

The Effect of Toolkits Usage on Firms' Co-Creation and Innovation: An Empirical Study on Malaysian Manufacturing Firms

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ABSTRACT – Organizations aim to create products that accomplish customer needs. Fulfilling customer needs through customer involvement in the product innovation process via toolkits usage has seen favorable outcomes for firms. Consequently, the intention of this study is to analyze the impact of toolkits usage on co-creation and innovation, respectively. To achieve the research objectives, we propose a model that develops based on literature to examine the relationship among toolkits usage and co-creation, as well as innovation. The model was examined utilizing survey data from the manufacturing organizations. This study includes a survey of 393 manufacturing firms in Malaysia. The survey questionnaire was distributed personally and online (google link), respectively. Results confirm the effective use of toolkits on co-creation and innovation hence reinforcing the importance of openness in co-creation and innovation theory. The results assert important implications for practitioners wanting to reap benefits from individualized products through toolkits usage. In sum, manufacturers can garner value from toolkits usage within the context of an emerging economy, like Malaysia.

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INTRODUCTION

The tremendous growth of information technology and Web 2.0 based communication systems such as social media have revolutionized opportunities for organizations to interact with customers for ideas. In the same way, this has enhanced firms' innovative and creative capabilities to develop new or improve existing products (Sharma & Sheth, 2004; Palacios-Marqués, Merigó, & Soto-Acosta, 2015; Scuotto, Del Giudice, Della Peruta, & Tarba, 2017; Wikström & Ellonen, 2012). To sustain and succeed in a competitive business environment, organizations are induced to produce products according to consumer needs (Gambardella, Raasch, & von Hippel, 2017). Therefore, many firms in various industries are trying to understand user needs by engaging customers in product co-creation and innovation processes. Engaging users or consumers in the product innovation process is progressively seen as a significant technique of the manufacturers to produce products that consumers want (Fernandes & Remelhe, 2016; Ye & Kankanhalli, 2018). Prior study has demonstrated that customers can produce several benefits, such as commercially attractive ideas, knowledge, and novel product competitively low cost (Shah, Winston Smith, & Reedy, 2012). Therefore, many manufacturing companies are developing social media platforms to engage customers or users in the innovation process (Ebner, Leimeister, & Krcmar, 2009). One popular form of customer engagement for product co-creation and innovation is *toolkits usage* for innovation (von Hippel, 2001), or customer *co-design* (Dahan & Hauser, 2002; Piller, Schubert, Koch, & Möslin, 2005).

Toolkits usage first emerged in the 1980s for designing and manufacturing customized integrated circuits (IC), which was a huge success. As a result, many firms started offering toolkits usage that allows customers to design their products. For instance, Nike has a system where customers can tailor their sneakers, and Dell offers an online selection process where users can configure their personal computers. The phenomenon underlying toolkits usage is it allows consumers to take part in the product innovation procedure which used to be strictly within the domain of organizations (von Hippel, 2001; Schreier, 2004; Franke & Piller, 2004).

Although several studies (Dahan & Hauser, 2002; Piller et al., 2005; Schreier, 2004) pointed out the significant advantages of the toolkit usage process, its' limitations have been advocated by other authors as well (Zipkin, 2001). Authors argue that customers might get limited value from the product that they developed by toolkits usage, as the cost for actively developing or co-creating products might exceed the benefits they are receiving. However, there have been several significant successful toolkits usage applications.

Although there are challenges, however studying toolkits usage is pertinent for emerging economies like Malaysia. Toolkits usage research in Malaysia has been centered mostly around user acceptance, user satisfaction, compatibility with other devices, and toolkits' impact on purchase intent (Adeyemi, Razak, Salleh, & Venter, 2016; Gharghan, Nordin, & Ismail, 2014; Lakulu, Abdullah, & Zidan, 2017; Loh & Then, 2015; Mansor & Ramdzan, 2014; Oon & Khalid, 2001; Ruzegea, 2011; Shaluf & Ahamadun, 2006). However, only one study examined the outcome of customers' customization

using a toolkit (Khalid & Helander, 2001). Hence, to the finest knowledge of the researchers, this research is the first in Malaysia to investigate the influence of toolkits usage for product co-creation and innovation, respectively.

Based on the above-indicated gap in the understanding of toolkits usage for co-creation and innovation, the intention of this study is to examine the effects of toolkits usage on co-creation and innovation. Consequently, in this research, we established a theoretical model to respond the following research questions: how toolkits usage affects co-creation and innovation in Malaysian manufacturing organizations? The following section covers a literature review followed by methodology and results. Discussion and conclusion are the final sections of this paper.

LITERATURE REVIEW

Toolkits Usage

Toolkits usage is a user engagement platform where users are permitted to take part in the product innovation process (Franke & Von Hippel, 2003; Lusch & Nambisan, 2015; Hein, Weking, Schreieck, Wiesche, Böhm, & Krcmar, 2019b). According to Kankanhalli, Ye, and Teo (2015) toolkits usage system is a single construct and significantly impact on innovation intention. Thus, manufacturers need to invest in tools where they can assist consumers participate in innovation activities that may give highly precise and valuable knowledge of future demand (von Hippel, 2005). Prior research suggested toolkits as a useful technique to assign need-related design tasks to consumers such that they may create a custom product according to their specific needs (Ghazawneh & Henfridsson, 2013).

Toolkits usage assist to develop, accelerate, and visualize each innovative route, carried out by designers as well as in multidisciplinary groups in any kind of organization (Tschimmel, 2012). It allows the innovator user to search for existing innovations and trends in the market to enhance their own ideas and to experiment with them (Kankanhalli et al., 2015). Thus, exploration support through toolkits usage platform should help to fulfil the need-related knowledge requirement for innovation. Such support should be particularly important during idea generation when need-related knowledge is usually collected for deciding what innovation should be created (Ye & Kankanhalli, 2018).

Literature has shown that market research, ethnography, and other types of conventional market research techniques have been used to explore user needs (Helminen & Ainoa, 2009). These methods are meant to transfer user need-related knowledge to manufacturers, however not all information from the user gets transferred. Because of the multifaceted nature of user needs and user atmosphere, some information is difficult to transfer. For example, it is impossible to fully transfer detailed, and subtle interactions to specifications (von Hippel, 2001). von Hippel called this information “sticky” and “costly-to-transfer” (p. 248). Consequently, manufacturers were frustrated by their inability to comprehend users' needs precisely and in detail. As a result, to fully comprehend need-related information of users, they were given toolkits usage for innovation (Ghazawneh & Henfridsson, 2013). Thus, giving customers a toolkit to design products relieved manufacturers from the daunting task of fully understanding user needs.

Researchers stipulate empirical evidence of favorable outcomes like decreased R&D cost, increased revenue, and improved innovation with the use of toolkits usage in helping design and manufacture products (Sun, 2012; Ogawa, Piller, 2006; Piller, Moeslein, & Stotko, 2005; Piller & Walcher, 2006). Toolkits usages provide discovering information regarding available innovation, consumer expectations, and market movements to develop innovation ideas (Franke, Keinz, & Schreier, 2008). However, toolkits usage is not a panacea. Customers may be unable to use the toolkits at the onset. Therefore, manufacturers must be aware of offering users the correct information for the added benefits. Moreover, toolkits usage platforms should be user-friendly so that customers can use it immediately without having to spend time learning its functionality and it should be in language familiar to users.

Although there are challenges in implementing toolkits usage platform for transferring need-related information, the benefits outweigh the costs. Firms have reported increased brand loyalty, enhanced new product development, the increased price per product, and the potential to obtain needs-related information from toolkits usage (Stelloo, 2011).

In the Malaysian context, there have been several studies examining toolkits usage. However, none of these studies investigated product design toolkits usage by customers and its influence on co-creation and innovation, respectively. Therefore, this research intends to fulfil the void in the Malaysian setting involving manufacturers. Nevertheless, only one study showed the reaction of customers after using toolkits for customization. In a study that tested the influence of cultural background on the usage and satisfaction of an Internet configuration tool, Khalid and Helander (2001) found Malaysian users showed more enthusiasm for idea customization compared to their Hong Kong counterparts. Another study has investigated the influence of website design and usability of online configurators, and the result found that users were more willing to purchase products from the website with the most navigation flexibility (Oon & Khalid, 2001). Other studies examined the compatibility of a medical toolkit with other devices and its connectivity in remote locations (Loh & Then, 2015). User feedback on a knowledge management toolkit (Lakulu et al., 2017), various methodologies for monitoring bicycle performance (Gharghan et al., 2014), user acceptance of an emergency expert toolkit (Shaluf & Ahamadun, 2006), and communication patterns of online users (Adeyemi et al., 2016). Two studies investigated library toolkits usage where one examined users' awareness, and understanding (Mansor & Ramdzan, 2014), while the other explored its usability and effectiveness (Ruzegea, 2011).

According to the above literature, we can summarize that toolkits usage is a social media platform tools that facilitate exploration of effort for product innovation and co-creation.

HYPOTHESIS DEVELOPMENT

Innovation

Innovation is a driving force for competitive advantage especially in this day and age when many economies like China accelerate manufacturing innovation that creates tremendous competition (Naqshbandi & Kaur, 2011; Chatzoglou & Chatzoudes, 2018). Due to stiff competition spurred by a shorter product life cycle, firms are faced with the reality that tapping external knowledge and skills can speed up its innovation. Hence building innovation of the enterprise has created a paradigm shift from Schumpeter's (Piller, Ihl, & Vossen, 2010), the notion of the individual entrepreneur bringing his/her innovation to the market. Therefore, stiff competition has compelled firms to collaborate in innovation (Singh, Jayasingam, & Klobas, 2016), and this transition reflects an open concept of innovation, as articulated and extensively researched by (Chesbrough, 2003a). Open innovation thrives on the idea that external parties such as customers or users are sources of knowledge to firms and researchers have found positive outcomes with the performance (Singh et al., 2016; Walsh, Lee, & Nagoaka, 2016; Wang, Chang, & Shen, 2015).

In this research, innovation is regarded as the competence of a firm in developing new products or improving existing products. Building innovation involves a lot of ambiguity in the form of "technical, production, needs and market uncertainties" (Piller et al., 2010). Thus, different types of information are accessed and transferred to reduce uncertainties. For example, accessing need-related information from users reduces uncertainty hence increases innovation effectiveness. This access includes an intensive comprehension and appreciation about users' prerequisites, activities, and procedures, which are usually transferred from users to manufacturers using market research techniques (Piller et al., 2010).

An active participation of users in the design or development of products using tools created by the manufacturer is an alternative approach to the conventional market research technique. Users are empowered to take part in the innovation procedure by using toolkits. Based on this and the preceding section, toolkits usage is known as a form of market research technique that can contribute to the innovation processes of a firm. Hence against this backdrop, we hypothesize that:

H1. Toolkits Usage has significant and positive impact on Innovation.

Co-creation

Consumers or users are no more passive recipients of products or services (Ramaswamy, 2008; Grabher & Ibert, 2018). Due to the Information Technology, and the Internet of Things, customers or users are currently well associated, informed, interacted, and empowered like never in the past. Customers or users have learned how to use these tools to be heard and seen by firms and be engaged in the product development or design procedures of the product. Subsequently, firms are taking advantage by getting customers or users actively participating in the firm's innovation procedure (Cui & Wu, 2016).

Actively involving users in designing or developing products is a type of co-creation, which is characterized as the users' vigorous involvement in product development and design of a new offering (Piller, Vossen, & Ihl, 2012; Yadav, Kamboj, & Rahman, 2016). Co-creation is facilitated by the manufacturer when users or customers interact with the manufacturer. Customer-centric management is applied in co-creation with the purpose of leveraging customer or user information and capabilities for the innovation process. Co-creation has the benefit of gaining knowledge about the customer's or user's product needs, applications, and solution technologies (Piller et al., 2010). There are many methods of co-creation and toolkits usage is one of them (Thomke & von Hippel, 2002).

Piller et al. (2010) proposed three characteristics that entail co-creation. First, the innovation process stage depicts the time when the new product development phase receives input from the co-creation activities. Customer or user input can be in the form of idea creation and concept enhancement. Second, the degree of collaboration is a reflection of the underlying relationship structure within an open environment scenario. Collaboration can be dyadic, which is the interaction between the organizations and one consumer or user simultaneously or collaboration between a network of customers or users only (without the firm). Third, the nature of tasks allocated to customers or users depicts degrees of freedom. A few degrees of freedom means the task is narrow and predefined while many degrees of freedom describe an unrestricted and creative task in which case a solution is barely conceivable. Thus, engaging customers or users in the product development or design procedure via toolkits usage fits in well with co-creation, which is the definition adopted in this study. Therefore, we hypothesize that:

H2. Toolkits Usage has significant and positive impact on Co-creation.

Research Framework

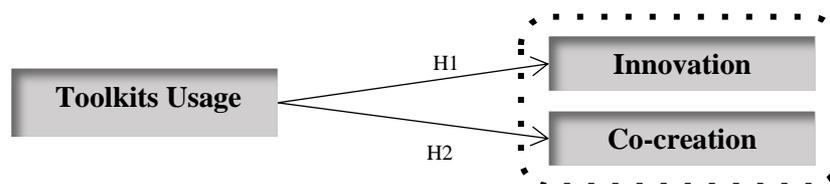


Figure 1. Research framework.

METHODOLOGY

Sample

The survey data for this research were accumulated over a period of seven months, from Malaysian manufacturing companies. Manufacturing companies were selected because of their huge contribution to Malaysia's economy and the prevalence and implementation of co-creation and innovation were projected to be stronger in the manufacturing industry (van de Vrande, De Jong, Vanhaverbeke, & De Rochemont, 2009). The population of this research included employees (at least manager, managing team, and owners) who were mostly engaged in the product operations, product development procedures, and R&D department. The unit of analysis was the manufacturing firms. Each respondent represented one manufacturing firm.

The sampling framework was selected from the Federation of Malaysian Manufacturers (FMM) Directory, 2016. A total of 2,400 manufacturing and export companies' comprehensive profiles were listed in this directory. Based on this, the manufacturing firms were shortlisted randomly. After a preliminary investigation, appointments were made over the phone for questionnaire distribution and justification was given wherever required.

In total, 536 manufacturing companies had shown their interest to answer the questionnaires. Questionnaires were distributed by email (Google link), WhatsApp (Google link) and personally (face-to-face) to the selected companies. However, an aggregate of 405 questionnaires were received from various companies. According to (Hair, Black, Babin, & Anderson, 2010), the questionnaires that have more than 10 percent missing values should be removed from the data analysis, hence 12 incomplete questionnaires were discarded. In total there were 393 acceptable questionnaires, from 393 manufacturing organizations, were deemed "clean" and utilized for the data analysis. The response rate is 68.23%.

Measures

The measurement of toolkits usage was adapted from Franke et al. (2008), which is the incorporation of customer suggestions into the self-design procedure. A 5-point Likert scale (1 = strongly disagree; 5 = strongly agree, where a rating of 3 = neutral) was applied. The measures for innovation and co-creation also used the same 5-point Likert scale. Respondents were required to show the degree to which they concurred toolkits usage help receive suggestions about product design improvements; invite customers to recommend product design improvements; stimulate discussion with customers and encourage group identity.

Innovation was measured by utilizing a 5-item measurement scale which was established by Grawe, Chen, and Daugherty (2009). Respondents were requested to show their concurrence with statements in regard to the innovation procedure in their company that delineates the way toward improving current products or developing new products. Respondents were required to answer according to the degree to which they agreed that their organizations readily accept new ideas for products; gains support from top management on product innovation; constantly seek new ways to improve products; and can develop new products.

The co-creation measure was adapted from Ng, Nudurupati, and Tasker (2010). Respondents were approached to show their concurrence with statements regarding co-creation. Co-creation involves the interaction among the firm and customers. Respondents were required to specify the degree to which they agreed that interaction with customers complements their existing skills and roles; that interaction allows customers to access resources, information, and technology and that interaction help customers find solutions to problems in products.

Pilot Test

A total of 50 top managers were selected from the manufacturing firms for the pilot study, which was conducted before the actual data collection. No amendments were made, as the respondents did not address any problems in responding to the questionnaire and they fully understood the questionnaire. The reliability test was carried out on the pilot study data, and Cronbach's alpha value for all variables were greater than 0.8 that is above the recommended threshold 0.7 (Hair et al., 2010; Nunnally & Berstein, 1994; Goforth, 2015).

Data analysis was conducted by utilizing Statistical Package for Social Sciences (SPSS®) windows version 21.0 and Analysis of Moment Structures (AMOS), version 21.0. The types of data analysis techniques used have been described in the following results section.

RESULT

Respondents Profile

Table 1 illustrates the demographic summary of the respondents. The majority of the 393 respondents (225 or 64.90%) were female, (147 or 37.40%) were Malay. Based on the age category most of the respondents, 201 (51.1%) were in the age category of 31- 40 years old, had a bachelor's degree (268 or 68.20%) qualification. Finally, most of the respondents were holding a managerial level position (182 or 46.30%).

Table 1. Respondents' profile

Variables	Frequency	Percentage (%)	Cumulative
Gender			
Male	138	35.1%	35.1
Female	255	64.9%	100

Ethnicity			
Malay	147	37.4	37.4
Chinese	128	32.6	70.0
Indian	100	25.4	95.4
Others	18	4.6	100
Age			
Under 30 Years	1	.3%	.3
31 – 40 Years	201	51.1%	51.4
41 – 50 Years	170	43.3%	94.7
Above 50 Years	21	5.3%	100
Education			
Secondary School	4	1.0%	1.0
Diploma	67	17.0%	18.1
Bachelor's Degree	268	68.2%	86.3
Postgraduate Degree	45	11.5%	97.7
Others	9	2.3%	100
Position			
Senior Executive	5	1.3%	1.3
Manager	182	46.3%	47.6
Senior Manager	152	38.7%	86.3
Director / Owner	54	13.7%	100

Normality

The result in Table 2 demonstrates that the skewness and kurtosis values for all variables are within the range (± 2 to ± 3 and Multivariate $c.r = 4.43 < 8.00$), thus data distribution for the sample is deemed normal (Hair, William, Barry, & Rolph, 2014; Pallant, 2016; Sekaran & Bougie, 2016).

Table 2. Assessment of Normality

Variables	Min	Max	Skewness	C.R	Kurtosis	C.R
Toolkits Usage	3.00	5.00	-.22	-1.78	-.43	1.72
Innovation	3.00	5.00	-.44	-3.58	.09	.38
Co-creation	3.00	5.00	-.56	-4.51	.22	.90
Multivariate					2.45	4.43

Exploratory Factor Analysis (EFA)

Using exploratory factor analysis (EFA), a total of 28 items were utilized to evaluate toolkits usage, innovation, and co-creation and these items formed three factors. However, three items for toolkits usage and nine items for co-creation were eliminated because of low factor loadings (Hair et al., 2010). The findings of the EFA are explained in Tables 3 and 4 respectively. Table 3 demonstrates the KMO and Bartlett's measure of sampling adequacy. In this study, KMO is 0.872, and Bartlett's Test of Sphericity was significant ($\chi^2 = 2207.670, p < 0.01$). Table 4 demonstrates that the three components achieved simultaneously described 55.63% of the variance with an eigenvalue of higher than 1.

Table 3. Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.872
Bartlett's Test of Sphericity	Approx. Chi-Square	2207.67
	df	120
	Sig.	0.000

Table 4. Exploratory factor analysis

	Component		
	1	2	3
TOOL3	.734		
TOOL4	.643		
TOOL5	.751		
TOOL6	.747		
TOOL7	.647		
TOOL9	.624		
INNO1		.764	
INNO2		.767	
INNO3		.855	
INNO4		.685	
INNO5		.654	
CC2			.641
CC5			.742

CC7			.773
CC11			.603
CC14			.651
Eigenvalue	5.364	2.097	1.441
Variance Explained	33.704	13.515	8.837

Extraction Method: Principal Component Analysis

Confirmatory Factor Analysis (CFA)

The primary model fit index for toolkits usage, innovation, and co-creation among all 28 items showed that the model does not fit (CMIN/DF = 4.66; CFI = .755, which is lesser than .900; GFI = .757, which is lesser than .900; RMSEA = .090 which is more than .080). However, a re-specified measurement model, as demonstrated in Figure 2 indicates the model fit index for toolkits usage, innovation, and co-creation. All 16 items indicated acceptable fit as the CMIN/DF value changed to 2.420 and significant (which is lesser than 5.0; $p < 0.01$). The CFI and GFI values improved (CFI = .932 and GFI = .930), while RMSEA reduced to .060.

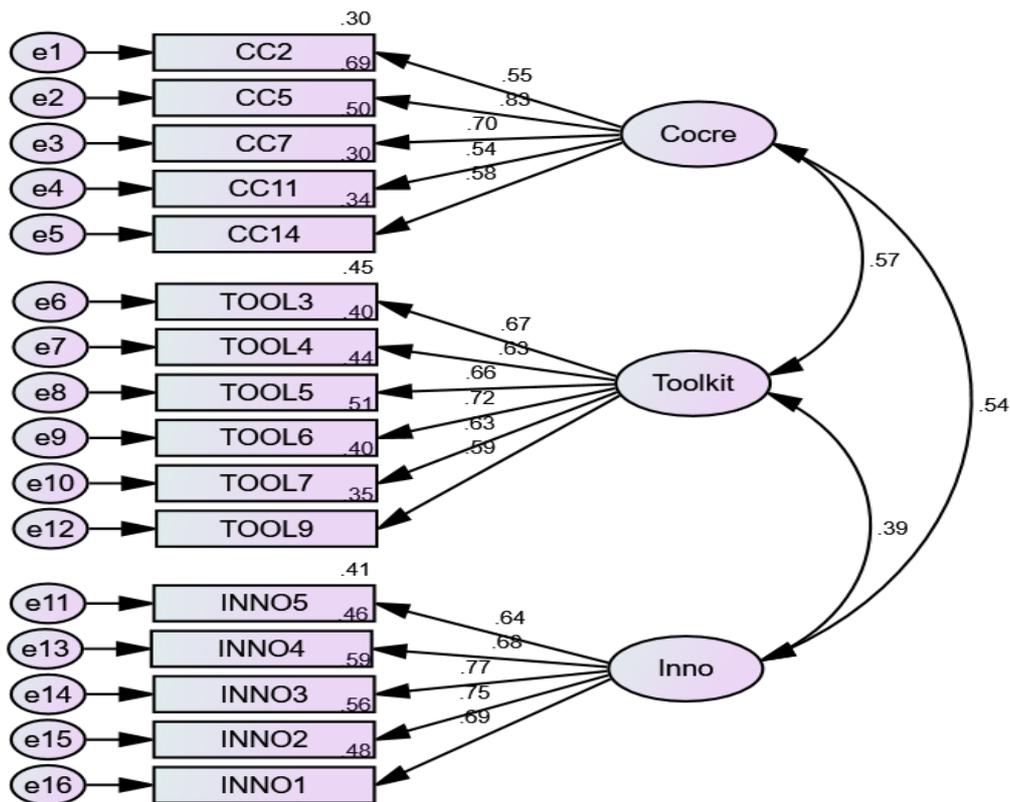


Figure 2. Confirmatory factor analysis

Reliability

Reliability analysis was conducted to evaluate the items' internal degree of consistency and reliability in which case, Cronbach's alpha test was calculated for all of the items of toolkits usage, innovation, and co-creation. The reliability in Table 5 shows that the Cronbach's Alpha value of each variable is more than .700.

Table 5. Reliability analysis

Measurements	Number of Items	Alpha
Toolkits Usage	6	.814
Innovation	5	.834
Co-creation	5	.779

Validity

We conducted convergent and discriminant validity tests of the constructs. As a result, shown in Table 6, Composite Reliability (CR) for all variables is higher than .700, and Average Variance Extraction (AVE) is higher than .500, which shows the convergent validity of the variables (Hair et al., 2010). Additionally, the correlation result explained that there is a significant and constructive correlation among each variable. Therefore, the result provides evidence that all the variables have reached convergent and discriminant validity (Hair et al., 2010).

Table 6. Composite validity

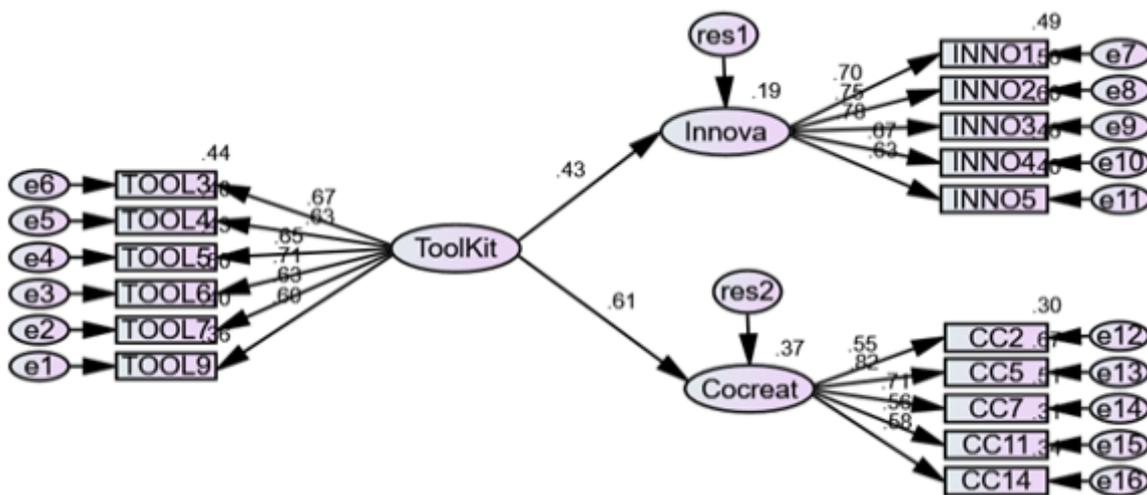
	CR	AVE	MSV	Co-creation	Toolkits Usage	Innovation
Co-creation	0.782	0.524	0.287	1		
Toolkits Usage	0.796	0.639	0.151	.575	1	
Innovation	0.834	0.503	0.287	.536	0.388	1

Common Method Bias

Usually, common method bias occurs when a single factor most of the variance is more than 50%. Established on Harman's single-factor analysis, the findings of EFA showed only 24.14% variance describing a single factor. Accordingly, we can validate that the data is free from common method bias.

Hypotheses Testing (Structural Equation Modeling)

SEM is a multivariate statistical method that was applied to examine structural interactions among the independent and dependent variables and latent constructs (Statistics-Solutions, 2017).

**Figure 3.** Structural Equation Modeling (SEM).**Table 7.** Standardized Regression Weights

Paths	P	Standardized β
Innovation <---> Toolkits Usage	.000	.433
Co-creation <---> Toolkits Usage	.000	.606

The above research model is a combined model that was established according to the hypothesis of this research. In this model toolkits usage is a predictor variable and innovation and co-creation are dependent variables. The outcome of the model fit synopsis in Figure 3 demonstrates the significant value of CMIN/DF (RATIO) of 2.780 ($p < 0.01$); whilst the remaining values supported a model that fitted accurately (CFI = .914; GFI = .921; RMSEA = .06). Consequently, we can determine that the model is fits. Additionally, Table 7 demonstrates that toolkits usage is significantly and positively correlated to innovation ($\beta = .433$, $p < 0.01$) and co-creation ($\beta = .606$, $p < 0.01$), respectively.

DISCUSSION AND CONCLUSION

This research intended to understand and analyze toolkits usage for value gained in the form of innovation and co-creation. Results confirm the effective use of toolkits usage on innovation and co-creation, in line with past researchers (Jeppesen, 2005; Pletikosa & Michahelles, 2011; Prugl & Schreier, 2006; Stelloo, 2011; von Hippel, 2001). These signal the perceived value appropriated by the Malaysian manufacturers who participated in this research.

It is not surprising that toolkits usage has been regarded positively by the manufacturers of this study. Since innovation is a driving force behind many firms' competitiveness, involving customers in product design increases the capability of the firm. The notion of building innovation by collaborating and developing ties with external parties like customers mirrors an innovation strategy that is open (Naqshbandi & Kaur, 2014; Singh, 2016). Besides when manufacturing firms develop products that enhance the value or utility of the product for the customer, the result is an increase in sales. Toolkits usage enable manufacturers to increase their innovation as well as reduce the uncertainty of customers' response to next-generation products (Piller, 2010).

The findings additionally recommend that the manufacturers of this study acknowledge consumers as active recipients of their products and potential contributors to product design (Ramaswamy, 2008; Piller, 2010). When companies involve customers to co-create their products, they are in a position to leverage customers' experiences, knowledge, and

capabilities to develop new or enhance existing offerings. Additionally, companies learn to better understand user needs and solutions (Piller, 2010). This method is a very efficient strategy for market testing and new product development thus substantiating toolkits usage.

Contributions

There are practical and theoretical contributions from this study. First, this study reinforces the co-creation and open innovation theories through the empirical investigation of toolkits usage. Second, the results confirm important implications for practitioners wanting to reap benefits from individualized products through toolkits usage. Third, this study brings to the fore the types of values garnered from toolkits usage. Moreover, this study empirically confirms the usage of the high-value toolkits can garner within the Malaysian context. Furthermore, the potential of raising the price of products can be gained from toolkit-based products, which is an avenue for future research. For example, Kalantari & Johnson (2019) discovered that consumers are usually willing to pay twice or more for self-created product.

This research's results add to the literature of toolkits usage, innovation, and co-creation within an emerging market setting. The fact that innovation is no longer a closed activity permeates the findings of this study. Embracing openness is one of the implicit implications of this study's findings, which is in line with the empirical outcome of another Malaysian study (Singh, et al., 2016). However, there are risks in opening up the innovation process especially within economies that are still strengthening their appropriability regimes. This risk has national implications for strengthening policies, market-supporting institutions, and the legal systems to support innovation building initiatives by firms (Naqshbandi & Kaur, 2014).

Limitation and Future Research

We selected manufacturing firms based on the 2016 Federation of Malaysian Manufacturers (FMM) directory. However, the population frame underlying the study might incorporate components that no more live or no more belong to the target population. Simultaneously, it might not include units that in fact do belong to the target population (Hair, Money, Samouel, & Page, 2007). Additionally, the findings from this study cannot be generalized as a non-probability sampling method was employed. However, there is a chance for future researchers. One impending investigation is to discover other value appropriation variables such as higher prices and innovation costs. It would be interesting to understand and validate empirically if higher prices and lower innovation costs can be reaped from toolkits usage. An Additional opportunity for future study is to test the extent of knowledge spill overs in toolkits usage and the operational mechanics used by firms at the firm and national policy levels to safeguard firms' internal competencies. Finally, co-creation could be tested in the future as an intervening variable between toolkits usage and innovation.

REFERENCES

- Adeyemi, I. R., Razak, S. A., Salleh, M., & Venter, H. S. (2016). Observing consistency in online communication patterns for user re-identification. *PLoS One*, *11*(12), 1-27. doi:10.1371/journal.
- Chatzoglou, P., & Chatzoudes, D. (2018). The role of innovation in building competitive advantages: an empirical investigation. *European Journal of Innovation Management*, *21*(1), 44-69.
- Chesbrough, H. W. (2003a). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.
- Cui, A. S., & Wu, F. (2016). Utilizing customer knowledge in innovation: antecedents and impact of customer involvement on new product performance. *Journal of the academy of marketing science*, *44*(4), 516-538.
- Dahan, E., & Hauser, J. R. (2002). The virtual customer. *Journal of Product Innovation Management*, *19*(5), 332-353.
- Ebner, W., Leimeister, J. M., & Krcmar, H. (2009). Community engineering for innovations: the ideas competition as a method to nurture a virtual community for innovations. *R&d Management*, *39*(4), 342-356.
- Fernandes, T., & Remelhe, P. (2016). How to engage customers in co-creation: customers' motivations for collaborative innovation. *Journal of Strategic Marketing*, *24*(3-4), 311-326.
- Franke, N., & Piller, F. (2004). Value creation by toolkits for user innovation and design: The case of the watch market. *Journal of Product Innovation Management*, *21*(6), 401-415.
- Franke, N., & Von Hippel, E. (2003). Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software. *Research policy*, *32*(7), 1199-1215.
- Franke, N., Keinz, P., & Schreier, M. (2008). Complementing mass customization toolkits with user communities: How peer input improves customer self-design. *Journal of Product Innovation Management*, *25*(6), 546-559.
- Gambardella, A., Raasch, C., & von Hippel, E. (2017). The user innovation paradigm: impacts on markets and welfare. *Management Science*, *63*(5), 1450-1468.
- Gharghan, S. K., Nordin, R., & Ismail, M. (2014). A survey on energy efficient wireless sensor networks for bicycle performance monitoring application. *Journal of Sensors*, *2014*, 1-16.
- Ghazawneh, A., & Henfridsson, O. (2013). Balancing platform control and external contribution in third-party development: The boundary resources model. *Information Systems Journal*, *23*(2), 173-192.
- Goforth, C. (2015). *Using and Interpreting Cronbach's Alpha*. Retrieved from <http://data.library.virginia.edu/using-and-interpreting-cronbachs-alpha/>.
- Grabher, G., & Ibert, O. (2018). Co-creation of Value: Open Firms and Active Customers. *The New Oxford Handbook of Economic Geography*, 286.
- Grawe, S. J., Chen, H., & Daugherty, P. J. (2009). The relationship between strategic orientation, service innovation, and performance. *International Journal of Physical Distribution & Logistics Management*, *39*(4), 282-300.
- Hair Jr., J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis*. New Jersey, NJ: Prentice Hall.
- Hair Jr., J. F., Money, A. H., Samouel, P., & Page, M. (2007). *Research methods for business*. West Sussex: John Wiley & Sons, Ltd.

- Hair, J. F., William, C. B., Barry, J. B., & Rolph, E. A. (2014). *Multivariate Data Analysis*. Englewood Cliffs, NJ: Prentice Hall.
- Hein, A., Weking, J., Schrieck, M., Wiesche, M., Böhm, M., & Kremer, H. (2019b). Value Co-Creation Practices in Business-to-Business Platform Ecosystems. *Electronic Markets*, 29(3), 503–518.
- Helminen, P., & Ainoa, J. (2009). User innovation toolkits in product development: Qualitative study in shopping center design. *International Conference on Engineering Design, ICED'09*. Stanford University, Stanford, CA USA, 265-274.
- Jeppesen, L. B. (2005). User toolkits for innovation: Consumers support each other. *Journal of Product Innovation Management*, 22(4), 347-362.
- Kalantari, H. D., & Johnson, L. W. (2019). Willingness to pay and wait for mass customised products. *International Journal of Mass Customisation*, 5(2), 111-129.
- Kankanhalli, A., Ye, H. J., and Teo, H. H. 2015. Comparing Potential and Actual Innovators: An Empirical Study of Mobile Data Services Innovation, *MIS Quarterly* 39(3), 667-682.
- Khalid, H.M., & Helander, M.G. (2001). Facilitating Mass Customization and Web-based Do-It-Yourself Product Design, in M.M. Tseng & F.T. Piller (Eds.) *Proceedings of the World Congress on Mass Customization and Personalization MCPC 2001, Hong Kong*.
- Lakulu, M. M., Abdullah, R., & Zidan, A. A. (2017). An evaluation of a KMS framework for an open source software development in a collaborative environment. *Science International*, 29(2), 137.
- Loh, B. C. S., & Then, P. H. H. (2015). Mobile imagery eXchange (MIX) toolkit: Data sharing for the unconnected. *Personal and Ubiquitous Computing*, 19, 723-740.
- Lusch, R. F., & Nambisan, S. (2015). Service innovation: A servicedominant logic perspective. *MIS Quarterly*, 39(1), 155–175.
- Mansor, Y. & Ramdzan, E. (2014). RDA perceptions among Malaysian catalogers. *Library Review*, 63(3), 176-188.
- Naqshbandi, M. M. & Kaur, S. (2014). Do managerial ties support or stifle open innovation? *Industrial Management & Data Systems*, 114(4), 652-675.
- Naqshbandi, M.M. & Kaur, S. (2011). Factors affecting open innovation: Evidence from Malaysia. *Australian Journal of Basic and Applied Science*, 5(12), 2783-2795.
- Ng, I. C., Nudurupati, S. S., & Tasker, P. (2010). *Value co-creation in the delivery of outcome-based contracts for business-to-business service*. Retrieved from <https://ore.exeter.ac.uk/repository/bitstream/handle/10036/99859/valueB2Bservices.pdf?sequence=1&isAllowed=y>.
- Nunnally, J. C., & Bernstein, I. (1994). *Psychometric theory* (3rd ed.). New York: McGraw-Hill.
- Ogawa, S. & Piller, F.T. (2006). Reducing the Risks of New Product Development. *MIT Sloan Management Review*, 47(2), 65-71.
- Oon, Y. B., & Khalid, H. M. (2001). Usability of Design by Customer Web Sites for Mass Customization. In M.M. Tseng & F.T. Piller (Eds.) *Proceedings of the World Congress on Mass Customization and Personalization MCPC 2001, Hong Kong*.
- Palacios-Marqués, D., Merigó, J. M., & Soto-Acosta, P. (2015). Online social networks as an enabler of innovation in organizations. *Management Decision*, 53 (9), 1906–1920.
- Pallant, J. (2016). *SPSS Survival Manual: A Step by Step Guide to Data Analysis using SPSS UK*: McGraw-Hill International.
- Piller, F. T., Ihl, C., & Vossen, A. (2010). A typology of customer co-creation in the innovation process. *SSRN Electronic Journal*, December, Retrieved from <https://www.researchgate.net/publication/228197334>.
- Piller, F. T., Vossen, A., & Ihl, C. (2012). From social media to social product development: the impact of social media on co-creation of innovation. *Die Unternehmung*, 65(1).
- Piller, F.T. & Walcher, D. (2006) Toolkits for idea competitions: a novel method to integrate users in new product development. *R&D Management*, 36(3), 307-318.
- Piller, F.T., Moeslein, K. & Stotko, C.M. (2005). Does mass customization pay? An economic approach to evaluate customer integration. *Production Planning & Control*, 15(4), 435-444.
- Piller, F.T., Schubert, P., Koch, M., & Möslin, K. (2005). Overcoming mass confusion: collaborative customer co-design in online communities. *Journal of Computer Mediated Communication*, 10(4).
- Pletikosa, I. & Michahelles, F. (2011). *The toolkit approach for end-user participation in the Internet of Things*. Retrieved from <https://www.researchgate.net/publication/227244683>.
- Prugl, R. & Schreier, M. (2006). Learning from leading-edge customers at The Sims: Opening up the innovation process using toolkits. *R&D Management*, 36(3), 237-250.
- Ramaswamy, V. (2008). Co-creating value through customer's experiences: The Nike case. *Strategy & Leadership*, 36(5), 9-14.
- Ruzegea, M. (2011). The usability of OPAC interface features: The perspective of postgraduate students at International Islamic University Malaysia (IIUM). *Library Philosophy and Practice*, 1.
- Schreier, M. (2004). Toolkits for user innovation and design. In C. Herstatt & J. G. Sander. (Eds.), *Product development with virtual communities* (pp. 199-219). Wiesbaden, Germany: Gabler Verlag Springer.
- Scuotto, V., Del Giudice, M., Della Peruta, M. R., & Tarba, S. (2017). The performance implications of leveraging internal innovation through social media networks: An empirical verification of the smart fashion industry. *Technological Forecasting and Social Change*, 120, 184-194.
- Sekaran, U., & Bougie, R. (2016). *Research Methods for Business: A Skill Building Approach* (7th ed.). Chichester, West Sussex: John Wiley & Sons, Inc.
- Shah, S., Winston Smith, S., & Reedy, E. J. (2012). Who are user entrepreneurs? Findings on innovation, founder characteristics, and firm characteristics (The Kauffman Firm Survey). *Findings on Innovation, Founder Characteristics, and Firm Characteristics (The Kauffman Firm Survey)*(February 2012).
- Shaluf, I. M., & Ahamadun, F-R. (2006). Technological emergencies expert system. *Disaster Prevention and Management*, 15(3), 414-424.
- Sharma, A., & Sheth, J. N. (2004). Web-based marketing: The coming revolution in marketing thought and strategy. *Journal of Business Research*, 57(7), 696-702.
- Singh, S. K. G., Jayasingam, S. & Klobas, J. (2016). Open innovation: Do inbound and outbound practices affect firm performance? *The 30th Australian and New Zealand Academy of Management Conference, ANZAM*, Queensland University of Technology, Brisbane, Australia, 6-9 Dec 2016, 1-23. Retrieved from <http://www.anzam.org/past-event-material/past-conference-papers/>.
- Statistics-Solutions. (2017). *Structural Equation Modelling*. Retrieved from <http://www.statisticssolutions.com/structural-equation-modeling/>.

- Stelloo, J. (2011). *How do companies compose their toolkits for customer co-design? Differences, similarities and relationships*. (Masters thesis, University of Amsterdam, 2011).
- Sun, H. (2012). Understanding user revisions when using information system features: Adaptive system use and triggers. *MIS quarterly*, 453-478.
- Thomke, S. & von Hippel, E. (2002). Customers as innovators: A new way to create value. *Harvard Business Review*, 80(4), 74-81.
- Tschimmel, K. (2012). Design Thinking as an effective Toolkit for Innovation. In *ISPIM Conference Proceedings* (p. 1). The International Society for Professional Innovation Management (ISPIM).
- van de Vrande, V., De Jong, J. P., Vanhaverbeke, W., & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 29(6-7), 423-437.
- von Hippel, E. (2001). User toolkits for innovation. *Journal of Product Innovation Management*, 18(4), 247-257.
- von Hippel, E. 2005. *Democratizing Innovation*, Cambridge, MA: MIT Press.
- Walsh, J. P., Lee, Y-N., & Nagoaka, S. (2016). Openness and innovation in the US: Collaboration form, idea generation and implementation. *Research Policy*, 45, 1660-1671.
- Wang, C-H., Chang, C-H., & Shen, G. C. (2015). The effect of inbound open innovation on firm performance: Evidence from high-tech industry. *Technological Forecasting & Social Change*, 9, 222-230.
- Wikström, P., & Ellonen, H. K. (2012). The impact of social media features on print media firms' online business models. *Journal of Media Business Studies*, 9(3), 63-80.
- Yadav, M., Kamboj, S., & Rahman, Z. (2016). Customer co-creation through social media: The case of 'Crash the Pepsi IPL 2015'. *Journal of Direct, Data and Digital Marketing Practice*, 17(4), 259-271.
- Ye, H., & Kankanhalli, A. (2018). User Service Innovation on Mobile Phone Platforms: Investigating Impacts of Lead Userness, Toolkit Support, and Design Autonomy. *MIS quarterly*, 42(1).
- Zipkin, P. (2001). The limits of mass customization. *Sloan Management Review*, 42(3), 81-87.

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