motivating consumers to adopt mobile payments in a retail environment. In the U.S., the

mobile payments market space is highly fragmented and filled with many competitors such as Apple Pay, Samsung Pay, and PayPal. With only 37.2% of the U.S. population reporting the adoption of a mobile payment solution of some kind (Wester, 2014). To increase adoption, mobile payments must achieve higher penetration into the consumer base, for instance, providing value-added services like purchase-tracking or loyalty program integration that creates added incentives for consumers to part with old payment habits (Wester, 2014). Essentially, mobile payments providers need to offer products that add value beyond the payment and to integrate mobile payments into the overall consumer experience.

Unlike consumers in developing countries such as Kenya, proving mobile payments' value propositions to consumers has been challenging, and it has been difficult to show how mobile payments are a more valuable payment mechanism than cash and credit cards. Little is still known about what factors will make consumers in the U.S. choose mobile payments over other payment mechanisms and other competing mobile payment providers. Traditional IS constructs, such as perceived ease of use and perceived usefulness, are just a small part of the value proposition for consumers. Thus, a greater understanding of customer's use of IS in a retail environment is needed than what popular IS constructs, such as perceived ease of use and perceived usefulness, can provide. Since perceived value has been found to be an essential indicator of repurchase intentions in the marketing literature (Petrick, 2002), it could be applied to the IS field to determine consumers' intentions to reuse IS. Valid and reliable measures of perceived value would allow for comparison of value between competing IS applications such as mobile apps. It would allow individual apps providers to identify the dimensions of perceived value in which they perform well or poorly. Though research has focused on the business value of IS, a multi-dimensional scale for the perceived value of IS services and applications from the consumer perspective still does not exist.

Therefore, the purpose of the current study is to develop a multi-dimensional scale for the perceived value of a customer information system. We will illustrate the scale's usefulness by applying it to the mobile payments retail environment. By doing so, we will gain insight as to which factors make a mobile payment app valuable and competitive.

2. Literature Review

Although the popularity of mobile payment systems has increased in recent years, so has privacy and security concerns associated with them. Privacy has been a central issue in the adoption and use of technology-enabled products or services. Several studies have shown that greater concerns regarding information privacy, will lower the individual intentions to use online services (Belanger & Crossler, 2011). Privacy concerns also lead to less voluntary sharing of personal information via the Internet (Belanger & Crossler, 2011). However, among the stream of research on privacy, there are contradictory results. Some researchers found that unauthorized use of secondary data does not have an impact on users' perception of privacy. Therefore, it does not affect their intention to use online services (Chen & Li, 2009; Drennan et al., 2006; Brown & Muchira, 2004). This paradox has not been explained in prior privacy studies. Further, an increasing number of customers who use mobile devices to shop and pay online share their personal and account information frequently. It can be expected that they will continue to be exposed to data security issues such as identity theft, hacking, account infiltration, and other security violations in their online transactions (Warkentin & Willison, 2009). Thus, privacy and security concerns should be prioritized when selecting and designing mobile payment systems.

Before receiving any E-service from vendors, potential customers usually need to give consent for their personal data to be disclosed to vendors. This information disclosure usually ensures services to be personalized to meet customers' preferences. However, the need to collect more personal data for personalization increases the risk that privacy will be violated (Dinev et al., 2006). According to the privacy calculus theory, individuals are willing to disclose personal data if benefits associated with such behaviors exceed costs (Laufer & Wolfe, 1977). Since information disclosure is inevitable in doing business via the Internet, the theory provides some insights that researchers and practitioners can maneuver to encourage customers' share of information to create higher value in return, meanwhile enforcing security procedures to ensure privacy be protected. Prior related studies have employed the privacy calculus theory to analyze drivers for information disclosure (Zhu et al., 2017; Wang et al., 2016). These researchers found that whether customers disclose personal data depends on the utility of the personalization of online services. In another study where researchers integrated the privacy calculus theory to develop a model to predict customer loyalty of mobile hotel booking services (Ozturk et al., 2017), personalization influenced privacy concern, trust, and perceived risk, in turn, influencing customer loyalty. Being able to personalize online services to meet customers' needs with privacy and security in mind has indeed increased mobile users' willingness to exchange their personal information for receiving services. Although these studies enabled our initial understanding of the application of the privacy calculus theory in a mobile device context, little is known about key drivers for personalization and its relationship with privacy and security when evaluating a mobile payment system. Further, it is not clear that what contributes to the perceived value of the system that leads to use and generates loyal customers. In the next section, we conducted an exploratory qualitative analysis to identify factors that are critical as part of an ideal mobile payment system from customers' perspectives.

3. Concept, Construct, and Hypotheses Development

To inform the construct conceptualization, we carried out a qualitative analysis of feedback on the mobile order and payment application on the Starbucks Idea site at mystarbucksidea.com. In December 2014, Starbucks launched an updated version of the Starbucks Mobile app, which gave customers the capability to order and pay outside the store and pick up the order by skipping the line and moving straight to the counter. The site administrators asked existing users to give feedback about their experience in using the Mobile Order and Pay application and requested suggestions to improve it. To systematically review and code users' comments, we posed the following two questions:

1. What are the advantages and disadvantages of using the application?
2. What are the essential features that should be included in the application?

We used Straus and Corbin's (1990) open and axial coding procedures to identify conceptually similar themes. To develop the initial items, we analyzed these comments for the period between December 2014 and November 2016. We used NVIVO 11 to code the data. As shown in Table 1, we clustered the open codes into subcategories that were conceptually similar to form the axial codes. We used these axial codes as a basis for construct development and associated them with the extant IS literature. In most cases, the axial codes matched existing constructs in the literature. Table 1 illustrates the process of comparing the initial conceptualization derived from our data analysis to the existing literature. In total, our analysis revealed nineteen constructs that represented the essential concepts in the present context.

Construct	Examples of Open Codes From Analysis of Starbucks Ideas Forum	Prior Literature
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	Data and Email Interviews	
Fulfillment	<ul style="list-style-type: none"> My drinks are always on time when I use this. However, they're also the wrong drink at least half of the time. 	Parasuraman et al., 2005
Privacy	<ul style="list-style-type: none"> How will my personal and banking information be handled? 	Liu et al., 2005
Security	<ul style="list-style-type: none"> On Christmas day someone hacked into my account, reloaded a total of \$300 (in \$100 increments) from the bankcard listed on my account to one of my Starbucks cards, uploaded their own Starbucks card to my account, transferred the \$300 from my cards to their own, then deleted their Starbucks card from my account, effectively absconding with my \$300. Merry Christmas to me. 	Liu et al., 2005; Suh & Han, 2003
Trust	<ul style="list-style-type: none"> You would have to trust this app and this company in ensuring your security and information will be safe. 	Gefen et al., 2003
Time Awareness	<ul style="list-style-type: none"> Can you adjust the app so I can have a morning, afternoon & evening drink [offer] for us frequent users 	Abowd et al., 1999; C. Emmanouilidis et al., 2013
Personalization	<ul style="list-style-type: none"> Based on my order history and saved favorites, you should be able to analyze my taste - what ingredients make up my favorite beverage and food - then suggest what I may like as and when you introduce something new - makes it easier for me to choose from a variety of things - and I can trust you! 	Sheng et al., 2008; Sherrie et al., 2006; Arora et al., 2008
Customization	<ul style="list-style-type: none"> Everything is super customizable down to how many pumps of syrup you want. 	Sherrie et al., 2006; Arora et al., 2008
Activity-Based Adaptation	<ul style="list-style-type: none"> It would be great to get an alert on my phone that my drink or food is ready. I can imagine walking into the store and not knowing how long it is until it is ready. 	Abowd et al., 1999; C. Emmanouilidis et al., 2013
Availability	<ul style="list-style-type: none"> Some drinks "aren't available at this location" comes up as an error for simple items such as a Skinny Carmel Macchiato. 	Dabholkar et al., 1996; Yang et al., 2002.
Environment	<ul style="list-style-type: none"> in Houston, multiple locations had to close for weather issue. The mobile app still let me place an order and charged my card. I only found out that the store was closed when I arrived to pick up my drink. 	Abowd et al., 1999; C. Emmanouilidis et al., 2013
Location Awareness	<ul style="list-style-type: none"> Imagine a world where you can order your morning coffee based on your location. -- Once the Starbucks app is installed and a user is within 500 feet of the set location, a verbal / visual notification pops up. "Would you like to order "xyz" with no whip and half fat as per usual? "Yes" says customer and verifies with a fingerprint or the voice recognition that is standard on most newer phones. 	Abowd et al., 1999; C. Emmanouilidis et al., 2013
Navigation	<ul style="list-style-type: none"> The app provided a map to the closest Starbucks where our order would be waiting (downstairs in my office building) with an estimated wait time of 4-8 minutes. 	Abowd et al., 1999; C. Emmanouilidis et al., 2013
Usefulness	<ul style="list-style-type: none"> Starbucks was very crowded with high school students. I simply walked up to pick up area, said the magic words and voila! My drink was ready. That alone was enough to sell me on this feature. 	Davis, 1989
Information Quality	<ul style="list-style-type: none"> You used to put the nutrition information for all your food and drinks, but I can't find it on the new app. Could you bring it back so I can make an informed choice of food/beverage that I want to consume. 	Ahn et al., 2007
Functionality	<ul style="list-style-type: none"> Since the latest app update, I am unable to tip using my iPhone app. Will you be adding that feature back into the app? Also, would you consider allowing us to tip a percentage rather than a random amount? 	Goodwin, 1987
Perceived Value	<ul style="list-style-type: none"> I like to get my Starbucks first thing on my lunch break, and this makes it easy to order before I even get out of work. 	Hoehle & Venkatesh, 2015
Ease of Use	<ul style="list-style-type: none"> Ordering the coffee was easy enough, everything is super customizable down to how many pumps of syrup you want. You even get the calorie count of your drink. 	Davis, 1989
Technical Compatibility	<ul style="list-style-type: none"> I am unable to use my phone to order. I received this invitation from Starbucks today. "3 BONUS STARS WHEN YOU MOBILE ORDER & PAY March 21, 2 p.m. – close" But I cannot order as no Mobile app exists for windows based phones. I feel I am being discriminated against and may consider using other vendors for my coffee in the future. 	Premkumar et al., 1994

Universal Access	<ul style="list-style-type: none"> I love using the mobile order feature. It works in the U.S. but it won't work in Canada even though mobile ordering is available in Canada now...What's up with that? 	Janda et al., 2002; Stephanidis & Savidis, 2001
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Table 1: Interplay between Constructs, Codes, and Literature

Based on the codes represented in Table 1, we defined the first-order constructs in Table 2 as follows:

Construct Name	Entity (E) to which the construct applies and General Property (GP)	Construct Definition	Source/ Reference
Fulfillment	E = Person, GP = perception about the ability of the mobile application merchant to fulfill its promises to the user.	The degree to which the mobile application merchant fulfills its promises to the user about order delivery.	Parasuraman et al., 2005
Privacy	E = Person, GP = perception about the ability of mobile application to protect the user's privacy.	The degree to which a user perceives that his/her personal information stored in the mobile application can be accessed or viewed by unauthorized entities.	Liu et al., 2005
Security	E = Person, GP = perception about the ability of the mobile application to safeguard the user's information from criminal use or abuse.	The degree to which a user perceives that the mobile application has safeguards and policies in place to protect his/her information.	Liu et al., 2005; Suh & Han, 2003
Trust	E = Person, GP = perception about the trustworthiness of the mobile application merchant.	The degree to which a user perceives that the mobile application merchant is trustworthy.	Gefen et al., 2003
Time Awareness	E = Person, GP = perception about the ability of the application to deliver the right product/service to the right use at the right time.	The degree to which a user perceives that the mobile application delivers the right product/service to the right user at the right time.	Abowd et al., 1999; C. Emmanouilidis et al., 2013
Personalization	E = Person, GP = perception about the ability of the application to personalize contents and services.	The degree to which a user perceives that the mobile application has the ability to provide content and services that are tailored to individuals based on knowledge about their preferences and behaviors.	Sheng et al., 2008
Customization	E = Person, GP = perception about the ability of the mobile application to allow users to customize the product/service they are purchasing.	The degree to which a user perceives that he/she is able to use the mobile application to specify and modify elements of a product/service.	Arora et al., 2008
Activity-Based Adaptation	E = Person, GP = perception about the ability of mobile the application to adapt the product /service according to the user's preferences and activities.	The degree to which a user perceives that the mobile application monitors the user's activity and adapts the product/service according to the user's preferences and activities.	Abowd et al., 1999; C. Emmanouilidis et al., 2013

Availability	E = Person, GP = perception about the mobile payment service's availability.	The degree to which the product/service and the mobile payment service are available when and where the customer wants it.	Dabholkar et al., 1996; Yang et al., 2002
Environment Awareness	E = Person, GP = perception about the ability of the application to adapt the products/services according to the user's environment.	The degree to which a user perceives that the mobile application adapts the products/services according to the user's environment.	Abowd et al., 1999; C. Emmanouilidis et al., 2013
Location Awareness	E = Person, GP = perception about the ability of the application to adapt the products/services according to the user's location.	The degree to which a user perceives that the mobile application is able to locate the user and adapt the product/services according to the user's location.	Abowd et al., 1999; C. Emmanouilidis et al., 2013
Navigation Services	E = Person, GP = perception about the ability of the application to support the user's navigation according to the user's purchases.	The degree to which a user perceives that the mobile application supports the user's navigation according to the user's purchases.	Abowd et al., 1999; C. Emmanouilidis et al., 2013
Usefulness	E = Person, GP = perception about the usefulness of the mobile application in accomplishing the user's tasks.	The degree to which a person believes that using the mobile application would be useful in accomplishing his/her tasks.	Davis, 1989
Information quality	E = Person, GP = perception about the ability of the mobile application to provide relevant, timely, and accurate information.	The degree to which a user perceives that the mobile application provides relevant, timely and accurate information.	Ahn et al., 2007
Functionality	E = Person, GP = perception about whether the mobile application includes the functions needed to carry out the user's task.	The degree to which a user perceives that the mobile application includes the functions needed to carry out his/her task.	Goodwin, 1987
Perceived Value	E = Person, GP = perception about how the net value of the benefits of adopting the mobile application exceeds the costs associated with its adoption.	The degree to which a user perceives that the net value of the benefits of adopting the mobile application exceeds the costs associated with its adoption.	Nielsen et al., 2006; Nah et al., 2005; Johnson et al., 2006; Hoehle & Venkatesh, 2015
Ease of use	E = Person, GP = perception about the extent to which mobile application use is free of effort.	The degree to which a person believes that using the mobile application would be free of effort.	Davis, 1989
Technical compatibility	E = Person, GP = perception about the extent to which the mobile application is compatible with various existing mobile platforms/systems.	The degree to which a user perceives that the mobile application is compatible with various existing mobile platforms/systems.	Premkumar et al., 1994
Universal Access	E = Person, GP = perception about the accessibility of the mobile application from any location.	The degree to which a user perceives that the mobile application is globally accessible.	Janda et al., 2002

Table 2: First Order Constructs, Construct Entities and Definitions

According to the first-order variables, Table 3 displays the definitions of the three second-order constructs as follows:

Construct Name	Entity (E) to which the construct applies and General Property (GP)	Construct Definition	Source/ Reference
Reputation	E = Person, GP = overall perception of the ability of the mobile application merchant's reputation.	The degree to which the user perceives that the mobile application's merchant is fair and honest.	Anderson & Weitz, 1992; Hoxmeier, 2015
Context-based Services	E = Person, GP = overall perception about the ability of the mobile application to dynamically adapt its behavior according to the user's and application's context.	The degree to which the user perceives that the mobile application dynamically changes or adapts its behavior based on the context of the application and the user.	Abowd et al., 1997; Brown et al., 1997; Davis et al., 1998; Dey et al., 1997; Korteum et al., 1998; Schilit et al., 1994; Ward et al., 1997
Application Utility	E = Person, GP = overall perception about the utility of the mobile application	The degree to which a user perceives that the mobile app generally serves its purpose well.	Hoehle & Venkatesh, 2015

Table 3: Second-Order Constructs, Construct Entities and Construct Definitions

Table 4 shows that three constructs (i.e., utility, reputation, and context-based services) are conceptualized and measured as second-order formative constructs, and two dependent variables (continued intention to use and loyalty) are conceptualized and modeled as first-order reflective constructs.

Construct	Type of construct	Dimensions
App utility	Formative	Time-saving
		Convenience
		Control
		Value
		Information quality
Vendor reputation	Formative	Security
		Privacy
		Fulfillment
		Trust
Context-based services	Formative	Identity awareness
		Environment awareness
		Time awareness
		Location awareness
Continued intention to use	Reflective	5 items
Loyalty	Reflective	5 items

Table 4: Constructs and Dimensions

Using the identified constructs, we defined four hypotheses as follows:

Hypothesis 1 (H₁): There is a positive relationship between the reputation of vendors and context-based services.

Hypothesis 2 (H₂): There is a positive relationship between context-based services and perceived utility.

Hypothesis 3 (H₃): There is a positive relationship between perceived utility and continued intention to use the mobile application.

Hypothesis 4 (H₄): There is a positive relationship between perceived utility and customer loyalty.

Figure 1 shows the proposed conceptual model.

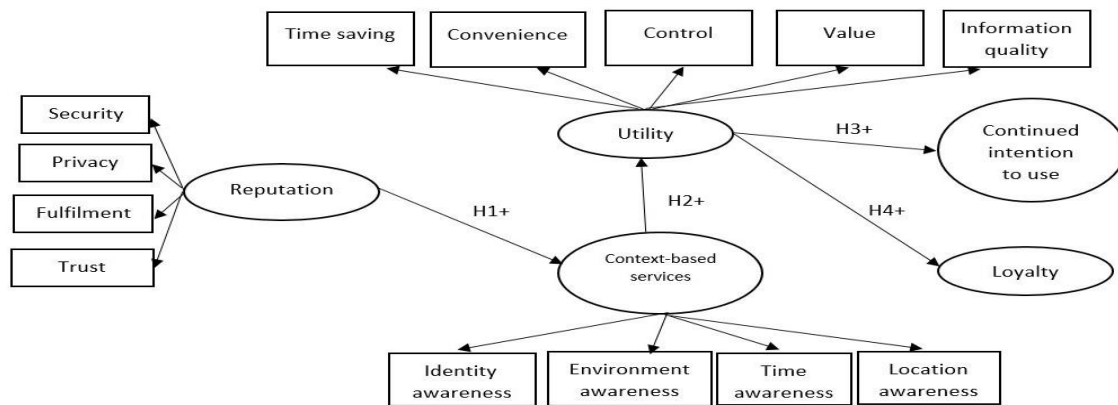


Figure 1: Conceptual Model

4. Methodology

Using Qualtrics software, we emailed the survey to 500 randomly chosen students enrolled in the evening MBA and BBA programs at a large university in the southeastern United States. After excluding responses that failed the response quality questions, the final set of useable and valid responses contained 450 samples.

5. Analysis

To validate the survey instrument, we performed a Confirmatory Factor Analysis (CFA) on all the constructs to assess the measurement model. To do so, AMOS (Version 20) was used to test convergent validity and discriminant validity. All AVEs are greater than 0.50 demonstrating convergent validity, and all values of Cronbach’s Alpha and composite reliabilities are higher than the threshold value of 0.7 (Table 5), which highlights that the reliability of constructs is adequate (Segars, 1997).

Constructs	Average Variance Extracted (AVE)	Cronbach’s Alpha	Composite Reliability
Reputation	0.763	0.923	0.927
Utility	0.785	0.948	0.948
Context-based services	0.637	0.872	0.870
Loyalty	0.866	0.97	0.97
Intention to use	0.866	0.97	0.97

Table 5: Convergent Validity Summary and Construct Reliabilities

We also tested the discriminant validity of the constructs (Table 6). All the diagonal values (the square roots of the AVEs) were greater than 0.7 and exceed the correlations between any pair of constructs (Fornell, Tellis, & Zinkhan, 1982). Therefore, the results indicate that the model fulfills the requirements of discriminant validity and it is assumed that the model also has adequate discriminant validity.

Constructs	Reputation	Utility	Context-based services
Reputation	0.873		
Utility	0.755	0.886	

Context-based services	0.433	0.609	0.798
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Table 6: Correlations among Latent Constructs

The indices values for CFI= 0.922, NFI=0.90, RFI= 0.90, IFI= 0.912 and TLI=0.912 are above 0.9 and the RMR= 0.058 and RMSEA= 0.067 are below 0.08 (Byrne, 2001). The fit indices support that there is a good fit between the hypothesized model and the observed data. The path analysis result significantly supports all proposed causal relationships (Table 7). The reputation of vendors significantly influences users’ perceptions of the merchant’s context-awareness offerings, supporting H₁ ($\beta = 0.651, p < 0.001$). Offering context-based services significantly influences the levels of utility perceived from the application, validating H₂ ($\beta = 0.806, p < 0.001$). Perceived utility significantly increases the continued intention to use the application supporting H₃ ($\beta = 0.462, p < 0.001$). Utility perceptions also enhance customer loyalty to the application, validating H₄ ($\beta = 0.432, p < 0.001$). Figure 2 displays the standardized path coefficients of the structural model under investigation.

	Path	Estimate	S.E.	C.R.	p-value
Reputation	→ Context-based services	.651	.039	12.179	***
Context-based services	→ Utility	.806	.054	15.985	***
Utility	→ Intention to Use	.462	.101	8.445	***
Utility	→ Loyalty	.432	.092	7.752	***

*** p < 0.001

Table 7: Path Analysis

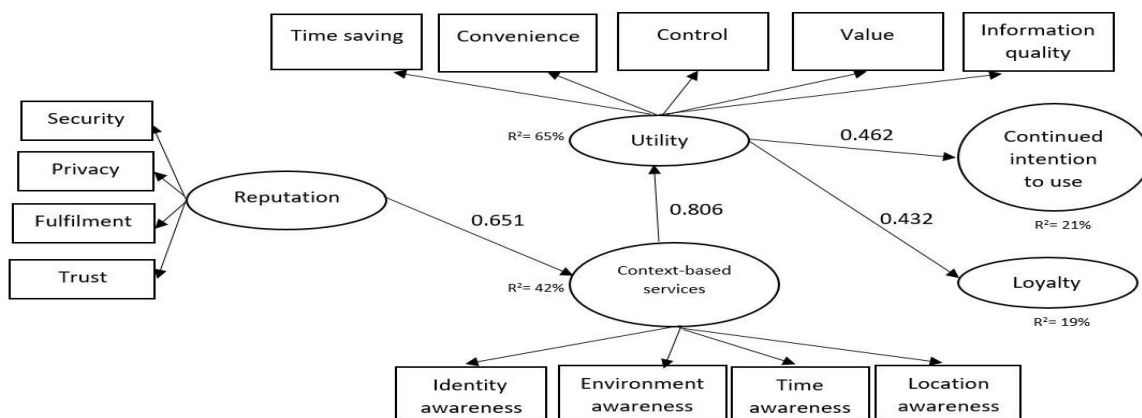


Figure 2: Path Coefficients

Overall, the proposed model can explain 65% of the variance in utility, 42% of the variance in context-based services, 21% of the total variance in users’ continued intention to use a mobile application. Moreover, the model is able to predict 19% of the variance in users’ loyalty to the application. These R square values show that future studies can extend this work by adding more relevant variables to enhance the explanatory power proposed by this model.

6. Discussion

The model showed that customers are more receptive to context-based services that are provided by a reputable mobile application. The context-based services (such as services offered based on time and location awareness) can lead to more perceived utility (such as time-saving and convenience). The more utility seen by users, the more willing they are to continue using the application in the future. Moreover, the perceived utility can make users loyal to the mobile app. This study demonstrated the significance of perceived security, privacy, fulfillment, and trust in vendors. Vendors should have a robust privacy policy statement, which clearly states the purposes of collecting, processing, and using customers' data. If users are aware of security safeguards, which used to protect personal data from unauthorized access and third parties, users are more likely to trust the vendor. If the measures to protect data security are robust, users will be more likely to use context-based services because they realize that their personal information is stored and processed by a reputable vendor to offer more personalized and customized services based on their context.

These customized services can bring about more convenience, value, time-saving, and perceived control. The more utility a mobile application generates, the more likely that users will continue using the application in the future. Users will also be more inclined to say positive things about the mobile app to others. This study showed that the levels of utility offered by an application could increase switching costs, enhance the functionality of the application, and finally increase the levels of customer loyalty. More importantly, our study confirmed the usefulness of the privacy calculus theory in a way that highlighted that customers would choose to continue to use mobile payment systems when the perceived utility is high.

Additionally, we expanded the theory to include other vital variables that significantly contribute to the benefits and risks of using mobile payments, such as reputation and context awareness. Path analyses yielded new insights to enrich the theory that reputation and context awareness can affect utility (for cost-benefit analysis), thus influencing customers' continued intention to use mobile payment systems and their loyalty. Our finding also filled the gap in prior related studies and found that both privacy and security have greater priorities than personalization when customers consider using mobile payment services. Moreover, we have validated and utilized multi-dimensional scales for measuring constructs and have demonstrated the usefulness of the scales in the mobile payment environment. With an increasing number of electronic hand-held gadgets and devices introduced to the market and utilized by people, future research can apply our model in other contexts to seek further validation.

7. Conclusion

Through the development of a model and an empirical study, this paper suggests that providing customization and personalization of mobile services based on customer contexts is the main competitive advantage of mobile application vendors. Context-based services can improve the utility offered by the apps, and in turn, encourage current users to continue using the apps in the future. Moreover, they will become more prone to recommend apps to other prospective customers. However, these positive use behaviors will not take place if the app vendors are not reputable in the market. Therefore, the findings demonstrate that the reputation of app vendors is the essential building block of this equation. If a reliable app vendor offers context-based services with high levels of personalization, users may see more utility. Consequently, they are more likely to use the app in the future and also encourage others to switch to it. The results of this study can contribute to both theory and practice.

References

- Abowd, G.D., Dey, A.K., Orr, R., Brotherton, J. (1997). "Context-Awareness in Wearable and Ubiquitous Computing." *1st International Symposium on Wearable Computers*, 179-180.
- Anderson, E., and Weitz, B.A. (February 1992). "The use of pledges to build and sustain commitment in distribution channels." *Journal of Marketing Research*, 29, 1, 18–34.
- Belanger, F., and Crossler, R. E. (2011). "Privacy in the Digital Age: A Review of Information Privacy Research in Information Systems." *MIS Quarterly*, 35(4), pp. 1017-1041.
- Brown, P.J., Bovey, J.D. Chen, X. (1997). "Context-Aware Applications: From the Laboratory to the Marketplace." *IEEE Personal Communications*, 4(5), 58-64.
- Brown, M., and Muchira, R. (2004). "Investigating the Relationship Between Internet Privacy Concerns and Online Purchase Behavior." *Journal of Electronic Commerce Research*, 5(1), pp. 62-70.
- Byrne, B.M., (2001). "Structural equation modelling: Perspectives on the present and the future." *International Journal of Testing*, 1(3-4), pp.327-334.
- Chen, S., and Li, J. (2009). "Factors Influencing the Consumers' Willingness to Buy in e-Commerce." in *Proceedings of the International Conference on E-Business and Information System Security*, Wuhan, China, pp. 1-8.
- Davies, N., Mitchell, K., Cheverst, K. Blair, G. (1998). "Developing a Context Sensitive Tourist Guide." *1st Workshop on Human Computer Interaction with Mobile Devices*, GIST Technical Report G98-1.
- Dey, A.K., Abowd, G.D. (1997). "CyberDesk: The Use of Perception in Context-Aware Computing." *1st Workshop on Perceptual User Interfaces*, 26-27.
- Drennan, J., Mort, G. S., and Previte, J. (2006). "Privacy, Risk Perception, and Expert Online Behavior: An Exploratory Study of Household End Users." *Journal of Organizational and End User Computing*, 18(1), pp. 1-22.
- Faulds, D. J., Mangold, W. G., Raju, P. S., and Valsalan, S. (2018). "The mobile shopping revolution: Redefining the consumer decision process." *Business Horizons*, 61(2), pp. 323-338.
- Fornell, C., Tellis, G. J., & Zinkhan, G. M. (1982). "Validity assessment: A structural equations approach using partial least squares." *In the Proceedings of American Marketing Association Educators' Conference*.
- Hoehle, H. and Venkatesh, V., (2015). "Mobile application usability: conceptualization and instrument development." *MIS Quarterly*, 39(2), pp.435-472.
- Korteum, G., Segall, Z., Bauer, M. (1998). "Context-Aware, Adaptive Wearable Computers as Remote Interfaces to 'Intelligent' Environments'." *2nd International Symposium on Wearable Computers*, 58-65.
- Laufer, R. S., & Wolfe, M. (1977). "Privacy as a concept and a social issue: A multidimensional developmental theory." *Journal of social Issues*, 33(3), 22-42.
- Mallat, N. (2007). "Exploring consumer adoption of mobile payments—A qualitative study." *The Journal of Strategic Information Systems*, 16(4), 413-432.
- Manis, K. T. and Choi, D. (2019). "The virtual reality hardware acceptance model (VR-HAM): Extending and individuating the technology acceptance model (TAM) for virtual reality hardware." *Journal of Business Research*, (100), pp. 503 – 513.
- Ozturk, A. B., Nusair, K., Okumus, F., & Singh, D. (2017). "Understanding mobile hotel booking loyalty: an integration of privacy calculus theory and trust-risk framework." *Information Systems Frontiers*, 19(4), 753-767.

- Segars, A. H. (1997). "Assessing the unidimensionality of measurement: A paradigm and illustration within the context of information systems research." *Omega*, 25(1), pp.107-121.
- Schilit, B., Adams, N. Want, R. (1994). "Context-Aware Computing Applications." *1st International Workshop on Mobile Computing Systems and Applications*. 85-90.
- Ward, A., Jones, A., Hopper, A. (1997). "A New Location Technique for the Active Office." *IEEE Personal Communications*, 4(5), 42-47.
- Petrick, J. F. (2002). "Development of a Multi-Dimensional Scale for Measuring the Perceived Value of a Service." *Journal of Leisure Research*, 34(2), pp. 119-134.
- Venkatesh, V., Aloysius, J. A., Hoehle, H., and Burton, S. (2017). "Design and evaluation of auto-ID enabled shopping assistance artifacts in customers' mobile phones: two retail store laboratory experiments." *MIS Quarterly*, 41(1), 83-113.
- Wang, T., Duong, T. D., and Chen, C. C. (2016). "Intention to disclose personal information via mobile applications: A privacy calculus perspective." *International Journal of Information Management*, 36(4), 531-542.
- Warkentin, M., and Willison, R. (2009). "Behavioral and Policy Issues in Information Systems Security: The Insider Threat." *European Journal of Information Systems*, 18(2), pp. 101-105.
- Wester, J. (2014). "Business Strategy: Results from the 2014 Consumer Payments Survey." *IDC Financial Insights*, pp. 1-16.
- Zhang, R., Chen, J. Q., and Lee, C. J. (2013). "Mobile commerce and consumer privacy concerns." *Journal of Computer Information Systems*, 53(4), 31-38.
- Zhu, H., Ou, C. X., van den Heuvel, W. J. A., and Liu, H. (2017). "Privacy calculus and its utility for personalization services in e-commerce: An analysis of consumer decision-making." *Information & Management*, 54(4), 427-437.

P28: Tailoring the Cyber Security Framework: How to Overcome the Complexities of Secure Live Virtual Machine Migration in Cloud Computing

Hanif Deylami
Auckland University of Technology,
New Zealand
hmohadde@aut.ac.nz

Jairo Gutierrez
Auckland University of Technology,
New Zealand
jairo.gutierrez@aut.ac.nz

Roopak Sinha
Auckland University of Technology,
New Zealand
roopak.sinha@aut.ac.nz

Abstract

This paper proposes a novel secure live virtual machine migration framework by using a virtual trusted platform module instance to improve the integrity of the migration process from one virtual machine to another on the same platform. The proposed framework, called Kororā, is designed and developed on a public infrastructure-as-a-service cloud-computing environment and runs concurrently on the same hardware components (Input/Output, Central Processing Unit, Memory) and the same hypervisor (Xen); however, a combination of parameters needs to be evaluated before implementing Kororā. The implementation of Kororā is not practically feasible in traditional distributed computing environments. It requires fixed resources with high-performance capabilities, connected through a high-speed, reliable network. The following research objectives were determined to identify the integrity features of live virtual machine migration in the cloud system:

- *To understand the security issues associated with cloud computing, virtual trusted platform modules, virtualization, live virtual machine migration, and hypervisors;*
- *To identify the requirements for the proposed framework, including those related to live VM migration among different hypervisors;*
- *To design and validate the model, processes, and architectural features of the proposed framework;*
- *To propose and implement an end-to-end security architectural blueprint for cloud environments, providing an integrated view of protection mechanisms, and then to validate the proposed framework to improve the integrity of live VM migration.*

This is followed by a comprehensive review of the evaluation system architecture and the proposed framework state machine. The overarching aim of this paper, therefore, is to present a detailed analysis of the cloud computing security problem, from the perspective of cloud architectures and the cloud service delivery models. Based on this analysis, this study derives a detailed specification of the cloud live virtual machine migration integrity problem and key features that should be covered by the proposed framework.

Keywords: Cloud Computing Infrastructure, Computational Modeling, Virtualization and Security, Live Migration, Integrity, Organizations.

1. Introduction

The word “Cloud” is a metaphor describing the web as space where computing has been preinstalled and exists as a service. Many companies, both large and small, are contemplating a migration to cloud computing (CC) to leverage the significant potential of this new paradigm [1-3]. Government agencies, small and medium-sized enterprises, and large organizations already make significant use of CC and they are spending considerable amounts of money, resources, and time on delivering secure services using information and communication technologies [4]. Security is crucial and it is one of the main challenges for CC adoption, as many surveys show [5]. Systems become significantly more susceptible to several cyber attacks when they move to cloud platforms, especially when this move is based on a lack of adoption of cloud-native models and the required adjustment in organizational processes to align with the features and capabilities of the chosen cloud platforms [2].

Virtualization is a technology that provides the ability to automate and orchestrate multiple, tightly isolated IT processes related to on-demand provisioning on a single piece of server hardware to create a virtual computer system or “Virtual Machine” (VM). With respect to virtualization technologies, a physical server can be divided into several isolated execution environments by developing a layer (i.e., VM monitor or hypervisor) on top of the hardware resources or operating systems (OSs); thus, a physical database can be divided into several separate execution environments with the help of virtualization technologies. The server’s execution environments (i.e., VMs) run in parallel without interruption. A VM, also called a guest machine, is a virtual representation, or software emulation of a hardware platform that provides a virtual operating environment for guest OSs. The task of moving a VM from one physical hardware environment to another is called migration. If the migration is carried out in such a way that the connected clients perceive no service interruption, it is considered a “live” migration. For example, database consolidation is made easier if VMs do not have to be shut down before they are transferred. The method is also used for administrative purposes; for instance, if a server needs to be taken off-line for some reason, live transferring of VMs to other hosts can be used to pass running VMs between cloud sites over wide-area communication networks.

A VM migration can occur in two ways: live and offline. In a live VM migration, the VMs are transferred from a source host to a destination host while they are running. After a successful VM migration, the source host removes the memory pages of the migrated VM. During a live VM job migration, there is considerable potential for compromise through malicious activities while information such as memory pages is copied from the host and transferred to the destination, presenting security risk(s) with regard to data integrity and confidentiality. The owner of the VM must have a framework to ensure live VM migration data integrity at both ends of the migration process. In other words, there is a need to ensure a clear memory portion is assigned to an incoming VM on the destination host, separated from previous VM data or malicious codes, and to secure the removal of the memory data of the outgoing VM. This situation might make organizations and businesses reluctant to switch to using the cloud because of the potential attacks on their assets.

This paper investigates the possibility of misuse of migrating VM’s data either in transit or present at source and destination during the live VM migration process. It then proposes a novel framework for a secure live VM migration by using a Virtual Trust Platform Model (vTPM) agent and four other agents: input/output, data plane, integrity analyzer, and data organization. While existing studies [6-9] have established a live VM migration framework for cloud systems integrity, an examination of the different types of research has identified a lack of empirical evidence and knowledge regarding which issues are the most important for

these areas. In this paper, the relative significance of the identified issues is determined first, to address the two related research questions listed below, and then the importance of the identified issues is discussed in the rest of the paper. *Research Question 1*: What are the opportunities and challenges for live VM migration in CC, with respect to the essential system attributes and essential system characteristics?, and *Research Question 2*: What are the characteristics of the proposed framework that is on the public cloud instead of in a traditional on-premises data center? According to Kitchenham et al. [10], a systematic literature review method is one of the best ways to identify and prioritize issues for decision making and to sort large volumes of references. This method assists in identifying the research questions and issues associated with the research topic. The overarching aim of this paper is to develop and design a secure live VM migration framework to help cloud service providers (CSPs) improve integrity protection in live VM migration from one VM to another in the same platform (with the same hardware features and the same hypervisor [Xen hypervisor]).

The remainder of this paper is structured as follows. Section 2 discusses the related work and motivation for this research. Section 3 explains the design of the framework system architecture and its agents. Section 4 presents the evaluation system architecture: that is, the state machine. Finally, Section 5 summarizes the paper and discusses future work.

2. Related Work and Motivation

Critical concerns for cloud users involve protecting workloads and data in the cloud and from the cloud, and ensuring trust and integrity for VM images launched on a service provider's cloud [11]. For live VM and workload data protection, cloud-user organizations need a framework to securely place and use their workloads and data in the cloud. Current provisioning and deployment frameworks include either storing the VM and application images and data in the clear (i.e., unencrypted) or having these images and data encrypted using keys controlled by the service provider, which are likely applied uniformly to all the tenants.

Live VM migration [12] in the inter-cloud is a new way of looking at VM migration. It allows the migration of VMs not only between data centers of the same cloud but also between servers on different clouds. The driving force behind live VM migration between clouds is to decrease the workload on a particular cloud and reduce the congestion of its network. The key point of a planned migration is to take snapshots that preserve the state and data of a VM at any given time. With these snapshots of a VM, an image of the VM in each state is copied and stored. The snapshot is then migrated to the destination cloud, where the hypervisor creates a new VM with the same configuration as the snapshot. The source cloud redirects the incoming traffic of its VM to the destination VM soon after the target VM is up and running.

Data deduplication [6] is a live VM migration technique that prevents large chunks of data from migrating, thereby reducing migration time. This operates on the concept of only selected memory material that has been altered on the source server being transferred. Thus, the phase of migration involves only those parts of the VM that were updated at the source end. A Dirty Block Tracking (DBT) mechanism and a new diff format are the two major components of data deduplication. The role of DBT is to record all the operations that cause changes in the picture of the VM disk, while the diff format is used to store the reported data. DBT monitors and labels each changed disk page as a dirty file. Only the pages identified by the DBT are migrated to the storage; the rest is left behind. Data deduplication is beneficial for VMs undergoing multiple migrations, resulting in multiple destination servers. As it

reduces the migration time by a factor of 10, it is one of the most effective techniques for live VM migration.

Yang et al. [7] suggest an Input/Output (I/O) Outsourcing scheme for Workload-Aware, (WAIO) to improve the efficiency of live processing for VM migration. During the migration, WAIO effectively outsources the working set of the VM to a surrogate device and creates a separate I/O path to serve VM I/O requests. The VM live storage migration process can be performed on the original storage by outsourcing VM I/O requests from the original storage to the surrogate device, without interfering with them, while the outsourced VM I/O requests are serviced separately and thus, much faster. This lightweight WAIO prototype implementation and extensive trace-driven experiments show that WAIO significantly improves the I/O performance of the VM during the migration process compared with the existing DBT migration approach. In addition, WAIO allows the hypervisor to migrate a VM at a higher speed of migration without sacrificing the I/O performance of the VM.

Riteau et al. [8] propose a live VM migration system, called Shrinker, which allows VM clusters to migrate between data centers linked via a network. Through integrating data duplication and cryptography hash functions, Shrinker reduces the data to be migrated. This operates on the principles of handling distributed information, and of allowing chunks of VMs to be migrated in multiple data centers across different servers. Shrinker is different from traditional live VM migration methods as it allows source and destination server hypervisors to interact with each other during migration.

Work on opportunistic replay [13] aims to reduce the amount of data in low bandwidth environments that are migrated. This approach keeps a record of all types of user events that occur during the execution of the VM. This information is then transferred to an identical manufactured VM and put into effect to produce almost the same state as the VM source.

Zheng et al. [9] present a novel scheduling algorithm for storage migration that can significantly improve the performance of I/O storage during wide-area migration. This algorithm is unique in that it considers the storage I/O workload of individual VMs, such as temporal location, spatial location, and popularity characteristics, to calculate efficient schedule data transfers.

Berger et al. [17] discuss a vTPM that provides trusted computing for multiple VMs running on a single platform. The key to this process is finding a way to store vTPM data encrypted in the source platform and restoring them safely in the in-destination platform, as well as a way to protect the integrity of the transferred data in the process of live vTPM-VM migration, where it is vulnerable to all the threats of data exchange over a public network. These include leakage, falsification, and loss of sensitive information contained in the VM and vTPM instances.

This paper proposes a better alternative live VM migration framework, which assigns valid but conspicuous values in the new system as “flags” for problem data. This means that when users find a flag in a certain record, they know that the migrated record contains information that could not be loaded immediately. The original data from the legacy system persist in a standard format and are connected to the new record for each such example. The user can quickly check the original source to interpret the data in a meaningful manner.

In addition, the proposed framework collects the target VM working set data over the migration period to the Kororā platform. This helps the framework process to access the data set during migration, while the I/O migration process is accessing the original disk most of the time. Consequently, it is possible to significantly reduce the traffic between I/O processes and the Kororā platform, and the overall integrity of the live VM migration can be improved.

3. System Architecture

The use of the IT security framework is supported by tools that enable service providers to bridge the gap between control requirements, technical issues, and business risks. Kororā is capable of measuring and preserving the integrity of live VMs migration in the cloud system. The expected benefits of using this framework include increasing the level of integrity among different physical hosts. Kororā allows users to check malicious files against three different malware providers' engines and it can check indicators of comparison details of hashes, URLs, IP addresses, and domains from different resources.

This section aims to explain the system requirements (representing the problem from a design point of view) through an intermediate model of logical architecture, to allocate the elements of the logical architecture model to the system elements of the Kororā physical architecture models. The proposed framework system requirements and the exact approach taken in the synthesis of solutions often depends on whether the system is an evolution of an already-understood product. The Kororā system architecture aims to meet the following system elements and system architecture requirements:

- *System Element 1 – Integrity of configuration files:* In this case, the VM image structure is such that it can represent a complete file system for a given platform integrity: for example, 'vbox' files in virtual box or '.vmx' files in VMware. Both these files can be edited by a third party to make changes in the configuration of VMs.
- *System Element 2 – Virtual hard disk integrity:* The life cycle of the VM image consists of different states. For instance, a VM image can be created, started, suspended, stopped, migrated, or destroyed. Essentially, VM images are loaded from a storage location such as a hard disk drive and run directly from a VM manager with a low level of integrity: for example, '.vmdk', '.vdi', '.ova' files. A third party can make changes to these files after running them in their own environment since it is the actual OS holding file; it would be easy to place a Trojan or malicious codes inside the files.
- *System Element 3 – The integrity of the data files on the VM, including all confidential files, and the integrity of the system files:* The VM is loaded from the storage location and the VM image may not comply with the intended settings and configurations needed for proper implementation in each environment. The VM image itself could be distorted (perhaps by an insider) or even maliciously modified. This work proposes two ways to analyze these files – "supply the data files" and "system files hashsum" – on the framework before migration and checking of the files after migration.

3.1. System Architecture Requirements

To apply the system design agents in the Kororā framework, the following requirements must be considered in the Xen hypervisor environment:

- 64-bit x86 computer with at least 1 GB of RAM (this can be a server, desktop, or laptop) and trusted platform module chipset on the motherboard. The TPM hardware must be activated through the BIOS.
- Intel virtualization technology or AMD-V support (optional for paravirtualization [PV], required for hardware VM and some PV optimisation).
- Sufficient storage space for the Kororā framework dom0 installation.
- Extensible firmware interface – this helps the hardware layer to select the OS and get clear of the boot loader. In addition, it helps the CSP to protect the created drivers from a reverse-engineering (back-engineering) attack.
- Software requirement cmake – this is the main additional product necessary for compiling a vTPM. To manage domains with vTPM, libxl should be used rather than 'xm' which does not support vTPM.
- Linux host (Ubuntu 12.4) must be installed on the machine.

The Kororā system architecture focuses on a hypervisor that preserves metadata using cryptography and hashing algorithms. The protected live VM migration framework based on this hypervisor was designed to identify the different attacks possible and perform an independent secure migration process. The approaches of live VM migration are generally divided into three different classes: 1) *Migration of the process*; 2) *Migration of memory*; 3) *Suspend/resume migration*. In this research, the process of live VM migration means the process of migrating a VM from a source host to a destination host without suffering any attacks. These requirements must be incorporated into the process of the secure live VM migration platform.

Before the migration starts, it is important to ensure that source hosts and destination hosts and VMs meet the requirements for migration that Kororā is trying to match and to verify whether the target is correct, and to create a cryptography rule. Effective access control policies must be provided to protect the process of live VM migration. If an unauthorized user/role begins the live VM process and initiates the migration, the use of access control lists in the hypervisor will avoid the occurrence of unauthorized activities (authorization). Using route hijacking or Address Resolution Protocol (ARP) poisoning techniques in the migration process, an attacker may initiate Man-in-the-Middle (MiTM) attacks. During live VM migration, the source and destination platforms need to perform mutual authentication in order to avoid MiTM attacks (authentication). An encrypted network must be set up so that no data can be accessed from the VM content by an intruder and any software alteration can be detected properly. This will help to prevent active attacks on live migration, such as memory manipulation, and passive attacks, such as sensitive information leakage (confidentiality and integrity). An intruder may intercept traffic and later replay it for authentication in the process of the VM migration. Therefore, the method of live VM migration should be immune to replay. For example, nonces in java applications help with the password for the migration authorization, as well as the public key of the machine where the user is sitting at, to provide the correct command that is transmitted to the server in migration to prevent playback attack (reply resistance). The source host cannot deny the VM migration activity. Using public key certificates can achieve this feature (source non-repudiation).

This framework is orthogonal to existing live migration approaches – including the Zehang et al. [9] and Mashtizadeh et al. [15] live migration patents, and the Fan Peiru [16] vTPM-VM live migration protocol – and it is a secure boost layer for most, if not all, VM live migration schemes. In addition, this framework can be used to improve the security of other VM tasks, such as those associated with the virtualization and the virtual networking layers, which may experience the same problem of data integrity as VM live storage migration. This research framework, as well as the three frameworks named above, exploit the secure live migration characteristics, but they improve the VM migration security in different ways. For example, the scheme of Zheng et al. [9] aims to significantly reduce the total amount of data transferred by exploiting the workload of the VM's locality. Rarely updated data blocks are differentiated from frequently updated data blocks in virtual disk images by analyzing the workload position. The rarely updated data blocks are transferred in the migration before the frequently updated data blocks, so that the re-transmissions of data blocks are minimized, thus reducing the total amount of data transmissions. While this current research framework secures the live VM migration, its methodology is completely different from that of Zehang [9].

Five agents of the design framework system architecture must be clarified. The responsibilities of these agents are as follows:

- *Virtual Trust Platform Model Agent*: The vTPM agent provides trusted computing for multiple VMs migration on a single platform [17]. With multiple VMs operating on a single platform, vTPM offers trusted computing. It is important to move the vTPM instance data along with its corresponding VM data to keep the VM security status synched before and after the live vTPM-VM migration process. Current live VM migration schemes only check the hosts' reliability and integrity. This poses a huge security risk for vTPM-VM migration. To solve this problem, the proposed framework uses vTPM to secure boot VM(s) over the Xen hypervisor (see Figure 1, Label 1).
- *I/O Agent*: The I/O agent redirects the necessary I/O requests to the replacement device from the operating VM itself. To minimize I/O traffic to the original replacement device, it redirects all write requests on the replacement device [18]. Meanwhile, the I/O redirects all the popular read requests identified by the Data Plane module to the replacement device. If the replacement device has only partial data for a request, the I/O issues read requests to the original replacement device and merge the data from the original device into the replacement device. Either the original storage device [18] or the replacement device can be redirected to the read requests from the migration module. While the original storage device generates most of the virtual disk images, the replacement device provides the modified chunks (units of information that contain either control information or user data) of data. Because of the VM workload locality, most of the requests will be routed to the original storage device (see Figure 1, Label 2).
- *Data Plane Agent*: Different memory contents are moved from one host to another host in this module (e.g., kernel states and application data). The transmission channel must, therefore, be secured and protected from any attack. All migrated data are transferred as clear data without encryption in the live VM migration protocol. An attacker may, therefore, use one of the following techniques to position himself in the transmission channel to execute a MiTM attack: ARP spoofing, DNS poisoning, or route hijacking [19, 20]. These attacks are not theoretical. Tools such as Xensploit work against Xen and VMware migration [21] (see Figure 1, Label 3).
- *Integrity Analyzer Agent*: Protection of information systems is concerned with three key information properties: availability, integrity, and confidentiality. These three critical characteristics of information are major concerns throughout the commercial and military sectors. Traditionally, confidentiality has received the most attention, probably because of its importance in the military. Unlike the military security systems, the main concern of commercial security is to ensure the integrity of data is protected from unauthorized users. Availability and confidentiality are equally significant within the commercial environment, where a secure working environment is required; however, Clark and Wilson (CW) [22] propose a security model that focuses on integrity in recognized mathematical terms by a set of constraints, or a valid state when it satisfies these. Since much of the attention in the security arena has been devoted to developing sophisticated models (e.g., Bell-LaPadula model [23, 24]) and mechanisms for confidentiality, capabilities to provide confidentiality in information systems are considerably more advanced than those providing integrity.

The integrity analyzer agent uses CW as a basic theory for specifying and analyzing an integrity policy for Kororā. Moreover, it adopts the CW model to live VM migration focusing on the subjects, objects (see Section 4), and their data exchange of users' applications to enhance the security of the live VM migration mechanism, as well as providing user convenience (see Figure 1, Label 4).

- *Data Organization Agent*: In the virtual disk images, the data organization agent monitors the popularity of reading requests from the live VM itself. Only the popular data blocks that will be read are outsourced to the replacement device. Since the replacement device serves all write requests, monitoring the popularity of write requests is not required. Each virtual disk image of the running VM is divided into chunks of fixed size and the data organization agent records each chunk's access frequency. If the access frequency exceeds a predefined threshold for a particular chunk, the entire chunk will be outsourced to the replacement device. All the subsequent accesses to this chunk will be served by the replacement device, which removes their I/O involvement with the migration process. By submitting read-only requests, the migration module usually scans the entire virtual disk files. Most of these requests will only be issued once, except for requests that read dirty blocks of data (see Figure 1, Label 5).

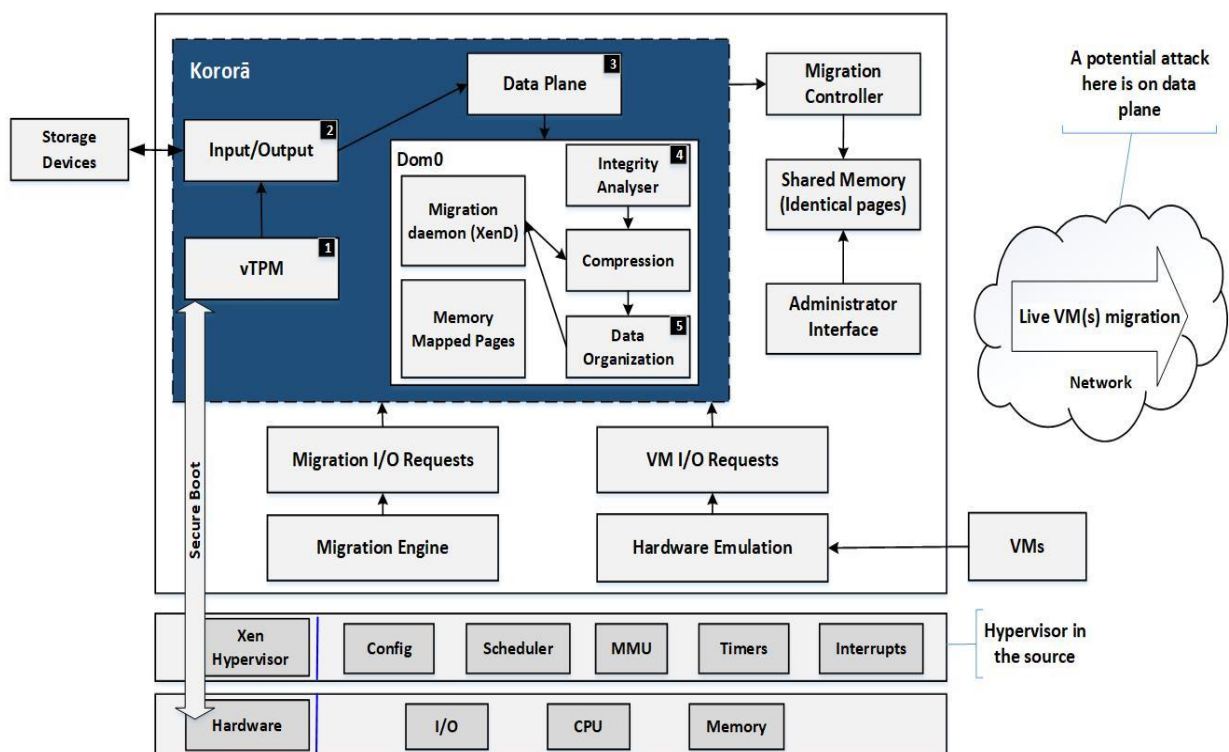


Figure 1. System Design Architecture of the Kororā

This paper focuses on adopting evaluation theory to define the research system machine and consequently identify a way to apply the integrity model in the design research framework, as discussed in the next section.

4. Evaluation of the System Architecture: State Machine

One of the primary aims of the proposed integrity framework is to consider the full cloud integrity environment and to capture all potential integrity attributes and elements as evidence, including functional and non-functional elements. Evaluation is a key analytical process for all intellectual disciplines and it is possible to apply different types of evaluation methods to provide knowledge regarding the complexity and ubiquity of the CSPs [25]. This paper aims to obtain a set of essential evaluation components. In particular, the evaluation of the system architecture method has been applied to review the secure establishment framework using the identification of these evaluation components and an analysis of their weaknesses and strengths. Evaluation theory [26] is considered a theoretical foundation for developing a secure live VM migration framework. Its processes are shown in Figure 2, which represents an overview of the components of evaluation and their interrelations, helping to establish a clear pathway for this study. Reaching a comprehensive and reliable integrity level in live VM migration processes is the main reason for using the evaluation theory. Further, this theory offers a clear, formal description of the evaluation concepts, as listed below:

- Target: Integrity between CSPs and cloud service users (CSUs).
- Criteria: Integrity elements of the CSPs and CSUs that are to be evaluated.
- Yardstick/standard: The ideal secure live VM migration framework measured against the current secure live VM migration framework.
- Data-gathering techniques: Critical or systematic literature review needed to obtain data to analyze each criterion.
- Synthesis techniques: Techniques used to access each criterion and therefore, to access the target, obtaining the result of the evaluation.
- Evaluation process: A series of tasks and activities that are used to perform the evaluation.

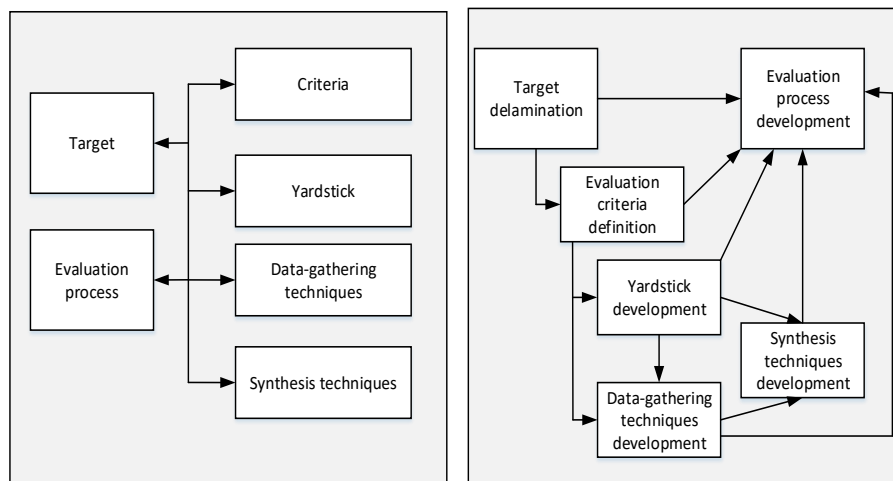


Figure 2. Components of an Evaluation and the Interrelationships between them [26].

4.1 System Architecture State Machine

The proposed framework in this research is a state machine framework. It consists of subjects, objects, access attributes, access matrix, subject functions, and object functions. Access attributes are defined as follows: Read, Write, Read and Write, and Execute (depicted in Figure 3).

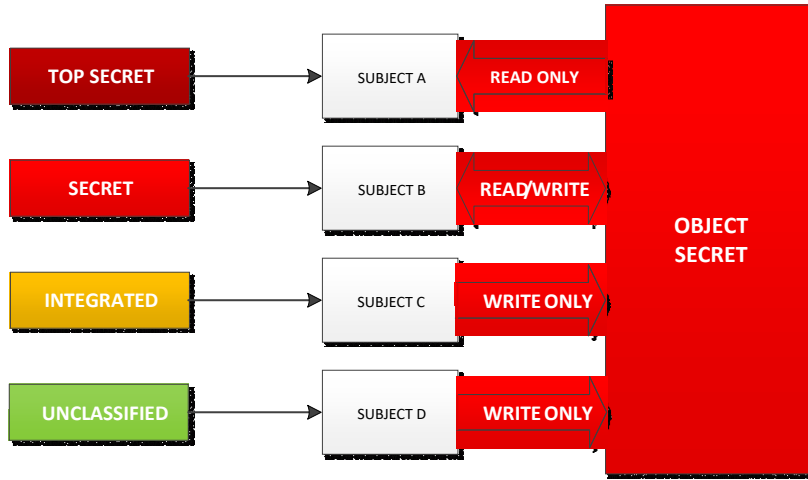


Figure 3. The Relationship Between Objects and Subjects

The proposed model state machine is as follows:

- 1) $t \in T$, where T is sorted Quaternion, each member of T is t
- 2) $T = (a, B, c, D)$, where,
- 3) $a \subseteq (S \times O \times A)$,
- 4) B is an access matrix, where $B_{ij} \subseteq A$ signifies the access authority of s_i to o_i ,
- 5) $c \in C$ is the access class function, denoted as $c = (c_s, c_o)$,
- 6) D signifies the existing hierarchy on the proposed framework,
- 7) S is a set of Subjects,
- 8) O is a set of Objects,
- 9) $A = [r, w, a, e]$ is the set of access attributes,
- 10) $ee: R \times T \rightarrow I \times T$ shows all the roles in the proposed framework, in which e is the system response and the next state, R is the requests set, and I is the arbitrary set of requests, which is [yes, no, error, question]. In this study, the question is important because if the response is equal to the question, it means that the current rule cannot deal with this request.
- 11) $\omega = [e_1, e_2, \dots, e_s]$, ω is the list exchange data between objects.
 $W(\omega) \subseteq R \times I \times T \times T$
 $(R_k, I_m, T^*, T) \in W(\omega)$
 if $I_m \neq \text{Question}$ and exit a unique J , $1 \leq j \leq s$, it means that the current rule is valid, subject and object also are valid because the object verifies the vTPM of the other object (attestee) by request (challenge) for integrity checking. Consequently, the result is,
 $(I_m, t^*) = e_i(R_k, t)$, which shows for all the requests in the t there is a unique response, which is valid.
 Where, $a \subseteq (S \times O \times A)$ where S is a set of Subjects, O is a set of Objects, and
 $A = [r, w, a, e]$ is the set of access attributes,
- 12) c_s is the security level of the subject (includes the integrity level $c_1(S)$ and category level $c_4(S)$). Figure 3 shows the security level in the proposed framework and the relationships between the subjects and objects. c_o signifies the security function of objects. Figures 3 show the relationship between the entire subjects, objects,

security functions, and security level of the proposed framework.

- 13) The integrity of the vTPM is highest in the state machine and lowest in the user agent. Therefore, the integrity level is $c_1(TPM)$, $c_2(TA)$, $c_3(IDP)$, $c_4(RP)$, and level $c_5(UA)$; this study should prove that each state of the proposed framework is secure. It has been assumed that each state is secure except for state three (Data Plane), as shown in Figure 1. Therefore, if state three is secure, all the states are secure.
- 14) $\Sigma(R, I, W, z_0) \subset X \times Y \times Z$
- 15) $(x, y, z) \in \Sigma(R, I, W, z_0)$, if $(z_t, y_t, z_t, z_{t-1}) \in W$ for each $t \in T$, where z_0 is the initial state. Based on the above definition, $\Sigma(R, I, W, z_0)$ is secure in all states of the system; for example, (z_0, z_1, \dots, z_n) is a secure state.
- 16) CW model has several axioms (properties) that can be used to limit and restrict the state transformation. If the arbitrary state of the system is secure, then the system is secure. In this study, the simple-security property (SSP) [27] is adopted. This property states that an object at one level of integrity is not permitted to read an object of lower integrity.
- 17) $t = (a, B, c, D)$
- 18) Satisfies SSP if,
 For all $s \in S, o \in S \Rightarrow [(o \in a(s: r, w)) \Rightarrow (c_s(s), > c_o(o))]$,
 i.e., $c_1(s) \geq c_2(o), c_3(s) \geq c_4(o)$.
 $c_1(G) \geq c_2(vTPM), c_1(IEU) \geq c_2(RP)$.

Based on Figures 1, 3, and the SSP axiom, all the objects of the proposed framework use two primary concepts to ensure the security policy is enforced: well-informed transactions and separation of duties. The integrity axiom is “no read down” and “no write up”, which means a subject at a specific classification level cannot read and write to data at a lower or higher classification respectively. Star property, Discretionary security, and Compatibility property are other models that can be used to limit and restrict the state transformation, and they will be used in future work.

5. Conclusions and Future Work

The proposed framework, called Kororā, is designed based on five agents running on the Xen privileged dom0 and communicating solely with the hypervisor. The cloud scenario for this paper is a public cloud environment, which means the tenants have the most responsibility and control over their systems; therefore, the risks are higher. Consequently, as a response to the research problem, this paper has represented a design system architecture of a secure live VM migration. For further study, two more agents, called Go Agent and Libvirt Agent will be added to the Kororā in order to support the proposed framework being run in VMs and Xen hypervisor, respectively. A prototype will be developed to prove the effectiveness of the Kororā.

References

1. Deylami, H., J. Gutierrez, and R. Sinha. *More Than Old Wine in New Bottles: A Secure Live Virtual Machine Job Migration Framework for Cloud Systems Integrity*. in IEEE 2018 Eleventh International Conference on Mobile Computing and Ubiquitous Network (ICMU). 2018.
2. Alliance, C.S., *Top Threats to Cloud Computing The Egregious Eleven*. 2019.
3. Alliance, C.S., *Security Guidance for Critical Areas of Focus in Cloud Computing*. 2017: p. 152.

4. Ali, M., S.U. Khan, and A.V. Vasilakos, *Security in cloud computing: Opportunities and challenges*. Information sciences, 2015. 305: p. 357-383.
5. Herrera, A. and L. Janczewski, *Issues in the study of organisational resilience in cloud computing environments*. Procedia Technology, 2014. 16: p. 32-41.
6. Han, Y., *Cloud computing: case studies and total cost of ownership*. Information technology and libraries, 2011. 30(4): p. 198-206.
7. Takahashi, K., K. Sasada, and T. Hirofuchi, *A fast virtual machine storage migration technique using data deduplication*. Proceedings of Cloud Computing, 2012: p. 57-64.
8. Yang, Y., et al. *WAIO: Improving Virtual Machine Live Storage Migration for the Cloud by Workload-Aware IO Outsourcing*. in *2015 IEEE 7th International Conference on Cloud Computing Technology and Science (CloudCom)*. 2015.
9. Riteau, P., C. Morin, and T. Priol. *Shrinker: Improving live migration of virtual clusters over wans with distributed data deduplication and content-based addressing*. in *European Conference on Parallel Processing*. 2011. Springer.
10. Zheng, J., T.S.E. Ng, and K. Sripanidkulchai, *Workload-aware live storage migration for clouds*. Vol. 46. 2011: ACM.
11. Choudhary, A., et al., *A critical survey of live virtual machine migration techniques*. Journal of Cloud Computing, 2017. 6(1): p. 23.
12. Buyya, R., R. Ranjan, and R.N. Calheiros. *Intercloud: Utility-oriented federation of cloud computing environments for scaling of application services*. in *International Conference on Algorithms and Architectures for Parallel Processing*. 2010. Springer.
13. Surie, A., et al. *Low-bandwidth VM migration via opportunistic replay*. in *Proceedings of the 9th workshop on Mobile computing systems and applications*. 2008. ACM.
14. Forrester, R.J., W.W. Starnes, and F.A. Tycksen Jr, *Method and apparatus for lifecycle integrity verification of virtual machines*. 2016, Google Patents.
15. Mashtizadeh, A. and S. Koundinya, *Live migration of virtual machine persistent data using mirrored input-output operations*. 2012, Google Patents.
16. Peiru, F., et al., *An improved vTPM-VM live migration protocol*. Wuhan University Journal of Natural Sciences, 2015. 20(6): p. 512-520.
17. Berger, S., et al., *vTPM: virtualizing the trusted platform module*, in *Proceedings of the 15th conference on USENIX Security Symposium - Volume 15*. 2006, USENIX Association: Vancouver, B.C., Canada.
18. Zhou, R., et al. *Optimizing virtual machine live storage migration in heterogeneous storage environment*. in *ACM SIGPLAN Notices*. 2013. ACM.
19. Oberheide, J., E. Cooke, and F. Jahanian, *Exploiting live virtual machine migration*. BlackHat DC Briefings, 2008.
20. Ver, M., *Dynamic load balancing based on live migration of virtual machines: Security threats and effects*. 2011.
21. Perez-Botero, D., *A brief tutorial on live virtual machine migration from a security perspective*. University of Princeton, USA, 2011: p. 8.
22. Clark, D.D. and D.R. Wilson. *A comparison of commercial and military computer security policies*. in *1987 IEEE Symposium on Security and Privacy*. 1987. IEEE.
23. Bell, D. and L. LaPadula, *Secure computer systems: Mathematical foundations*. 1973.
24. Sandhu, R.S., *Lattice-based access control models*. Computer, 1993. 26(11): p. 9-19.
25. Alabool, H.M. and A.K.B. Mahmood, *A novel evaluation framework for improving trust level of Infrastructure as a Service*. Cluster Computing, 2016. 19(1): p. 389-410.
26. Lopez, M., *An evaluation theory perspective of the architecture tradeoff analysis method (ATAM)*. 2000, Carnegie-Mellon Univ Pittsburgh pa Software Engineering.
27. McLean, J., *A comment on the 'basic security theorem' of Bell and LaPadula*. Information Processing Letters, 1985. 20(2): p. 67-70.

P29: The Effect of e-Filing on Tax Compliance among Micro Enterprises in Jamaica

Genee Tracey
The University of the West Indies
geneetracey_10@yahoo.com

Steven Rob
The University of the West Indies
stevenrobb22@gmail.com

Lisandra Bartley
The University of the West Indies
brightsparks_lisa@hotmail.com

Delroy Chevers
The University of the West Indies
delroy.chevers@uwimona.edu.jm

Abstract

Over the past decades government revenue authorities, especially in developing countries have implemented a series of reforms towards strengthening their revenue collection capabilities. Electronic filing (e-Filing) of taxes was introduced in Jamaica to improve tax compliance. However, the adoption of this initiative remains low which results in loss of tax revenue. This condition ultimately limits the government's ability to finance needed projects and address critical needs of citizens. This study seeks to investigate the effect of e-Filing on tax compliance among micro enterprises in Jamaica. Tax-compliant firms found the e-Filing system easy to use and cost effective, while the non-compliant firms did not adopt this initiative because it was felt that paying taxes was not a priority at this stage of the firm. It is hoped that the insights gained from this study can guide government policy makers regarding the introduction of information and communication technology (ICT) in tax administration.

Keywords: e-Filing, information and communication technology, tax compliance, micro enterprises

1. Introduction

For years government revenue authorities especially in developing countries have been implementing a series of reforms towards strengthening their revenue collection capabilities (Bruhn & McKenzie, 2014; Salami, 2011). These reforms include but not limited to the introduction of ICT with the principal objective to improve tax collection. In an effort to make it easier to pay company income tax (CIT), Electronic filing of taxes was introduced in Jamaica in 2016. It was believed that this initiative would improve tax compliance. However, the adoption of this initiative remains low. The low adoption results in loss of tax revenue, which ultimately limits the government's ability to finance needed projects and address critical needs of citizens (Frazoni, 2000; Wenzel, 2005). One of the critical functions of any tax system is to collect resources to fund government's recurrent expenses and expenditure to facilitate growth and development (Phillips, 2012). However, many enterprises willingly perform tax evasion (Abiola & Asiweh, 2012; Jacobs, Crawford, Murdoch, Hodges, & Lethbridge, 2013; Tax Administration of Jamaica, 2018). However, there are firms who are desirous of being compliant in paying tax but view the tax system and processes as cumbersome and thus become non-compliant.

This low adoption rate was regrettably mainly among micro enterprises (Powell, 2019). In this study, micro enterprises are defined as firms that employ five employees or less with annual sales of J\$15 million. Micro enterprises have been important drivers of economic growth and sustained development in Jamaica (Aremu & Adeyemi, 2011). These enterprises create wealth and generate employment. It is estimated that 97.6% of all classified commercial taxpayers are micro enterprises (Ministry of Industry, 2017). Furthermore, over 413,000 Jamaicans are classified as self-employed. It is estimated that 80% of the jobs in Jamaica are from micro enterprises (Ministry of Industry, 2017).

It is interesting to note that micro enterprises in Jamaica are highly informal, hard to regulate, and contribute the lowest to tax revenue (Ministry of Industry, 2017). Table 1 shows the tax compliance statistics with respect to company income tax in Jamaica in financial year 2015/16. The compliance management philosophy by the Tax Administration Jamaica are:

- Simplify interactions, maximize automation and reduce compliance costs by providing and integrated online experience
- Improve online services to small and micro enterprises and reduce paper transactions

Company Size	Payment Compliance in 2015/16
Large	95.3%
Medium	40.3%
Small	26.6%
Micro	17.4%

Table 1: Comparative Filing of Company Income Taxes in Jamaica
Source: (Powell, 2019)

It is believed that compliance by micro enterprises can be challenging due to cost and other operational factors. However, Nisar (2013) argued that recent trends in tax avoidance emphasizes the need to develop an easier system of tax payment/collection that involves the Internet. The deployed ICTs are expected to assist taxpayers in accessing accurate financial balances and provide a greater user friendly approach in filing returns. It is hoped that these benefits will enhance compliance.

Jamaica is regarded as one of those countries in which the payment of taxes is difficult and is perceived to be a major hindrance to doing business (Phillips, 2012). As a result, the Jamaican government introduced a series of reforms with the last reform in 2014. This gave autonomy to both the revenue administrators and taxpayers by increasing the ability to manage internal affairs regarding tax payment in a timely manner and improve taxpayers' experience. Hence, the research question, "What is the effect of e-Filing on tax compliance among micro enterprises in Jamaica"? The contribution of this study is to provide useful insights which can guide government policy makers regarding the best approach to introduce information and communication technology (ICT) in the management of tax collection.

2. Literature Review

Micro enterprises have been considered globally as the driving force behind many economies (Aremu & Adeyemi, 2011). In 2015 approximately 83% of all classified taxpayers in Jamaica fall within the category of micro enterprises (Ministry of Industry, 2017). According to the International Council for Small Businesses, formal and informal micro, small and medium size enterprises make up over 90% of all firms globally. It is estimated that 80% of jobs in Jamaica are from micro enterprises (Ministry of Industry, 2017). This sector is characterized by a high degree of informality (Bruhn & McKenzie, 2014). It is stated that Jamaica has a

very active informal economy which represents about 40% of total economic activity with small entrepreneurs representing the majority in the sector (Ministry of Industry, 2017). This sector is also characterized by low tax compliant rate (Ministry of Industry, 2017).

One of the main challenges when trying to measure and ensure compliance is the informality of a large share of economic activity in Jamaica - businesses which operate without being registered. In Jamaica, there is a high incidence of unregistered companies. These companies do not report their income to the relevant authorities and do not file or pay taxes. Previous estimates of the scale of informality in the Jamaica economy have put it between 40% - 80% of the official economy (Torero et al., 2006; Witter and Kirton, 1990). Significant levels of informality among enterprises have implications for revenue collection and enforcement costs by the government (Abiola & Asiweh, 2012). Importantly, businesses classified as wholesale and retail comprise the largest grouping among micro enterprises and the highest contributor of GDP at 16% but only contributed to only 9.8% of tax revenue (Ministry of Industry, 2017).

Another factor that prevents micro businesses from utilizing the Tax e-Filing application is the lack of the proper infrastructure (Dowe, 2008). It is felt that the basic prerequisites for implementing successful e-payment systems are: (1) a reliable and accessible Internet service; (2) cooperative and trustworthy financial institutions; (3) an IT oriented atmosphere; and (4) access to adequate financing to set up the appropriate infrastructure in tax offices. Ideally, the setting of an e-payment system should form part of a comprehensive IT design, development and implementation strategy. The infrastructural requirements becomes challenging for some micro enterprises and entrepreneurs because of the lack of access to reliable Internet services, especially in some rural areas. In 2017, 56% of Jamaicans were using the Internet. However, this percentage was highly skewed towards prepaid cell phone Internet users.

These factors result in tax administrations attempting to control the situation through encouraging compliance. However, these compliance measures are generally ineffective given the minimal resources the tax administrators contribute to the compliance effort. Electronic-filing (e-filing) is the transmission of tax information directly to the tax administration using the Internet. E-filing may take place anywhere. Nisar (2013) argued that recent trends in public taxation stress the need of developing a system of tax assessment and collection that involves internet services. E-filing is enhanced with the ability to conduct electronic-payment (E-payment). E-payment is the transfer of money from a person's bank account to the tax administration's bank account using an electronic banking platform over Internet at any time (during and after banking hours), and from any place (Caribbean Regional Technical Assistance Centre, 2008, 6).

E-tax filing minimises the cost of preparation and submission of tax returns due to the fact that these transactions are executed in a paperless environment (Azmi and Kamarulzaman, 2010). Similar findings were discovered in Muturi and Kiarie (2015) study. According to Muturi and Kiarie (2015), e-Filing improves on convenience to the clients, as well, as it ensures accuracy and timely reconciliations of the captured data. Prior research also confirmed that e-Filing improves efficiency, reducing errors and avoiding mis-postings.

Tax compliance can be defined generally, as adhering to all the laws of the country as it pertains to the paying of taxes. More specifically, it involves "taxpayers' willingness to comply with tax laws, declare correct income, claim the correct deductions, relief and rebates

and pay all taxes on time” (Palil and Mustapha 2011, 558). Inherent in tax compliance, is the willingness on the part of the taxpayer to declare truthfully and file his/her taxes based on all income earned for the period.

A survey conducted in South Africa, Ukraine and Nepal revealed that the lack in infrastructure and the cost to procure and implement e-Filing systems is a major deterrent among micro operators. Another factor that affects micro enterprises is the lack of knowledge and awareness of the e-Filing option, and some who are aware of the facility, do not understand how to navigate through the software application. According to CAPRI (2016) only 31% of micro businesses filed their taxes online. Further, there is low business registration among this group, and lack of awareness as to Tax Administration Jamaica (TAJ) software. Tax evasion and avoidance in developing countries are difficult to address (Fuest and Riedel, 2010).

It is the taxpayers’ responsibility to make sure that they are aware of all their obligations. However, it is in the tax authority’s interest to ensure that taxpayers (owners of firms) are educated about all their tax responsibilities with the hope that they comply. It is posited that the Government of Jamaica must create a simple framework, as well as provide infrastructure and support services to support economic growth and sustainable development (Ministry of Industry, 2017).

A study found that perceived usefulness, perceived ease of use and perceived risk were shown to be an important construct to influence taxpayer’s perceptions on electronic tax filing given the fact that the adoption of the electronic tax filing system is voluntary in Malaysia (Azmi and Bee, 2010). The findings suggest that a system that is useful and easy to use are important for taxpayers to voluntarily e-file their tax returns. In addition, the adoption of e-Filing requires a huge initial investment by the business in capital assets and also in the time and effort required to climb the learning curve (Yilmaz and Coolidge, 2013). Also, the perceived risk construct defined by privacy and performance risk was found to have a negative influence on behavioural intentions, this means that if taxpayers perceive that the electronic tax filing system is risky their perceptions of usefulness of the system will decrease.

The results of another study in Malaysia revealed that three skills were necessary for a taxpayer to interact with technology-based tax system, these were knowledge of spreadsheets, Microsoft word and email (Ling and Nawawi, 2010). The Malaysian Internal Revenue Board encountered public readiness challenges in adopting systems. Although the benefits were communicated, the adoption rate was only 5%. There is also the access reliable Internet and the required technological skills required to adequately utilize the software application (Maisibal and Atambo, 2016). It was found that Internet experience and manual tax filing experience are significant determinants to the adoption of e-Filing systems (Mas’ud, 2019). It was also found that e-Filing adoption are low with older business owners (Pippin and Tosun, 2014).

3. Methodology

This is a quantitative study in which data was collected from the owners of micro enterprises. The owners were believed to be the best persons to represent the views of the companies. The survey instrument was pre-tested by eleven executives of micro enterprises in Kingston, Jamaica. The main focus of the pre-test was face validity and the relevant adjustments made.

The resulting survey instrument contained twenty close ended questions and seven open ended questions. The size of the micro enterprises in Kingston, Jamaica was estimated over 100,000. The target sample size was 384 based on Yamane (1967) sample size formula at 95% confidence and 5% margin of error. A self-administered approach was taken to collect the data. The targeted respondents were assured that the information given is confidential and their participation in the study was voluntary. In the final analysis, only 42 questionnaires were completed and analyzed.

4. Findings and Discussion

The profile of the forty two respondents were 55% male and 45% female (n = 42). In terms of age distribution, the age range 26-35 years old accounted for the majority of the respondents at 40.5%, while 36-50 years old accounted for 35.7%. 51-64, 19-25 and 65 years and older accounted for 16.7%, 4.8% and 2.4% respectively. With regards to the highest level of education attained, the majority of the respondents (33%) possessed an undergraduate degree. 29% had a trade/skill certification, 17% had CXC subjects and 14% had master's degrees. The majority of the respondents were fully self-employed amounting to 61.9%, while the remainder 38.1% were employed to some other organization along with having their own enterprise.

With respect to respondents who were employed to other organizations, 26% were working full time with another company, 11.9% were working on a contractual basis while 7.1% stated that they were employed on a part time basis. Respondents were asked to state how long they have been business. 38.1% of the respondents had been in business for 1-5 years, this is followed closely by respondents who were in business for 6-10 years which accounted for 33.3% of the respondents, while 19% of the businesses were in existence for 11 years and over, and the remaining 9.5% were in business for less than one year.

In an attempt to establish the level of formality among the surveyed micro enterprises, they were asked to state whether or not the business was registered with the Companies office of Jamaica. 74% of the businesses were registered with the Companies Office of Jamaica, and 26% were not registered. Table 2 provides a summary of the businesses that have Internet access and are registered e-Filing users.

The respondents were asked whether or not the business had access to Internet. The cross tabulation in Table 2 shows the majority of the businesses had access to the Internet at 83.3% (n=35) while only 16.7% stated that they have no access to internet. The results revealed that the majority of the business even though they had access to Internet, most of them are not registered to use the Tax Administration of Jamaica e-Filing system, only 34.3% were registered to the system. Pertaining to the micro enterprises use of the e-Filing system, the majority (69%) were not users of the system while 31% of the respondents stated that they were registered to use the system.

In terms of industry type, the majority (57.1%) of the micro enterprises were from the Wholesale and Retail sector. Food and hospitality accounted for 14.3%, Professional services accounted for 11.9%, with transport, manufacturing and motor vehicle and appliances accounting for 7.1%, 4.8% and 4.8% respectively.

	Business have Internet Access		Total
	yes	no	

Is the business registered as an e-Filing User	Yes	Count	12	1	13
		% within Is the business registered as an e-Filing User	92.3%	7.7%	100.0%
		% within Business have Internet Access	34.3%	14.3%	31.0%
	No	Count	23	6	29
		% within Is the business registered as an e-Filing User	79.3%	20.7%	100.0%
		% within Business have Internet Access	65.7%	85.7%	69.0%
Total	Count	35	7	42	
	% within Is the business registered as an e-Filing User	83.3%	16.7%	100.0%	
	% within Business have Internet Access	100.0%	100.0%	100.0%	

Table 2. Cross tabulation showing summary of businesses that have internet access and are registered e-Filing user

The results of the study revealed that the majority (83%) of the micro enterprises maintained proper books and records, while 17% stated that they did not maintain proper books and records for the businesses. Cash book was the main record been kept. The types of books and records that were kept are as follows:

- Cash book = 29.3%
- Sales and Income = 26.8%
- Purchases journal = 13.4%
- Bank statement = 18.3%
- Bank reconciliation = 7.3%
- Other records = 4.9%

The majority of the respondents, 88.1% have a positive perception towards paying and filing taxes while 9.5% did not believe in filing taxes and only 2.4% stated that they wanted to file taxes but don't know how to do so. Of the majority who believed in filing and paying taxes 75.7% of them were currently paying some form of taxes.

The results of the cross tabulation regarding the relationship between the enterprises that are aware of the e-Filing system and are registered as an e-Filing user, shows that 61.9% were aware of the e-Filing system. However, of those who were aware 50% are actually registered to use the system while the other 50% are not registered to use the system.

In addition, the results of the cross tabulation between size of enterprises and registration of the e-Filing system, shows that enterprises with more employees tend to be registered as e-Filing user, while those with fewer employees tend not to use the system. Another interesting finding is the discovery that micro enterprises with higher annual revenues are more inclined to use the e-Filing system. The analysis also shows that micro enterprises are registered to pay payroll tax, income tax and general consumption tax (GCT) at 57.1%, 50% and 50% respectively.

Number of Sample Points	Pearson Correlation	Significance
42	0.525**	0.000

** Correlation is significant at the 0.01 level (2-tailed)

Table 3: Correlation between e-Filing system and awareness of the system

Table 3 shows the results of the Pearson correlation between awareness and registration of the e-Filing system. The test revealed a moderate positive relationship between awareness of the e-Filing system and the registration of the system. The result implies that as the awareness of the system increases, so does the registration of the system, but at a moderate pace. This is statistically significant at $p < 0.01$.

Number of Sample Points	Pearson Correlation	Significance
42	-0.351*	0.023

** Correlation is significant at the 0.05 level (2-tailed)

Table 4. Correlation between e-Filing and Annual revenues

The results of the Pearson correlation revealed a weak negative relationship between annual revenues and the registration of the e-Filing system. The result as shown in Table 4 indicates that as the revenues of the enterprises decrease, so does the registration of businesses for the system at a moderate rate. This is statistically significant as $p < 0.05$.

Reasons micro enterprises do not use the e-Filing system	Number	Percent
Not a priority for the business	22	71.0%
Do not possess computer related skills for e-Filing	5	16.1%
e-Filing system will be too costly	3	9.7%
The firm's information is not secure	1	3.2%

Table 5: Reasons why micro enterprises do not use the e-Filing system

The respondents were asked why they were not registered as an online user, and 71% stated that the e-Filing system was not a priority for the business. 16.1% indicated that they did not possess the computer related skills to currently use the system, while 9.7% felt that the e-Filing system was too costly to implement (as shown in Table 5).

Of the micro enterprises who use the e-Filing system, 53% of the respondents stated that they experienced challenges with the system while 47% of the respondents did not encounter any challenges with the system.

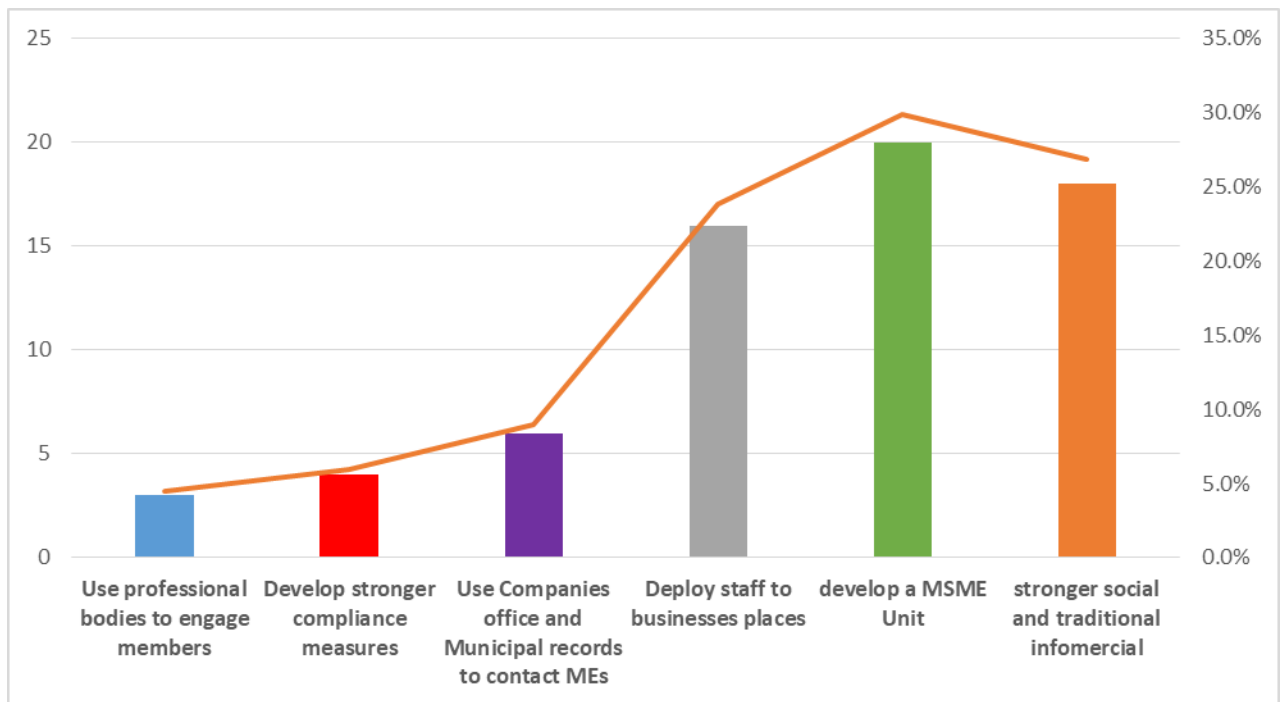


Table 6: Bar graph showing ways micro enterprises can engage in tax compliance

Respondents were asked how the Tax Administration of Jamaica (TAJ) can engage micro enterprises about tax compliance, the majority of respondents (30%) revealed that the TAJ should develop a MSME unit to deal with them specifically, they also were of the view that deploying TAJ staff to their enterprises would be an effective way of engaging them, and stronger social and traditional media infomercials would be an effective way to encourage micro enterprises to comply (as shown in Table 6).

5. Discussion

The research confirmed the notion that most micro entrepreneurs are self-employed. The majority of the respondents (74%) reported that their business was registered with the Companies' Office of Jamaica. This finding was contrary to Naidoo and Smulders (2013) study that discovered that many micro enterprises choose to remain in the informal sector. To some extent many of these enterprises have made the first step to become a formalized enterprise, but after a few years they become delinquent and renege on their tax obligations. The results of the study revealed that only a small percent (31%) of the micro enterprises file their taxes online. This finding is consistent with the study conducted by CAPRI (2016) which posits that 31% of the micro businesses in Jamaica file taxes online.

According to Coolidge and Yilmaz (2014) "The reliable availability of Internet access and electricity, capability in computer usage, awareness of or being informed about the process are essential to the process to "; however, the study revealed that despite the majority (83%) of the enterprises reporting that they had access to the Internet, and were aware of the system the results showed that these factors did not have a positive impact of ME's adoption of the system.

The e-Filing system was not short of its challenges as respondents were asked if they experienced any challenges with the system, and 53% stated that they experienced some form of challenges. Some of the challenges expressed were problems relating login difficulties and system delays caused by slow Internet. These problems are consistent with Kumar (2017) study which revealed that taxpayers experienced difficulties with network problems and problems associated with registration and passwords. As a result, the responsibility must reside with the Tax Administration to ensure that the online systems are always operating effectively.

In an examination of micro enterprises reluctance to use the e-Filing system, it was discovered that it was not a priority for these enterprises. This finding is consistent with CAPRI (2016, 25) study, which found that most enterprises that do not file tax online was due to inertia. This is compounded with the fact that a considerable amount of the micro enterprises were in businesses before the system was introduced.

In a survey conducted in Malaysia, the Malaysian Inland Revenue Board encountered challenges with public readiness because there was lack of dialogue between the private sector and the government in the development of the project, this later led to a decrease in the use of the system two years later (Ling and Nawawi, 2014). In an attempt to achieve high usage of the system, there must be buy-in by the recipient of the system (users) and the benefits must be clearly stated at the beginning of the project.

The micro enterprises that use the e-Filing system had good experiences with the system. The majority revealed that the e-Filing system made the process of tax compliance much easier, cheaper and time efficient. These findings are consistent with Suharyono (2018) study in which it was found that the benefits that taxpayers can realize in using any e-Filing system are a quicker, safer, convenient and cheaper way of filing taxes. Prior research also confirms this notion (Osebe, 2013).

6. Conclusion

The study found that persons who filed their tax electronically had a positive attitude towards tax compliance. This positive attitude could be attributed to the benefits being derived from using the system. The e-Filing system has resulted in improvements as it relates to submitting tax information but challenges has been associated with its utilization. The system has also reduced the related tax compliance costs, hence is a positive step towards tax compliance as it relates to the submission of tax information.

As a result, the system can be used to increase the rate at which micro enterprises comply in providing tax information and paying taxes. The study revealed that the major reasons for not using the Efiling system is that they felt that the system was *“not a priority for the business”*. Coolidge and Yilmaz (2014) purports that micro enterprises should not be forced to use the e-Filing systems until the majority of them have had the chance to become familiar with the system on a voluntary basis.

It was also felt that the TAJ should develop a unit that deals with specifically with micro enterprises. This view was shared by the World Bank (2014) who posited that just as how there are tailored services provided to large taxpayers by the government there also needs to be such establishments for micro enterprises seeing that they are more skewed towards entrepreneurship.

The TAJ can engage micro enterprises by conceptualising stronger social and traditional infomercials. It appears that businesses prefer information from a push standpoint rather than having to go search for information from the website of TAJ or from workshops and seminars (CAPRI 2016, 29).

It is recommended that the TAJ offer incentives to micro enterprises, according to OECD (2008, 31) countries such as Australia have offered non-monetary incentives such as extended filing periods for businesses that file electronically. In Ireland the revenue authority provides an additional two weeks to file returns where this is done using the online systems. Further studies could expand the scope to other parishes in Jamaica in an attempt to make the findings more generalizable.

Reference

- Abiola, J., & Asiweh, M. (2012). Impact of tax administration on government revenue in a developing economy - A case study of Nigeria. *International Journal of Business and Social Science*, 3(8), 99-113.
- Aremu, M. A., & Adeyemi, S. L. (2011). Small and medium scale enterprises as a survival strategy for employment generation in Nigeria. *Journal of Sustainable Development*, 4(1), 200-206.
- Azmi, A and Kamarulzaman (2010). The adoption of tax e-filing: a conceptual paper. *African Journal of Business Management*, 4(5), 599-603
- Azmi, C.A. and Bee, N, L.2010. The acceptance of the e-filing system by Malaysian Taxpayers: a simplified model. *Electronic Journal of e-Government*, 8 (1) 13-22
- Bruhn, M., & McKenzie, D. (2014). Entry regulation and the formalization of microenterprises in developing countries. *The World Bank Research Observer*, 29(2), 186-201.
- CAPRI (2016). Improving tax compliance in Jamaica, 1-6.
- Caribbean Regional Technical Assistance Centre CARTRAC. (2008). E-filing and E-payments-the way forward. Denise Edwards Dowe. Paper presented at the *Caribbean Organization of Tax Administration* in Belize City
- Coolidge, J. & Yilmaz, F. (2014). Does E-Filing Reduce Tax Compliance Costs in Developing Countries?. Investment climate in practice;no. 21. *World Bank Group*, Washington, DC.
- Frazoni, L. (2000). Tax evasion and tax compliance. In Brouckard and G.Degeest, *Encyclopaedia of Law and Economics*. Cheltenham.
- Fuest, C., & Riedel, N. (2010). Tax evasion and tax avoidance in developing countries: The role of international profit shifting. *Oxford University Centre for Business Taxation*, 1-46.
- Jacobs, A., Crawford, D., Murdoch, T., Hodges, Y., & Lethbridge, C. (2013). Detailed guidelines for improved tax administration in Latin America and the Caribbean. *USAID*, 1-530.
- Kumar, S & Gupta, S. (2017). A study on income tax payers perception towards electronic filing. *Journal of Internet Banking and Commerce*, 1-14.
- Ling, A.L., Masrom, M. & Din, S. (2014). The influence of e-Participation on e-Filing participation: A study of citizen adoption on e-Government services. *International Journal of Engineering Science and Innovative Technology*, 3, 251-260.
- Maisiba, G J and Atambo, W. (2016). Effects of electronic tax system on the revenue collection efficiency of Kenya revenue authority: a case of Uasin Gishu County. *Imperial Journal of Interdisciplinary Research*, 2(4), 1-12.

- Mas'ud, A. (2019). Determinants of user awareness of new information systems - Electronic tax filing perspective. *International Journal of Engineering and Advanced Technology*, 8 (5), 21-32.
- Ministry of Industry, C., Agriculture and Fisheries,. (2017). Jamaica: Micro, small and medium enterprises (MSME) and entrepreneurship policy. *Planning Institute of Jamaica*, 1-150.
- Muturi, H, Kiarie, N. (2015). Effects of online tax system on tax compliance among small tax payers in Meru County, Kenya. *International Journal of Economics, Commerce and Management*, 3(13): 280-297
- Nisar, T.M. (2013). E-governance in revenue collection and administration. School of Management, University of Southampton, UK. *The internet society II: Advances in Education, Commerce and Governance*, 265-274
- Osebe, R. (2013). An Analysis of Factors Affecting Tax Compliance in the Real Estate Sector in Kenya: A Case Study of Real Estate Owners in Nakuru Town. *Journal of Emerging Issues in Economics, Finance and Banking (JEIEFB)*, 1(4), 7-9
- Palil, M and Mustapha, A. (2011). Factors affecting tax compliance behaviour in self-assessment system. *African Journal of Business Management*, 5(33) pp. 12864-12872. Dec 2011
- Phillips, P. (2012). White paper on tax reform 2012. *Ministry of Finance and Planning*, 1-20.
- Pippin, S.E and Tosun, M.S. (2014). Electronic tax filing in the United States: An analysis of possible success factors. *Electronic Journal of e-Government*, 12(1), 22-38.
- Powell, A. (2019). Tax administration Jamaica: National compliance plan 2017/18. *Tax Administration of Jamaica*, 1-41.
- Salami, A. (2011). Taxation, revenue allocation and fiscal federalism in Nigeria: Issues, challenges and policy options. *Economic Annals*, 56(189), 27-50.
- STATIN (2017). The Jamaica Labour Force Survey 2016, 1-15.
- Tax Administration of Jamaica. (2018). National compliance plan financial year 2018/2019. *Tax Administration of Jamaica*, 1-36.
- Torero, Maximo, Robles, Miguel, Manuel Hernandez, De la Roca, Jorge (2006). The informal sector of Jamaica. *Inter America Development Bank*, Re3-06-010.
- Wenzel, M. (2005). Motivation or Rationalisation? Causal relationship between ethics, norms and tax compliance, work paper no.63. Centre for tax system integrity, *Research School of Social Science*, Australian National University, Canberra
- Witter and Kirton, C. (1990). The informal economy in Jamaica, some empirical exercises WP 36, *Institute of Social and Economic Research*, 1-12.
- World Bank (2014). Does Reduce Tax Compliance Costs in Developing Countries? <http://documents.worldbank.org/curated/en/970451468321559619/pdf/9111910BRI0Box30D0VC0KNOWLEDGE0NOTES.pdf> . Retrieved August 6, 2019
- Yamane, Taro. 1967. *Statistics, An Introductory Analysis*, 2nd Ed., New York: Harper and Row.
- Yilmaz, F. and Coolidge, J. (2013). Can e-Filing reduce tax compliance costs in developing countries? *World Bank. Policy Research Working Paper* 6647.

P30: Use of Network Analysis Technique for Prioritizing Project Portfolio: A Case Study

Greta Carenine Paes Amorim Araújo Jiupato
FGV EAESP
grejiupato@gmail.com

Cláudio Luís Carvalho Larieira
FGV EAESP
claudio.larieira@fgv.br

Eduardo de Rezende Francisco
FGV EAESP
eduardo.francisco@fgv.br

Abstract

Network analysis is widely used in the context of exploring social phenomena that involve disciplines such as economics, marketing and psychology. This work proposes the use of network analysis from an optics perspective as a strategic analytical intelligence tool, where it discusses its use as a support tool when prioritizing project portfolios. The research was defined through a case study carried out in a Brazilian bank, in which a specific scenario of the need to prioritize demands within the existing portfolio was considered, covering the period from 2018 to the first quarter of 2019. To study these scenarios, 2-mode networks were analyzed to visualize the context and measures of centrality degree, proximity and intermediation were also used to provide analytical intelligence in identifying the best options for negotiation and prioritization. It was concluded, through the information provided by the use of network analysis, that complex scenarios and difficulties for prioritization can be predictively diagnosed, as well as the centrality measures allow the identification of the best options for prioritization and selection and the view of the impacted areas to be involved in the negotiation. The use of network analysis technique as a support tool for decision making in the prioritization of projects portfolio is very promising and becomes potential as a new efficient option to be considered, evaluating its ability to provide analytical intelligence and insights predictive of the prioritization scenarios.

Keywords: Analytics; Network Analysis; Portfolio Prioritization; 2-mode network; Centrality Measures.

1. Introduction

New business models and startups are changing the pattern of competition, causing consolidated companies to “disrupt historical operators and reformulate production, consumption, transport and delivery systems” (Schwab, 2016). Therefore, a resource adopted for the transformation of the company is the use of information technology, whose benefits obtained in projects were considered as a basic condition for the survival and competition of companies (Albertin & Albertin, 2016). Another important factor is the need for analytical intelligence – Kugler (2013) considers that “raising the level of intelligence in organizations is not optional; it is a question of survival”. Davenport, Harris & Morison (2010) observe that the application of tools and analytical intelligence make it possible for the company to identify new insights and serve as a knowledge support providing of information for action and decision making. Companies in the Brazilian banking sector that have historically been recognized for their technology adoption invested R\$ 19.5 billion in the sector in 2018 (around US\$ 5.34 billion, at the time). 80% of banks identified investment in analytics as one

of the most recent innovation technologies (Federação Brasileira de Bancos [FEBRABAN] & Deloitte, 2018), representing 32% of the expenditures for new technologies.

Considering then the need for organizations to have information in a faster way in order to prioritize projects that meet strategic objectives, this work presents the use of an analytics technique called network analysis as an instrument when prioritizing projects in portfolio, providing analytical intelligence and views of predictive scenarios. This analysis is given through a case study in a Brazilian bank, which occupies a position among the four largest in Brazil considering shares listed on the stock exchange and total assets in 2018. It was developed through the exercise of technique in the project portfolio, using the RStudio statistical software and R programming language, with the demonstration of the results evaluated through network graphics and centrality measures. The network analysis technique, based on the mathematical graph theory, allows the study of the interdependence and connection properties between elements, called nodes or actors. It is a non-parametric technique, as well as decision trees, whose principle of utility lies in modeling the problem. This analytics technology, also known as graph analytics, will have significant disruptive potential over the next three to five years (Moore, 2019).

In a solid process like portfolio management, the current proposals for the evolution of the theme are based on new frameworks or adaptation of methodologies, and this proposal is based simply on providing existing information in a structured way when prioritizing projects, adding the analytical intelligence that makes it possible to exercise and explore scenarios to support decision making at the moment of prioritization, thus reflecting on an evolution from qualitative decision methods to more quantitative and therefore more objective methods.

The use of network analysis is largely related to social network analysis (SNA), which is commonly represented by studies with themes referenced to people or organizations. Considering that this type of analysis assesses the relationship between structures with the same or different characteristics, this model can be applied to other themes, generating value through the exercise of the relationship between structures, enabling the presentation of information that can assist in the performing predictive analyzes. Pondering this concept, the present work conducts an analysis of networks with the theme of project portfolio aiming to demonstrate how the application of the network analysis technique can contribute to the prioritization of projects in portfolio, providing the vision of the relationship of projects with competing areas for a predictive analysis of the impacts for the prioritization decision.

2. Theoretical Reference

2.1 Portfolio Management

The term portfolio is defined by the Project Management Institute [PMI] (2018) as a collection of “projects, programs, subsidiary portfolios and group-managed operations to achieve strategic objectives”. Portfolio management is a dynamic decision process, marked by uncertain and variable information, containing projects that are selected and prioritized, with the need to periodically review the projects contained in the portfolio (Cooper, Edgett & Kleinschmidt, 1999). Cooper, Edgett & Kleinschmidt (2000) argues the main difficulties for project portfolio management reflect on four issues: balancing resources (balancing the need for projects with the amount of available resources), prioritizing projects (obstacles begin to appear during execution), decisions in the absence of solid information (Go/No Go - investment decisions based on little or unreliable information) and many smaller projects in the portfolio (absence of more significant revenue generators). These authors also indicate that for an efficient project portfolio management, the quality of information must be improved, establishment of gates already creating a barrier for lower quality projects and a

process that directly activates the executives, bringing a better understanding when prioritizing.

2.2 Analytics concept

In the references of the analytics theme, most of the literature is related to the extraction of perceptions and information of value through Business Intelligence (BI) and the analysis of Big Data. Analytics is one of the tools that allows the extraction of information through structured bases for generating reports and that is referenced by Chen, Chiang & Storey (2012) within the different fields of Text Analysis, Network Analysis, Web Analysis, Mobile Analytics and Big Data Analytics as an emerging opportunity in analytical research. For Davenport and Harris (2017) analytics is defined as the extensive use of data, statistical and qualitative analysis, explanatory and predictive models and fact-based management for actions and decision making. The analytics techniques are categorized by Davenport & Harris (2017) as descriptive, predictive, prescriptive and autonomous, where Gartner presents questions to identify these divisions (Hagerty, 2016), according to the definitions below:

- Descriptive Analysis: access to historical or current information, which can provide alerts, exploration or reports and which answer the question: "What happened?";
- Predictive Analysis: use of quantitative techniques (network analysis, segmentation, propensity and econometric analysis) in data from the past that can result in prediction of the future and that answer the question: "What will happen?";
- Prescriptive Analysis: use of various quantitative techniques and technologies to identify ideal behaviors and actions that answer the question: "What should I do?";
- Autonomous Analysis: use of artificial intelligence or cognitive technologies to create and improve models and learn the data that in this case was identified by Gartner through the term diagnosis, and that answer the question: "Why did it happen?".

2.3 Network Analysis

The computational representation of objects and their relationships is usually performed through a mathematical structure called graphs (Goldschmidt, Passos & Bezerra, 2015), which refers to mathematical abstractions that can represent a network. Networks are collections of nodes or vertices (nodes) joined by edges (edge), which capture the pattern of interactions between parts of a system (Newman, 2018) as well as the notion of elements in a system and their interconnection (Kolaczyk; Csárdi, 2014). The network demonstrated through the presentation of a graph structure allows us to acquire important information about its elements and their relationships, then dealing with the role of network analysis. In the analysis of a network, we can observe the situation in which an entity (node or vertex) can have a greater influence than others, and this identification can be evaluated through measures of centrality, which measure the importance of a vertex. The best-known measures of centrality are:

- Degree centrality (degree): represents the number of connections (edges) that affect the node; the greater the number of neighboring vertices a given vertex has, the greater its importance in the network (Goldschmidt et al., 2015), which allows identification to focus attention on the most influential elements (Newman, 2010);
- Proximity centrality (closeness): measures the cumulative (smallest) distance from each node to all others in the network; they are vertices where from it is the easiest way to reach other vertices (Goldschmidt et al., 2015), presenting the measure of the average distance from one vertex to other vertices (Newman, 2010);
- Centrality of intermediation (betweenness): measures how much a vertex intermediates the relationship between two other vertices being on the shortest path between them (Goldschmidt et al., 2015) and that they have power through their position within the

network, which can be a guide to the influence that a vertex has on the flow of information among other vertices (Newman, 2010).

2.4 2-Mode Networks

In network analysis, when the behavior of vertices with common characteristics is observed, the graph designed for this network is called 1-mode (a mode). When comparisons are generated between two types of vertices with different characteristics, the network is called 2-mode (two modes), which is also known as bimodal or bipartite, representing relationships between two different types (Tsvetovat & Kouznetsov, 2011). The 2-mode networks, according to Tomaél & Marteleto (2013 apud Brusco, 2011) are characterized by the establishment of close relations between the two different sets of objects, where data are collected and the relationships between these structures are identified. These links "are considered as conductors of information and it is through them that one entity receives influence from the others".

According to Tomaél & Marteleto (2013), the 2-mode network can be represented by means of a matrix that registers the affiliation between the different entities (nodes) and also by means of a bipartite graph. The matrix is formed through the relationship between the two distinct nodes, where the existence of a connection between the nodes is identified. In the bipartite graph, the nodes are in two different sets, with their connections being made from one node in one set to the node in another set.

3. Case Study Scenario

3.1 Bank A: Brief history of the company

The company in this study is a large national private bank, which due to the confidentiality agreement for the performance of this analysis will be called Bank A, where the period from 2018 to the first quarter of 2019 was considered for analysis, with a portfolio of 7.096 demands. In 2015, Bank A began a transformation in the organizational structure of the Information Technology area, focused on efficiency in serving projects. Firstly, it defined the organization of a functional model, with the creation of technology boards specialized in the subjects of Architecture, Development, Engineering, Quality, Sustainability and centralized project portfolio management through the creation of the Portfolio Management, adopting the agile methodology as incremental process model for carrying out the projects. In 2017, Bank A redefined the project service model by creating 28 Delivery Business Tribes (DBT), which represented a grouping of subjects with synergy within the same distinct business and who would be responsible for the development and delivery of the projects. Each DBT was formed matrix by the technology teams of the specialized functional structures organized in a collection of squads, having as inspiration model the structure of service of projects of the company Spotify.

3.2 Bank A: Portfolio Composition Process

Following the strategies of organizational restructuring of the Information Technology area, Bank A organized all project demands in a Unified List of Demands Portfolio (ULDP), following an order of attendance following the prioritization based on strategic planning which is defined in the executive committee and reviewed quarterly. The Bank A categorizes demands into 3 main groups: Service to Regulatory Bodies, Risk for Operation and Financial Return, where this order also follows the characteristic of importance for the institution. In the service queue, there are exceptions that may occur in demands for Service to Regulatory Bodies or Risk for the Operation, being received at different periods of the quarterly calendar of the executive committee, going so far as to change the sequence of the ULDP, reflecting in

a repriorization in the defined service order previously. After the conclusion of the ULDP for that quarter, the Portfolio Management, following the order of prioritization, sends the demands to the DBT, and they receive only the demands that have their business scope, becoming responsible for delivering the demand. The DBT responsible for a demand is called “Centralizer”, and if there is a need to involve more DBT due to the shared scope, they are called “Associate” in that demand.

3.3 Bank A: Service of projects by the technology team

When a DBT is defined as Demand Centralizer, it then performs the service assessment and identifies whether other DBT need to participate to fulfill deliveries of this demand, then sending a service request to the Associates, who in turn perform the scope assessment, the capacity of available resources and DBT current service backlog. In this process of meeting demands, the same DBT can go through the following scenarios in parallel:

- Receive demands in which it will be called Centralizer;
- Be involved as an Associate, sharing a demand with other DBT(s);
- Receive priority demands outside the quarterly planning (such as demands for Service to Regulatory Bodies or Risk for Operation);
- Receive late involvement as an Associate, due to a deficiency in scope verification (superficial analysis) or scope change (incremental model process of agile methodology).
- To suffer changes in the scope of the ongoing project that impact the cost and deadline.

During this period, several meetings are held to evaluate attendance (which can take up to two weeks), holding impact assessment meetings, several decentralized negotiations in situations of competition in prioritization, the need for the involvement of several teams and a lack of depth in the visibility of risk, where this set of situations makes the process time consuming and exhausting.

4. Methodology

4.1 Research Type

The present work consists of presenting a panorama of analysis of portfolio prioritization with the identification of the existing scenarios in the competition of demands between the respective Delivery Business Tribe (DBT). Such scenarios are observed using network analysis, seeking to demonstrate how this analytics technique can contribute as predictive support, providing a visualization of the favorable or unfortunate possibilities available at the moment of prioritization decision. We opted for a methodological approach of case study, which investigates a contemporary and non-historical phenomenon, with quantitative evidence and can be a useful method for making an assessment (YIN, 2015). An applied research with qualitative characteristics was carried out through the collection of data from the projects of the Portfolio Management in the period from 2018 to the first quarter of 2019, carrying out a confidentiality agreement between the researchers and the company.

4.2 Data collection

The first step of the analysis was the selection of sources for data collection: base 1, of demand information originating from the market tool, base 2, which was an electronic spreadsheet handled by the Portfolio Management, adding information that was not included in the market tool and the base 3 with requests for involvement of DBT from a market tool. Information on the demands present in base 1 (tool) and base 2 (spreadsheet) were consolidated, resulting in base 4 with a total of 7.096 demands in the portfolio. Following, a selection was made only of demands with status in execution, excluding canceled and completed ones to generate the necessary scenario of the current demands, which resulted in

an amount of 4.490 demands in the study. To identify the demand in the study, a code masking was used, resulting in a reference like DEM associated with a sequential number, according to the order of demand in the portfolio, and for the name of DBT, the same concept was used, with the DBT associated with a sequential number, following the alphabetical order of the area names. After selecting the demands, it was time to verify the base 3 that has all the requests for involvement. First, all approved requests were discarded as they would be attended by DBT, using only rejected requests for study, which for this reason leave the demands pending, without being able to complete their final delivery. For a demand to be executed and completed, all involvement must be approved for execution, otherwise, the demand will never be able to be completed, as it will have part of its scope pending execution.

4.3 Selection of DBT

To make more focused observations, it was defined to focus the study on the vision of a single DBT, and to simulate the options in this area for the prioritization scenarios. In order to select the best DBT for the study, the following criteria were considered: DBT having demands with characteristics of Centralizer and Associate, having demands shared with other DBTs and having pending requests for involvement. Considering these premises, DBT01 was selected, which in the Centralizer situation contained a portfolio of 66 demands in execution that had a shared scope with 21 DBT in total and, as an Associate, a portfolio of 162 demands in execution that had a shared scope with 27 DBT.

4.4 R and RStudio Statistical Software

For the analysis of networks and generation of network graphics, an open source tool called RStudio was used, which allows statistical analysis and has “software resources for data manipulation, calculation and graphical display” (The R Foundation). It is an integrated development environment (IDE - Integrated Development Environment) that has a console and a window that supports the execution of direct code and uses the R programming language to perform data and statistics analysis. R is a computer language and a tool for data analysis aimed at solving statistical problems. According to the IEEE Spectrum classification of the main programming languages, the R language occupies the seventh place in the ranking, being a specialized language for manipulating statistics and big data (Cass, 2018). The packages made available by R are free and publicly accessible, and information on their use as well as the main packages can be found on the CRAN website (Comprehensive R Archive Network).

5. Presentation and Analysis of Results

5.1 2-mode network: Pending engagement requests

The 2-mode network represents the comparison between nodes with different characteristics, and the first situation analyzed refers to the pending approval of the involvement as a Member of the DBT to carry out a demand. To demonstrate this situation between the competing demands in requests with the number of orders and the DBT that were related, a 2-mode network was generated, using R's visNetwork package, which allows interactive network visualization. For the design of this 2-mode network, two types of nodes were considered, the first node referring to demand (represented by the gray diamond) and the second node referring to DBT (represented by the circles in blue and red).

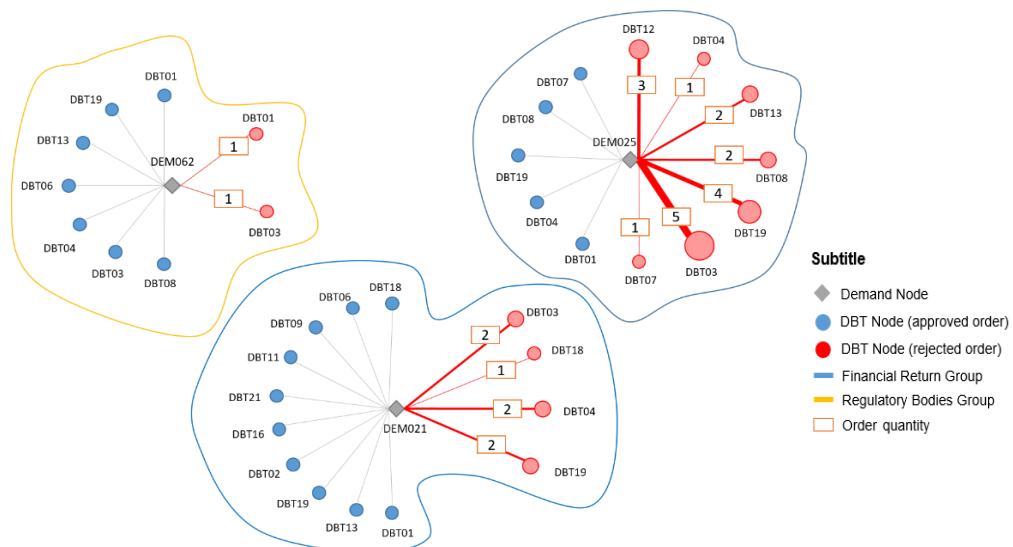


Figure 1: Representation of the 2-mode network: requests for involvement (DEM and DBT)
(Source: Developed by the Authors)

The DBT nodes were identified differently, where the blue circle identifies the DBT that accepted the involvement as Associates, and the nodes with red circles those that refused. The same demand may have accepted and refused involvement requests with the same DBT, as the scope of each request may belong to squads different from this DBT, which have different service capacity plans. The functions of the visNetwork package allow a series of implementations that assist in visualization, and in this analysis a grouping was applied to define areas, identifying the demands classified as Financial Return with a blue line and the demands of Service to Regulatory Bodies in yellow. Another function of the visNetwork package is demonstrated in the representation of the number of involvement refused, in which the thickness of the red line varies between thinner or thicker, following the value of the number of involvements. In the example in figure 1, a single involvement refused is shown by a thin red line, while the increase in the number of involvement refused shows a thicker line, as can be seen in the demonstration of the number of five involvements refused.

For the generation of this model, two files edited in the excel electronic spreadsheet with extension .csv (comma-separated variable) were used, one with the identification of the demands and DBT and the other with the relationship matrix between them. Simply evaluating the scenario, DEM062 has two pending approval related to two DBT (DBT01 and DBT03) to negotiate, while DEM021 demand has seven order pending with four DBT. DEM025 represents the most complex, with eighteen pending orders related to seven DBT, 50% of which are concentrated in two specific DBT (DBT03 and DBT19). DEM062 has priority classification for being Service to Regulatory Bodies (area highlighted in yellow), which in this case, according to the order of importance of this classification in Bank A, needs to prioritize service more than the others evaluated. Having the knowledge that the DEM062 demand will need to be met, now the process will be to use the 2-mode network to evaluate the portfolio in progress, and to identify the best selection for the prioritization evaluation of the portfolio in execution.

5.2 2-mode network: Eligible Demands for Repriorization

After defining the priority of the DEM062 demand for service, the next step was to check the portfolio in progress, analyzing the other demands contained therein and their relationships with the respective DBTs involved. In the data source, only the demands in execution that involved DBT01 and DBT03 were selected simultaneously, considering that the negotiation

for reprioritization within the portfolio would be more effective. With the selection defined, a relationship matrix was generated between the demands and the DBT, indicating the existence or not of a connection between them. Through this matrix, a 2-mode network was generated using the Gplot function, which produces a two-dimensional graph, where the “twomode” argument was included, which represents that the data must be interpreted as two modes.

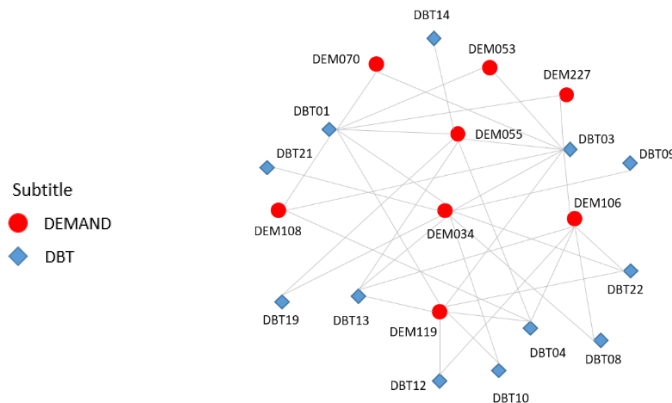


Figure 2: Representation of the 2-mode network: demands eligible for reprioritization (Source: Developed by the Authors)

The network was represented in figure 2, where the relationship in two ways is demonstrated through the connection between the demands and DBT, where the nodes in the shape of red circles are the demands, and the nodes represented by blue diamonds are the DBT.

With a view of the demands and their relationships with DBT, it is possible to quickly identify that certain demands have a greater amount of involvement with some DBT than others. For the definition of the best option for the reprioritization negotiation, centrality measures will be used, using the techniques of centrality degree, proximity centrality and intermediation centrality.

5.3 2-mode network: Centrality of Degree (degree)

To measure the centrality of degree, the “degree” function was used, with the graph visualized through the “gplot” function with the “twomode” arguments representing the network in two ways, the nodes being represented by the red circles the demands and the nodes represented by blue diamonds the DBT, and the “indegree” argument, which returns the number of connections received at each node.

Just to demonstrate a better view of the connections of the centrality of degree, two representations were separated in figure 3, with the left side showing the demands only, while the right one highlights the DBT view.

Below each figure, there is information on the number of connections identified through the “degree” function.

Demand Vision

DBT Vision

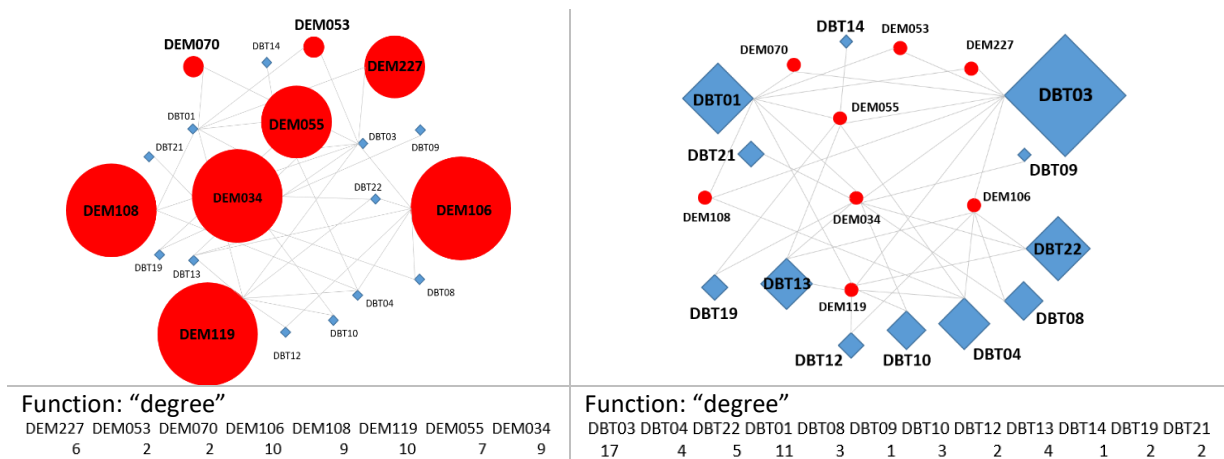


Figure 3: Representation of the 2-mode network: centrality of degree (degree)
(Source: Developed by the Authors).

Visually considering the node size and the connection information provided by the “degree” function just below the image of each network, it is possible to identify two possible candidate demands for the reprioritization negotiation, these being the DEM053 and DEM070 demands. Both have the least number of relationships (two connections) with NETs and are also related only to DBT01 and DBT03. Likewise, the DEM106, DEM119, DEM108 and DEM034 demands have higher grade centralities, thus reflecting as less indicated options because they have the largest number of connections, resulting in a more complex prioritization negotiation, due to the number of links with DBT.

5.4 2-mode network: Proximity Centrality (closeness)

To visualize the closeness centrality (closeness) the function “closeness” was used, with the visualization of the graph through the function “gplot” with the arguments “twomode” representing the network in two modes. The nodes represented by the red circles are the demands and the nodes represented by blue diamonds the DBT, and the formatting of the number that represents the proximity value was defined with a limit of two tenths in the visualization. Figure 4 shows the values of the centrality of proximity to the demands and DBT, where the demands and DBT that have greater communication with the others were highlighted with blue boxes.



Figure 4: Representation of the 2-mode network: centrality of proximity (closeness)
(Source: Developed by the Authors)

In the observation, the demands that have a greater degree of proximity are DEM106, DEM108 and DEM119, which represents for the study the demands with greater complexity at the time of prioritization assessment, as they are the ones that are most related to a high

number of DBT. The demands that showed the lowest degree of proximity to the DBT, including the same value calculated at the centrality of proximity were the DEM053, DEM070 and DEM227 demands, being those that would cause less complexity for the negotiation scenario for the reprioritization with the DBT involved, looking at the proximity to the low number of DBT.

5.5 2-mode network: Intermediation centrality (betweenness)

In the calculation of the centrality of intermediation (betweenness), the function “betweenness” was used, with the visualization of the graph through the function “gplot” with the arguments “twomode” representing the network in two modes. The “vertex.cex” argument was indicated with division by three, where it receives the measurement of each node staggered according to its intermediation centrality, where this division was used so that the nodes can be visualized, otherwise they would cause overlap in the visualization of the nodes.

The number representing the intermediation centrality value was defined with a limit of three tenths in the visualization. The measure of intermediation centrality in figure 5 demonstrates first assessing DBT, that DBT09 and DBT14 do not influence the communication path with other vertices, being exclusively related to each demand. DBT03 and DBT01, as described in the proximity assessment, in which the participation of both was a mandatory premise for selection, reflected in the greater result of the degree of intermediation, which are then the most influential vertices.



Figure 5: Representation of the 2-mode network: centralization of intermediation (Source: Developed by the Authors)

Assessing the demand nodes, DEM106 is the one with the highest degree of intermediation, which identifies in the study that this would not be a good candidate for reprioritization, since it has a strong influence with the other DBT nodes. This would result in greater negotiation complexity due to the greater amount of relationship between DBT that would be involved in the reprioritization discussion. Likewise, the demands DEM034 and DEM055 follow, which occupy the sequence of second and third places with the highest degree of intermediation, resulting in the same scenario as DEM106. For the case studied, the best scenario for selecting demands for reprioritization using this measure would be the one with the lowest degree of demand intermediation, and with this consideration the best options result in demands DEM053, DEM070 and DEM227.

6. Conclusion

To start the discussion of the conclusion, we begin by evaluating the results provided by the graphs and measures of centrality, where in the graphical representation of the demand map related to the respective DBT, it is already possible to have a broad view of this portfolio in a

simple way. Using the first measure of centrality of the study, the degree centrality (degree), the best options were identified from the perspective of this measure, being then the demands DEM053 and DEM070, having the least number of connections with DBT. In contrast to the demands DEM106, DEM119 and DEM034, with high degrees of centrality, they would reflect in more complex prioritization negotiations as they have a greater number of links with DBT.

Observing the measure of closeness degree (closeness), the best selection scenarios were indicated by the demands DEM053, DEM070 and DEM227. These showed the lowest degree of proximity to DBT, unlike the demands DEM106, DEM108 and DEM119, which have the highest proximity values, impacting most DBT for the prioritization negotiation scenario. Finally, the measure of intermediation (betweenness) presented DEM053, DEM070 and DEM227 as the best options, and DEM034, DEM055 and DEM106 were less indicated.

For the representation of the results of the centrality measures, the analysis of the results of the measures were concentrated only in the most representative ones to indicate the best and worst options, and unanimously, the demands DEM053 and DEM070 presented the best selection scenarios for reprioritization, according to with the amount of relationships and connections with DBT. The worst view was identified in the DEM106 demand, with the presentation of results of the measures indicating that this demand would bring the most complex scenario for the discussion of reprioritization with DBT. Thus, decision making for the prioritization negotiation would be considering a more assertive scenario, already segregating the demands that would present more complex negotiation scenarios due to its relationship with DBT, and containing the visualization of the most promising scenarios, increasing the analytical capacity. decision makers, providing the necessary information for the evaluation.

But, this work demonstrates that it is not just a matter of considering which demands with more DBT involved are the most complex to be prioritized, but which are the demands to be negotiated and which DBT in which these negotiations can occur, already indicating what the impact on the portfolio on both sides. A DBT can have several squads to attend to, having a considerable number of demands executed in parallel, and exploring demands and other related areas, being able to set up an impact analysis and understand who should be involved in the prioritization negotiation, and what is advisable or not to be negotiated.

The work concludes that the results obtained in the study can contribute as a technical option to be used when prioritizing the project portfolio, in addition to presenting another perspective for the use of network analysis considering the relationship structure between projects and impacted areas, bringing analytical intelligence to the business. For this, it considers data capture by structuring information without the support of people, the need for tools or frameworks, and allowing simulation of scenarios with a predictive view of the situations to be considered. This context supports decision making with fewer dependencies, bringing speed in obtaining information, together with assertiveness, given the possibility of exercising the scenarios proposed for the assessment.

This work focused on the prioritization stage of the project portfolio, but we understand that it can be expanded within other themes of portfolio management such as the evaluation, categorization and selection process, as well as other insights within the broad theme can also be explored of SNA, with comprehensive potential for interesting assessments on the use of this analytical technique. Despite the limitations intrinsic to the experiment scenario, the technique was successfully used and the results demonstrate that it can be applied in project portfolio prioritization scenarios, thus representing a performance gain for this process.

References

- Albertin, A. L. and R. M. de M. Albertin (2016). *Projetos de Tecnologia da Informação: Como aumentar o valor que o uso de tecnologia de informação agrega às Organizações*, 1st edition, São Paulo, SP: Editora Atlas.
- Cass, S. (2018). “The 2018 Top Programming Languages”. *IEEE Spectrum*. Retrieved 16 March 2019, from <https://spectrum.ieee.org/at-work/innovation/the-2018-top-programming-languages>
- Chen, H., R. H. L. Chiang and V. C. Storey (2012). “Business intelligence and analytics: from big data to big impact”. *MIS Quarterly*. Retrieved 13 February 2019, from <https://pdfs.semanticscholar.org/f5fe/b79e04b2e7b61d17a6df79a44faf358e60cd.pdf>
- Cooper, R. G., S. J. Edgett and E. J. Kleinschmidt (1999). “New Product Portfolio Management: Practices and Performance”. *Journal of Product Innovation Management*. Retrieved 18 March 2019, from <https://www.sciencedirect.com.sbxproxy.fgv.br/science/article/pii/S0737678299000053>
- Cooper, R. G., S. J. Edgett and E. J. Kleinschmidt (2000). “New Problems, New Solutions: Making Portfolio Management More Effective”. *Research Technology Management*. Retrieved 18 March 2019, from https://www.researchgate.net/publication/233648606_New_Problems_New_Solutions_Making_Portfolio_Management_More_Effective
- Davenport, T., J. G. Harris and R. Morison. (2010). *Inteligência Analítica nos negócios: Como usar a análise de informações para obter resultados superiores*, 1st edition, Rio de Janeiro, RJ: Elsevier.
- Davenport, T. and J. G. Harris. (2017). *Competing on Analytics: Updated, with a New Introduction: The New Science of winning*, 1st edition, Boston, Mass.: Harvard Business School Press.
- Federação Brasileira de Bancos [FEBRABAN] and Deloitte (2018). Pesquisa FEBRABAN de Tecnologia Bancária 2018. Retrieved 11 January 2019, from https://cmsportal.febraban.org.br/Arquivos/documentos/PDF/febraban_2018_Final.pdf.
- Goldschmidt, R., E. Passos and E. Bezerra (2015). *Data Mining: conceitos, técnicas, algoritmos, orientações e aplicações*, 2nd edition, Rio de Janeiro, RJ: Elsevier.
- Hagerty, J. (2016). “Planning Guide for Data and Analytics”. Gartner. Retrieved 16 February 2019, from https://www.gartner.com/binaries/content/assets/events/keywords/catalyst/catus8/2017_planning_guide_for_data_analytics.pdf
- Kugler, J. L. (2013). *Competência analítica: Conceitos e estratégias para a construção da empresa inteligente*, 1st edition, São Paulo, SP: Saraiva.
- Kolaczyk, E. D. and G. Csárdi (2014). *Statistical Analysis of Network Data with R*, 1st edition, New York, NY: Springer.
- Moore, S. (2019). *Gartner Top 10 Data and Analytics Trends*, Retrieved from <https://www.gartner.com/smarterwithgartner/gartner-top-10-data-analytics-trends/>
- Newman, M. E. J. (2010). *Networks: An introduction*, 1st edition, New York, NY: Oxford University Press.
- Newman, M. (2018). *Networks, 2nd edition*, New York, NY: Oxford University Press.
- Project Management Institute [PMI] (2018). *Um guia do conhecimento em gerenciamento de projetos - Guia PMBOK, 6th edition*, São Paulo, SP: Saraiva.
- Schwab, K. (2016, April). “The fourth industrial revolution”. World Economic Forum 2016. Retrieved 11 January 2019, from <https://cormolenaar.nl/wp-content/uploads/2016/04/The-fourth-industrial-revolution.pdf>
- THE R FOUNDATION. “The R Foundation”. R Documentation Web Site. Retrieved 07 March 2019, from <https://www.r-project.org/foundation/>
- Tomáel, M. I., R. M. Marteleto (2013). *Redes sociais de dois modos: aspectos conceituais*. Retrieved 18 March 2019, from <http://www.scielo.br/pdf/tinf/v25n3/07.pdf>

- Tsvetovat, M. and A. Kouznetsov (2011). *Social Network Analysis for Startups: Finding connections on the social web, 1st edition*, Sebastopol, CA: O'Reilly Media.
- Yin, R. K. (2015). *Estudo de caso: planejamento e métodos, 5th edition*, Porto Alegre, RS: Bookman.

P31: Using Knowledge Management to Strengthen Information Security Policy Development in Developing Countries: Case - Jamaica

Nadine A. Maitland
University of Technology, Jamaica,
nmaitland@utech.edu.jm

Kweku-Muata Osei-Bryson
Virginia Commonwealth University,
KMOsei@vcu.edu

Gunjan Mansingh
The University of the West Indies,
gunjan.mansingh@uwimona.edu.jm

Abstract

Information security incidents continue to grow exponentially amidst the development of advanced technological solutions aimed at protecting information system resources. Today, the growth in information systems' breaches remains at an alarming rate. The strategies developed by malicious users are becoming more sophisticated in nature and are introduced unabated across various networks. However, security experts and developers are lagging behind in their response to the information security phenomenon. Today, developing countries continue struggling to effectively address information security issues and are becoming the main avenue for cyber criminals who capitalize on the weaknesses that exist in these regions. An effective response to information security requires a significant amount of resources. In developing countries there are limited human, financial and technological resources and weak legislative frameworks and these are fundamental requirements for combating cyber-crime. One major cyber-crime incident could be catastrophic for businesses and governments in these small, fragile economies and could have far reaching effects on their citizens. Knowledge management can be employed to assist in strengthening the capability of organizations and governments in the development of context-sensitive information security policies in developing regions. In this paper we present a knowledge acquisition model that brings together the two most widely adopted standards COBIT, ISO/IEC 27005 and tacit knowledge that exists in repositories (human) within the information security domain to support the development of context-sensitive information security policies. A quantitative methodology was used in the development of an artifact, preliminary evaluation was done using the informed argument approach and results and recommendations for future research are presented. This study can add to the limited literature on the use of knowledge management in the information security domain and the artifact presented can assist information security practitioners in small/medium-sized organizations.

Keywords: information security, knowledge management, information security policy, cyber security.

1. Introduction

Managing information security knowledge aimed at developing and implementing context sensitive security policies for developing countries as they increasingly participate in the digital economy. Improving Knowledge Management (KM) capabilities in organizations can strengthen their policy development capabilities in an environment where the Internet is

becoming the medium of choice for communication. However, parallel to the benefits offered by the use of the internet are drawbacks. Presently, new and more diverse information security vulnerabilities created daily and information security breaches continue to occur unabatedly (Alshaikh, Maynard, Ahmad, & Chang, 2018; Jalali, Siegel, & Madnick, 2019). There is rapid development of new, evolving and sophisticated cyber weapons and Developing Countries (DC) are still at the very early stage of developing cyber-defense (Caldwell, 2013; de Barros & Lazarek, 2019; Gercke, 2011). In the developing regions there are inadequate cyber-security controls and a scarcity of the knowledge and skills that are required to develop effective cyber-security strategies (Jenkins, Grimes, Proudfoot, & Lowry, 2014; Khan, Moon, Rhee, & Rho, 2010; Muller, 2015).

The implementation of KM to assist with policy development could result in a more effective and efficient policy development process. Information security safe-guards are much weaker in developing regions when compared to developed countries; this makes them the avenue of choice for cyber criminals who exploit the weaknesses that are present in these systems (Kshetri, 2010; Schia, 2018). According to Jenkins et al. (2014) users of the Internet in developing countries are targeted by hackers because of the perception that there are limited programs to secure cyberspace and there are inadequate laws to enforce cyber security. Jamaica like other developing countries has limited information security resources (human and financial) and is lagging behind in enacting the necessary legislations which are required for the full protection of data and systems. Therefore, KM can bring together the distributed information security knowledge repositories and the limited information security expertise that exist in developing countries.

This study makes both theoretical and practical contribution. From a theoretical perspective it examines how knowledge management processes can assist developing countries with the management of information security, thus adding to the paucity of knowledge that exists in literature regarding knowledge management and information security. From a practical perspective, the proposed knowledge acquisition model facilitates knowledge sharing in the domain. The knowledge acquired during this exercise can result in improved information security decision making processes, increased efficiency and strengthen policy development capabilities. In this study we will look at how knowledge management can be used in developing countries to develop context-sensitive information security policies. This study uses a design science research (DSR) approach for the creation and evaluation of the proposed Knowledge Acquisition Model along with an initial Knowledge Management Model. Preliminary evaluations of the models are presented with subsequent evaluation to be done in future research. The rest of this paper is organized as follows: a background to this research that looks at the state-of-the-art of information security and knowledge management, the design science methodology used to conduct the study, a Knowledge Acquisition Model (KAM) that has been developed and preliminary evaluation of the proposed KAM and results of the initial evaluation are presented in the Knowledge Management Model (KMM).

2. Background

Success in today's technologically driven world is partially dependent on effective information security and the ability to control information (Caldwell, 2013). Effective information security begins with the development of effective information security policies which includes guidelines for protecting technical and information resources as well as monitoring human behavior (Khan et al., 2010; Peltier, 2016). However, the complexity and dynamic nature of these interconnected systems makes developing information security policies a challenging task because there are no simple solutions, neither does one size fit all (Alberts & Dorofee, 2002; Alshaikh et al., 2018; Syamsuddin & Hwang, 2009). Researchers

Jalali et al. (2019) in their study point out that only 19% of chief information security officers believe that information security incidents are addressed adequately in organizations. Knowledge in the information security domain is distributed, fragmented and resides in various repositories. The main sources of information security knowledge reside in explicit (codified) format in systems and frameworks. However, additional knowledge sources that are very important to the success of information security are implicit (human) knowledge that resides in domain experts. Bringing distributed and fragmented knowledge together is challenging and very costly. No single developing country or organization in these countries can effectively manage information security because managing information security requires large amounts of financial and human resources (Ellefsen & Von Solms, 2010; Tu & Yuan, 2014).

2.1 Knowledge Management

Knowledge Management can be described as achieving the best results through maximizing the use of the organizations knowledge resources within the organization. According to Alshaikh et al. (2018) knowledge management encourages the “creation and sharing” of knowledge within an organization to maximize the use of its knowledge resources. Knowledge management processes can be employed to assist with the development of context-sensitive information security policies. Knowledge management Systems (KMS) can be described as flexible technologies that provide a platform for the creation, sharing and application of related knowledge in organizations (Maier & Hädrich, 2011; Mansingh, Osei-Bryson, & Reichgelt, 2009). By its very nature a KMS is designed to be a collaborative tool that supports knowledge management. Knowledge management can result in more effective and efficient knowledge management processes and improved productivity of “knowledge work” (Maier & Hädrich, 2011). Knowledge management provides a conduit for codifying knowledge that is associated with a process. This knowledge is broken down into rules or related courses of action resulting in a more accurate direction as it relates to procedures or processes (Turner & Makhija, 2006). Process-related knowledge can be proactively delivered in its most correct form to the process performer and can be found in things such as documents, experts and help files just to name a few (Jung, Choi, & Song, 2007). The present research looks at addressing information security management by applying explicit/codified knowledge that resides in established frameworks. However, very few researchers have looked at how knowledge management (KM) processes can be used to assist with the management of information security (Belsis, Kokolakis, & Kiountouzis, 2005). In this study we will investigate how knowledge management can assist in the development of effective information security policies in developing countries.

2.2 Information security

Several information security (InfoSec) standards have been developed to assist with designing information security policies including security governance guidelines such as Control Objectives for Information and Related Technology (COBIT), the Capacity Model for security (CMM-SEC), Guidelines for Management of IT security GMITS International Organization of Standards (ISO) and the International Electro-technical Commission (IEC), Integration Solution Framework (ISF) : ISO/IEC 27001/2, BS7799, PCIDSS, COSO, ITIL, OPM3, PRINCE2, PMMM, (Blum, 2006; Njenga & Brown, 2008; Palilingan & Batmetan, 2018; Susanto12, Almunawar, & Tuan, 2012; Susanto & Almunawar, 2015). There is also the Communication and Information System (CIS) Security Capability Breakdown/ Framework designed to assist practitioners manage information security across the organizations communication platform (Bernier & Perrett, 2014). However they are not widely adopted, with the highest adoption rates ranging between 6% - 26% for COBIT and ISO/IEC 27002

(Susanto12, Almunawar, & Tuan, 2011; Susanto12 et al., 2012). The low adoption rate is attributed to multiple factors including complexity, certification requirements, lack of resources, difficulty in understanding and implementing the guidelines, culture and the lack of trained personnel (Susanto12 et al., 2011, 2012; Tunçalp, 2014; Von Solms, 2005). Despite the continuous increase in security breaches many security tools / guidelines remain underutilized by practitioners (Witschey et al., 2015). Making decisions regarding the security of an organization's information resource is a very important issue and could be the difference between secured and vulnerable systems.

In May, 2019 the General Data Protection Regulation (GDPR) implemented its new regulation. While some of these requirements are not entirely new it however, in the new implementation processing personal data without consent is unlawful. Therefore, it is imperative that governments and organizations align their information security policies aimed at preventing these types of breaches. These new legislation has far reaching implications because they are applicable worldwide and applies to any jurisdiction that does business directly with countries within the European Union or its uses its citizens personal data. The GDPR implementation of May, 2019 makes it even more important that organizations in developing countries like Jamaica implement policies aimed at meeting these information security requirements.

2.3 Knowledge Management and Information Security

Effective management of information security depends on knowledge (past and present) from an organizational context along with trends in technology (Belsis et al., 2005). Managing various types of knowledge in organizations has been investigated, however not much attention is given to knowledge management from an information security knowledge perspective (Belsis et al., 2005). There is a limited and an incomplete representation of systematic documentation of information security knowledge at the management level that outlines how this knowledge contributes to the information security experts' work (Belsis et al., 2005; Fenz & Ekelhart, 2009). A few researchers have looked at knowledge and information security; however, there is paucity of study that investigates how knowledge management can strengthen information security in organizations that are constrained because of their lack of or limited resources.

Researchers (Kesh & Ratnasingam, 2007) proposed an information system knowledge architecture (ISKA) that is aimed at capturing "time-invariant" knowledge at the high level and provides a framework for organizational knowledge to be dynamically captured. The proposed ISKA is the first step in the acquisition of information security knowledge and provides a medium for organizations to capture initial knowledge and incrementally update this knowledge based on the needs of the organization. The ISKA applies the knowledge management principles and uses primary and secondary interfaces to connect all the components of KM. The primary interfaces are concerned with the relationship between components such as knowledge dimensions, knowledge characteristics, knowledge resources and the relevant stakeholders. The secondary interfaces are only concerned with the knowledge components. The study proposed that implementation of their proposed architecture would require that knowledge architecture be developed for each group of stakeholders.

Researchers (Fenz & Ekelhart, 2009) proposed an information security ontology that models the information security knowledge that is encoded in the German IT Grundschutz Manual and the ISO/IEC 27001 standard. This ontology uses the OWL-DW W3Web ontology

language standard to model the relationships between the organization's information resources (assets) and their vulnerabilities. The aim of this study was to propose a structure that could support the information security risk management but provide a general model that could support the information security domain including the infrastructure. The researchers pointed out that previously proposed information security ontologies were very limited in their scope and suggested that future studies could look at expanding the scope.

A study of knowledge management for information security done by (Belsis et al., 2005) sought to identify the primary sources of information security knowledge. This study conducted field research aimed at identifying the main sources of information security knowledge. The three core areas relating to information security knowledge that were identified are the strategic, tactical and operational levels. The researchers suggested that the operational level is considered to be the greatest source of information security knowledge. In the study the researchers identified that the most relative sources of information security knowledge within an organization are at the strategic, tactical and operations levels.

A structural framework was developed that comprised three layers namely: policy, guidelines and measures. This framework was used develop a model that represents the logical flow of information security knowledge in organizations. This knowledge can be used to develop context-sensitive information security policies. The researchers point out that capturing and documenting knowledge relating to information security remains an "ad hoc" process and controlling information security knowledge remains "unobtrusive" in most organizations. Researchers suggested that there is a need for research that looks at the use of knowledge management and information security as presently, information security scholarships are limited mainly to documents / framework (Belsis et al., 2005). Information security policies can be describes as a "means to an end" therefore, it should be viewed beyond the protection of data on a device, and policies should incorporate the organizations assets both internally and externally (Peltier, 2016).

In this study we extend / build on the study presented by (Belsis et al., 2005) and we propose a knowledge acquisition architecture/ model that uses the knowledge management principles. We distill the two most widely adopted information security standards namely: COBIT and ISO/IEC 2005 with the Value Focused Thinking (VFT) technique that facilitates the input of the decision maker. The proposed Knowledge Acquisition Model (KAM) provides a medium for the combination and codification of explicit/ codified knowledge that exist in the information security frameworks and implicit/tacit knowledge of domain experts. Information security experts / practitioners posse tacit knowledge ("cognitive and technical elements") acquired through previous problem solving methods and practical experience. Explicit information security knowledge exists in various forms of documents (frameworks, manuals and handbooks etc.). The amalgamation of tacit of information security knowledge that resides in human repositories and explicit ("articulated, codified and communicated") could yield more efficient and effective output. Using knowledge management technologies, "Codifiable" process-oriented knowledge can be broken down into rules or related courses of action and can result in accurate procedures being followed (Turner & Makhija, 2006). Process-oriented knowledge if proactively delivered in its most correct form to the process performer can result in increased efficiency therefore improves the usability of the organization's knowledge assets (Jung et al., 2007).

The proposed KAM brings together tacit knowledge of domain experts and process - related knowledge taken from the ISO 27005 and the COBIT standards. The explicit knowledge

from the COBIT and ISO /IEC 27005 will be distilled along with the VFT approach that facilitates the decision maker and domain experts input. Design Science is ideal for this study because it provides a framework for the utilization of existing knowledge and the addition of proven knowledge management concepts extending the literature while providing a model aimed at solving a real world problem. In this study we present a model that applies the knowledge management concepts to the information security domain. The results suggest that implementation of knowledge management techniques in the information security domain could strengthen information security policy development capabilities in cases where there are limited resources such as developing countries. The KAM presented can assist in the development of context-sensitive information security policies. Design science research contribution can be significant and publishable if what is presented is “new” because although the artifact presented may be incremental the practicality of its application can complement the contribution to knowledge (Gregor & Hevner, 2013).

3. Research Methodology

A qualitative approach was used to conduct this study. Design science is a technology-oriented paradigm which has its foundation in the sciences and engineering and is central to what information system practitioners and researchers do (Hevner & Chatterjee, 2010a). According to (Nugrahanto & Morrison, 2008; von Alan, March, Park, & Ram, 2004) the generally accepted activities in design science are to build and evaluate, where building looks at the development of an artifact to meet specific requirements and; evaluating is concerned with how well they achieve the intended purpose and contribute to knowledge. Design science brings together technology-based artifacts that can be classified as instantiations, constructs, methods or models (Golding & Donaldson, 2009). Design science (DS) aims to simplify a problem and build artifacts that are referred to as human-machine with the intent of “supporting operations, management, analysis, and decision-making activities” in organizations (Hevner & Chatterjee, 2010b). DS research aims to build/develop improved or new solutions in a problem domain when the application’s context is unclear, unknown or where solutions are not optimal (Gregor & Hevner, 2013).

3.1 Design Science Research Guidelines

Researchers (Hevner & Chatterjee, 2010b; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007) point out that design science research (DSR) aims to develop useful technological solutions based on business requirements aimed at: (a) Producing artifacts that are “implementable” and which provide solutions for unsolved problems. (b) Applying rigorous methods both in the construction and evaluation of the artifact. (c) Facilitating the search process, for unearthing a solution for a problem. Therefore, producing “effective design” will depend on knowledge of both the application and the solution domains. (d) Constructing an artifact that can be evaluated as the output. (e) Evaluating the design of the artifact. An artifact is “complete and effective” if it meets the requirements and produces the intended solution to the relevant problem. (f) Communication of research results.

Guideline	Activity of this Research Project
Identification and clear description of a relevant organizational, IT problem	Information security is a growing problem worldwide and organizations in developing countries are struggling to address the problem because of the lack of the required resources (human, financial).
Demonstrate that no adequate solution exist in the extant IT knowledge-base	Several information security guidelines/standards have been developed however, they are costly, difficult to implement and often require certain expert skillsets in quantities and at levels that are not easily attained by organizations in developing economies. The adoption rates of these standards remain extremely low.

Development, and presentation of a novel IT artifact (constructs, models, methods or instantiations) that addresses the problem	In this research we present a conceptual Knowledge Acquisition Model (KAM) for strengthening the development context-sensitive information security policies.
Rigorous evaluation of the IT artifact enabling the assessment, of its utility	For this stage of the research program, the conceptual KAM is presented along with preliminary results from a knowledge management model outlining the results obtained from the output attained from the initial Knowledge Management Model (KMM).
Articulation of the value added to the IT knowledge-base and practice	The Definition and illustration of an appropriate conceptual knowledge acquisition model that uses knowledge management concepts in the information security domain to strengthen information security capabilities in organizations in the development of context-sensitive information security policies. This adds to the limited knowledge available in relation to the use of knowledge management in the information security domain and practitioners can utilize this method to share and manage information security knowledge within organizations
Explanation of the implications for management and practice	Utilization of established techniques to define the conceptual knowledge acquisition Model that is consistent with the previously proposed Hybrid VFT/Delphi Framework (Maitland & Osei-Bryson, 2014), and A Conceptual Data Model for a Domain Knowledge Base (Barrett-Maitland et al., 2015), and the justification of this 'solution' framework.

Table 1: Application of the design science methodology to this study based on recommendations outlined in (Gregor & Hevner, 2013)

In this study we present an example using a use case. We then developed a conceptual knowledge acquisition model (KAM) see Figure 1. The KAM brings together explicit knowledge in the two most widely adopted security frameworks / standards: COBIT and the ISO/ IEC 27005, and the Value Focused Technique. Figure 2 presents preliminary results of the knowledge management model (KMM) that is being developed based on the KAM presented in Figure 1.

4. Results

In this section we present a use case, a conceptual knowledge acquisition model (KAM), for the development of a knowledge management model (KMM). A sample of the metadata generated after interaction with the KAM is presented in Table 2. In Figure 2 we present a sample of the implementation description of the suggested policies generated by the proposed Knowledge Management Model (KMM). The proposed KAM model can strengthen information security policy development capabilities of organizations in developing countries as it facilitates the development of context-sensitive information security policies.

4.1 Use Case

A small business that sells organic products in Jamaica is expanding its reach to the Caribbean and North America. The company wants to allow customers to interact with the system electronically via the Internet; this includes establishing a social media presence. However, the company is aware of the vulnerabilities that this digital expansion can create and is keen on securing its copyrights and trade secrets. The company intends to offer delivery services via a courier or customers may pick-up orders at the nearest location. Presently, a manual system is used for recording and keeping these records and they are classified as normal, sensitive and extremely sensitive. The present business processes do not require a formal information security policy document. There are three categories of users; senior management, supervisors and line workers. Customers can make orders, view available stock items and request information such as balances, order details, prices. This company will also advertise its products and services and provide basic information regarding

the services offered. One very important aspect of this venture is the development of a formal information security policy that will govern interactions of staff at all levels, with other internal stakeholders and with the various publics.

Building on work presented by Belsis et al., (2005) where the tactical and operational levels were identified as the main sources of information security knowledge in organizations'. In Figure 1 we present a conceptual knowledge acquisition model (KAM) for the acquisition of knowledge with a focus on the strategic and operational levels. In table 2 we present a sample of some of the metadata that would be generated after interaction with the KAM. In figure 2 we present output from the knowledge management model that outlines the initial procedures and information that would be generated based on the initial knowledge updated from information security frameworks and other sources of knowledge via the KAM. As pointed out in work done by (Belsis et al., 2005) the strategic and the operational levels are the most valuable sources of information security knowledge. The strategic level will inform policy as it outlines the information security policies and procedures that should be followed for the implementation of these policies. The operational level consists of knowledge repositories such as domain experts (implicit) and explicit sources of knowledge such as frameworks, documents and other system resources.

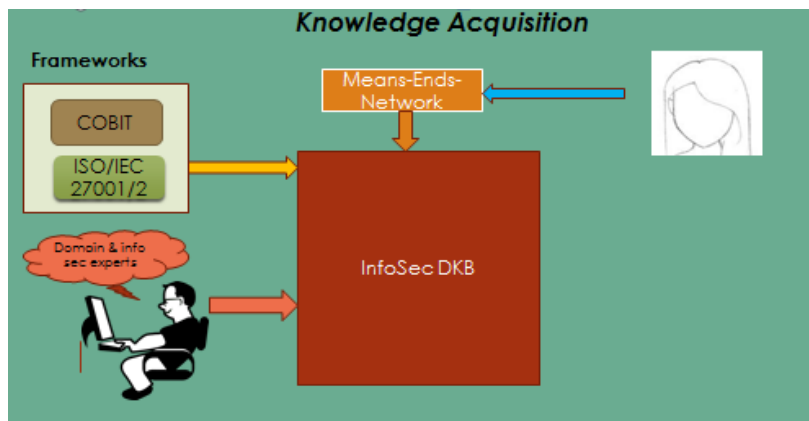


Figure 1: The proposed conceptual knowledge acquisition architecture / Model (KAM)

The conceptual KAM presented in figure 1 brings together the information security control objectives detailed in the COBIT framework and the implementation procedures outlined in the ISO/ IEC 2007 along with the Value Focused Thinking (VFT) objectives and suggestions of domain experts, decision makers and other information security stakeholders. The COBIT and ISO/IEC 2007 standards are the two most widely adopted information security standards as outlined in the previous sections of this study. The KAM provides a medium for strengthening information security policy development as it capitalizes on the strength of each framework. Researchers (Von Solms, 2005) point out that the COBIT framework, though described as a well-researched framework, is not widely adopted because of challenges it poses for information security practitioners. The COBIT framework by its very nature is difficult to implement as it mainly focuses on “what” should be done. On the other hand the ISO/IEC 2005 is described as the practitioners’ handbook as it focuses on “how” things should be implemented. The low adoption rate is attributed to its stand-alone nature and the difficulty to integrate it with other systems. The KAM combines the strength of both frameworks and utilizes the VFT methodology to incorporate the domain experts (decision makers) as part of the development of a context-specific information security policy. The aim of KAM is to provide a medium for the combination of explicit and implicit knowledge in a

manner that can result in a more efficient and effective process of knowledge acquisition, resulting in the strengthening of the information security policy development process.

Responsible Team	Strategic	Operational
Management team	Information security is to protect the organization's information assets from unauthorized use.	An information security document that is aligned with the strategic objectives of the organization and lines up with the laws and regulations of the data protection act/ policy must be developed.
Designated information security officer	Outlines commitment and support that the organization will provide to enable the achievement of information security objectives / goals.	Updates the information security document with the information that outlines management's commitment to the information security process.
Chief information security officer	Controls objectives, objectives risk assessment and management.	Outlines how external stakeholders will interact with the organization's information assets. Determines how information from external sources is handled (stored, cleared) and updated to the system. Controls the verification process for transactions to identify the accuracy of transmitted information (or identify if breaches have occurred. Outlines protocol for accessing and managing the information assets (copying, sharing/ disclosing of companies information. Determines access control policies: Identification requirements for entering controlled environments Clearly document the acceptable use of company/ organization's information assets.
Chief information security officer	Outlines requirements for compliance with legislation and contractual requirements (JDPP, GDPR). Outline the business continuity plan and how it should be managed. Determines consequences of information security policy breaches.	Provides documented policies that state the organization's compliance with regulatory legislations and its contractual agreements. Outlines the business continuity plan example: If there is a natural disaster, fire and any other unforeseen circumstance what is the procedure that must be followed to ensure the business' information assets are protected/ secured? If an employee resigned or is terminated what should be done regarding access to information assets? When should users' access rights be terminated, denied or removed etc.? What are the disciplinary procedures for breaches? The protocol for returning company assets (Identification cards and access chits etc.)

Table 2: Sample metadata after interaction with the KAM

CON_DSC	CON_ID	PR_ID	IMP_ID	IMP_DSC
Service level Management of service level proce...	5001	1001	5507	Ensure informationsecurity controls, service def...
Define service characteristics and business requ...	5002	1001	5507	Ensure informationsecurity controls, service def...
Defining Service Level Agreements in accordanc...	5003	1001	5507	Ensure informationsecurity controls, service def...
Operating level agreements. Define technical d...	5004	1001	5507	Ensure informationsecurity controls, service def...
Monitoring and reporting of service level achiev...	5005	1001	5508	Ethe third party information security terms and ...
Review service level agreements and contracts ...	5006	1001	5508	Ethe third party information security terms and ...
Monitoring and reporting of service level achiev...	5005	1001	5509	The changes to the third party management pr...

Figure 2: Proposed knowledge management model (KMM)

4.2 Preliminary Evaluation of the Artifact

Maes & Poels (2006) presented an assessment framework based on Seddon's re-specified information systems success model (Seddon, 1997) which acknowledges quality as an antecedent to system's success. This model identified four interconnected construct categories as necessary to assess the quality of an artifact:

- **Perceived semantic quality** describes the correspondence between the information that users think the model contains and the information that users think the model should contain, based upon their knowledge of the problem domain (Krogstie, Lindland, & Sindre, 1995).
- **Perceived usefulness** relates to "the degree to which a person believes that using a particular system has enhanced his or her job performance" (Davis 1989).
- **User satisfaction** is a subjective evaluation of the various consequences evaluated on a pleasant to unpleasant continuum (Seddon 1997).

- *Perceived ease of use* refers to the extent that the user believes using the system would require little effort (Davis, 1989) or perceived as being difficult to use (Moore & Benbasat, 1991).

In Table 3 we present the results of the use of an informed argument approach to conduct a preliminary evaluation of our proposed Conceptual Knowledge Acquisition Model based on the Maes & Poels (2006) framework. This evaluation aims to analyze the benefits of the application of knowledge management to the information security domain and its usefulness in this environment. In Figure 2 we present preliminary results of the proposed knowledge management model (KMM) developed based on the KAM.

Category	Activity
Perceived semantic quality	A Hybrid Value Focused Thinking (VFT) /Delphi methodology proposed by (Maitland & Osei-Bryson, 2014) aims to provide knowledge management support for the elicitation phase of the knowledge acquisition process. A Conceptual Data Model (CDM) proposed by (Maitland, N., Osei-Bryson, K. M., and Mansingh, G. 2015) that compared and combined the equivalent factors of the IS security frameworks ISO/IEC 27001/5, COBIT along with the fundamental objectives of the VFT approach these were identified and modeled. Given that the KAM is based on the integrated combined knowledge of established / information security frameworks and previously proposed Information Security Domain VFT models that contain desires of decision makers, then the corresponding should contain the information that users think it should contain.
Perceived usefulness	Given that the KAM is based on explicit knowledge/information expressed in established frameworks and provides a medium for querying the corresponding Knowledge Management Architecture, then use of the KAM should result in improved performance by stakeholder. The proposed KAM uses knowledge management-based process that could assist stakeholders to develop context-sensitive information security policies.
User satisfaction	Given that stakeholders may be at different levels of knowledge and competence with regards to information systems security, and limitations on human's ability to recall all relevant information, then stakeholders should be satisfied to have access to relevant information that would be contained in the knowledge management system which is based on the KAM.
Perceived ease of use	The stakeholders would not be interacting directly with the KMS but rather through software facilities including those provided by the knowledge management system.

Table 3: Application of the information system success model to the KAM

5. Conclusion and Future Work

In this research we have proposed a conceptual KAM for information security knowledge management that aims to assist developing countries in strengthening and managing information security policy development. Bringing together the various sources of knowledge can result in a more robust framework for developing information security policies. The knowledge acquisition model brings together both explicit and tacit knowledge sources, explicit knowledge that is embedded in the most widely adopted standards COBIT and ISO/IEC 27005 along with tacit knowledge of the information security experts. Preliminary results reveal that knowledge management practices could assist in the development of context-sensitive information security policies. Future components of this research program will involve the development of a software system followed by the evaluation of the system.

References

- Alberts, C. J., & Dorofee, A. (2002). *Managing information security risks: the OCTAVE approach*. Addison-Wesley Longman Publishing Co., Inc.
- Alshaikh, M., Maynard, S. B., Ahmad, A., & Chang, S. (2018). An exploratory study of current information security training and awareness practices in organizations.
- Belsis, P., Kokolakis, S., & Kiountouzis, E. (2005). Information systems security from a knowledge management perspective. *Information Management & Computer Security*, 13(3), 189-202.
- Bernier, M., & Perrett, K. (2014). *Mission Function Task Analysis for Cyber Defence*. Retrieved from
- Blum, D. (2006). Making Business Sense of Information Security. *Security and Risk Man.*

- Caldwell, T. (2013). Plugging the cyber-security skills gap. *Computer Fraud & Security*, 2013(7), 5-10.
- Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319-340.
- de Barros, M. J. Z., & Lazarek, H. (2019). *A Conceptual Model for the Development of Cybersecurity Capacity in Mozambique*. Paper presented at the European Conference on Cyber Warfare and Security.
- Ellefsen, I., & Von Solms, S. (2010). *Critical information infrastructure protection in the developing world*. Paper presented at the International Conference on Critical Infrastructure Protection.
- Fenz, S., & Ekelhart, A. (2009). *Formalizing information security knowledge*. Paper presented at the Proceedings of the 4th international Symposium on information, Computer, and Communications Security.
- Gercke, M. (2011). Understanding Cybercrime. A Guide for Developing Countries. *International Telecommunication Union (Draft)*, 89, 93.
- Golding, P., & Donaldson, O. (2009). A design science approach for creating mobile applications. *ICIS 2009 Proceedings*, 165.
- Gregor, S., & Hevner, A. R. (2013). Positioning and presenting design science research for maximum impact. *MIS quarterly*, 337-355.
- Hevner, A., & Chatterjee, S. (2010a). Design science research in information systems *Design research in information systems* (pp. 9-22): Springer.
- Hevner, A., & Chatterjee, S. (2010b). *Design science research in information systems*: Springer.
- Jalali, M. S., Siegel, M., & Madnick, S. (2019). Decision-making and biases in cybersecurity capability development: Evidence from a simulation game experiment. *The Journal of Strategic Information Systems*, 28(1), 66-82.
- Jenkins, J. L., Grimes, M., Proudfoot, J. G., & Lowry, P. B. (2014). Improving password cybersecurity through inexpensive and minimally invasive means: Detecting and deterring password reuse through keystroke-dynamics monitoring and just-in-time fear appeals. *Information Technology for Development*, 20(2), 196-213.
- Jung, J., Choi, I., & Song, M. (2007). An integration architecture for knowledge management systems and business process management systems. *Computers in industry*, 58(1), 21-34.
- Kesh, S., & Ratnasingam, P. (2007). A knowledge architecture for IT security. *Communications of the ACM*, 50(7), 103-108.
- Khan, G. F., Moon, J., Rhee, C., & Rho, J. J. (2010). E-government skills identification and development: toward a staged-based user-centric approach for developing countries. *Asia Pacific Journal of Information Systems*, 20(1), 1-31.
- Krogstie, J., Lindland, O. I., & Sindre, G. (1995). *Towards a deeper understanding of quality in requirements engineering* (Vol. 932/1995). Berlin / Heidelberg: Springer.
- Kshetri, N. (2010). Diffusion and effects of cyber-crime in developing economies. *Third World Quarterly*, 31(7), 1057-1079.
- Maier, R., & Hädrich, T. (2011). Knowledge Management Systems.
- Mansingh, G., Osei-Bryson, K.-M., & Reichgelt, H. (2009). Issues in knowledge access, retrieval and sharing—case studies in a Caribbean health sector. *Expert Systems with Applications*, 36(2), 2853-2863.
- Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, 2(3), 173-191.
- Muller, L. P. (2015). Cyber security capacity building in developing countries: challenges and opportunities.

- Njenga, K., & Brown, I. (2008). *Collective Improvisation: Complementing Information Security Frameworks with Self-Policing*. Paper presented at the ISSA.
- Nugrahanto, S., & Morrison, I. (2008). A Design Science Approach to Modelling and Facilitating Clinical Workflow and Decision Making.
- Palilingan, V. R., & Batmetan, J. R. (2018). *Incident management in academic information system using ITIL framework*. Paper presented at the IOP Conference Series: Materials Science and Engineering.
- Peppers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, 24(3), 45-77.
- Peltier, T. R. (2016). *Information Security Policies, Procedures, and Standards: guidelines for effective information security management*: CRC Press.
- Schia, N. N. (2018). The cyber frontier and digital pitfalls in the Global South. *Third World Quarterly*, 39(5), 821-837.
- Seddon, P. B. (1997). A Respecification and Extension of the Delone and McLean Model of IS Success. *Information Systems Research*, 8(3), 240-253.
- Susanto¹², H., Almunawar, M. N., & Tuan, Y. C. (2011). Information security management system standards: A comparative study of the big five.
- Susanto¹², H., Almunawar, M. N., & Tuan, Y. C. (2012). Information security challenge and breaches: novelty approach on measuring ISO 27001 readiness level. *International Journal of Engineering and Technology*, 2(1).
- Susanto, H., & Almunawar, M. N. (2015). Managing compliance with an information security management standard *Encyclopedia of Information Science and Technology, Third Edition* (pp. 1452-1463): IGI Global.
- Syamsuddin, I., & Hwang, J. (2009). *The application of AHP model to guide decision makers: a case study of e-banking security*. Paper presented at the Computer Sciences and Convergence Information Technology, 2009. ICCIT'09. Fourth International Conference on.
- Tu, Z., & Yuan, Y. (2014). Critical success factors analysis on effective information security management: A literature review.
- Tunçalp, D. (2014). *Diffusion and adoption of information security management standards across countries and industries*: Taylor & Francis.
- Turner, K. L., & Makhija, M. V. (2006). The role of organizational controls in managing knowledge. *Academy of Management Review*, 31(1), 197-217.
- von Alan, R. H., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *Mis Quarterly*, 28(1), 75-105.
- Von Solms, B. (2005). Information Security governance: COBIT or ISO 17799 or both? *Computers & Security*, 24(2), 99-104.
- Witschey, J., Zielinska, O., Welk, A., Murphy-Hill, E., Mayhorn, C., & Zimmermann, T. (2015). *Quantifying developers' adoption of security tools*. Paper presented at the Proceedings of the 2015 10th Joint Meeting on Foundations of Software Engineering.

P33: Who Should I Approach?

Knowledge Sourcing in Enterprise System Implementation

Sharath Sasidharan
Bowling Green State University
ssasidh@bgsu.edu

Bethany Niese
University of North Georgia
bethany.niese@ung.edu

Abstract

During enterprise system implementation, organizations transfer system-related knowledge to end users through training sessions and by having them involved in the system design and implementation processes. However, during actual use of the system, end users acquire informal knowledge from co-workers through their social networks. Existing research has focused on the structural features of social networks and their impact on regulating knowledge flow between end users and across the network. The personal attributes and preferences of end users that could impact their knowledge acquisition and processing capabilities have not been considered. This paper examines the expertise level of end users, their gender, and the complexity of their job tasks in influencing system-related knowledge acquisition and its impact on performance outcomes. Data for this study was collected from active users of a new Enterprise Resource Planning (ERP) system that had been implemented across multiple business units of diversified business conglomerate in the United States.

Keywords: Social Networks, Enterprise Resource Planning, Advice Networks, Expertise Networks, Gender.

1. Introduction

Enterprise systems integrate data across business units within organizations for the purpose of enhancing efficiency and effectiveness (Ranjan et al., 2016). They usually are replacing legacy systems which typically manage data and business processes of a single department. Transitioning from a legacy environment to an integrated environment requires end-users to be more collaborative and have a cross-organizational perspective. As a result, end-users need to master the tools and procedures of the new system, understand how upstream and downstream processes are affected by their actions, understand how the newly restructured data flows across multiple processes, and how the resulting information will be used (Garg & Agarwal, 2014; Kini & Basaviah, 2013; Tarhini et al., 2015). Researchers and practitioners have emphasized the need to disseminate system-related knowledge during and after enterprise system implementation. The vehicles to deliver knowledge can be in the form of training, end-user involvement during implementation, and the use of experts and technology champions within organizational departments (Arasanmi, 2019; Bano & Zowghi, 2015; Bhattacharya et al., 2019; Ma'arif & Satar, 2018).

Despite these measures, end users often reach out to their social networks to learn about system use in the context of a specific role, share best practices, address on-the-job technical issues, and to address business challenges (Freeze et al., 2012; Sasidharan et al., 2012; Sasidharan et al., 2017; Sykes et al., 2009; Sykes et al., 2014).

2. Social Learning Theory and Social Networks

The social learning theory argues that learning is a social activity facilitated primarily through observation. Their environment impacts how people learn new things and acquire

new behaviors (Bandura, 1977). This concept of environment-driven learning forms the basis of social networks: the study of how and why people or groups interact with one another (Hanneman & Riddle, 2005). In a work environment, employees may acquire knowledge from co-workers to solve job-related problems. A co-worker who might not an answer to a question may in turn reach out to another co-worker for help, leading to the development of an informal knowledge acquisition network. Social network techniques help codify these knowledge networking patterns to identify network players and network structures that can influence knowledge flows across the organization (Borgatti & Cross, 2003; Brass, 1984, 1985, 2011; Hanneman & Riddle, 2005).

3. Social Advice Networks and Enterprise System Implementation

Workplace social networks are composed of informal, context-relevant employee interactions, formed in real-time based on shared beliefs, preferences, goals, and objectives (Borgatti & Cross, 2003; Brass, 1984, 1985, 2011; Hanneman & Riddle, 2005). Research on social networks in the context of enterprise systems has found that system-related knowledge gained through such informal network structures facilitates an improved understanding of the system, in addition to improving job performance. Such knowledge transfer social networks are referred to as advice networks. As opposed to the more formalized “text-book” knowledge acquired during training sessions, advice networks have been found capable of providing direct fixes to unanticipated and context-dependent problems. In addition, it reduces the amount of time required for problem resolution (Freeze et al., 2012; Sasidharan et al., 2012; Sasidharan et al., 2017; Sykes et al, 2009; Sykes et al., 2014).

Network researchers have primarily focused on the structural features of advice networks that calibrate the amount of knowledge flowing through the network. The unit of analysis could be the network or the individual user (Hanneman & Riddle, 2005). Network level measures include knowledge tie density which can be indicative of the speed of knowledge transmission across the network. Other approaches include identifying closely connected sub-networks or cliques within the overall network based on commonalities such as demographics. At the level of the individual user, the primary focus has been on the immediate network surrounding the user – the user is called the “ego”, and the network of those users that ego approaches to acquire knowledge is called the ego network. The ego network often forms the most immediate and primary knowledge acquisition source for a user (Hanneman & Riddle, 2005).

The effective use of enterprise systems requires end users to constantly acquire knowledge and integrate its features into their work, so a large ego network provides individuals with increased access to others’ knowledge (Brass 1984, 1985; Brass & Burkhardt, 1993; Ibarra & Andrews, 1993). The centrality measure reflects the positioning of a user within an advice network in relation to his or her knowledge acquisition and knowledge transmission potential. This could be in terms of closeness (the number of direct knowledge ties of a user with other users) or betweenness (the extent a user is between otherwise unconnected users, such users transmit knowledge between unconnected users gaining knowledge and institutional power in the process). Increasing centrality provides exposure to a variety of experiences, information, challenges, and solutions which would not have occurred in isolation (Hanneman & Riddle, 2005). Central users possess influence, power, and control within the network (Borgatti & Cross, 2003; Brass, 1984; Ibarra & Andrews, 1993).

While this body of research has provided a better understanding of how users access and process informal knowledge in the workplace, the focus essentially has been on a numerical

count of the knowledge ties between end users, and not on the end users themselves. The implicit assumption has been that the higher the number of knowledge ties, greater the amount of knowledge acquisition, leading to improved performance outcomes. We argue that while the number of knowledge ties do matter, for a more holistic appreciation of the knowledge dynamics at play within the network, the end user too must be taken into account, as his or her personal attributes, preferences, and perspectives can impact the quantity and quality of knowledge flows and their subsequent utilization (Aubert et al., 2013; Shih, 2006; Sun et al., 2009).

4. Research Framework

We now examine the expertise level of end users, their gender, and the nature of their job tasks in influencing knowledge flows and subsequent performance outcomes.

4.1 Expertise Level of Knowledge Sources

The expertise level of knowledge sources can impact the quality of knowledge flows across the advice network. While all end users would likely have undergone formal organizationally mandated training, the extent to which this knowledge would have been internalized by recipients can depend on a variety of factors, including prior experience with similar technologies, technical self-efficacy, and learning capabilities. Some end users would have participated in the system design and implementation processes, and would arguably possess more procedural or know-how expertise than others who did not have that experience. Knowledge flows emanating from those with authentic system related expertise would have a greater positive impact on recipients than that sourced from those lacking such expertise.

Hoffman's expertise model (Hoffman, 1998) conceptualizes expertise as a continuum, ranging from those with little or no domain knowledge (the naïve and the novice) to those with foundational and higher than foundational domain knowledge (the apprentice, the initiate, and the journeyman), and finally to those with competence and experience in both domain and related subdomains (the expert and the master). In the context of this study, the expert and the master are viewed as possessing system-related knowledge to the extent that they can function as reliable sources of high quality knowledge flows. The subnetwork within the overall advice network connecting these system-related experts is referred to as the expertise network.

The quality of knowledge accessible to an end user can have an impact on performance outcomes, hence greater the overlap between the end user ego network and the expertise network, higher would be the performance outcomes.

P1: The extent of overlap between the end user ego network and the expertise network would be positively related to end user performance outcomes.

4.2 Gender

Social networks capture human interactions and gender can play a role in the manner in which relationships are initiated, nurtured, and expanded. Prior research on workplace social networks have concluded that they have by and large been disadvantageous to women (Forret & Dougherty, 2004; McGuire, 2002; Ibarra, 1995, 1997; Loscocco et al., 2009; McPherson et al., 2001). Women view workplace interpersonal relationships as a means of gaining reciprocal trust, developing intimacy, and fostering closeness. On the other hand, men are more goal-oriented with their workplace relationships being a tool for achieving job success, acquiring power, and establishing dominance (Basow & Rubenfield, 2003; Mason, 1995;

Mulac et al., 2001; Tannen, 1990). A new enterprise system would be replacing an existing system which would have an associated advice network. Women would be more likely than men to call upon their existing advice network to acquire knowledge regarding the new system as it would further nurture and cement their existing relationships. However, use of the newly implemented system may require access to knowledge flows different from what is available from within their current advice network. Men being goal-oriented would be more likely to deliberately venture outside of their existing advice network and acquire knowledge from those perceived as system-related experts. Hence, men are expected to have higher performance outcomes than women.

P2: The extent of overlap between the end user ego network and the expertise network would be higher for men than women.

P3: Men will have higher performance outcomes than women.

4.3 Job Tasks

The nature of the job task performed by end users can vary in and structure and complexity. At one extreme, tasks may be well-defined and structured. The steps involved for executing structured tasks are usually documented and require minimal cognitive input (e.g., generating routine expense reports). At the other extreme job tasks may be unstructured and may require creative thinking and analytical reasoning (e.g., modeling a supply chain). The execution of such tasks through an enterprise system may demand higher levels of cognitive input on the part of the end user and familiarity with more complex system functionalities (Chang et al., 2014; Giachetti, 2016). End users executing such unstructured tasks would benefit more from high-quality knowledge flows than those end users involved in more routine structured tasks. A greater overlap between the end user ego network and the expertise network would provide the end user with the high-quality knowledge flows required for such tasks. Hence, we propose an interaction effect between the nature of the job task (unstructured versus structured) and accessibility to high quality knowledge flows.

P4: The joint effects of end user task structure and the extent of overlap between the end user ego network and the expertise network will be positively related to end user performance outcomes.

5. Research Methodology

Our study context was an agribusiness company located in midwestern United States having interests in grain storage and distribution, commodity trading, and plant nutrients. They implemented an Enterprise Resource Planning (ERP) system with the intent of improving efficiency and maximizing productivity through streamlining operations across their various business units.

An online questionnaire was used to collect data from heavy users of the ERP system belonging to the three business units that were most impacted by the implementation. These users were shortlisted based on transaction logs that included both the frequency and complexity of system-related interactions. Networking data was collected using the “roster” method – each end user was provided with a roster of other users within their business unit and asked to identify those that they had approached for acquiring system-related knowledge. Those identified in this manner constituted the ego network for that user. This data was used for generating the advice networks for end users. End users also self-reported their level of

expertise with the system. This was used in conjunction with data provided by the company regarding expertise levels of end users to create the expertise network.

In addition to networking data, demographic details of participants such as age, gender, experience, and educational qualifications was also collected. Data regarding the extent of structuredness and complexity of job tasks was also collected. Performance outcomes of end users was measured using the individual impact component of the DeLone and McLean Information Systems Success (DMISS) model (DeLone & McLean, 1992). The individual impact component spans performance indicators such as time savings, innovative idea generation, client satisfaction, and productivity improvements.

5. Current Status

We have completed data collection and the data is being tabularized for analysis. Two of the three operational groups had 27 end users each (representing an 80% response rate), and the third unit had 25 end users (representing an 75% response rate). The UCINET and NetDraw (Borgatti et al., 2002) is being used for mapping the ego networks and generating networking parameters. We expect to present our preliminary findings at the conference.

6. Concluding Remarks

Current research on knowledge sourcing through advice networks has focused on structural influences impacting the amount of knowledge acquired by end users. We expand on this narrowly defined research paradigm to encompass attributes and characteristics pertaining to the end user and their impact on knowledge acquisition. The expertise level of end users, their gender, and the complexity of their job tasks in influencing system-related knowledge acquisition and its impact on performance outcomes is considered.

References

- Arasanmi, C. (2019). "Training Effectiveness in an Enterprise Resource Planning System Environment." *European Journal of Training and Development*, 43(5/6), 476-489.
- Aubert, B., V. Hooper, and A. Schnepel (2013). Revisiting the Role of Communication Quality in ERP Project Success. *American Journal of Business*, 28(1), 64-85.
- Bandura, A. and R. Walters (1977). *Social Learning Theory*, Englewood Cliffs, NJ: Prentice-Hall.
- Bano, M. and D. Zowghi (2015). "A Systematic Review on the Relationship Between User Involvement and System Success." *Information and Software Technology*, 58, 148-169.
- Basow, S. and K. Rubinfeld (2003). "Troubles Talk: Effects of Gender and Gender-typing." *Sex Roles*, 48(3-4), 183-187.
- Bhattacharya, M., S. Wamba, and J. Kamdjoug (2019). "Exploring the Determinants of ERP Adoption Intention: The Case of ERP-enabled Emergency Service." *International Journal of Technology Diffusion*, 10(4), 58-76.
- Borgatti, S. and R. Cross (2003). "A Relational View of Information Seeking and Learning in Social Networks." *Management Science*, 49(4), 432-445.
- Borgatti, S., M. Everett, and L. Freeman (2002). *Ucinet for Windows: Software for Social Network Analysis*, Cambridge, MA: Analytic Technologies.
- Brass, D. (1984). "Being in the Right Place: A Structural Analysis of Individual Influence in an Organization." *Administrative Science Quarterly*, 29(4), 518-539.
- Brass, D. (1985). "Men's and Women's Networks: A Study of Interaction Patterns and Influence in an Organization." *Academy of Management Journal*, 28(2), 327-343.
- Brass, D. (2011). "A Social Network Perspective on Industrial/Organizational Psychology" *Handbook of Industrial and Organizational Psychology*, 1, 107-117.

- Brass, D. and M. Burkhardt (1993). "Potential Power and Power Use: An Investigation of Structure and Behaviour." *Academy of Management Journal*, 36(3), 441-470.
- Chang, J., J. Jiang, G. Klein, and E. Wang (2014). "Do Too Many Goals Impede a Program? A Case Study of Enterprise System Implementation with Multiple Interdependent Projects." *Information and Management*, 51(4), 465-478.
- DeLone, W. and E. McLean (1992). "Information Systems Success: The Quest for the Dependent Variable." *Information Systems Research*, 3(1), 60-95.
- Forret, M. and T. Dougherty (2004). "Networking Behaviors and Career Outcomes: Differences for Men and Women?" *The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, 25(3), 419-437.
- Freeze, R., S. Sasidharan, and P. Lane (2012). "Incremental Experts: How Much Knowledge Does a Team Need?" *International Journal of Knowledge Management*, 8(3), 62-82.
- Garg, P. and D. Agarwal (2014). "Critical Success Factors for ERP Implementation in a Fortis Hospital: An Empirical Investigation." *Journal of Enterprise Information Management*, 27(4), 402-423.
- Giachetti, R. (2016). *Design of Enterprise Systems: Theory, Architecture, and Methods*, Boca Raton, FL: CRC Press.
- Hanneman, R. and M. Riddle (2005). *Introduction to Social Network Methods*, Riverside, CA: University of California Riverside.
- Hoffman, R. (1998). How Can Expertise Be Defined? Implications of Research from Cognitive Psychology. In *Exploring Expertise*, London: Palgrave Macmillan, 81-100.
- Ibarra, H. (1995). "Race, Opportunity, and Diversity of Social Circles in Managerial Networks." *Academy of Management Journal*, 38(3), 673-703.
- Ibarra, H. (1997). "Paving an Alternative Route: Gender Differences in Managerial Networks." *Social Psychology Quarterly*, 60(1), 91-102.
- Ibarra, H. and S. Andrews (1993). "Power, Social Influence, and Sense Making: Effects of Network Centrality and Proximity on Employee Perceptions." *Administrative Science Quarterly*, 38(2), 277-303.
- Kini, R. and S. Basaviah (2013). "Critical Success Factors in the Implementation of ERP Systems in Small and Midsize Businesses." *International Journal of Enterprise Information Systems*, 9(1), 97-117.
- Loscocco, K., S. Monnat, G. Moore, and K. Lauber (2009). "Enterprising Women: A Comparison of Women's and Men's Small Business Networks." *Gender and Society*, 23(3), 388-411.
- Ma'arif, M. and N. Satar. (2018). "ERP Training Mechanism for Upskilling Users and Optimization of ERP System." *Advanced Science Letters*, 24(4), 2908-2912.
- Mason, E. (1995). "Gender Differences in Job Satisfaction." *The Journal of Social Psychology*, 135(2), 143-151.
- McGuire, G. (2002). "Gender, Race, and the Shadow Structure: A Study of Informal Networks and Inequality in a Work Organization." *Gender and Society*, 16(3), 303-322.
- McPherson, M., L. Smith-Lovin, and J. Cook (2001). "Birds of a Feather: Homophily in Social Networks." *Annual Review of Sociology*, 27(1), 415-444.
- Mulac, A., J. Bradac, and P. Gibbons (2001). "Empirical Support for the Gender-As-Culture Hypothesis: An Intercultural Analysis of Male/Female Language Differences." *Human Communication Research*, 27(1), 121-152.
- Ranjan, S., V. Jha, and P. Pal (2016). "Literature Review on ERP Implementation Challenges." *International Journal of Business Information Systems*, 21(3), 388-402.
- Sasidharan, S., R. Santhanam, D. Brass, and V. Sambamurthy (2012). "The Effects of Social Network Structure on Enterprise Systems Success: A Longitudinal Multilevel Analysis." *Information Systems Research*, 23(3), 658-678.

- Sasidharan, S., R. Santhanam, and D. Brass (2017). "Assimilation of Enterprise Information Systems: Knowledge Support from People and Systems." *International Journal of Technology Diffusion*, 8(1), 18-32.
- Shih, Y. (2006). "The Effect of Computer Self-efficacy on Enterprise Resource Planning Usage." *Behaviour & Information Technology*, 25(5), 407-411.
- Sun, Y., A. Bhattacharjee, and Q. Ma (2009). Extending Technology Usage to Work Settings: The Role of Perceived Work Compatibility in ERP Implementation. *Information & Management*, 46(6), 351-356.
- Sykes, T., V. Venkatesh, and S. Gosain (2009). "Model of Acceptance with Peer Support: A Social Network Perspective to Understand Individual-level System Use." *MIS Quarterly*, 33(2), 371-393.
- Sykes, T., V. Venkatesh, and J. Johnson (2014). "Enterprise System Implementation and Employee Job Performance: Understanding the Role of Advice Networks." *MIS Quarterly*, 38(1), 51-72.
- Tannen, D. (1990). *You Just Don't Understand: Men and Women in Conversation*, New York: Morrow.
- Tarhini, A., H. Ammar, and T. Tarhini (2015). "Analysis of the Critical Success Factors for Enterprise Resource Planning Implementation from Stakeholders' Perspective: A Systematic Review." *International Business Research*, 8(4), 25-40.