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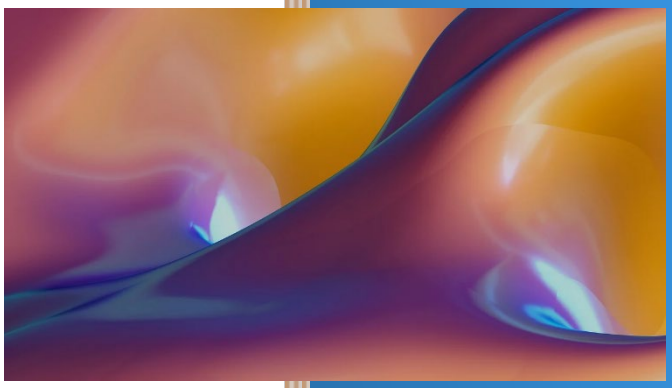

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Contents

Revealing a Non-Linear Relationship Between Knowledge Assets and Firm's Value

Kyriakos Christofi, Pieris Chourides and George Papageorgiou
SYSTEMA Research Centre, School of Business Administration, European University Cyprus, Nicosia, Cyprus

Ky.christofi@external.euc.ac.cy
P.chourides@euc.ac.cy
G.Papageorgiou@euc.ac.cy

Abstract: This paper investigates the effects of knowledge assets on firm's value. Developing knowledge assets has been gaining momentum in recent years under the lens and scope of knowledge management. However, there is an ongoing debate regarding the optimum level and combination of knowledge assets that would lead to firm's value maximization. The aim of this paper is to provide a resolution to this debate by investigating how knowledge assets affect firm's value and competitiveness in a real market context. By means of accounting indicators data, an examination is carried out on the identifiable knowledge assets derived from company annual reports. Consequently, the impact on firm's value over time is explored via multiple regression analysis using panel data. As a result, the optimal structure/balance between internal and external knowledge assets that lead to maximum market value is explored. The main findings show that knowledge assets generate greater firm value when they are coupled with complimentary assets. Additionally, externally acquired knowledge is equally important as knowledge which has been developed from internal research and development efforts. As a result, it is shown that an optimal balance between internal and external knowledge assets leads to greater firm value. Note that while similar studies tend to explore the impact of knowledge assets on various aspects, such as international and innovation performance, little has been done to investigate the impact of knowledge on the overall value of the firm. The presented study is not limited to product development, but it takes into consideration the capitalization of those products in the real market context. Thereby, managerial implications are explored, and suggestions are given on specific structures of knowledge assets that maximize organizational value.

Keywords: Knowledge management, Strategic management, Knowledge assets, Knowledge acquisition, Firm value

1. Introduction

In today's turbulent and highly competitive business environment knowledge assets are becoming a crucial component for developing unique strengths for almost any organization. As suggested by (Munjal, et al., 2022; Denicolai, Ramusino and Sotti 2015) such intangible assets can provide a business the capacity for creating a sustainable competitive advantage. Intangible assets are defined by the International Accounting Standards (IAS, p.38) as "*scientific or technical knowledge, design and implementation of new processes or systems, licences, intellectual property, market knowledge and trademarks*". This definition captures the whole spectrum of assets related to a firm's knowledge. Note that several scholars in the field (Zhang, et al., 2021; Doytch, 2021; Martinez, Zouaghi and Garcia 2017; Denicolai, Zucchella and Strange, 2014) distinguish between the knowledge assets and the totality of intangibles, referring to the subcategories of copyrights, licences, patents, development cost, self-generated software and design models. Taking such an approach, scholars are able to capture the value of assets that directly contribute to product advancement and breakthrough innovations (Denicolai, Ramirez and Tidd 2014).

In recent years, there is a growing interest on the investigation of firms' knowledge assets with respect to many areas of competitiveness. For instance, Denicolai, Ramusino, and Sotti (2015), highlight that organizations, which invest to the development and the acquisition of knowledge assets exhibit greater performance and potential for growth. Denicolai, Zucchella and Strange (2014) as well as Munjal, et al., (2022), argue that knowledge assets act as a catalyst to a firm's international expansion. Similarly, Zhang, et al., (2021), found that knowledge assets support the speeding up of a corporation's internationalization. Additionally, Uddin, Hasan and Abadi (2022), report that corporations which invest on intangible assets show resilience in periods of exogenous shocks.

Further, an important suggestion coming from the aforementioned studies is that knowledge assets should also be combined with complimentary tangible and intangible assets in order to get to the maximum levels of performance. Denicolai, Zucchella and Strange (2014) for example, suggests that a combination ratio of around eighteen per cent of knowledge assets relative to other assets would lead to a maximum level of international

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performance. Similarly, Denicolai, Ramusino, and Sotti (2015), argue that knowledge assets should be combined with complementary assets to maximize firm's growth.

Despite the progress on somewhat revealing the role of knowledge assets, little has been done on how knowledge assets impact the company's overall market value, which is the ultimate indicator of success. Although studies have been focusing on investigating the contribution of knowledge intangibles to revenue growth, (Denicolai, Ramirez and Tidd 2014; Denicolai, Ramusino, and Sotti 2015), to profitability (Hsu & Cohen, 2019), to internationalization (Denicolai, Zucchella and Strange 2014; Munjal, et al., 2022), and to firm's performance (Zhang, et al., 2021), the direct influence of knowledge assets on the overall firms' value remains unknown.

To fill-in the gap in the literature this paper investigates the direct impact of knowledge intangibles on the company's overall value. We therefore seek to reveal the role and the optimal structure/combination of knowledge assets with other intangible assets that would bring companies to the maximum possible level of their market value. Our study thereby contributes to the field of knowledge management in relation to assets capitalization.

The next section provides the theoretical foundation for developing a series of hypotheses. This is followed by a description of the main research methods employed and the results section presenting the multiple regression analysis model with the main findings. Further on a discussion on managerial implications is conducted based on the findings, emphasizing the need for an optimal balance in the structure of knowledge assets. Finally, conclusions are drawn and recommendations are provided for maximizing firm value.

2. Literature Review

2.1 Knowledge Assets and Firms' Value

In today's high velocity business environment, where changes are occurring on a daily basis in multiple directions, intangible assets are considered by scholars as a catalyst to improve firm's productivity, efficiency and value creation, (Uddin, Hasan, and Abadi 2022; Hasan and Uddin, 2022; Eisfeldt and Papanikolaou, 2013; Denicolai, Ramirez and Tidd 2014). According to the knowledge-based view of the firm, sustainable competitive advantage relies on a firm's ability to generate, accumulate, apply and therefore effectively capitalize knowledge, (Grant, 1996). Thus, organizations should attempt to internally develop and externally acquire knowledge assets in an effort to constantly renew their knowledge portfolio. In this way firms could align with the highly competitive landscape (Zhang, et al. 2021; Uddin, Hasan, and Abadi 2022; Christofi, et al. 2021). The question that remains unanswered though is: what is the actual impact of intangible assets on the firm's value?

International accounting standards (IAS, p.38) define intangible assets as technical or scientific knowledge which is recognized only if it is identifiable from its goodwill and has the ability to generate future economic benefits. Therefore, intangible assets are associated with the firm's research and development, as well as with its innovation efforts reflecting the explicit nature of knowledge of a firm. (Yang and Driffield, 2022; Martinez, Zouaghi and Garcia 2017; Doytch, 2021; Hsu and Cohen, 2019; Denicolai, Zucchella and Strange 2014). In recent years, research on intangibles assets has been gaining momentum by revealing the role and effects of knowledge intangibles on various aspects of competitiveness. Specifically, scholars have examined the impact of knowledge intangibles on the internationalization process (Denicolai, Zucchella and Strange 2014; Zhang, et al., 2021; Kotler, et al. 2019), firms' growth (Denicolai, Ramirez and Tidd 2014), and innovation performance (Berchicci, 2013; Denicolai, Ramirez, and Tidd, 2016).

However, little has been done on investigating the direct effect of those intangibles on the firms' overall value. The value of a firm is estimated by the achieved performance on a specific timeframe and its potential for future development (Cho, 2020). Investing in knowledge assets would add to both performance and potential for future development. In today's knowledge economy, organizations through research and development (R&D) efforts and other strategic moves, attempt to create unique knowledge assets, that would allow them to enhance their competitiveness, and as a result to increase their overall value (Belderbos, Park, and Carree, 2021). Knowledge assets refer to technical know-how and other intangible assets. Several studies argue that knowledge assets serve as crucial organizational inputs since they can support the development and leverage of capabilities and competencies towards value generation (Cho, 2020; Asiaei, et al., 2021; Liu, Wu, and Han 2021).

The literature also includes several examples of more specific benefits of knowledge assets. Denicolai, Zucchella and Strange (2014), for instance found that knowledge assets can support corporations towards global expansion and influence international performance. Similarly, Zhang, et al., (2021) observe that knowledge

assets act as moderators between speed of internationalization and performance. Additionally, Denicolai, Ramirez and Tidd (2014) found that knowledge assets help firms to grow and create value over the long-term. Furthermore, Uddin, Hasan, and Abadi (2022), point out that organizations with high-level of knowledge assets show more resilience in economic-wide exogenous shocks, such as the COVID-19 pandemic.

An important element of the above studies is that knowledge assets would be more impactful when they are coupled with other complementary intangibles and tangible assets. For example, Denicolai, Zucchella and Strange, (2014) found that firms perform better in international markets, when they manage to balance their knowledge assets with complementary assets. In some cases, firms that rely exclusively on knowledge without properly structuring their assets portfolio, exhibit worse performance in foreign markets, as compared to those who balance their assets portfolio. Cuervo-Cazurra, Maloney, and Manrakhan, (2007) also stress out the role of complementary assets in internationalization. It was shown that the lack in complementary assets may limit the effectiveness in international markets. Organizational benefits that result from the proper balance of assets are not limited to internationalization. Cho (2020) argues that in order to create a sustainable competitive advantage and long-term value both intangible and tangible resources are important. As it is further explained tangible assets may result in efficiencies through economies of scale, whilst intangible and knowledge assets act as a catalyst for new product development, and the cultivation of an innovative culture.

Based on the above discussion we assume that there is an inverse quadratic relationship between knowledge assets and firm's value. To empirically investigate our assumption the following hypothesis is proposed:

H1 There is an inverse U-shape relationship between firm's knowledge assets and firm's value.

By carrying out hypothesis testing, we aim to explore if there is an optimal balance between knowledge and non-knowledge assets that lead organizations to maximize their overall value.

2.2 Internally Developed Vs Externally Acquired Knowledge Assets

The literature of knowledge management and intangible assets, shows that the choosing the source of knowledge and knowledge intangibles represents a major strategic decision. The main dilemma is whether a company should make or externally acquire its knowledge assets, (Keegan and Green, 2016). According to Ferraris, Santoro, and Dezi (2017), in an era of technological evolution the focus on internal capabilities and research and development activities are no more sufficient in order to create value on the long term. Therefore, organizations should explore opportunities in order to identify and externally obtain know-how and technological assets. In this way they would increase their innovation performance as well as improve their innovative outcomes (Ardito, et al., 2015; Bedford, et al., 2022).

Many scholars suggest a complementary combination of internal research and development investments and activities, with the externally acquired knowledge, where companies can improve their innovation performance and increase their overall competitiveness and value (Sun, Zhang, and Wang, 2022; Zhou and Li, 2012; Denicolai, Ramirez and Tidd (2014). For instance, Zhou and Li (2012) observed that companies that use deep internal knowledge in combination with external knowledge, show more capability in radical innovation development.

There are several benefits that result from the acquisition of external knowledge. First knowledge acquisition help organizations to avoid the familiarity trap by expanding their horizons beyond their existing technologies and capabilities (Almodóvar and Quyen, 2022). Second, external knowledge allows access to new practices of product development, new technologies, while it acts as a catalyst to localize innovation from aboard (Un, 2016; Aiello, et al., 2020). For instance, Lee, Park, and Bae (2017), observe that corporations which were engaged in technology licencing, present greater turnover from product development, as compared with corporations that have not integrated technology licencing into their innovation strategy. Third, knowledge acquisition allows organizations to faster fulfil knowledge gaps (Denicolai, Ramirez and Tidd 2016).

However, in order to capitalize on the benefits received from external knowledge sources, strong internal research and development capabilities are required (Tsai and Wang 2007; Berchicci, 2013; Santoro, Ferraris, and Winteler 2019). Acquisition of external knowledge may include hidden costs, and organizations should be very careful in examining the side effects of a potential takeover (Delgado-Verde, et al., 2021). Therefore, organizations should invest in internal research and development to enhance their internal capabilities and to improve their organizational absorptive capacity. Stronger internal R&D capabilities lead to effective recognition of missing knowledge and result to greater absorption and integration of the acquired knowledge (Berchicci, 2013; Santoro, Ferraris, and Winteler 2019). Denicolai, Zucchella and Strange (2014), suggest that strong internal R&D capabilities allow companies to have a holistic view on how the external knowledge suits the overall

business model. This contributes to the value creation process. Additionally, Tsai and Wang (2007) study the effect of external technology licencing on financial performance. Their findings argue that external technology positively influence financial performance only in the presence of internal R&D efforts.

As a result, we conclude that externally acquired knowledge should be part of a firm's knowledge assets portfolio. Additionally, the externally acquired knowledge assets should be complementary to internal knowledge. This realization points out to the need for an investigation for the optimal balance, between internal and externally acquired knowledge assets. Therefore, expanding on the previous hypothesis for an inverse quadratic relation between external knowledge intangibles and firms value we built the following hypothesis.

H2 There is an inverse U-shape relationship between firm's external knowledge assets intensity and firm's value.

3. Research Methodology and Data Sample

The empirical investigation carried out, relies on a panel data regression analysis model. Gathering of the data was performed with the application of a specific protocol relying on accounting values that serve as proxies for the variables under investigation. This technique was chosen for two main reasons. First, panel data allow us to test the hypotheses in a longitudinal manner, capturing in that way the influence of our explanatory variables across time (Wooldridge, 2010). Second, accounting indicators create more robust measurements than survey methods, capturing the real value of knowledge, away from the threat of respondents' biases (Ketchen, Ireland and Baker 2012; Escribano, Fosfuri and Tribó 2009; Berchicci, 2013).

Data was obtained from the Revinitiv Eikon database (formerly Thompsons Reuters). Focus was placed on the European context, hence data was extracted from all the companies listed at European stock exchanges for the financial years of 2012-2021. European listed companies are drawn since they are required to use International Financial Reporting Standards (IFRSs). This ensures comparability across the dataset. Note that all European listed companies are using the same accounting principles.

After the initial extraction an application of a three criteria protocol is carried out, in order to reach out to the final dataset. First, we concentrated only on corporations which provide explanatory details about their "Intangible Assets" in their annual reports. Specifically, we included only firms that their annual reports state the book value of the following knowledge intangibles: copyrights, design models, self-generated software, know-how, acquired technology, licences, capitalized development cost, product development, and patents. Second focus was placed on the source of those intangibles. We included only corporations that clearly state whether the net book value of a specific knowledge intangible is a result of internally generated efforts or is externally acquired. Third, we have included only the companies that their fiscal year is until the end of December in order to avoid any time lags in our observations. Very similar criteria were applied in similar studies that investigate the effects of knowledge intangible assets (Denicolai, Zucchella and Strange 2014; Denicolai, Ramirez and Tidd 2016; Zhang, et al., 2021).

Table 1: Country and Industry Composition of the Final Sample

Country of exchange	Industry Classification Sector (ICS)					Total
	Healthcare	Industrial	Technology	Telecommunications	Other	
France	1	3	2	0	1	7
Germany	5	21	7	4	6	43
Switzerland	2	3	2	0	1	8
United Kingdom	11	26	16	2	3	58
Other	3	9	6	1	5	24
Total	22	62	33	7	16	140

After the application of the protocol our final dataset resulted in 140 companies that count for a total of 1184 observations. Table 1 indicates the distribution of our dataset with respect to the country of exchange coupled with the Industry Classification Sectors (ICS) classified by Financial Times Stock Exchange (FTSE) Russell's.

3.1 Measurements and Research Model

3.1.1 Dependent variable: Firm value

The depended variable refers to the firm value (VALUE) and we apply the Tobin's q (Chung and Pruitt, 1994) as a proxy to measure it. Tobin's q plays important role to financial interactions, and it is used to capture the market value of a firm over its assets (Lee and Makhija, 2009; Chung and Pruitt, 1994). Furthermore, Tobin's q is a forward-looking market base indicator that captures growth potential and investor expectation and is considered to be a superior proxy to company's value as compared to other accounting-based indicators. This is because it eliminates the threat of manipulations and distortions, which occur in the reporting process (Ahmad and Jusoh, 201; Ben-Horim and Callen , 1989; Hendratama & Huang, 2021; Noh, 2019). Following the common approach in the relevant literature, we apply the operationalization formula of Chung and Pruitt (1994), and Lee and Makhija (2009). Thus, we calculate Tobin's q as the sum of market value of common stock, the book value of preferred stock and debt respectively, divided by company's total assets.

3.1.2 Explanatory variables

As explanatory variables we include the firm's knowledge intensity (KNI) in terms of its assets and the firm's external sourcing intensity ratio (EXT). As mentioned earlier in this paper, our dataset consists of corporations that allow us to identify both their knowledge assets and their source of development. These are based on proxies that were previously used and therefore are acceptable by scientific community of knowledge management (Denicolai, Zucchella and Strange 2014, Denicolai, Ramusino and Sotti 2015, Denicolai, Ramirez and Tidd 2016; Zhang, et al., 2021). We calculate the firm's knowledge intensity as the ratio of the net book value of their knowledge intangibles over the net book value of the total non-current assets as presented on their yearly annual reports. Similarly, we calculate the external sourcing intensity ratio as the net book value of the external acquired knowledge assets over the net book value of the total knowledge assets. To test the existence of an inverse U-shape relationship of both explanatory variables we also include their squared term in our proposed model in order to capture possible interactions.

Further, several control variables are included into our proposed model. Specifically, we include the firm size (SIZE) and research and development intensity (RDI). We are interested to examine if large corporations capitalize their knowledge assets in different degrees of effectiveness as compared to small corporations. We also expect that corporations that invest heavily in the R&D function enjoy greater market value. Finally, we include the economic sector and country of exchange using dummy variables. Table 2 presents the exact operationalization of our valuables which result to the following multiple regression model (omitting the industry and country dummies):

$$\text{Firm Value}_{it} = \alpha + \beta\, KI_{it} + \gamma\, KI^2_{it} + \delta\, EXT_{it} + \varepsilon\, EXT^2_{it} + \eta\, Size_{it} + \theta$$

$$RDI_{it} + e_{it}$$

Table 2: Operationalization of Constructs

Dependent Variable		
Variable	**Operationalization**	**Source/ Adapted From**
Firm Value (Value)	$\dfrac{\text{Market value of } common\ stock + \text{Book value of } Preferred\ stock + \text{Book value of } Debt}{Book\ value\ of\ total\ assets}$	Lee and Makhija, (2009)
Explanatory Variables		
Knowledge Intensity (KNI)	$\dfrac{Net\ Book\ Value\ of\ Knowledge\ Assets}{Net\ Book\ Value\ of\ Non\ current\ Assets}$	(Denicolai, Zucchella and Strange 2014; Denicolai, Ramirez and Tidd 2014; Zhang, et al., 2021)
External Knowledge Sourcing (EXT)	$\dfrac{Net\ Book\ Value\ of\ Externally\ \text{Acquired}\ Knowledge\ Assets}{Net\ Book\ Value\ of\ Knowledge\ Assets}$	Denicolai, Zucchella and Strange 2014; Denicolai, Ramirez and Tidd 2016.
Control Variables		

Size	ln (Turnover)	Denicolai, Ramirez and Tidd, 2016
Research and Development Intensity (RDI)	$\frac{\text{Research and Development Expenses}}{Revenue}$	Denicolai, Ramirez and Tidd 2014; 2016); (Cheng and Shiu, 2020)
Industry dummies	TECH = 1 if company is classified as part of technology sector = 0 otherwise IND = 1 if company is classified as part of industrials and materials sector; 0 = otherwise. TELEC = 1 if company is classified as part of telecommunications sector; 0= otherwise HEALTH = 1if company is classified as part of healthcare sector; 0= otherwise	
County dummies	UK = 1 if company is listed in the UK; = 0 otherwise SW = 1 if company is listed in Switzerland; = 0 otherwise FR = 1 if company is listed in France; = 0 otherwise GER = 1 if company is listed in Germany; = 0 otherwise	

3.2 Descriptive Statistics

Table 3 indicates the range, as well as the Pearson correlation coefficients of the main continuous variables in our study. As shown on Table 3, our dataset includes both companies that invest heavily on research and development and rely on a notable amount of knowledge assets. It also includes companies that invest only a minimal amount of their profits on research and development. Similarly, out dataset includes both companies that rely exclusively on internally generated knowledge assets and companies that rely exclusively on externally acquired intangible assets, since the range of external sourcing ratio (EXT) range from 0-1.

Further, correlation tests were carried out between the key explanatory variables. The tests exhibit low correlation coefficients, thus reducing the presence of multicollinearity in the proposed model. This was verified by a variance inflation factors analysis (VIF). The calculated values range from 0.686 to 1.459, indicating that no multicollinearity is detected among the independent variables since the accepted value is up to 10. (Hair, et al., 1995; Battisti, et al., 2021)

Table 3: Means, Standard Deviations and Correlation Coefficients

	Obs.	Min	Max	Mean	Std. Deviation	Value	RDI	SIZE	KNI	EXT
VALUE	1184	0.1060	8.5243	1.6565	1.211	1				
RDI	1184	0.0001	0.9694	0.0714	0.100	.245**	1			
SIZE	1184	12.7924	25.8751	19.9741	2.284	-.212**	-.375**	1		
KNI	1184	0.0017	0.8871	0.1877	0.169	.163**	.429**	-.471**	1	
EXT	1184	0.0000	1.0000	0.4196	0.299	-.061*	-.081**	.255**	-.249**	1

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

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

4. Empirical Results

We first estimate our model by including only the control variables: R&D intensity, size, as well as industry and country dummies. The explanatory power of this initial model is relatively low (R2 0.2220), but is better than similar models in the field (Denicolai, Zucchella and Strange, 2014). As it is indicated in our regression results (see table 4, model 1) the country dummies of the United Kingdom and Switzerland present a positive and statistical significance influence on firm's value. This result is not surprising since the London stock exchange is one of the most active stock exchanges and an attractive destination for cross-listing where companies show higher overall valuation (Ghadhab and Hellara, 2016). Furthermore, Switzerland is considered to be the most innovative economy worldwide, as it ranked first for twelve consecutive years at the global innovation index

(GII). This is reported by the world intellectual property organization (WIPO, 2022) in collaboration with academic and industrial partners.

Looking at the various economic sectors of Table 3, we see that technology, healthcare, and industrial sector present positive and statistical significance influence on firm's value. This means that corporations operating in these economic sectors create greater value than the rest in our sample. This is expected since they are considered the most rapidly valuable sectors that even in time periods of negative financial shocks their stocks exhibits a positive return (Mazur, et al., 2021). Research and development intensity (RDI) also shows positive, statistically significant results ($p<0.01$). In our analysis there seems to be no impact of the size of the firm on the firm's value. Further our results are in alignment with the mainstream literature, which supports the view that R&D investments contribute to the firm's overall value (Peters, Roberts, and Vuong 2022; Rababah, Molavi, and Doust, 2022; Rahman and Howlader, 2022).

As a second step the model is extended (see model 2 in table 4) by adding the variable of knowledge intensity in order to examine the role of knowledge assets on affecting firm's value. As a result, the explanatory power of our model slightly increases in relation with the initial model (R2 = 0.2347). The results indicate that knowledge intensity (KNI) has a positive impact on firms' value, which is statistically significance ($p<0.01$), while its squared term (KNI2) shows a negative impact which is also statistically significant ($p<0.01$). Therefore, we may conclude that an inverse U-Shape relationship exists between the firm's knowledge assets and its value. This finding supports hypothesis 1. In other words, knowledge assets can help organizations to increase their real market value across time, but only up to a point. Note that our results are consistent with the mainstream literature, which argues that knowledge assets should be combined with complimentary assets in order to lead companies to a maximum level of performance (Cho, 2020; Belderbos, Park, and Carree, 2021; Denicolai, Zucchella and Strange 2014).

Table 4: Regression Results

Variable	Model 1	Model 2	Model 3
UK	0.3564***	0.4388***	0.4234***
	(0.1066)	(0.1063)	(0.1077)
GER	-0.1940**	-0.1287	-0.1502
	(0.0935)	(0.0937)	(0.0960)
FR	-0.0882	-0.0615	-0.0241
	(0.1988)	(0.1987)	(0.1937)
SW	1.0053***	1.1159***	1.0789***
	(0.1780)	(0.1763)	(0.1756)
TECH	0.6552***	0.6117***	0.6122***
	(0.1194)	(0.1188)	(0.1217)
IND	0.2281***	0.2735***	0.2751***
	(0.0849)	(0.0836)	(0.0877)
TELEC	-0.0504	-0.1744	-0.1375
	(0.0935)	(0.1014)	(0.1046)
HEALTH	1.0184***	1.0002***	0.9858***
	(0.1392)	(0.1364)	(0.1399)
RDI	1.5472***	1.4356**	1.4513**
	(0.5891)	(0.6159)	(0.6201)
SIZE	0.0025	0.0248	0.0229
	(0.0153)	(0.0152)	(0.0157)
KNI		2.4628***	2.4052***
		(0.5711)	(0.5561)

Variable	Model 1	Model 2	Model 3
KNI²		-2.8967***	-2.7758***
		(0.8699)	(0.8571)
EXT			0.7254*
			(0.4211)
EXT²			-0.8478**
			(0.4118)
cons	0.9625***	0.1835	0.1577
	(0.3480)	(0.3491)	(0.3537)
Obs	1184	1184	1184
R²	0.2220	0.2347	0.2380

Notes:

1. Robust standard errors in parenthesis

2. * Denotes that the regression coefficient is significant at the 10%; ** at the 5%; *** at the 1%

Organizations therefore should find the optimal ratio of knowledge assets over their total non-current assets that will drive them to the maximum possible level of value. The relative size of the estimated coefficients suggests a turning point at about KNI = 0.425. In practice, this means that corporations investing on the development of knowledge assets create value across time. However, those corporations that have more than 42.5% knowledge assets in relation to other assets they could exhibit a fall in their market capitalization capability. As a result, a need emerges for firms to couple their knowledge assets with other long-term investments on assets.

Finally, we extent our model by including two more terms related with the source of knowledge (EXT and EXT2), in order to examine the effects of externally acquired knowledge on firm's value (see model 3 in table 4). The result of adding those terms leads once again to the improvement of the explanatory power of our model (R2 = 0.2380). The estimated coefficients for knowledge intensity as well as for the control variables show enough robustness since they retain their level of significance. In this case the knowledge intensity ratio, that gives value maximization is slightly increased to 0.4332 (43.3%) showing a 1% difference as compared with the previous model.

Our results show positive effect (statistical significance, $p<0.1$) of external knowledge intensity (EXT) on firms' value, while its squared term (EXT2) show a negative effect ($p<0.05$). In other words, externally acquired knowledge help organizations to increase their overall value but only up to a point since such internal knowledge is required to lead organization to a maximum level of value. Based on our results an inverse U- shape relationship between external knowledge assets intensity and firm's value is clearly present, thus hypothesis 2 is also supported.

Our findings are supporting the views for the complementary role of external knowledge (Berchicci, 2013; Santoro, Ferraris, and Winteler 2019; Denicolai, Zucchella and Strange 2014; Tsai and Wang 2007; Almodóvar and Quyen, 2022 Sun, Zhang, and Wang 2022; Zhou and Li, (2012) Bedford, Bisbe, and Sweeney 2022). We may also argue that external knowledge acquisition can be better capitalized only if there are strong internal R&D capabilities and abortive capacity. This view suggests that organizations should investigate for an optimal balance between internal and external knowledge in order to maximize value. The relative size of the estimated coefficients suggests a turning point at about 43%. In practice this can be interpreted that organizations should build strong internal R&D capabilities. These capabilities can then act as the foundation to host external knowledge as a complement to maximize the capitalization of their knowledge assets. The suggested percentage is that externally acquired assets should account for approximately 43% over a firm's total knowledge assets.

5. Discussion - Managerial Implications – Conclusion

In this paper we investigate the role as well as the structure of knowledge assets in relation to firm's value over time. Developing a multiple regression model using several accounting indicators we show that companies should invest on a complementary balance of knowledge assets in relation to other assets. Note that overreliance on knowledge assets could erode the market value of the firm. In other words, knowledge assets are more effectively capitalized when they are coupled with other tangible assets such as facilities, as well as intangible long-term assets, such as customer and supplier relationships. We argue that the optimal percentage of knowledge assets over a firm's total non-current assets is approximately 43.3%. This would on average lead to maximum firm value.

Further, we found that acquisition of knowledge assets from external sources can also increase firm's value. However, this should be coupled with internal research and development capabilities and other internally existing knowledge. We observe that organizations with an overreliance on externally acquired knowledge are valued less than organizations, using external knowledge as a complement in their internal knowledge assets portfolio. Specifically, we argue that the optimal percentage of external knowledge assets over the corporation's total knowledge assets is approximately 42.8%.

This paper contributes to the literature of knowledge management and the debates over role of knowledge assets. First it contributes to the knowledge management field with respect to revealing the role of knowledge assets with respect to different aspects of performance. Some researchers argue that companies should focus on the development of as many knowledge assets as possible, in order to increase their performance and competitiveness (Kuivalainen, et al., 2004; Asiaei, et al., 2021). Contrary to this argument, our results suggest that the relationship between knowledge assets and firm's value is non-linear. In fact, complementary other assets are also required in order to maximize the benefits received from knowledge intangibles. Our findings are in alignment with the complimentary views on the role of knowledge assets (Cuervo-Cazurra, Maloney, and Manrakhan 2007; Denicolai, Zucchella and Strange 2014; Zhang, et al., 2021; Cho, 2020). Therefore we argue that firm's value can be maximized by combining knowledge assets with both tangible and intangible resources.

Finally, this paper contributes to the current state of knowledge by examining the market value that is gained through acquiring knowledge assets. Most studies are limited to specific dimensions of performance such as internationalization (Cuervo-Cazurra, Maloney, and Manrakhan 2007; Denicolai, Zucchella and Strange, 2014), and innovation performance (Aiello, et al., 2020; Un, 2016; Almodóvar & Quyen, 2022). The majority of studies examine the effects of knowledge assets with ratios that are mainly developed based on sales and the commercialization of new products. Our study investigates the impact of knowledge assets on the overall firm's value, capturing in this way the ability of firms to capitalize on knowledge in a real market context.

Our investigation makes also methodological contributions. The application of accounting indicators and the proposed applied protocol allowed us to focus to the knowledge intangibles by investigating the optimal level and source that can lead to maximum level of market value. Such an approach, provides a more solid set of proxies than merely investments on research and development. In this way we capture in our model the real market value of corporations and we examine how firms capitalize value based on their assets.

Similar to all empirical and conceptual investigations, this study has its own limitations. First it relies on accounting indicators that mainly capture only the explicit knowledge of the firm. Second it focuses on corporations that are listed in stock exchange markets of advanced economies. In advanced economies or high-income countries, corporations mainly compete by developing knowledge assets and new product innovations (Keegan and Green, 2016). Therefore the findings of this study may not be entirely generalized for the case of emerging or developing economies. It would be therefore interesting to carry out further research and derive the optimum ratio of internal/external knowledge assets for firms in emerging/developing economies. Such findings could then be compared to the optimum ratio of firms in advanced economies.

Future research could also be carried out to examine the role of tacit knowledge on the capitalization ability of knowledge assets, as well as to examine different knowledge assets structures under different levels of tacit knowledge. On more point is that the current study merely focuses on internal and external knowledge assets. It would be interesting to further examine the various types of partnerships among corporations and to investigate if there is an optimal balance among open innovation strategies that lead to better assets capitalization. Moreover, there is an emerging trend in the literature that examines the effectiveness of firms' intellectual capital (Chen, Cheng and Hwang, 2005; Nadeem, Farooq and Ahmed, 2019). The effectiveness or value-added intellectual capital VAIC is also measured based on accounting indicators, as initiated and calculated

by (Nazari and Herremans, 2007). It would therefore be quite interesting for a future study to investigate an optimal balance, if any between external and internally development knowledge assets that lead to the maximization of intellectual capital effectives. Definitely, the field of knowledge management is rapidly changing with tremendous possibilities for future development. Revealing some of the subtle interrelationships between knowledge assets and firm's value could act as guide for developing effective strategies in highly complex business environment.

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Knowledge Management Practices for Enhanced Organisational Performance: Can Leadership Style be a Moderator?

Rosemary Boateng Coffie[1], Kofi Agyenim Boateng[1] and Abubakar Umar Alhassan[2]

[1]KNUST School of Business, College of Humanities and Social Sciences, Kwame Nkrumah University of Science and Technology, Ghana

[2]Ministry of Employment and Labour Relations, Efigya Kwabre, Ghana

framaygh@yahoo.co.uk (Corresponding Author)
rbcoffie.ksb@knust.edu.gh
kaboateng.ksb@knust.edu.gh
umaralhassan@yahoo.com

Abstract: This study introduces the moderating influence of leadership style on the connexion between knowledge management and organizational performance studies. We present a Knowledge-Based Theory and associated hypotheses for testing. A survey design using a case study approach of four organisations in the Petroleum, Energy, Micro Banking, and Education sectors in Ghana was used to collect quantitative data. Data analysis shows the Structural Equation Modelling of the study using Analysis of Moment Structures. The outcome shows a strong and significant relationship between Organisational Performance and Knowledge Management as well as Leadership Style and Organisational Performance. However, results indicate that Leadership Style does not moderate the relationship between Knowledge Management and Organisational Performance. The implication of the study suggests the implementation of comprehensive knowledge management policies through employees to enhance organisational performance.

Keywords: Knowledge management, Leadership style, Organizational performance, Transactional leadership, Transformational leadership

1. Introduction

Knowledge management (KM) for enhanced Organisational performance (OP) continues to assume a dominant aspect of organisational practice and theorizing (see, for example, Nonaka and Hirose, 2015; Gupta et al., 2022). The dominant practice and theory have informed several discussions on the subject. The discussions have emphasized diverse viewpoints and perspectives of KM, such as the synthesis process of knowledge creation (Nonaka and Hirose, 2005), sustainable competitive advantage (Gupta et al., 2022), and the phenomenological nature of knowledge reconceptualisation (Nonaka et al., 2021), among others. The growing intensity of competition and dynamism in today's polymorphous marketplace and business environment could largely be traceable to KM practices reinforced by rapid advances in technology. In effect, KM practices provide a template for driving an organisation's improved performance (Shih, Chang, and Lin, 2010).

Following Wickramasinghe and Lubitz (2007), we consider KM to involve techniques used by a company to manage its knowledge assets, including how to gather, store, transfer, apply, update, and produce knowledge. Preference for this explanation is consistent with the ideals and aspirations of this study. In effect, this study draws on the generally held understanding of KM as activities and processes designed to manage knowledge in an organisation (Girard, 2015). Applying the process-oriented approach in this study serves the singular purpose of accommodating the observation that Leadership Style (LS) could play a moderating role in OP. The consideration of KM practices for meaningful OP has wider implications worldwide. Globally, more organisations look to KM as a means of cultivating, organising, distributing, and applying crucial knowledge and skills required for handling tasks such as conflict resolution, flexible learning, strategic planning, and decision-making (Ayatollahi and Zeraatkar, 2020). Due to these operations, KM functions stimulate and condition the growth of fresh and original knowledge in anticipation of enhanced performance. The essence of enhanced performance is to reinforce the possibilities of improving the capabilities of an entity to expand processes that lead to anticipated outcomes. Such outcomes find expressions in the form of innovative products, the benefit of which is reflected in a higher market share and growth in earnings (McIver et al., 2018).

Given that previous studies have considered the consequences of OP in KM from practical and theoretical perspectives (see, for instance, Kim, 2020) there are still many prospects and promises to establish the extent to which LS moderates the relationship between OP and KM practices. The belief in these promises and

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prospects is premised on the observation that the literature appears to be silent on the subject in view, that is, KM in relation to OP with LS as a moderating factor. Further, some existing KM models (see, for instance, Kamath, 2016; Lee et al., 2005; Tuamsuk, Phabu, and Vongprasert, 2013) represent systems of discrete knowledge development and distribution activities without taking into account their interactions with other critical organizational functions such as LS in moderating an organisation's performance.

The driving rationality in the pursuit of this objective is justified in the following counts. First, undertaking such a study is supposed to broaden the frontiers and widen the perspectives of the KM subject matter concerning firm performance in Ghana and, quite possibly, sub-Saharan Africa. But to apply such a concept here in Ghana (a developing nation), there must be a great deal of consideration as there is a considerable paucity of literature on the subject pertinent to this geographical setting. Research on knowledge management strategies in most Ghanaian firms is seriously lacking. Also, Ghana makes for an ideal geographical setting as both national and organizational cultures put a stock on autocratic leadership as the predominant style of leadership. Hence, information dissemination is bureaucratic in nature and this invariably cripples the process and facets of knowledge sharing and management. It is against this backdrop that the current research was created, with the goals of examining the linkages between LS and knowledge management techniques as well as understanding how these interactions affect organizational performance in Ghana.

In the course of achieving this aim, this research accounts for the shortfall in the knowledge gap in the area, especially by way of the theoretical predispositions that the study seeks to advance. Finally, this study aspires to come out with an empirical understanding of the moderating effect of LS necessary to secure enhanced OP. By analysing firm performance as a dependent variable in light of the independent variable of KM practices, the compendium draws on LS as a moderator to make some propositions via the instrumentality of the empirical data.

In our application of LS as part of the means to deepen our understanding of KM for enhanced firm performance, we are sympathetic to Kim et al.'s (2014) contention that KM does not operate in a vacuum but functions within, and is contingent on contextual factors such as leadership, culture, structure, and processes. Organizational leadership, like other operations in organizational behaviour, is undergoing significant changes in both theory and practice. Recent developments, such as the notions of shared leadership as well as the theory of dispersed leadership (Konradt, 2014), redefine the role and focus of leadership from a centralised and unilateral process of control to create highly motivated and self-managing teams with duties and responsibilities among a group of people operating as leaders at their respective levels (Day, 2006).

There is no gainsaying in the point that LS plays a critical role in nurturing and developing human capital in organizations (Tarkhanov and Mayo, 2001) and as a perceptive resource, the LS in place affects the ability to harness and use knowledge in an organizational environment.(Jain and Jeppesen, 2013). Thus, the appreciation of the value of KM and the commitment of the leader is likely to ensure the innovative and efficient allocation of resources for the development of KM systems (KMS) and positively influences KM practices (Donate et al., 2015; Yee, Tan, and Thurasamy, 2019; Muhammed and Zaim, 2020) with the ultimate goal of securing enhanced OP for expected results.

Organizational leaders are responsible for institutionalising KM as a continuous and ongoing process as well as building and maintaining a corporate culture that values knowledge and encourages continuous learning. The importance of KM procedures stimulates experimentation and questioning through empowerment, fosters trust, and supports practical learning through the application of both implicit and overt knowledge (Mills and Smith, 2011). Thus, instead of acting as a gatekeeper of knowledge and information, LS inspires and enables the generation and dissemination of information to all segments within the organisation (Politis, 2004). When leaders cultivate a culture of honesty and trust, employees perform better (Pfau *et al.*, 2002). Studies have pointed to a link between leadership and leveraging KM for a competitive advantage (Bryant, 2003;Singh, 2008). In a fast-changing and intensely competitive marketplace brought about by rapid advancements in technology and globalisation, firms' sustainability and effectiveness largely depend on their dynamic capabilities and competitive abilities. Through KM, organisations can harness their internal knowledge base and expertise for deployment at operational levels to improve OP (Eissa, Lester and Gupta, 2020). Daud and Yusoff (2010) concluded that a firm's performance and survival depend on how quickly it leverages the knowledge process relative to its competitors.

The remainder of this paper is organised in this order. After this introduction is a review of the contemporary as well as landmark studies in the area of KM as they relate to OP and LS as they relate to OP. The essence of this literature call-out is to bring us up to speed by updating our knowledge on the sort of matters that have

engaged the attention of scholars and practitioners on the subject so far. The ensuing section describes the research methodology that enabled various data-collection techniques for the presentation and interpretation of the collected data.

2. Literature Review

2.1 Knowledge Management

We consider KM in this study to reflect the ideals of Kim et al., 2021 as "activities and processes designed to manage knowledge in an organization" p. 2. We deem the activity orientation to understanding knowledge management crucial to the intentions and aspirations of this study. The rationality for this perspective is not far-fetched. For the activities and processes in this explanation capture such KM operations as training programmes, workshops, organisational records keeping, coaching and mentoring functions as well as database management practices. The details of the training programmes and workshops can manifest in such forms as seminars (Namdev Dhamdhere, 2015) and the dynamics of best practice (Galliers and Newell, 2003). Knowledge as 'best practice' for instance, calls for flexible approach to the application and use of knowledge in diverse situational organising. The flexibility comes with a cautious realignment of KM operations to suit local exigencies that relate to the contextual matters' sensitive to the idiosyncrasies and particularities of the firm in question. Paying attention to the unique organizational dynamics is crucial as time and circumstances can cause an organization. to abandon its own KM tools because the passage of time and other circumstantial factors have rendered such tools irrelevant (ibid).

It is our contention that drawing on this graphic contextualisation of KM provides the opportunity of aligning it to the matters of OP in ways that highlight the study's objectives. Developing nations have been the site of a sizable number of KM research. Given this, organizations are adopting KM techniques and technologies in greater numbers (Ode, 2020). The story is however different in Ghana as a good number of the private sector and state institutions do not have a fully-fledged KM system in place, partly because the concept of KM is poorly conceived and practiced by low-skill employees coupled with a lack of the relevant technologies, and other needed resources (Narteh, 2008). Nonaka and Takeuchi, (2007), underscored the significance of KM by affirming that "successful companies are those that consistently create new knowledge, disseminate it widely throughout the organization and quickly embody it in new technologies and products" (p.162). The knowledge dissemination exercise in Nonaka and Takeuchi's notion of KM embodies practices that suggest the accessibility of knowledge by employees in such forms of mentoring and coaching for efficient and productive performance. The progress of KM ingenuity largely hinges on favourable internal environmental factors such as a supportive organizational culture and positive employee behaviour and attitudes, which requires strong leadership to bring about (Lai and Lee, 2007) OP.

2.2 Knowledge Management and Organisational Performance

There is extant research linking KM initiatives with higher OP (Tubigi and Alshawi, 2015; Ha and Lo, 2018). Malik, (2013) found out that KM not only improves performance but also helps in employee retention. Every organization regardless of its nature and sector of operations sets out to achieve an objective or target and it is measured by certain standards within a certain period. As Schechner and Brady (2017) simply put it, performance is the level of target achieved by an organization. The manner of linking OP to target levels can manifest in diverse forms. For instance, OP is connected with cultural dynamics of learning as pertains to internal processes, (Tibbs and Langat, 2016; Rintawi, Gachunga and Senaji, 2018); the effect of innovation on OP Akpoviroro et al (2015) such that technological transformation becomes instrumentally vital to the opportunities for enhanced organisational prospects. The enhanced prospects for OP induce new product development (Ojoajogu *et al.*, 2021) by careful dynamic appreciation and accommodation of the changing environmental considerations that inform part of the context of the organisation. These matters notwithstanding, sometimes sales promotion is applied as a tool for organisational performance (Odunlami and Ogunsiji, 2011). This somewhat direct relationship between sales promotion on OP also has direct association with the positive financial performance as attested to by Carton and Hofer (2010). The positive financial performance in this scenario could be occasioned by cost effectiveness mechanisms that have meritorious bearing on the extent to which KM practices characterise the operations of the organisation (Alkhuzaei 2020). The operations and management practices involve service innovation and the extent to which it becomes involved with OP (Åkesson et al, 2016).

Extant literature also points to a strong and significant connexion between KM and improved OP (Theriou and Chatzoglou, 2009; Pina, Romão and Oliveira, 2013) and how internal factors such as leadership, organizational

culture, and structure impact the progress or otherwise of Knowledge Management Systems (KMS) (Ahmady and Nikooravesh, 2016; Koohang, Paliszkiewicz, and Goluchowski, 2017; Lee, 2018) According to academics, effective and efficient KM is essential for OP (Anwar and Ghafoor, 2017; Martin, 2000; Valmohammadi and Ahmadi, 2015). Kim et al., (2014) pointed out that by preserving essential knowledge at every level, applying existing knowledge to all circumstances, fusing knowledge in practical ways, continually gaining pertinent information, and creating novel knowledge through continuous learning, KM initiatives seek to guarantee consistency and performance improvement in organisations. In light of this, it is doubtful that KM initiatives would ever take off or be successful if KM does not penetrate all levels of the business, starting at the top (Durst and Zieba, 2019). Chang et al., (2022) assert that even though all members of staff have a distinct role to play, top management must get involved in the KM process.

2.3 Understanding Leadership and Leadership Styles

The management literature extensively discusses leadership as a soft talent and personal knowledge. Leadership is the capacity to inspire others to strive toward shared objectives and to inspire ordinary people to perform extraordinarily (Razak, Sarpan, and Ramlan, 2018). Leadership has been correlated with a person's aptitudes, capacities, and amount of influence to convince others to take decisions, do activities they otherwise would not have taken, or proceed in a certain path (Aldulaimi and Hameed Aldulaimi, 2018). Ojokuku, Odetayo, and Sajuyigbe., (2012) define leadership as an artistic and scientific profession that emphasizes connections in the workplace and organizations. It also requires taking accountability for outcomes. Leaders give strategic guidance and forecast the trajectory of goals., and explore “outside the box”. According to Cherry (2006), there are three major leadership styles. Autocratic leaders make decisions without involving their workforce. This could be the ideal course of action when decisions need to be made quickly and when team participation and consensus are not necessary for a good outcome. This approach could result in a high personnel turnover rate and absenteeism. Democratic leaders make the final choice, but they consult the team as a whole before doing so. Employees are frequently very interested in initiatives and choices since they promote innovation. Team members thus typically have really productive employment and are quite happy with their work. Laissez-faire managers allow their staff a great deal of latitude in how they carry out their responsibilities and establish their deadlines. If assistance is required, they offer resources and counsel but otherwise refrain from getting involved. Contemporary leadership styles such as transactional and transformative leadership are the two categories propounded by Bass (1999). Since the late 1990s, scholars have focused on understanding the complexity of the environments in which leaders develop, and have recognised that transactional leaders emerge in low-complexity conditions and transformational leaders in high-complexity scenarios. When a leader practices transactional leadership, followers receive rewards for achieving performance goals. This type of leader places special emphasis on collective achievement. Transformational leaders exhibit charisma and develop a vision, respect, and trust. It is imperative to understand that the selection of a leadership style will lead to a particular organizational climate (Coffie and Coleman, 2018).

2.4 Leadership Styles and Organizational Performance

The constant pursuit of performance improvement is a response by organisations to a rapidly changing environment and frequently contradictory customer demands for a strategic edge in the current challenging economic climate (İşcan, Ersari, and Naktiyok et al., 2014). Rodriques, Ruivo and Oliveira’s (2021), study simply regards organisational performance as “strategic benefits”. Strategic benefits that accrue to organisations by way of their performance exploits and capabilities bear on such functional outcomes as enhanced efficiency and restricted cost of operations that reinforce the business value of their products and service appeal to their customers. Business value of products in addition to service appeal could be the culminating effect of such outcome of firm performance in the form of innovation and its allied consequence of new product development. Further, employee performance at work is significantly influenced by the leader's LS. OP is also impacted by LS (Bastari, Eliyana, and Wijayanti, 2020 et al., 2020). It has been widely explored how LS affects how a company performs. According to most studies, there is a substantial association between LS and organizational success. Depending on the research variables, different LS may have a positive or negative link with OP (Cherian, Gaikar, and Raj, 2020). Fu-Jin, Shieh and Tang., (2010) suggest that to sustain an effective corporate operation, organizational leaders must use procedures or approaches that reflect optimum leadership LS. Therefore, they must adopt strategically planned human resource management and demonstrate various LS in acceptable ways. Linking LS with the organisation has particular implications for OP. Some scholars even suggest LS can have either positive or negative influence on OP (Bhargavi and Yaseen, 2016). Following (Lewin, Lippitt and White, 1939), LS such as autocratic or authoritarian, democratic or

participative continue to remain a dominant aspect of organisational sociology. We consider the idea that the styles of leadership demonstrate the mechanics and the conditions of offering 'implementing plans, directions, and motivating people' (Bhargavi and Yaseen, 2016) for meaningful performance. We find the implementation of plans, the offer of a sense of direction and the inducement of people at work to be not only legitimate and justified for the objectives of this study, but also the point that they inform OP one way or another.

We rely on these concepts of LS to assemble the data for this study. The rationality for this choice and decision reflects the notion that within leadership circles, the literature supports the application of these concepts for reaching out to OP. For instance, in the context of democratic LS, leaders can encourage feedback from subordinates or even collaborate with them for achieving a common goal. The collaborative environment can motivate an atmosphere of 'give and take' which would make subordinates cultivate the mentality of self-worth, a feeling that heightens their sense of participation for increased OP.

In situations of autocratic leadership, too, leaders reserve very little room for subordinate participation, if any (Al Khajeh, 2018). Welfare matters pertaining to subordinates outside working hours are least of worry to leaders. All of this culminate in a hostile environment for practical organisational performance. It is nonetheless necessary to suggest that autocratic leadership can be vitally important in conditions of emergency where the leader does not have to consult before making crucial decisions (Longe 2014).

In terms of delegated or laissez-faire LS, the orientation for leaders is for leaders to consider the notion that anything the subordinate does is regarded as right. Leaders naturally wait for things to get out of hand before they act. This kind of leadership predisposition is known for its unproductive, inefficient and unhappy outcomes, see, for instance, Al-Khaled and Jee Fenn (2020).

The management literature highlights LS as a significant element that affects organizational innovation (Alblooshi, Shamsuzzaman and Haridy, 2020, İşcan et al., 2014). There is already a universal consensus that transactional LS is less likely than transformational ones to encourage creativity inside a company. Transformational LS, on the other hand, emphasizes collaboration and involvement (İşcan et al., 2014). By linking job performance to deserving incentives and ensuring that employees have the tools they need to do the task at hand, an effective LS helps businesses more effectively accomplish their existing goals. Effective LS is regarded as a powerful tool for managerial advancement and long-term competitive advantage.

2.5 Theoretical Background

2.5.1 Knowledge-Based theory

The organisation's knowledge base is considered to be its most important resource from a strategic standpoint, according to the firm's knowledge-based theory. The diversity of knowledge bases, according to those who support knowledge-based resources, is among the most crucial aspects defining sustainable competitive advantage because Knowledge-based resources have complicated social dynamics and are difficult to imitate. The corporate culture and identity, rules, practices, documents, systems, and personnel are just a few of the many elements that carry and embody this information. This perspective, which has its roots in the literature on strategic management, expands and builds upon Penrose's (1959) resource-based view (RBV) of the company (Barney, 2001). The RBV acknowledges the critical part knowledge plays in organisations gaining a competitive advantage, notwithstanding the claims made by advocates of the RBV that the resource-based approach is insufficient in scope. In particular, the RBV views information as a general tool without distinctive attributes. As a result, it does not differentiate between various knowledge-based capacities. Information systems may be utilized to synthesise, enhance, and accelerate substantial intra- and inter-firm KM, which can significantly contribute to the organization's knowledge-based vision (Alavi and Leidner, 2001).

2.6 Hypothesis Formulation and Conceptual Framework

2.6.1 Hypothesis

The focus of this study is to assess the impact of KM on the performance of the Case Study Organizations (CSOs) and to determine the role of LS in this relationship. The following assumptions are put out by the authors based on the results of research on KM procedures carried out by organisations around the world and examined in this study:

H1: KM relates positively to OP.

H2: LS positively relates to OP

H3: LS moderates the relationship between KP and OP.

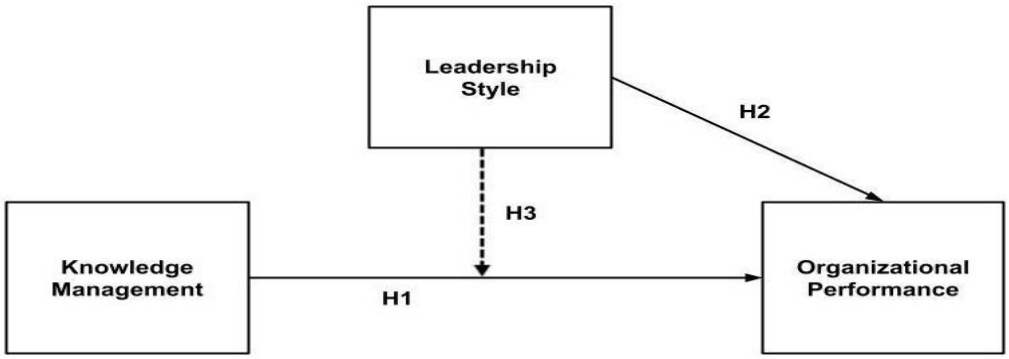

Figure 1: Conceptual Framework

2.6.2 Conceptual framework

The conceptual framework as presented in figure 1 is based on theorized relationships and supported by reviewed literature, on KM and OP, LS and OP and LS moderating KM and OP. The Knowledge-Based Theory (KBT) postulated by Grant (1996) asserts that KM confers a strategic advantage to an organization and leads to improvements in OP.

3. Methods

3.1 Research Design and Approach

The quantitative and descriptive research approach to collect and analyse data for the study was employed. Data for this study was gathered primarily from employees in the energy sector, oil marketing companies, banking, and education sector. The variations in the sectors were to aid researchers to have a clear picture of issues relating to KM from various backgrounds.

3.2 Population and Sampling

The population involved in this study spans a total number of Two Thousand and Thirty-Six (2,036) workers from the four chosen Case Study Organizations (CSOs) which include Volta River Authority (VRA), National Petroleum Authority (NPA), Kumasi Technical University (KsTU) and Amanano Rural Bank (ARB). To get our sample size, the researchers employed the Stratified Random Sampling Technique to divide the respondents into subgroups called strata based on their industries. From the strata, the convenience sampling technique was used to get to 291 respondents.

3.3 Response Rate

Out of a total of 291 questionnaires distributed, 78 constituted the management level questions while 213 were questionnaires for staff members. The actual questionnaires collected indicate that 238 questionnaires were answered, comprising 54 managers and 184 staff members. The total response rate of 81.78% is highly reliable since it is far above the minimum acceptable level of 50% proposed by Cooper, (2014).

3.4 Research Instrument

Two sets of questionnaires; one for top and middle-level managers and the other for lower-level staff were developed for administration, as KM practices may differ at these levels. Both sets have the same layout, sections, and questions except for the part related to LS where the set for managers is a self-assessment form and that of staff is a rating form to assess their leaders based on the Multifactor Leadership Questionnaire (MLQ) developed by Bass (1999). Sections A, B, C and D are the four primary components of the questionnaire. The respondents' demographic data is included in Section A while section B deal with KM issues, Section C deals with OP issues, and D deals with LS issues to reflect the specific objectives of the research. In all, section B, C and D has 47 (forty-seven) items consisting of 18 questions under KM Practices, 8 for OP, and 21 for LS. Questions on KM practices are based on the work of Darroch, (2003). Questions on OP was measured based on the strategic implementation of knowledge management practices whereas LS was measured based on Bass, (1999) multifactor leadership questionnaire (MLQ). As a standard practice, a test run of the questionnaire was undertaken to identify any shortcomings and rectify them before administering it to respondents.

3.5 Data Analysis

A structural equational model using analysis of moment structures (AMOS) version 22 was employed to analyse the data to assess the proposed research model. Again, Statistical Package for Social Sciences (SPSS) version 24 was used to establish the construct reliability whilst AMOS and Excel were used to analyse the validity of the constructs.

4. Results and Discussions of the Study

Data were congregated from the management and staff of the various companies used for the study. Generally, it was realized that transformational LS was best for the model fit. Responses on autocratic, democratic, transactional, and laissez-faire LS constructs were dropped entirely since their models were not feasible with the data collected.

4.1 Measurement Model

A confirmatory factor analysis was conducted (CFA). As part of CFA, factor loadings (see Table 2 and Figure 2) were calculated for each item, and five items (KM1, KM3, KM4, OP1, and OP2) were deleted due to low factor loadings (<.50). The model-fit measures indicates that the model's overall goodness of fit and all values for the three-factor model (KM, TLS, and OP) were within their particular acceptance levels (Balkaya, 2021) see Table 1.

Table 1: Model Fit Statistics

Fit Indices	Recommended Value	Obtained Value
P	Insignificant	0.000
CMIN/df	< 3	1.882
GFI	>.90	0.905
CFI	>.90	0.922
TLI	>.90	0.909
SRMR	<.08	0.0628
RMSEA	<.08	0.061

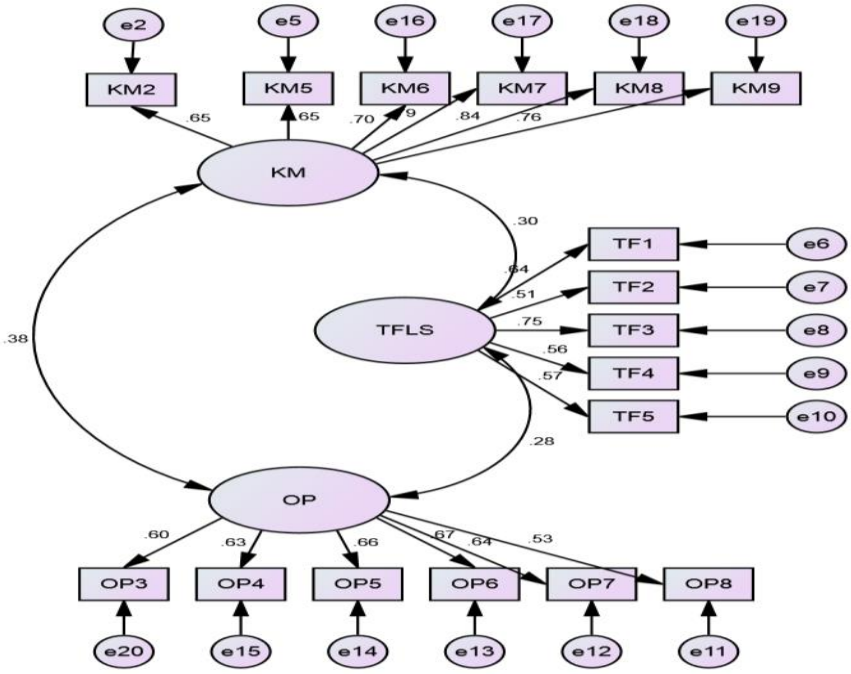

Figure 2: Structure Model of KM, TLS, and OP

Table 2: Loadings, Reliability, and Convergent Validity

Items	Loadings	Alpha	Composite Reliability	AVE
Knowledge Management		0.874	0.875	0.539
KM2	.653			
KM5	.649			
KM6	.704			
KM7	.790			
KM8	.837			
KM9	.756			
Organizational Performance		0.784	0.79	0.387
OP3	.601			
OP4	.633			
OP5	.657			
OP6	.666			
OP7	.636			
OP8	.530			
Transformational Leadership Style		0.741	0.746	0.374
TFLS1	.636			
TFLS2	.511			
TFLS3	.750			
TFLS4	.563			
TFLS5	.572			

CMIN/df =1.882, GFI =0.905, CFI =.922, TLI =.909, SRMR =. .0628, RMSEA =.061

Cronbach Alpha for the constructs was over the minimum acceptable limit of .70 (Hair et al., 2017). The AVE values were beyond the threshold value of 0.50 (Mikhalkin et al., 2017) for KM only. However, since the composite reliability was well over the required value, the researchers conclude that the OP and TFLS constructs were valid (see Table 2 above).

Discriminant validity is said to have been observed per Fornell and Larcker's criteria when a construct's square root of AVE is greater than its correlation with the other constructs in the study, as this study's correlation with the other constructs was (see Table 3).

Table 3: Fornell and Larcker criterion.

	KM	OP	TFLS
KM	**0.734**	0.378	0.297
OP	0.378	**0.622**	0.279
TFLS	0.297	0.279	**0.611**

4.2 Moderation Analysis

The study evaluated how TFLS influenced the relationship between KM and OP (see Figure 3). The results revealed an insignificant moderation of TFLS on the link between KM and OP (b = .020, t = .364, p = .716). Thus, there is evidence that TFLS does not moderate the connection between KM and OP due to the p-value being higher than 0.05 (see Table 4).

Table 4: Moderation Analysis Summary

Relationship	Beta	C.R.	P
OP <--- KM	.190	4.570	***
OP <--- TFLS	.129	2.321	.020
OP <--- INTER	.020	.364	.716

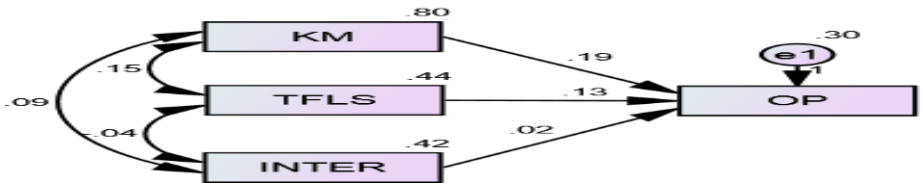

Figure 3: SEM Model of TFLS as a Moderator in the relationship between KM and OP

4.3 The Impact of KM on OP

A regression analysis test showed that KM has a direct and significant effect on OP ($p<0.01$). A 0.378 coefficient value implies that for every unit increase in KM, there will be a corresponding increase in OP by 0.378 units. This is evident in the structural equation model and regression weight table for this analysis as shown in Figure 4 and Table 5 respectively.

Table 5: Standardized Regression Weights

Relationships			Beta	S.E.	C.R.	P	Label
OP	**<---**	**KM**	.378	.063	4.210	***	par_11

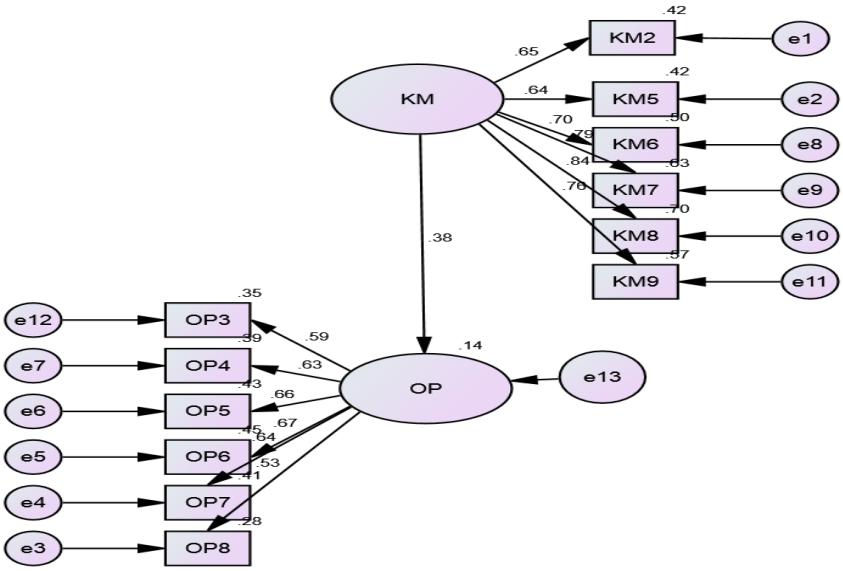

Figure 4: Structure Model of the Impact of KM on OP

CMIN/df =2.707, GFI =.914, CFI =.914, TLI =.893, SRMR =.0683, and RMSEA =.085

4.4 The Impact of TFLS on OP

A regression analysis test showed that TFLS has a direct and significant effect on OP ($p<0.01$). A 0.276 coefficient value implies that for every unit increase in TFLS, there will be a corresponding increase in OP by 0.276 units. This is evident in the structural equation model and regression weight table for this analysis as shown in Figure 5 and Table 6 respectively.

Table 6: Standardized Regression Weights

Relationships			Beta	S.E.	C.R.	P	Label
OP	**<---**	**TFLS**	.276	.074	3.022	.003	par_10

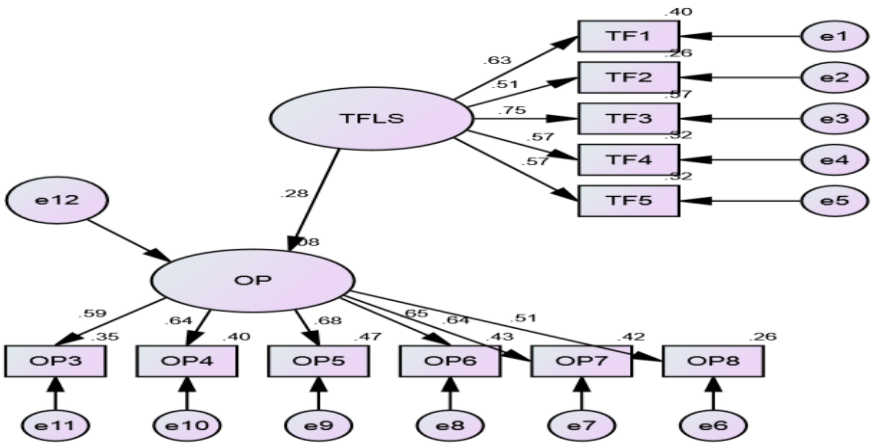

Figure 5: Structure Model of the Impact of TFLS on OP

CMIN/df =2.227, GFI =.933, CFI =.913, TLI =.889, SRMR =.0580, and RMSEA =.072

Table 7: Summary of Hypothesis

Hypothesis	B	p-value	Decision
H1: KM positively relates to OP.	.378	***	Supported
H2: LS positively relates to OP	.276	.003	Supported
H3: LS moderates the relationship between KM and OP	.020	.716	Not supported

4.5 Discussion

The analysis of the data from the responses implies that KM has a positive and significant effect on OP. This is implied as the coefficient value of KM on OP is 0.378. The direct implication is that for every unit increase in KM, there will be a corresponding increase in OP by 0.378 units. This finding confirms those of Pina, Romão, and Oliveira, (2013) and Jain and Jeppesen, (2013) that KM confers a competitive advantage and thereby enhances the performance of organizations that invest in its implementation. The findings of the study suggest that the performance of an organization will be fiercely improved by the creation of an environment conducive to further enhancing the application of KM through the preservation of essential knowledge at various levels of the organization, the application of existing and improvised KM practices in all circumstances, and the creation of new knowledge through continuous and inter-departmental shared learning.

The second hypothesis suggests there is a positive relationship between LS and OP. The study analysis affirms this conjecture as the co-efficient value between LS and OP is 0.276. This finding confirms the assertion of Bastari et al., (2020) that LS positively impacts OP since a unit increase in LS will result in a corresponding increase in OP by 0.276 units. Organizational leaders must follow policies or strategies that best represent their leadership style (LS) to maintain an efficient OP. They must thus employ carefully thought-out human resource management practices and appropriately display diverse LS. Based on the findings of the study, contemporary LSs should be vigorously adopted since they encourage a highly motivated workforce dedicated to pursuing OP. A successful LS helps firms effectively achieve their current goals by connecting work performance to merit-based rewards and making sure that employees have the resources they need to complete the task at hand. This contributes to successful management and competitive advantage both culminating in an effective OP.

However, no form of LS moderates the link between KM and OP. This is evident as the p-value of the moderation is greater than 0.05. This invalidates our H3 hypothesis that LS (any form of it) has a moderating effect on the link between KM and OP. This finding connotes that to perpetuate KM with the hope of resulting in OP, consideration should be given to the various aspects of KM. Organisations should to a great extent employ contemporary KM practices and create an enabling environment to accommodate the free flow of information and innovation without so much as giving great priority to leadership styles. Singh (2008) gives credence to the role played by knowledge management on organisational performance while downplaying the influence of leadership styles. KM is geared towards advancement and consistency of performance by preserving critical knowledge at all levels, applying current knowledge in all circumstances, combining knowledge in synergistic ways, and creating new knowledge through continuous learning. The success of this process moderately depends on the involvement of leaders in the organisation. Per the findings of the study, the onus lies on the organisational leaders to ensure the organisation gives enough wiggle room to the employees to propagate their innovative ideas and initiatives. Though the impact of the type of leadership style employed in this regard could partially matter, according to the findings of this study, optimum OP will be realised if KM is practised by everyone, including management and leaders of the organisation.

5. Conclusion

5.1 Research Implication

This study seeks to establish the relationship between KM and OP with LS as a moderator. KM practices are found to have been adopted by all the case study organizations and have had a significantly positive impact on their performance. The researchers then seek to ascertain how the management's LS has an impact on the performance of these institutions. Based on statistical analyses using AMOS, the various LSs were found to be insignificantly related to performance. It can therefore be concluded that LS is not a strong moderator in the

KM and OP link toward future efforts to improve upon the formulation of policies and implementation of KM initiatives.

It is therefore worthy of consideration that the management of organizations gives careful attention to the adoption of a comprehensive KM policy that has the endorsement of all staff in its development. Presumably, this goes a long way to ensure ownership and support for its implementation. As has been demonstrated by this research, a well-fashioned and implemented KM initiative has a strong potential of enhancing the overall OP. Also, the HR department of organizations must be instrumental in the implementation of KM policies and practices by not only getting top management's backing to make necessary resources accessible.

5.2 Research Limitations

Quite a few impediments were encountered during the research. That notwithstanding, painstaking efforts were employed by the researchers to minimize the impact of these bottlenecks and safeguard the integrity of the outcome. Firstly, the research involves four case study organizations two of which are in the energy sector and one each in the education and banking sectors. This makes the generalization of the findings across all sectors difficult. Secondly, data was collected post-C0VID 19. Per regulatory restrictions, visits to workplaces were limited to essential personnel only making our access to senior management and staff markedly impossible. That notwithstanding, we were able to gather enough information to work with.

To overcome these limitations and challenges, firstly the researchers avoided sweeping generalizations by limiting findings to the sectors covered and recommending further studies in other sectors to give a more comprehensive outlook of KM in Ghana. Also, relying on secondary documents like reports submitted to regulatory state agencies and other generic non-confidential memos; helped minimize the impact of the restricted information on the findings of the study.

5.3 Suggestions for Future Studies

The current study sought to assess the link between KM and OP with LS and employee innovation as moderator and mediator respectively. KM practices were found to be adopted by all the case study organizations and had a significantly positive impact on their performance. The researchers then sought to assess the effect of the LS in the relationship between the knowledge management and organisational performance of these institutions. Based on statistical analyses using AMOS (Analysis of a Moment Structure), the various LS was found to be insignificantly related to performance when it serves as a moderator between KM and OP. It can therefore be concluded that LSs are not a strong moderator in the KM and OP link. In view of this conclusion, further research can focus on other sectors and industries to get enough empirical bases to predict, with a higher degree of certainty, the contextual factors that are responsible for influencing the success or otherwise of KM practices. Last but not least, qualitative research philosophy and approach can be applied as a means of obtaining an in-depth understanding of the underlying causal matters involved with OP in link to KM grounded in LS dynamics.

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The New Typology and Evolution of Multinational Corporation Subunit Roles: An Explorative Study

Xiaoyu Pu[1] and John Cantwell[2]
[1]State University of New York at New Paltz, New Paltz, NY, United States
[2]Rutgers University, Newark, NJ, United States

pux@newpaltz.edu
cantwell@rutgers.edu

Abstract: This paper conducts an explorative study to examine the evolution of Multinational Corporation (MNC) subunit roles based on the characteristics of its competence creating (CC) activities. The study focuses on the heterogeneity of firm-specific evolutionary paths in the patterns of knowledge accumulation that support competence creating (CC) activities. Using continuous variables instead of creating categorization of subunit roles, we create a model to examine the strategic roles of MNC subunits, based upon the evolutionary trajectory of a subunit's CC activities and its technological distance from its parent company. We identify and measure subunit CC intensity and subunit technological distance as the two determining dimensions that characterize an MNC subunit's pattern of innovation in terms of competence-creating. The innovative activity was observed from large firms of the general chemical industry, with data that covers an over thirty-year window, to explore the characteristics of competence creation activities, and to examine the proposed typologies. Using the longitudinal observation, we further examine the evolution of MNC subunit roles based on the characteristics of their competence creating activities, and demonstrate several real world business examples of subunit typologies. This research makes both theoretical and methodological contributions to the literature of MNC innovation and subunit strategic roles by presenting a continuous model to examine competence-creating activities of MNC subunits. A connection between statistical data analysis and individual firm examples is made in the discussion of subunit evolutionary trajectories, which can lend itself to possibilities of in-depth case studies. Using the typology designed in this study, we can further examine the relationship between MNC strategy and subunit role evolution, using the continuous variables to describe a subunit's innovative activities rather than categorizing subunits as a CC or CE type, which in turn allows for a more realistic understanding of MNC subunit behavior – as innovative firms should always have a combination of CC and CE innovations.

Keywords: Competence creating, MNC innovation, subsidiary role

1. Introduction

Knowledge management is a process that involves the development, storage, retrieval, and dissemination of information and expertise within an organization, with the purpose of improving organizational performance (Wiig, 1993; Gupta, Iyer and Aronson, 2000). Knowledge management for organizations requires an understanding of the process in which information and know-how are being recombined via internal and external learning, to create market opportunities for a firm (Kogut and Zandar, 1992). In the arena of multinational corporations (MNCs), a firm's capability of managing the sourcing and recombination of knowledge through the nest of subsidiaries would greatly influence its innovation performance.

Typically, MNCs designate strategic mandates to their foreign subsidiaries, which determines the role that these subsidiaries serve within the corporation, and this role in turn influences the knowledge seeking or creating activities conducted by the subsidiary. Subsidiaries are then categorized into different typology systems based on the different combinations of knowledge related activities. Gupta and Govindarajan (1991) created a typology of subsidiaries by applying the magnitude and the direction of knowledge flows of subsidiaries, in which they identify subsidiaries as the provider or receiver of knowledge. Their model distinguishes these four types of subsidiaries: Global innovator, integrated player, implementer, and local innovator. Birkinshaw and Morrison (1995) provided a three-fold typology which classifies subsidiaries as local implementer, specialized contributor, and world mandate. Ambos and Reitsperger's study (2004) identified technological mandate subsidiaries and task-related interdependence subsidiaries. These studies are all based on the characters and natures of intra-MNC knowledge flow. Cantwell and Janne (1999)'s research adopted a different angle to compare the technological interrelatedness of R&D activities in foreign centers with those in domestic countries. In other words, the research activities by foreign facilities are distinguished as either 'replication' or 'diversification'.

Besides the research on identification and distinction of subsidiary roles, it is important to recognize that as subsidiaries evolve with their foreign locations, their strategic roles may evolve overtime. Subsidiary evolutions are driven by both internal (initiated by subunits themselves) and external factors (investment from parent

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company or other external forces) (Birkinshaw and Hood, 1998). External forces largely shape the options of subunit, while it is the subunit managers to take the initiative to respond to the external opportunities. The idea that multinational subsidiaries are differentiated according to their technological capabilities and roles can be traced back to Ghoshal and Bartlett's study (1988) on subunit tasks. They argued that the tasks of affiliates can be classified in three categories: creation, adoption and diffusion. 'Creation' is to use subunit's own technical and managerial resources to respond to local circumstances; 'adoption' is to adopt innovation developed by parent company or a central R&D facility, or other national subsidiaries of the firm; and 'diffusion' is to diffuse their local innovations back to the parent company or to other subsidiaries. Similarly, Pearce (1999) characterized MNC subsidiaries as world product mandate and regional product mandate by distinguishing their subunit-level capabilities. Almeida et al (Almeida, Dokko and Rosenkopf, 2003) discussed the same question by unbundling the process of knowledge management, defining this process as search, transfer, and integration, and linking each of these components with subunit capabilities.

Research on subsidiary roles and strategies has recognized the explorative vs. exploitative natures of subsidiary innovation (March, 1991; Ancona et al, 2001; He and Wong, 2004). Another baseline of identifying the strategic roles of MNC subsidiaries is to examine its integration within the MNC framework and its local embeddedness (Bartlet and Ghoshal, 1989). Subsidiaries leverage knowledge and resources both internally from the MNC network and externally from the foreign host location (Cantwell, 1991; Cantwell and Piscitello, 2000), these two different focuses lead subsidiaries to be either a competence exploiting (CE) type or a competence creating (CC) type – the former assumes a role that essentially just exploits parent company competence in foreign location, whereas the latter creates new competences that learns and recombines knowledge from the host location and beyond (Cantwell, 1987; Cantwell and Mudambi, 2005). Using the scope of competence exploration and exploitation, this typology can be further tailored into international competence exploitation (ICE) subsidiaries, local competence exploration (LCE) subsidiaries, and global competence creation (GCC) subsidiaries (Pu et al., 2016).

Intuitively, there can be a trade-off effect between the subsidiary's MNC integration and its local embeddedness given the limited resource of management and investment focus. The current literature in both knowledge management and MNC strategy have generally treated the typology of subsidiary roles to be the "exploration" or the "exploitation" types. However, as suggested by researchers, in certain circumstances when the MNC operates within (and sometimes contributes to) a fast-changing environment, this trade-off effect could be eliminated, and instead, a complementary instead of competitive relationship between the involvements into the two networks (MNC network or local network) could exist (Andersson, Forsgren and Holm, 2001). Hence, a subsidiary can have local competence creating activities such as knowledge transferring and innovation based on its relations with local partners and resources, while increasingly relying on competence exploiting exchanges within its MNC group. Together, they reinforce the subsidiary's position in both the local and MNC networks. Based on this argument, a subsidiary could technically be both an "exploitation" type and an "exploration" type at the same time – depending on the various innovative activities that it is involved in. Therefore, it is sometimes inaccurate to categorize a subsidiary to be an "exploitation" type, when it has been also actively engaged in exploration (competence creating) activities concurrently, and vice versa. Thus, this study proposes a continuous model to examine the strategic roles of MNC subsidiaries, considering of all CC type innovation activities, and measure the "technological distance" in combination with CC innovation intensity. Our main research question in this explorative study is:

Do the knowledge creating activities of an MNC's subsidiary reflect its strategic role?

Upon understanding this question, we also want to examine the evolution of subsidiary roles over time based on their knowledge creating activities. The aim is to create a new way of investigating MNCs' innovation strategy and their knowledge management capabilities. Moreover, this paper discusses a few cases as examples to indicate how the subsidiary role in our new typology reflects its innovative capability.

2. Theoretical Framework

2.1 The Knowledge Based View and MNC Knowledge Management

The foundation of this research is the knowledge-based view (KBV), which in the context of multinational corporations emphasizes the "international network" of interconnected entities that create, transfer, and reconstruct knowledge as one of the key drives of their innovation process (Szulanski, 1996; Wiig, 1997; Gupta and Govindarajan, 2000; Almeida, Song and Grant, 2002). This recognition led its way into the expansion of knowledge management (KM) studies, seeking further understanding of knowledge-intensive firms and the

fundamental role of their knowledge workers (Drucker, 1993), via the creation, access, dissemination and application of knowledge (Nonaka and Takeuchi, 1995), and the study of KM has since become one of the dominating forces in understanding innovation, learning, and technological development of organizations. Further research has cross examined the concept of KM and organizational learning (OL), which involve the internal creation and external acquisition of knowledge (Huber, 1991), finding that although there are overlaps between these two concepts, KM has gradually absorbed the field of OL (Castaneda, Manrique and Cuellar, 2018). KM in its own path of development, has shifted from the technocentric view with a focus on explicit knowledge before the mid-1990s, to a more strategic focus in the 2000s, till now a characteristic of high complexity of the knowledge domain (Serenko, 2013). It is the latest development embracing the complexity of knowledge in KM, and the understanding of knowledge-based activities, that led the groundwork of this research project, which is focused on the examination of a multinational corporation (MNC)'s knowledge accumulation, creation, and innovation.

The multinationality of MNCs provides them an advantage as they can acquire and utilize knowledge across national borders via their intra-firm connections (Kogut and Zander, 1993; Nonaka, 1994; Gupta and Govindarajan, 2000). There has been evidence that the transfer of knowledge within the intra-firm network, as well as via the embedded network of home, host, and third-country (Jimenez-Jimenez, Martinez-Costa and Sanz-Valle, 2014; Berry, 2015), and cross-border knowledge management helps MNCs maintain competitive advantages by both improving the effectiveness of knowledge acquisition as well as integrating and recombining existing knowledge (Nonaka, Toyama and Konno, 2000; Darroch, 2005; Ferraris, Santoro and Dezi, 2017). Since knowledge sourcing and recombination is a key drive for MNCs' competitive advantage, knowledge management in the MNC context becomes an increasingly important topic, not only to the domain of knowledge management, but also presents great importance in the strategic perspectives of MNC and their foreign operations. This research project has stemmed from the identification of knowledge complexity and its impact on innovative activities (Pu, Cantwell, and Li, 2022), to a further examination of how these knowledge-intensive activities evolves overtime with different strategic roles held by MNC subsidiaries, thus bridges the gap of current literature between MNC knowledge management and its strategic implication on subsidiary roles.

2.2 MNC Subunits and Their Competence Creating Activities

It is known that large MNCs tend to have multiple operational units overseas, sometimes more than one subsidiary could be set up in a single foreign host country. From a business standpoint this could make sense when that particular host country provides a wide range of geographical locations suitable for foreign investment, and these investments could fall into different divisions of operation, which makes setting up multiple subsidiary entities necessary; or for certain legal or political reasons MNC needs to divide up their foreign operation into different functional companies, sometimes these registered companies may even only exist for the purpose of keeping the right paperwork. For these various reasons, it has been difficult for research on subsidiary level of MNC to match the company activities in one geographical location to the real subsidiaries of the MNC. In this study, an *MNC subunit* is defined as an operational unit of an MNC outside its home country. For each MNC, all of its operational activities in one single foreign host country are treated as one foreign subunit. For instance, Dow Chemical may have several subsidiaries in Japan registered as part of the Monsanto group, but we treat these subsidiaries as a single Dow Chemical - Japan subunit for our analysis purpose. Instead of looking at the organizational structural sense of an MNC's foreign entity, the focus of this study is on the innovative activities of the MNC that are taking place outside the home country of the parent company. Parent company, in this study, refers to the part of MNC that conducts innovative activities in the MNC's home country.

In organizational learning theories, the concept of exploitation is referred to as "the refinement and extension of existing competencies, technologies, and paradigms" and exploration as "experimentation with new alternatives that have returns that are uncertain, distant, and often negative." (March, 1991) Based on the distinction between the two concepts, studies of a wide range of management fields have shown that exploitation and exploration require substantially different structures, processes, strategies, capabilities, and cultures to pursue and may have different impacts on firm adaptation and performance (He and Wong, 2004). In general, exploration is associated with organic structures, loosely coupled systems, path breaking, improvisation, autonomy and chaos, and emerging markets and technologies. Exploitation is associated with mechanistic structures, tightly coupled systems, path dependence, routinization, control and bureaucracy, and stable markets and technologies (Ancona et al., 2001; Lewin, Long and Carroll, 1999).

Innovative activities of an MNC subunit can be influenced by several factors - the parent group pressure, the locational pressure, or the subunit autonomy. The composition of the CC and CE types of innovative activities is determined by the subunit's strategic position based on MNC parent group's initial mandate, but overtime this

composition can change in proportion or in direction. Because the creation of competence demonstrates the capability of a subunit to innovate into new profitable technological fields, which in turn earns the subunit better position within the MNC network, and hence more favorable resource allocation by the parent group, subunit management are encouraged to seek to achieve a mandate of CC by initiating local knowledge seeking or new competence creating (Cantwell and Mudambi, 2005). More recent study has shown that both CC and CE type of innovative activities have a positive influence on firm's performance, especially when there is a balanced complementary combination between these two (Zhang, Jiang and Cantwell, 2015). At the subunit level, knowledge management of the subunit is at the core of their capability of long-term success, which in tern influences the subunits capability of balancing their CC and CE activities (Andrews and Smits, 2021).

2.3 Typology Based on Innovation Pattern

Before discussing the measurement for these two dimensions, we need to refer to the index used to identify and calculate an MNC subunit's area of expertise. Revealed Technological Advantage (RTA) is an index that demonstrates the level of technological specialization for one unit of observation (in this study, a foreign subunit of an MNC) in a given technological field (Patel and Pavitt, 1991; Cantwell, 1995). The RTA index of a firm in a particular technological field is given by the firm's share of patenting in that field divided by its share of patenting in all sectors and is defined as follows:

$$RTA_{ij} = (P_{ij} / \sum_i P_{ij}) / (\sum_j P_{ij} / \sum_i \sum_j P_{ij})$$

In which P_{ij} is the total number of patents of firm i in field j. The index varies around unity, such that values greater than one suggests a firm's comparative advantage in the field of activity in question relative to other firms in the same industry, while values less than one are indicative of a position of comparative disadvantage (Cantwell and Piscitello, 2000). When this is calculated at a subunit level, the unit of analysis is then changed from firm to subunit – a firm's activities within a foreign host country.

In the past, the notion of competence creation (CC) is often times treated as itself a categorizing factor for subunit typology. Namely, using indicators measuring the amount of unique innovative activities that stem from the parent company's knowledge portfolio, subunits are then categorized with or without the "CC" role (Cantwell and Mudambi, 2005). However, as we understand, a subunit can have a complex variety of innovative activities, it can be abrupt to give the subunit a simple label to indicate its involvement in CC. We aim to design a continuous measurement for the CC activities of MNC subunits. Now if we take a look at the innovation patterns of foreign subunits, instead of their knowledge sourcing compositions, it is understandable if we shift focus to the actual competence creating / competence exploiting activities. The composition of these two types of activity could determine a subunit's strategic position within the MNC group. In this study, we will create a typology of subunit roles based on (1) the extent to which a subunit's innovative activities are CC as opposed to CE, and (2) the technological distance between the subunit and its parent company.

The first dimension is defined as subunit CC intensity. It is measured with the share of competence creating activities among all innovative activities (CC+CE) within a subunit. The construction of this variable takes two steps. First, we identified the innovative activities in fields that are categorized as competence creating vis-à-vis competence exploiting by comparing the RTA value of subunit i in field j (RTA_{ij}) to the RTA value of subunit i's parent company in field j (RTA_{pj}). If RTA_{ij} >1 and RTA_{pj} <1, field j is considered a field of CC for subunit i. This comparison is done by all subunits in all technological fields. Second, we calculate the number of patents that belong to these CC fields for each subunit, and then divide this number by the total number of patents for each corresponding subunit. The result is a percentage number indicating the CC intensity of a subunit. A higher CC intensity indicates the subunit to be more competence-creating oriented, since a higher percentage of innovative activities conducted by this subunit are identified as competence-creating type. On the other hand, a lower CC intensity indicates the subunit's innovative activities are more dependent on its parent company's areas of expertise – note that this does not mean the subunit is less innovative, but only indicates a closer relationship to its parent group R&D activities.

The second dimension is subunit distance – the technological distance between innovative activities of a subunit and its parent company. This dimension examines how far the foreign subunit's innovation has "strayed" away from its parent group. The larger the distance, the less likely this subunit is simply "exploiting" its parent group competence. A shorter distance, however, does not indicate the subunit is less innovative; it reflects a similar focus and thus a likely closer relationship between the subunit and its parent company's R&D activities.

Combining these two dimensions generates a two-by-two matrix (as illustrated in Figure 1).

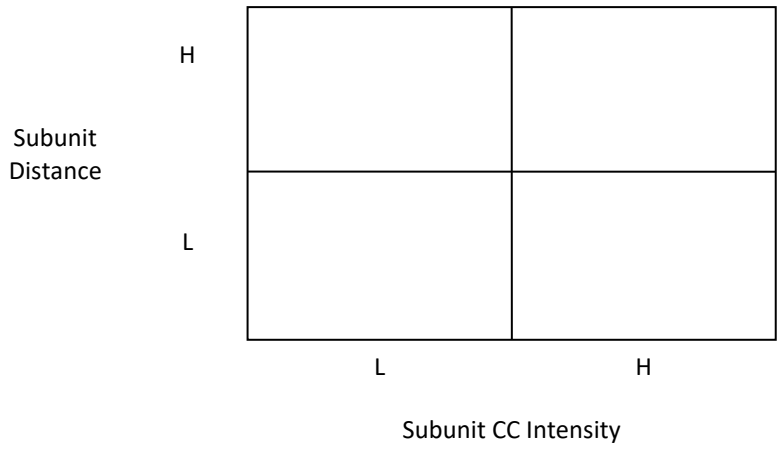

Figure 1: Subunit Typology by Competence Creativeness

Subunits that are positioned in the lower left corner (Quadrant III of Figure 1) have both low degree of CC intensity and low distance from its parent company. This type of subunit is mostly a miniature replica of the parent company in a foreign location; its innovation is mainly incremental ones based upon the technological specialties of the parent company. This fits the description of traditional subunits, which have a large share of CE activities as opposed to CC.

Subunits positioned at the upper right corner (Quadrant I of Figure 1), on the other hand, is the other extreme of the case. These subunits are not just highly innovative, but their innovation is to a large extent composed of CC activities, and their portfolios of these activities are significantly different from that of their parent companies'. These subunits are of high strategic importance to an MNC group as they bring in new potentials to the entire group, especially when some of these CC areas are matured, the group can then recognize them as part of its new core competency, and therefore spread these specialties across the MNC group's international network. Their strategic role could be categorized the ultimate competence creating type, and they are considered centers of excellence within their MNC group's network.

Subunits that fall under the category of high technological distance from its parent company while having low CC intensity (Quadrant II of Figure 1) could be the ones that has a technology portfolio that includes mostly in some certain areas of expertise that are same as the parent company's areas of specialization, but their technological field diversification is highly skewed by a few outliner fields that don't fall into the categories of parent company specialization. These subunits are developing some niche applications based on their local host country competency, while their main innovative activity is still focused on the exploitation of MNC group specialties.

In the lower right quadrant (Quadrant IV of Figure 1), subunits are found to have high degree of CC intensity with low technological distance compared to their parent companies. These subunits are the ones of most interest in my typology. They concentrate their innovative efforts on areas that are not particularly specialized by the parent company. However, these areas are not completely unrelated or brand new to the MNC group. Their technology portfolio shows consistency with the parent company, just that they tend to concentrate more on the fields that are relatively new to the group. The new knowledge combinations these subunits are making are close to the core competency, and they conduct a more focused exploration compared to those with a CC role or a Niche Application Role. We therefore categorize this type of subunit as "Core Base Extension". These subunits have the most potential to bring in new competencies to the MNC group and incorporate these new areas of technology into the development of new group level core competency.

3. Data and Results

3.1 Data and Measures

To understand the long-term effect of knowledge management activities in MNCs, this research chooses patent data as the proxy to represent outcomes (as well as sources) of innovative activities. As an indirect measure of innovative activities, patent data (in this research both granted patents and patent citations) reflects a measurable outcome of knowledge creation, whereas patent citations create connection amongst organization or individuals involved with the KM process, either directly or indirectly, hence reflects the accumulation of

knowledge. This study examines the US patent data of 147 large chemical industry firms, with patents granted between 1976 and 2006. Note that the United States Patent and Trademark Office (USPTO) grants patents to both domestic and foreign firms, this database is truly global, representing a wide range of innovative activities across the globe. Data for this study is collected mainly from NBER US Patent Database, and patent database developed by one of the authors. Both these databases were derived from the USPTO patent database, providing collective data on patents such as citation, inventor's location, technological class, etc; the former is publicly available via NBER, whereas the latter is from Dr. Cantwell's personal database accumulated over the years. Some individual patent records were pulled directly from the USPTO patent database. General chemical industry is selected as the object of this research because of its fully matured development as an industry over hundreds of years, yet widely spread into various sub-sectors of technologies with some of them being newly emerging within the past few decades. Its historically consistent concentration on technology development has brought in life not only in-depth research of fields that are closely related to traditional chemical industry, but also streams of newly emerged knowledge in fields that are expanded around the main sectors, such as pharmaceutical, biotechnology, etc. Compared with many other industries, chemical industry consistently emphasizes on the protection of intellectual property by the means of patenting; the analysis of patenting behavior in chemical industry can to a large extent reflect the actual advancement of technology in this field.

Table 1 demonstrates the distribution of home countries of the MNCs and the number of patents granted to inventors in each country (we take the first inventor's location in cases of multiple inventors).

Table 1: Distribution of Multinational Firm Home Countries

Country	Number of Firms	Number of Patents
Australia	2	100
Belgium	1	973
Canada	2	101
Denmark	2	1,144
Finland	1	102
France	7	18,747
Germany	8	31,285
Israel	1	240
Japan	30	47,405
Korea	2	154
Netherlands	2	2,084
Norway	2	375
Switzerland	6	16,496
Taiwan	2	13
UK	10	19,327
US	77	148,122
Total	**155**	**286,667**

There are 286,667 patents analyzed in this study, with about 79% granted to parent companies and the remaining 21% by foreign subunits. The primary field of technological activity of each patent is derived from the US patent class system, and these fields are grouped into 56 technological sectors (Cantwell and Andersen, 1996). This grouping is established based on the class system, providing economic meanings for each of these fields. Due to the limitation of industry sample, some fields among these 56 are not as highly represented as others; as a result, an analysis across these 56 fields of technological sectors would somehow demonstrate a skewed result. Therefore, this study further grouped these 56 fields into 31 respective ones in order to have meaningful representative numbers for each technological field so that there is a comparable structure of data distribution. Table 2 demonstrates a brief description of each technological field and patent frequencies of these fields in this research.

Table 2: Distribution of patents among technological fields

N°	Field	Number of Patents
1	Food and tobacco products	1,735
2	Distillation processes	738
3	Inorganic chemicals	4,139
4	Agricultural chemicals	5,035
5	**Chemical processes**	**13,636**
6	Photographic chemistry	9,461
7	Cleaning agents and other compositions	15,082
8	**Synthetic resins and fibres**	**37,678**
9	Bleaching and dyeing	3,130
10	**Other organic compounds**	**48,999**
11	Pharmaceuticals and biotechnology	57,747
12	Other chemicals and Related - disinfecting, preserving, textiles and explosives	815
13	Metallurgical processes	2,488
14	Miscellaneous metal products	4,080
15	**Chemical and allied equipment**	**10,947**
16	Paper making apparatus	1,808
17	Assembly and material handling equipment	1,694
18	Other specialised machinery	3,553
19	**Other general industrial equipment**	**2,813**
20	Mechanical engineering nes	3,870
21	**Electrical devices and systems**	**2,146**
22	**Other general electrical equipment**	**4,427**
23	**Office equipment and data processing systems**	**2,431**
24	Electrical equipment nes	4,290
25	Transport equipment	896
26	Rubber and plastic products	4,056
27	Non-metallic mineral products	14,143
28	Coal and petroleum products	6,579
29	Photographic equipment	2,417
30	**Other instruments and controls**	**14,019**
31	Other manufacturing and non-industrial	1,815
Total		**286,667**

The calculation of the first dimension of our typology – subunit CC intensity – is mentioned in the previous section. The second dimension – subunit distance, is calculated using the Jaffe (1986) approach which borrows the concept of Euclidean vector calculation using (1 – Cosin Similarity) to construct a measure for distance:

$$Tech\ Distance = 1 - \frac{\sum(Sub \times Parent)}{\sqrt{\sum Sub^2} \times \sqrt{\sum Parent^2}}$$

Where Sub and Parent represents the number of patents in field j granted to the subunit and parent, respectively; the $\sum$ in this equation is calculating the sum of patents through all technological fields.

Figure 2 shows a distribution of subunits among these four categories across the dimensions of subunit technological distance and subunit CC intensity. After the mapping of the full sample, we then controlled the sample size to include only large subunits – in the effort of capturing subunits with higher level of innovative activities, we included in this subset only subunits with more than 50 patents granted in a five-year window. The distribution pattern of this subset is shown in Figure 3.

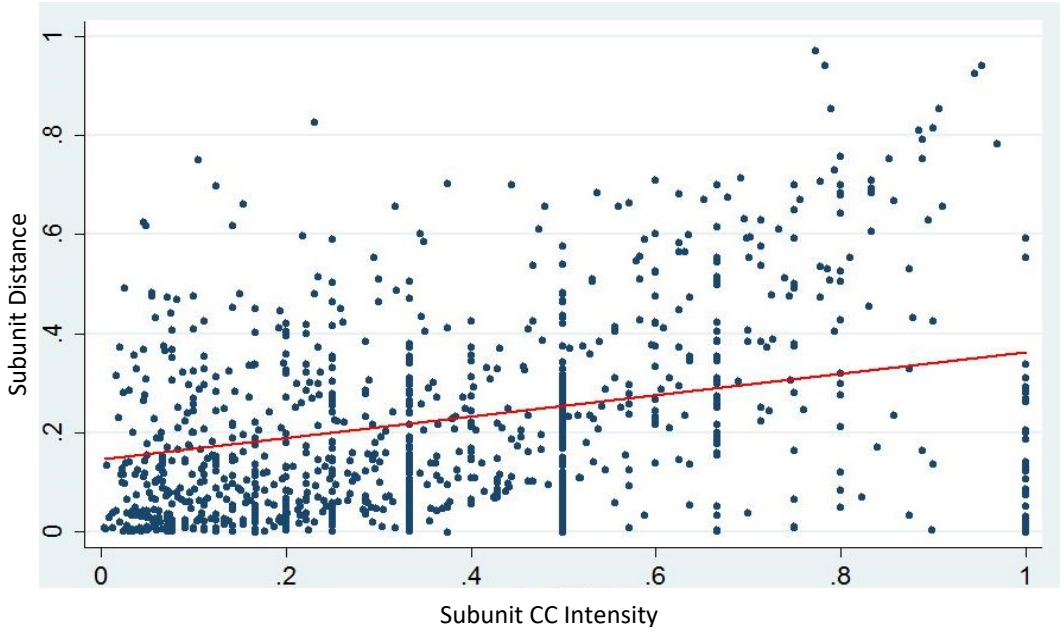

Figure 2: Subunit Distance and CC Intensity (full sample)

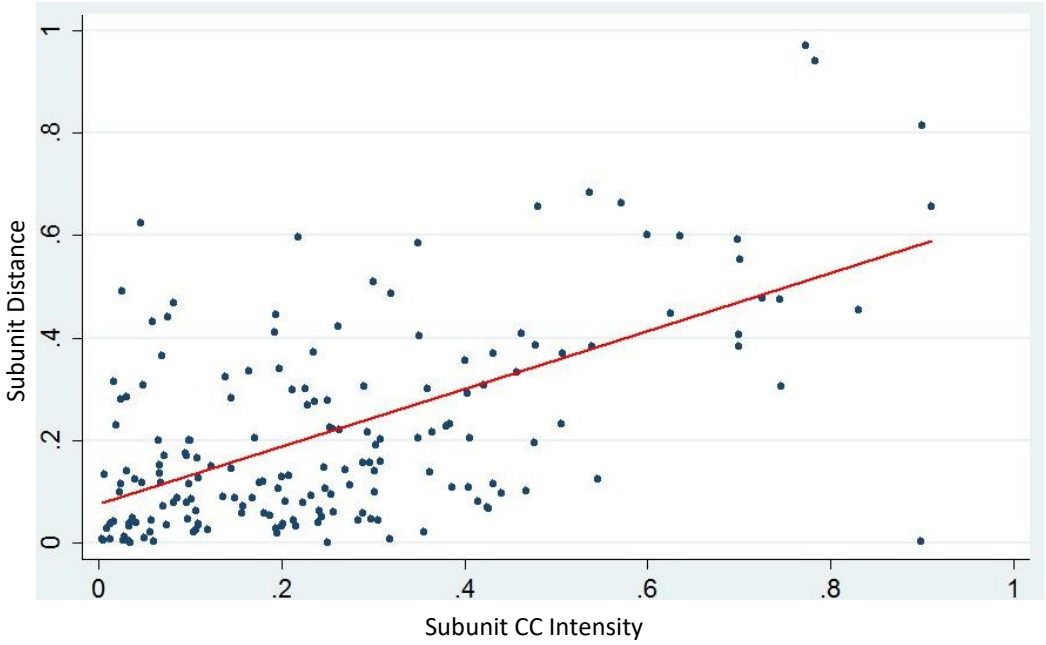

Figure 3: Subunit Distance and CC Intensity (Large Subunits)

Comparing these two figures, large subunits demonstrate a stronger positive relationship between dimensions of subunit technological distance and subunit CC intensity. Large subunits distribute more closely along the fitted regression line, while smaller subunits tend to have more various types of positioning as shown on the diagrams.

3.2 Evolution of Subunit

To examine the trajectories of subunit role evolution, we use the typology developed in the previous part with dimensions of subunit CC intensity and subunit technological distance. By examining the change in each of these dimensions over different time periods, we can construct a new model that distinguishes subunit evolution paths based on their directions of movement.

Figure 4 shows the scattered distribution of subunits' evolution patterns. Since this chart uses the change in value of the two dimensions as the axis, it is intuitive to use value 0 as the dividing cut-up point to distinguish types of subunit evolution pattern. We use all data sample in this diagram. The large subunits sample shows

almost the same results, except with fewer observations. The reason of this is that subunits have to show a consistency in their overall competence creativeness throughout more than one-time window to be included in this result. Smaller or newer subunits are not showing this consistency; therefore, it's hard to capture their evolution patterns. Large subunits, however, are more likely to show up repeatedly in this chart because of the capability of conducting continuous CC activities.

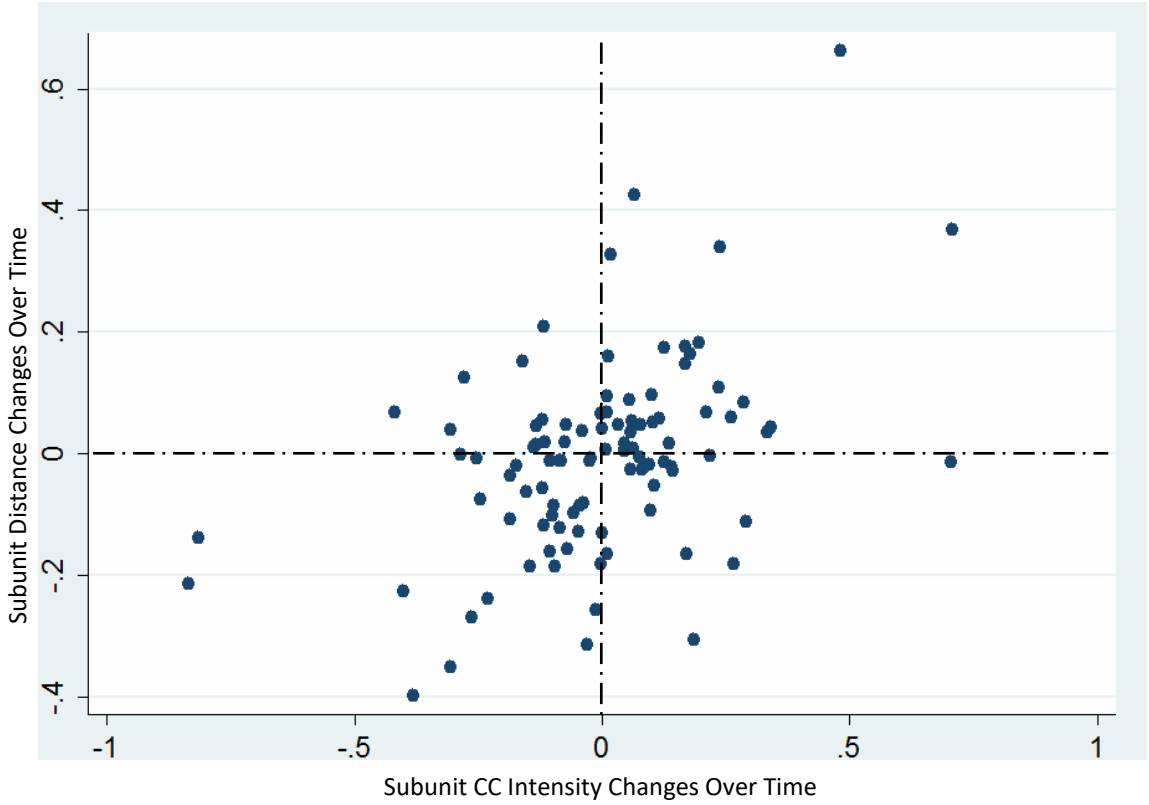

Figure 4: Subunit Evolution Patterns

In Quadrant I of Figure 4, subunits are demonstrating an increase in both their technological distance from their parent group and their CC intensity. These subunits are likely those that are heavily embedded in host country local environment while at the same time possess a favorable mandate from the MNC group to facilitate their further development of innovative activities that are new to the MNC group. 42 subunits are identified in Quadrant I, among which the most consistency is shown by the subunit of the Swiss firm Novartis in the US. Novartis is a pharmaceutical company that has its center of research and development based in Basel, Switzerland, with other key research sites located in Horsham, UK; Vienna, Austria; Tsukuba, Japan; East Hanover, New Jersey, USA. Their strategy for innovation is "focused diversification" (from Novartis website), by which they mean a concentration on pharmaceutical, biomedical innovation while encouraging diversification into related areas. It is shown in the data that Novartis US started as a traditional type of subunit, with technological distance of 0.04 and CC intensity of 0.04; in the following period this pair of numbers were increased to (0.09, 0.30), whereas towards the end of my observation period the numbers reached (0.11, 0.40). It is clear that Novartis US is on the trajectory of evolving into a category of more emphasize on CC type of activities.

Quadrant II of Figure 4 includes subunits that are increasing in their technological distance from the parent company, yet the level of CC activity intensity decreases overtime. These subunits are moving into the direction of concentrating more on CE activities, but their areas of niche application stays strong and even draws further away from the parent company. A typical example of subunit in this quadrant is ExxonMobil's operation subunit in Canada.

Quadrant III is consisting of subunits that are decreasing on both technological distance and CC intensity. Depending on the actually type of subunit, falling into this type of evolutionary trajectory could mean one of the

two possibilities: (1) the subunit is already well advanced in both technological distance and CC intensity as a center of excellence, now it is time for the competence created by this subunit to be transferred back to the parent company and then further to the international network of MNC group – as a result the subunit itself demonstrates a relatively lower level of CC intensity and technological distance overtime; (2) the subunit is less of a center of excellence, and the field of specialization which is new to the parent company is either no longer a specialty of the subunit itself, or somehow adapted by the parent company. One typical example is US company Schering Plough's operation in Germany. Its subunit technological distance dropped from 0.033 to 0.004, while its CC intensity dropped from an outlining 0.949 all the way down to 0.387. This is an extreme case due to a merger between the US company Plough Inc. and Germany company Schering Corporation. In this case, the reduction of CC activity presence is showing the effect of two companies corresponding and transmission technological capabilities into one another.

Quadrant IV indicates an increase in CC intensity while the technological distance decreases. This could be caused by a more focused effort on CC areas that are to some extent related to the parent company's fields of specialization – just like apples don't fall far from the tree. An example would be Novartis's operation in Germany, which follows perfectly to the company's strategy – "focused diversification" as explained in previous discussion.

4. Discussion and Conclusion

This study uses patent data, conducting exploratory data analysis to create a new typology for MNC subunit roles, which provides a continuous measure to examine an MNC subunit's innovation pattern. We then applied this typology to examine the evolutionary trajectory followed by the paths of technological growth of MNC subunits. There are two dimensions of subunit innovation patterns that this study identifies: subunit CC intensity and subunit distance. Using USPTO data from the general chemical industry, we are able to identify different types of subsidiaries using our new measure of CC activities, indicating the various strategic roles assumed by the subsidiaries. Our results demonstrated a preliminary understanding of our research question – knowledge creating activities of a subsidiary does reflect its strategic role. Furthermore, the over-time evolution of roles is reflected in shifting CC activity patterns.

The paper makes both theoretical and practical contributions to the literature of MNC innovation and subunit strategic roles by presenting a continuous model to examine competence-creating activities of MNC subunits. There has been a gap in the knowledge management literature on the topic of the competence creating roles of MNC subsidiaries. The current KM literature has demonstrated a keen interest in MNC knowledge transfer, but there is little discussion on how different types of knowledge accumulation, leading to either competence creation or exploitation, affects the subsidiary strategy roles. Traditionally the knowledge activities are identified at the subsidiary level, categorizing a subsidiary to be either CC or CE type, allows little flexibility or complexity for reality. This paper addresses this gap by providing a continuous measure to subsidiary knowledge activities.

Methodologically, a connection between statistical data analysis and individual firm examples is made in the discussion of subunit evolutionary trajectories, which can lend itself to possibilities of in-depth case studies. Using the typology designed in this study, we can further examine the relationship between MNC strategy and subunit role evolution, using the continuous variables to describe a subunit's innovative activities rather than categorizing subunits as a CC or CE type, which in turn allows for a more realistic understanding of MNC subunit behavior – as innovative firms should always have a combination of CC and CE innovations.

On the management and practical side, the findings of this exploratory study provide insights on the strategies of MNC and subsidiary knowledge management. Firms can apply the newly categorized roles to better define their strategic intentions for their subsidiaries, while allowing for flexibility, and anticipating the trajectory of evolution in the future. Subsidiary management can creatively engage in a combination of CC and CE activities, strategically placing their innovative efforts in areas that are related to their parent company, and in the meantime develop their own unique knowledge portfolio. As MNCs make their strategic goals for their various subsidiaries, depending on their long term visions and the location specific advantages from the host country locations, they are able to create focused yet flexible knowledge management objectives to balance the CC and CE activities in each location, therefore achieving an optimal combination between MNC strategic integration and locally embedded development.

One of the limitations of this study is due to the nature of patent database – since MNC subunit are identified at country level, there are large countries (especially the US) that can have internal variation in terms of MNC activities. Our current study does not identify these within-country variations. A future study could be designed

to identify regions of large countries and break the data of large countries down to regional level, which may provide more interesting results when MNC subunits are identified at a lower level.

Future study could concentrate more on a comprehensive empirical analysis of the evolutionary trajectory for subunits. Host country location's industry conditions could also be taken into consideration when analyzing these evolutionary trends, as the host country co-evolves with large MNC's subunits.

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The Association of Knowledge Management and Academic Performance in Academia

Krishna Prasad Paudel
School of Education, Kathmandu University, Lalitpur, Nepal

kpaudel.np@gmail.com
kppaudel@kusoed.edu.np

Abstract: The usage and practices of knowledge management in higher educational institutions are growing after the development of information and communication technology. Knowledge management in educational institutions is being practiced to enhance academic activities, particularly in innovative change in the research as along with teaching and learning practices. Knowledge management in academia impact on the academic performance of faculty members while conducting academic activities and promoting academic discourses is today's concern. In this background, this research adopts a quantitative methodology to collect data from the 445 academic staff employed at four universities in Nepal. The factor analysis was used to explore the variables and items associated with knowledge management and academic performance. This process has identified seven processes of knowledge management and four processes of academic performance. The relationship was carried out by using correlation analysis while the multiple regression analysis was used to measure the association of knowledge management and academic performance. The research shows the association between the processes of knowledge management and academic performance. The association and relationship of knowledge management and academic performance matter highly in academia. Furthermore, the knowledge creation process enhances the intellectual capital of every individual which has an impact on the knowledge economy of a society.

Keywords*:* Knowledge management, Academic performance, Association, Model, Academia

1. Introduction

The importance of Knowledge Management (KM) has been highly recognized in educational institutions, particularly in academia. KM in academia has been prioritized for a long time, seeking educational productivity and performance. Petrides and Nodine (2003) knowledge management practices seek to help teachers and faculty gather data and share information about which teaching approaches are most effective in specific learning environments.. Hence, the statement describes the importance of KM for stakeholders of higher educational institutions and universities to run their academic activities and enhance their academic performance. The majority of the organizations recognize knowledge as a major resource to obtain and sustain a competitive advantage. Knowledge has become an organizational asset that increases an organization's productive and adaptive capabilities (Marquardt, 2011). Knowledge management in academia is being used to enhance individual and institutional productivity. The effective KM in higher educational institutions demands how the academic activities of the university along with teachers and students are being practiced (Santosh & Panda, 2016). In this context, KM in Nepalese academia is being practiced to enhance academic activities in different areas such as research and publication, and theoretical integration in the teaching and learning process. Present research explored seven processes of knowledge management i.e., knowledge acquisition, generation, dissemination, transfer, creation, presentation, and utilization. It also explored four processes of academic performance i.e., research and publication, interactive learning, innovation, and capacity building. The study showed the association of research and publication with knowledge utilization, acquisition, and creation; innovation with knowledge utilization, acquisition, and presentation. It also confirmed interactive learning activities with knowledge utilization, generation, and dissemination; and capacity building with knowledge utilization, generation, acquisition, transfer, and creation.

2. Literature Review

The human mind can generate knowledge through reflection, interpretation, synthesis, and context of data that are available in the field. Davenport (1997, p. 9) clarified that data are "observations of states of the word, which can be easily structured, captured on the machine and later on can be transferred easily". The two dimensions of knowledge creation as identified by Nonaka, Toyama, and Hirata (2008) are epistemological and ontological. The epistemological dimension concerns the conversion of knowledge from tacit to explicit and vice-versa in any institution. The ontological dimension transforms knowledge from individuals to groups and then transfers that knowledge from groups to the organization (Nonaka, 1994) to enhance organizational efficiency and

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productivity. The combination of these two dimensions is referred to as the model of SECI (Socialization, Externalization, Combination, and Internalization).

Knowledge management includes the process of conversion of tacit knowledge into explicit knowledge. This knowledge is further accessed, shared, and transferred by individuals and groups within organizations. Based on the context and situation, either we follow a technology-focused process or a process-focused process to convert tacit knowledge into explicit one. Knowledge management needs to study three elements- people, processes, and technology (Edwards, 2011). The people or users at the different institutions use some types of technological tools either to generate or transfer to solve problems. According to Mao, Liu, and Zhang (2015), people implement organizational changes to enable a knowledge-sharing culture. Literature has revealed that knowledge management is composed of 80% people and 20% technology (Girard and Girard, 2015). Thus, people must be motivated to share what they know. People with high technical skills are very innovative and are needed in most organizations (Bassi, 1998). Parlby (1997) defines it as the discipline of capturing knowledge-based competencies for storing and disseminating them for the benefit of the organization as a whole.

2.1 Knowledge Management and Academic Performance

KM has been broadly applied not only in the business sector but also in the higher education arena. The goal of KM in academic institutions also relates to the management of knowledge to achieve an institution's advantages (Mohayidin et al., 2007; Yusoff, Mahmood, and Jaafar, 2012). These advantages cover the achievement of the higher education mission such as teaching, conducting research, and community servicing along with the improvement of organizational management that covers developing strategic plans and improving decision-making processes.

Universities are the prior place to conduct academic activities, along with research and publication. According to Steinberger (1993), academic performance is a multidimensional concept related to human growth and cognitive, emotional, social, and physical development. Academic performance is used to enhance the capacity of the individuals in HEIs. Fairweather (1996); Marsh and Hattie (2002); and Asif et al., (2017) explain academic performance as activities like teaching and research. They focus on the academic performance of the faculty members as they teach inside classrooms and conduct research outside the classrooms. After teaching, the next job would be to conduct research activities that generate new concepts and enhance the capacity of both the students and faculty members.

The main objective of the academic output is to prepare both the faculty members and students for the research and innovation activities. Besides this, another objective is to prepare them to deliver the ideas and concepts of research inside the classroom along with developing new concepts. University Grant Commission (UGC) of India (2010) has identified the academic performance indicator (API) in three categories as (1) teaching, learning, and evaluation-related activities; (2) co-curricular, extension, and professional development related activities; and (3) research and academic contributions related activities. Their framework highlights both activities of lecturing in classrooms and conducting research activities outside the classrooms. Research innovations inside as well as outside the classrooms help them to develop new knowledge. It also enhances the capacity of the individuals in the context of educational institutions.

The review of the existing KM literature in higher education suggests that various KM definitions can be categorized into three distinct perspectives: economic, cognitive, and information management (Wiig, 1993; McCarthy, 2006; Lee, 2007). Each perspective leads to the underlying assumptions of each KM definition. The major objectives of the university are to teach and make active participation of the learners along with the faculty members in the research activities. They are expected to produce the new knowledge which is required to the society and nation. It enhances the individuals and organizational capacity. Hilman and Abubakar (2017) regard academic performance as the student-related academic activities and their extra-curricular achievements. The study conducted by Zwain, Lim, and Othman (2012) emphasize the collaboration of KM in higher educational institutions to enhance academic performance. Further, they explored the student-related academic attainment as students' academic status, classes of degree, and graduation rates as the indicators of assessing university performance. The extracurricular achievements consist of having competitive positions, innovation, organizational agility, sustainability, and market share.

The learning behavior, network-building capacity, and information accessing attitude of faculty members help to enhance their capacity-building processes to produce new knowledge in academia (Paudel, 2020). The existing literature shows that there exists a relationship between knowledge management and academic

performance. The present study explores which processes of knowledge management is highly correlated with academic activities in higher educational context.

2.2 Knowledge Management in Nepalese Context

After the establishment of democracy in Nepal in 1990, the use of ICT is being prioritized in all sectors. The Ministry of Information and Communication (MOIC) developed the IT Policy (2000) that emphasizes the inclusion of computer education in the curriculum from the school level. The IT Policy (MOIC, 2010) prioritized assisting educational institutions and encouraging domestic and foreign training in fulfilling the requirement of appropriate human resources of information technology. The purpose was to enhance organizational effectiveness and efficiency.

Referring to National ICT Policy (MOIC, 2015), it focuses on the ICT in education, research, and development. Likewise, the higher education policy of the Ministry of Education (2015) focuses on (i) producing human resources competent enough in the global context, (ii) prioritizing research and development, (iii) establishing higher education research council, and (iv) enhancing the impacts of higher education studies and research and make it contextually relevant, useful and globally competent. Similarly, the HE Policy by UGC (UGC Nepal, 2015) emphasized (i) to promote access to higher education by regulating, managing, and maintaining the dignity of the higher education institutions regarding its establishment, operation, regulation, and management, (ii) to develop human resource inclined to science and technology, competitive and enterprising for the overall socio-economic development having established higher education as cornerstones of original knowledge and identity considering extension and diversification of school education, and (iii) to make globally competitive citizens with due focus on relevance, usefulness, and quality, increasing the opportunities for higher education and research.

National Planning Commission (2016) recommended making higher education accessible, competitive, and researchable. Likewise, as enshrined in the National Educational Policy released by the Ministry of Education, Science, and Technology (MOEST, 2019), the goal of education is to develop human resources by making education competitive, techno-friendly, employment-oriented, and productive as per the need of the country. In this regard, universities in Nepal are getting involved in producing innovative knowledge businesses. To get innovative concepts and ideas demands support from the stakeholders of the universities.

3. Method

A survey method was used to conduct this research. The self-developed survey tools was used to collect the data. The tools was developed by the researcher through the Delphi method. The Delphi method is a popular process to achieve consensus on important issues or complex social problems with the help of subject experts and practitioners in the particular field (Linstone and Turoff, 2002). The Delphi process generally includes in-depth interviews with practitioners in the field (grounded), written interviews, open-ended questions, and panel discussions with experts. Thus, the Delphi process carries out the local knowledge, norms, and values in the social context (Paudel, 2019a). Campanelli (2008) advised three steps in tools development such as literature review, experts' consultation, and understanding of participants' cultural and language issues while developing the survey questions.

The steps of the tools' development have been defined as:

Step I: Books, journal articles, working papers, research reports, and empirical studies of knowledge management and academic performance in the contexts of higher educational institutions were reviewed.

Step II: Open interviews with knowledge management experts and practitioners to identify the contextually measurable items of knowledge management and academic performance were conducted. Guzys, Dickson-Swift, Kenny, and Kenny (2015) suggested selecting the participants on the basis of their experience and knowledge.

Step III: Guzys et al. (2015) opined that such a panel discussion was a part of Delphi. Therefore, a panel discussion consisting of a team of experienced experts and role players in the areas of knowledge management sector was conducted. Dew and Xiao (2011) also argued that the panel discussion among the experts help in assuring face and content validity.

Step IV: Collecting the items

In this study, the identified indicators from the grounded data including experts' views and insights received from panel discussion were compared with literature and categorized into different dimensions of knowledge management and academic performance. The variables/items of knowledge management were named; KM1,

KM2 and so on. For the variables/items of academic performance were named; AP1, AP2, and so on. The researcher developed 7-point Likert scales from the indicators identified from the field (grounded) expert interviews and literature to measure knowledge management practices. Croasmun and Ostrom (2011) argue that high-scale points increase reliability. On that account, the researcher followed the 7-point scale to develop a questionnaire for this study. The tool used to conduct this research is presented in Annex. The reliability and validity of the tool were tested before collecting the data. Many statistical tools are available to measure the reliability and internal consistency of the data. Among them, the split-half method and alpha coefficient of consistency are mostly used (Best and Kahn, 2006). Cronbach's alpha coefficient was then used in the study to check the consistency of the instrument. "For an instrument to be used, its internal reliability coefficient Cronbach's alpha (α) must be at least 0.7" (Santos, 1999). In this study, all of the dimensions of knowledge management had a value greater than 0.7 and satisfied this condition. Creswell (2013) explained that validity seeks whether the questionnaire measures what it intends to measure or not. Among many types of validity, construct, content, and criterion validity are three principal validities that need to be considered at the very outset of quantitative research (Cohen, Manion, and Morrison, 2018). Construct, content, and criterion validity are evaluated during the whole process of research (Babbie, 2001; Huck, 2012).

The population of this study primarily comprised all the faculty members (professors, associate professors/readers, and assistant professors/lecturers) working at the central schools/departments of the four universities of Nepal. The faculty members were taken from the general education stream, particularly the Humanities, Education, Management, and Science departments. The faculty were taken from Tribhuvan, Kathmandu, Purvanchal and Pokhara University. First of all, I managed to prepare a list of the respondents with the contact numbers and meeting were requested with them with the help of the head of department of each schools/departments. The survey was conducted in the group meeting according to the schedule provided by the respective central colleges of the university. In each survey, I requested selected participants to fill up the questionnaire. I confirmed self-enumeration of the data to reduce the non-response error, incomplete response, the cost of data collection. Also, it was to help in managing secrecy of sensitive issues (Weisberg, 2009). As I collected the data, the research has opened two options to respond to the questionnaire, either to fill up the printed copy of the questionnaire or provide the information through e-mail by using google form that I developed.

The data was collected from 445 faculty members of higher educational institutions of Nepal, working in central campuses of four universities. The data was collected through stratified sampling methods between January to July 2017. Initially, the data was coded in SPSS version 25. The factor analysis was executed to explore the dimensions of knowledge management and academic performance. Factor analysis is a multivariate statistical technique (Rummel, 1967; Shenoy and Madan, 1994), which is used to determine a large number of variables in terms of relatively few hypothetical variables called factors. The correlation analysis was executed to see the relationship between dimensions of knowledge management and academic performance. The correlation analysis explains three fundamental dimensions of data: significance, direction, and magnitude (Sekaran, 2003). To measure the associations between knowledge management and academic performance, the regression analysis was executed. The main reason for conducting a multiple regression analysis was to determine whether the regression coefficients of the given predictor set of variables were statistically different or not (Cohen, West, and Aiken, 2014). The current study determined the association between knowledge management and academic performance in a higher educational context.

4. Results

The dimensions of knowledge management and academic performance were identified by using factor analysis. Before executing factor analysis all the conditions (Field, 2005) were checked. Once the number of items under each factor was identified, the name of the factor was given based on the variables within the factors (Young & Pearce, 2013) based on the researchers' judgement. The items/variables of factors of knowledge management is presented in Table 1.

Table 1: Final Factors of Knowledge Management

Factor	Item Name	Factor Loading						
		1	2	3	4	5	6	7
1	Improve Efficiency	0.723						
	Conduct Research	0.718						

Factor	Item Name	Factor Loading						
		1	2	3	4	5	6	7
	Increase Thought	0.645						
	Daily Life Issues	0.595						
	Solving Problem	0.552						
2	Interaction		0.724					
	Discussion		0.723					
	Modern Technology		0.671					
	Conducting Training		0.46					
3	Individual Performance			0.734				
	Organizational Leadership			0.616				
	Professional Networks			0.606				
	Conference Participation			0.514				
4	Knowledge by Teaching				0.697			
	Usage of Social Media				0.682			
	Institutional Research				0.58			
5	Usage of e-Portal					0.718		
	Learning Environment					0.715		
	Training Sessions					0.571		
6	Mentoring new faculty						0.748	
	Joint Projects						0.563	
	Workshop/Conference						0.532	
	Purchase of e-Sources						0.411	
7	Individual Training							0.73
	Simulators							0.693
	Consultancy Services							0.515

Table 1 shows the keywords of the items of the variable with their respective factors of knowledge management identified by factor loading. Based on the keyword of the items/variables, the name of the factors was given. These factors were named Knowledge Utilization (KU), Knowledge Acquisition (KA), Knowledge Generation (KG), Knowledge Dissemination (KD), Knowledge Transfer (KT), Knowledge Creation (KC), and Knowledge Presentation (KP) respectively.

The items/variables of factors of academic performance is presented in Table 2.

Table 2: Final Factor of Academic Performance

Factors	Items Name	Factor Loading			
		1	2	3	4
1	Involvement in Research	0.879			
	Bringing Research Insights to Classroom	0.875			
	Mentoring through Technology	0.600			
	Conversion of Theory into Practice	0.530			
	Number of Publications	0.515			
	Interaction with Students	0.433			

Factors	Items Name	Factor Loading			
		1	2	3	4
2	Quality Information Inside Classroom		0.844		
	Classroom Environment		0.783		
	Case-based Learning		0.702		
	Focuses on Activities		0.430		
3	Preparation of Lesson Plan of Semester			0.790	
	Preparation of Lesson Plan of Topics			0.755	
	Use of e-Portal During Class			0.613	
4	Generation of New Knowledge				0.715
	Involvement of Students in Research				0.700
	Technology in Classrooms				0.673

Table 2 shows the keywords of the items of the variable with their respective factors of academic performance identified by factor loading. The factors of academic performance were termed considering the keyword of each item/variable. The first factor was named as Research and Publications (RP) while rest of other factors were termed Innovation (INNO), Interactive Learning (IL), and Capacity Building (CB) accordingly. Hence, this study identified the seven processes (factors) of knowledge management and four processes (factors) of academic performance.

To check the relationship of the dimensions of knowledge management and academic performance correlation analysis was executed. The study showed the correlations between the processes of knowledge management and the academic performance of faculty members. Each of the knowledge management processes, namely knowledge utilization, acquisition, generation, dissemination, transfer, creation, and presentation were correlated and regressed on each of the four dimensions of academic performance such as research and publication, innovation, interactive learning, and capacity building. The output of the correlation analysis is presented in Table 3.

Table 3: Correlations Between Knowledge Management and Academic Performance

	KU	KA	KG	KD	KT	KC	KP
RP	.44**	.36**	.33**	.32**	.20**	.36**	.24**
INNO	.40**	.33**	.26**	.37**	.12*	.18**	.25**
IL	.38**	.30**	.41**	.33**	.18**	.22**	.11*
CB	.52**	.37**	.53**	.38**	.38**	.18**	.24**
*Correlation is significant at the 0.01 (**.), 0.05 (*.) level (2-tailed).							

The results presented in Table 3 indicate the positive correlations between dimensions of knowledge management and academic performance at different levels. According to Bartz (1999), the relations among dimensions are from the range of very low to moderate level. However, since all the coefficients were found to range from very low to moderate correlation (Bartz, 1999), it was deemed necessary to conduct a regression analysis to determine the existence of a causal influence of knowledge management on academic performance. Multiple regression analysis was conducted to examine the contribution of the predictors of knowledge management for the dimensions of academic performance. The output of the multiple correlation analysis is presented in Table 4.

Table 4: Output of Multiple Regression Analysis

Predictor of KM	RP		INNO		IL		CB	
	Beta	t-Value	*Beta*	t-Value	*Beta*	t-Value	*Beta*	t-Value
Utilization	0.255	5.012*	0.224	4.245*	0.188	3.587*	0.287	6.351*
Acquisition	0.144	2.795*	0.085	1.585	0.088	1.658	0.085	1.852

Predictor of KM	RP		INNO		IL		CB	
	Beta	t-Value	*Beta*	t-Value	*Beta*	t-Value	*Beta*	t-Value
Generation	0.072	1.426	0.060	1.139	0.296	5.667*	0.369	8.190*
Dissemination	0.041	0.798	0.205	3.824*	0.109	2.039	0.060	1.301
Transfer	-0.052	-1.128	-0.094	-1.966*	-0.053	-1.123	0.150	3.651*
Creation	0.208	4.409*	0.008	0.155	0.006	0.133	-0.175	-4.192*
Presentation	0.065	1.491	0.129	2.859*	-0.054	-1.197	0.042	1.089
R	.531[a]		.479[a]		.490[a]		.659[a]	
R^2	0.282		0.229		0.240		0.435	
Adjusted R^2	0.270		0.217		0.228		0.425	

From the data of table 4, out of seven different independent variables, only three variables viz. knowledge utilization, acquisition, and creation are found significant for research and publication at a 5% level of significance. Similarly, knowledge utilization, dissemination, and presentation are found significant for innovation at a 5% level of significance. Likewise, knowledge utilization, generation, and dissemination are found significant for interactive learning at 5% of significance. And knowledge utilization, generation, transfer, and creation are found significant for capacity building at 5% of significance.

When the coefficients are significant, it proves that the respective predictor variables are relatively important in predicting the criterion variable. The results were interpreted using non-standardized beta coefficients and the R-square. Un-standardized coefficients show a change that is observable when the variables are in raw form. They are not standardized in the sense that they have different means and different standard deviations. The higher the beta coefficients of the independent (predictor) variables are, the more predictive power they have on the dependent (criterion) variable if the coefficient is significant. The R-square, in contrast, indicates the percentage of variance in the dependent variable, which is explained jointly by the independent variables (Hair et al., 1998). To analyze the significance, the step-wise regression was conducted. The output for a maximum number of the significant independent variable is presented in Table 5.

Table 5: Model Summary of Dimensions of Academic Performance

Dimension	R	R Square	Adjusted R Square	Std. Error of the Estimate
RP	.521[a]	0.272	0.267	0.65338
INNO	.466[b]	0.217	0.212	0.83895
IL	.481[c]	0.232	0.226	0.75932
CB	.656[d]	0.431	0.425	0.90258

- Predictors: (Constant), Knowledge Utilization, Knowledge Construction, Knowledge Acquisition
- Predictors: (Constant), Knowledge Utilization, Knowledge Dissemination, Knowledge Presentation
- Predictors: (Constant), Knowledge Utilization, Knowledge Generation, Knowledge Dissemination
- Predictors: (Constant), Knowledge Generation, Knowledge Utilization, Knowledge Transfer, Knowledge Construction, and Knowledge Acquisition

Table 5 shows that the model for research and publication; R=0.521 and R^2 =0.272 and Adjusted R^2 = 0.267. Taking the value of adjusted R^2, we can say that knowledge utilization, creation, and acquisition combine to explain the research and publication variable by 26.7%. That means, still 73.3% explanation of the research and publication is undefined. However, 26.7% is the pretty larger value to define a faculty's research and publication status due to different dimensions of knowledge management. Table 3 also shows the model of innovation; R = 0.466 and R^2 = 0.217 and Adjusted R^2 = 0.212. Taking the value of adjusted R^2, we can say that knowledge utilization, dissemination, and presentation combine to explain the innovative variable by 21.2%. That means, still 78.8% explanation of the innovation is undefined. However, 21.2% is the pretty larger value to define a faculty's innovation status due to different dimensions of knowledge management.

Table 5 shows the model of interactive learning; R = 0.481 and R^2 = 0.232 and Adjusted R^2 = 0.226. Taking the value of adjusted R^2, we can say that knowledge utilization, generation, and dissemination combine to explain the interactive learning variable by 22.6%. That means, still 77.4% explanation of the interactive learning is

undefined. However, 22.6% is the pretty larger value to define a faculty's interactive learning status due to different dimensions of knowledge management. Table 5 shows the model for capacity building; R = 0.656 and R^2 = 0.431 and Adjusted R^2 = 0.425. Taking the value of adjusted R^2, we can say that knowledge utilization, generation, acquisition, transfer, and creation combine to explain the capacity building Variable by 42.5%. That means, still 57.5% explanation of the capacity building is undefined. However, 42.5% is the pretty larger value to define a faculty's capacity-building status due to different dimensions of knowledge management. It is required to test the regression value based on the residual values after identifying the model of each dimension of academic performance. It is presented in Table 6.

Table 6: Regression and Residual Values of Dimensions of AP

Dimension		Sum of Squares	df	Mean Square	F	Sig.
RP	Regression	70.222	3	23.407	54.83	0.000[a]
	Residual	188.265	441	0.427		
	Total	258.487	444			
INNO	Regression	86.263	3	28.754	40.854	0.000[b]
	Residual	310.392	441	0.704		
	Total	396.655	444			
IL	Regression	76.615	3	25.538	44.295	0.000[c]
	Residual	254.263	441	0.577		
	Total	330.878	444			
CB	Regression	270.879	5	54.176	66.502	0.000[d]
	Residual	357.632	439	0.815		
	Total	628.511	444			

- Predictors: (Constant), Knowledge Utilization, Knowledge Construction, Knowledge Acquisition
- Predictors: (Constant), Knowledge Utilization, Knowledge Dissemination, Knowledge Presentation
- Predictors: (Constant), Knowledge Utilization, Knowledge Generation, Knowledge Dissemination
- Predictors: (Constant), Knowledge Utilization, Knowledge Generation, Knowledge Acquisition, Knowledge Transfer, and Knowledge Construction

In Table 6, the F test for research and publication was found significant (F = 54.83 and p-value = 0.000 ($<\alpha = 5\%$)). This means, the best-fit regression model with explanatory variables like knowledge utilization, creation and acquisition, and output variable research and publication can be developed. Likewise, the F test for innovation was found significant (F = 40.86 and p-value = 0.000 ($<\alpha = 5\%$)). This means, the best-fit regression model with explanatory variables knowledge utilization, and presentation and output variable innovation can be developed.

Table 6 shows that the F test for interactive learning wassignificant (F = 44.30 and p-value = 0.000 ($<\alpha = 5\%$)). This means, the best fit regression model with explanatory variables knowledge utilization, generation and presentation and output variable interactive learning can be developed. And, the F test for capacity building was found significant (F = 66.5 and p-value = 0.000 ($<\alpha = 5\%$)). This means, the best-fit regression model with explanatory variables knowledge generation, utilization, transfer, creation and acquisition, and output variable capacity building can be developed. Now, the result of the regression analysis for the t-test has been presented in table 7.

Table 7: Coefficients of Dimensions of Academic Performance

Coefficient		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig
RP	Constant (a)	1.843	0.311		5.931	.000

Coefficient		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig
	Knowledge Utilization	0.298	0.05	0.284	5.995	.000
	Knowledge Creation	0.241	0.044	0.234	5.453	.000
	Knowledge Acquisition	0.158	0.043	0.172	3.707	.000
INNO	Constant (b)	1.674	0.403		4.153	.000
	Knowledge Utilization	0.314	0.063	0.242	5.008	.000
	Knowledge Dissemination	0.221	0.043	0.24	5.088	.000
	Knowledge Presentation	0.19	0.061	0.138	3.128	0.002
IL	Constant ©	2.737	0.298		9.175	.000
	Knowledge Utilization	0.229	0.058	0.194	3.938	.000
	Knowledge Generation	0.224	0.039	0.274	5.752	.000
	Knowledge Dissemination	0.118	0.04	0.14	2.919	0.004
CB	Constant (d)	-0.557	0.443		-1.258	0.209
	Knowledge Utilization	0.491	0.072	0.301	6.786	.000
	Knowledge Generation	0.43	0.05	0.382	8.62	.000
	Knowledge Acquisition	0.165	0.059	0.115	2.788	0.006
	Knowledge Transfer	0.206	0.054	0.156	3.815	.000
	Knowledge Creation	-0.27	0.067	-0.168	-4.041	.000

- Dependent Variable: Research and Publication
- Dependent Variable: Innovation
- Dependent Variable: Interactive Learning
- Dependent Variable: Capacity Building

The data presented in Table 7 produces the four different models of academic performance concerning knowledge management. The multiple regression equation can be presented in the form of:

$$Y = \beta_0 + \beta 1x1 + \beta 2x2 + \beta 3x3 + ... + \varepsilon$$

Now, according to the value of Table 5, we can develop the following models of academic performance;

$$RP = \beta_0 + \beta 1KU + \beta 2KC + \beta 3KA + \varepsilon \text{.....i}$$

$$INNO = \beta_0 + \beta 1KU + \beta 2KD + \beta 3KP + \varepsilon \text{..... ii}$$

$$IL = \beta_0 + \beta 1KU + \beta 2KG + \beta 3KD + \varepsilon \text{..... iii}$$

$$CB = \beta_0 + \beta 1KU + \beta 2KG + \beta 3KA + \beta 4KT + \beta 5KC + \varepsilon \text{ .....iv}$$

After developing the model, Field (2005) suggests fulfilling the following conditions to confirm the models for their best fit: (1) No existence of autocorrelation, (2) No multi-collinearity, (3) No heteroscedasticity, (4) Normality of residuals.

To check the autocorrelation test, the Durbin-Watson Test was performed. The result of Durbin-Watson Test is presented in table 8.

Table 8: Durbin-Watson Test Statistics of Academic Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.521[a]	0.272	0.267	0.65338	1.827

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
2	.466[b]	0.217	0.212	0.83895	1.539
3	.481[c]	0.232	0.226	0.75932	1.962
4	.656[d]	0.431	0.425	0.90258	1.878

- Predictors: (Constant), Knowledge Creation, Knowledge Acquisition, and Knowledge Utilization; Dependent Variable: Research and Publication
- Predictors: (Constant), Knowledge Utilization, Knowledge Dissemination, and Knowledge Presentation; Dependent Variable: Innovation
- Predictors: (Constant), Knowledge Generation, Knowledge Utilization, and Knowledge Dissemination; Dependent Variable: Interactive learning
- Predictors: (Constant), Knowledge Utilization, Knowledge Generation, Knowledge Acquisition, Knowledge Transfer, and Knowledge Creation; Dependent Variable: Capacity Building

Since the value of Durbin-Watson presented in table 8 is 1.827 (model 1), 1.539 (model 2), 1.962 (model 3), and 1.878 (model 4) lying between the range of 1.5 to 2.5 (Field, 2005), it represented that there was no autocorrelation issue in the dataset. After measuring the value of Durbin-Watson it further tested the collinearity of Variance Inflation Factor (VIF), which is presented in Table 9.

Table 9: Collinearity of VIF Test Statistics of Academic Performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig	Tolerance	VIF
		B	Std. Error	Beta				
1	Constant (a)	1.84	0.31		5.93	.000		
	KU	0.30	0.05	0.28	6.00	.000	0.73	1.36
	KA	0.16	0.04	0.17	3.71	.000	0.77	1.31
	KC	0.24	0.04	0.23	5.45	.000	0.90	1.12
2	Constant (b)	1.67	0.40		4.15	.000		
	KU	0.31	0.06	0.24	5.01	.000	0.76	1.32
	KD	0.22	0.04	0.24	5.09	.000	0.80	1.25
	KP	0.19	0.06	0.14	3.13	.002	0.92	1.09
3	Constant (c)	2.74	0.30		9.18	.000		
	KU	0.23	0.06	0.19	3.94	.000	0.72	1.39
	KG	0.22	0.04	0.27	5.75	.000	0.77	1.30
	KD	0.12	0.04	0.14	2.92	.004	0.76	1.32
4	Constant (d)	-0.56	0.44		-1.26	.209		
	KU	0.49	0.07	0.30	6.79	.000	0.66	1.52
	KA	0.17	0.06	0.12	2.79	.006	0.76	1.32
	KG	0.43	0.05	0.38	8.62	.000	0.66	1.52
	KT	0.21	0.05	0.16	3.82	.000	0.78	1.29
	KC	-0.27	0.07	-0.17	-4.04	.000	0.75	1.34

- Dependent Variable: Research and Publication
- Dependent Variable: Innovation
- Dependent Variable: Interactive Learning
- Dependent Variable: Capacity Building

Table 9 showed that the VIF for each of the independent variables was between 1- 10 (Field, 2005). This means there is no issue of multi-collinearity. Further, to test the best fit of the model, the effect of the independent variables on the residual was checked to understand the issue of heteroscedasticity. After testing VIF, it further tested Heteroscedasticity which is presented in Table 10.

Table 10: Heteroscedasticity Test Statistics of Academic Performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Std. Error	Beta		
1	(Constant)	-3.1E-15	0.311		.000	1.000
	KU	.000	0.05	.000	.000	1.000
	KA	.000	0.043	.000	.000	1.000
	KC	.000	0.044	.000	.000	1.000
2	(Constant)	1.768	0.403	.000	.000	1.000
	KU	.000	0.063	.000	.000	1.000
	KD	.000	0.043	.000	.000	1.000
	KP	.000	0.061	.000	.000	1.000
3	(Constant)	2.479	0.298	.000	.000	1.000
	KU	.000	0.058	.000	.000	1.000
	KG	.000	0.039	.000	.000	1.000
	KD	.000	0.04	.000	.000	1.000
4	(Constant)	1.37E-15	0.443		.000	1.000
	KU	.000	0.072	.000	.000	1.000
	KA	.000	0.059	.000	.000	1.000
	KG	.000	0.05	.000	.000	1.000
	KT	.000	0.054	.000	.000	1.000
	KC	.000	0.067	.000	.000	1.000

As observed in Table 10, none of the independent variables significantly contributed to the unstandardized residual. So, it can be claimed that the model does not have the issue of heteroscedasticity. After this, the normality of distribution was tested. The histogram was produced and it showed that there were no issues of normality. Thus, the model presented in the model summary in table 5 has (a) no issue of autocorrelation, (b) no issue of multicollinearity, (c) no issue of heteroscedasticity, and (d) residuals are normally distributed. It showed that there was an association between knowledge management and academic performance, particularly the linear relationship among the research and publication with knowledge utilization, acquisition, and creation; innovation with knowledge utilization, dissemination, and presentation; interactive learning with knowledge utilization, generation, and dissemination; and capacity building with knowledge utilization, acquisition, generation, transfer, and creation. The association is presented below.

If we put the value of Table 5 to equations (i), (ii), (iii), and (iv), then we get;

RP = 5.931 + 5.931KU + 5.995KC + 3.307KA …….. (1)

INNO = 4.153 + 5.008KU + 5.088KD + 3.128KP …….. (2)

IL = 9.175 + 3.938KU + 5.752KG + 2.919KD …….. (3)

CB = 1.258 + 6.786KU + 8.620KG + 2.788KA + 3.815KT + 4.041KC ……..…..(4)

The model of academic performance in higher educational institutions explains the relations of different academic activities through knowledge management to enhance academic discourses. The research and

publication demand some six activities of knowledge utilization, six activities of knowledge creation, and three activities of knowledge acquisition to perform the research and publication activities in higher educational institutions if other things remain constant. The model further demands five activities of knowledge utilization, five activities of knowledge dissemination, and three activities of knowledge presentation to make innovative academic works.

The model further explained that interactive learning can be done through the integration of four activities of knowledge utilization, six activities of knowledge generation, and three activities of knowledge dissemination. The last model explained the capacity building of the faculty members in HEIs. It demands the integration of six activities of knowledge utilization, eight activities of knowledge generation, two activities of knowledge acquisition, three activities of knowledge transfer, and four activities of knowledge creation in the context of higher educational institutions. Hence, an association exists between knowledge management and academic performance. The association of research and publication was determined by knowledge utilization, creation and acquisition; innovation by knowledge utilization, dissemination, and presentation; interactive learning in knowledge utilization, generation, and dissemination; and capacity building on knowledge utilization, generation, acquisition, transfer, and creation in the context of higher educational institutions.

5. Discussion

The previous researches were views form the concepts of the KM and collaboration of KM in academia. But this research focuses how the academic activities and discourses is demanded to practice knowledge management in academia to enhance intellectual capital and knowledge economy of a country. The study also indicates that the faculty members of HEIs can empower with high academic excellence which impact on the effectiveness of transferring the new knowledge to students. In this regard, the regression analysis identified the linear relationship of research and publication only with three dimensions of KM, namely knowledge utilization, knowledge acquisition, and knowledge creation. Mainly the interaction, group discussion, conduction of training activities, usage of modern technology, mentorship to the new faculty, conduction of joint projects, accessing of e-sources, participation in the workshop and conferences help to enhance the personal efficiency to conduct research activities in the educational context. KM enhances research collaboration across a university, increasing the number of research projects and publications (Chumjit, 2012; Cranfield, 2011; Tan and Noor, 2013). New methods for research are created that facilitate researchers to develop research proposals that are matched with private sector needs, including receiving extra funding from the private sector (Chumjit, 2012). For this, technology allows employees to access, collect, and assimilate existing internal knowledge within an organization and/or external knowledge from outside (Dalkir, 2005; Watcharadamrongkun, 2012) and helps to generate new knowledge. The systems/facilities such as the internet, e-mail, intranet, groupware, telecommunication, memorandum, weblogs, mobile technology, online/web-based learning system, and CD/DVD/VCD facilitate KM at the universities for research activities. The knowledge management behavior of individuals enhances the research activities within educational institutions.

Similarly, the test statistics presented in table 3 show that there exists a linear relationship between knowledge management and innovation. In the same chapter, the regression analysis identified the linear relationship of innovation only with three dimensions of KM, namely knowledge utilization, knowledge dissemination, and knowledge presentation. It is found that consultancy services, development of simulators, conduction of training sessions, usage of social media, problem-solving capacity are in good position. Problem seeking and solving in higher education (Mohamad, 2012) is enhancing innovation within the educational context mainly in the higher education institution of Nepal. The knowledge disseminating and presenting behavior of faculty members enhance the innovative process of the faculty member and help to generate new knowledge. Involvement and participation affect knowledge sharing in higher education (Mohamad, 2012).

Knowledge management supports innovation in two ways (Maqsood and Finegan, 2009). First, it helps organizations locate innovative knowledge in the outside world, brings that knowledge inside the organization, and effectively incorporates it into work practices. Second, knowledge management supports innovation by helping organizations to perform more productively. The KM processes help organizations to obtain, assimilate and use external innovative knowledge. The innovation is guided by the theory of SECI (Socialization, Externalization, Combination, and Internalization) developed by Nonaka and Takeuchi. According to Petrides and Nodine (2003), the entire objective of KM in education is to augment and ensure that students get the right knowledge through the quality of material or instructions. Bhusry and Ranjan (2011) state that KM can enhance the quality of teaching and learning in tertiary educational institutions. It implies that the knowledge management behavior of individuals impacts the innovative process of the individuals.

Likewise, the test statistics presented in table 3 show that there exists a linear relationship between knowledge management and interactive learning. In the same chapter, the regression analysis identified the linear relationship of interactive learning only with three dimensions of KM, namely knowledge utilization, knowledge generation, and knowledge dissemination. Gopal and Shobha (2012) recommended integrating the KM in university for the teaching and learning process. The study conducted by Zwain, et al., (2012) followed literature to identify the dimensions of knowledge management and academic performance, then tested the significant relationship between knowledge management and academic performance in Iraqi HEIs. For this research, the researcher followed factor analysis to identify the dimensions of knowledge management and academic performance of Nepalese HEIs after developing the tools from the Delphi method. The study of Zwain, et al., (2012) focuses on the leadership role while testing the hypothesis in Iraqi HEIs but the researcher highlighted the academic activities and discourses of the academic staff of Nepalese HEIs to test the association between knowledge management and academic performance. The current study examined the association of academic performance, particularly research and publication, innovation interactive learning, and capacity building along with the knowledge management practices in higher educational institutions of Nepal. Chumjit (2012) explored the application of knowledge management (KM) in the higher education institutions of Thailand for new methods for improving teaching, research, administration, and strategic planning within various sections and departments. These days, interactive learning is impacting technology. The modern tools of IT and ICT are playing a vital role to enhance the interactive learning process in the educational context. University obtains new methods for teaching which will encourage students to pay more attention to their studies (Chumjit, 2012). Higher education intended to promote learning at the institutional level should implement practices related to the generation of knowledge employing research, training, and documentation (Turyasingura, 2011). Thus, knowledge management impacts the interactive learning process in the context of higher education institutions.

Similarly, the test statistics presented in table 3 examine that there exists a linear relationship between knowledge management and capacity building. In the same chapter, the regression analysis identified the linear relationship of capacity building with five dimensions of KM, namely knowledge utilization, knowledge acquisition, knowledge generation, knowledge transfer, and knowledge creation. The ultimate goal of a university is to build up the capacity of the faculty member. They can enhance the capacity of the faculty member through conducting training activities, conducting seminars and workshops, engaging in research activities, etc. The ICT Policy of Nepal (2015) emphasizes the ICT in education, research, and development. Hence, the influence of knowledge management in academic performance is in the same line as the previous finding of Chumjit (2012) that the universities can identify their core competencies and improve their abilities in teaching, research, and administrative systems. Turyasingura (2011) indicates that higher education institutions intending to promote learning at the institutional level should implement practices related to the generation of knowledge through research, training, and documentation, as well as by rendering easily accessible such knowledge for others to use. The study of Paudel, Bhattarai, and Chalise (2021) shows that knowledge management is helping to enhance academic activities and discourses in academia. Hence, the knowledge management processes mostly focus on how the knowledge is acquired in an organizational context, how the knowledge is disseminated and transferred to the seekers of knowledge, and how individuals, groups, and organizations manage and utilize such types of knowledge to enhance the organizational efficiency and productivity. Likewise, academic performance, particularly, academic activities are concerned with the faculty member to enhance their capability of conduction of research and dig out the knowledge from such research. It also focuses on how the students can be engaged in such activities and work to enhance their conceptual and practical knowledge. Moreover, it focuses on how the interactive learning process can enhance in an educational context, and how the capacity of both faculty members and students can enhance academic discourses in academia. The SECI model helps to internalize the concepts and ideas to enhance the capacity building process along with innovative process of faculty members and students in higher educational context.

The model of academic performance in academia digs out the concepts of the model drawn by regression analysis. It shows that it demands some activities of knowledge utilization, acquisition, and creation to enhance the capabilities of the research and publication in academia. In the same line, it demands some activities of knowledge utilization, dissemination, and presentation to make faculty members more innovative and productive. Likewise, interactive learning seeks some activities of knowledge utilization, generation, and dissemination to make the classroom activities and the learning effective and student-centric. In the same line, enhancing the capacity of faculty members demands the practices of knowledge management such as knowledge utilization, acquisition, generation, transfer, and presentation in the academic context. As universities are the center of knowledge production and creation, the knowledge creation process of individual, group, and institution impact to enhance the intellectual capital of individual (Paudel, 2019b). Hence, in the era

of the knowledge economy, society is always driven by the concept and knowledge of the intellectual, so-called teachers of the university.

6. Limitations and Future Research

The findings of the current study were drawn from four different universities, particularly Tribhuvan, Kathmandu, Purvanchal, and Pokhara University of Nepal. Respondents were taken from the four different departments/schools, i.e., Arts/Humanities, Education, Management, and Science. The research provides a reference to potential future researchers who would like to explore the association of knowledge management and academic performance in academia, particularly in HEIs. This research has mostly focused on the individual characteristics of the faculty members; other researchers can explore in wider context either in experimental or case-based study from the different universities of Nepal.

7. Conclusion

The faculty members' knowledge management practices and their academic performance are highly associated in higher educational context. The organizational leadership, culture, environment, distinct academic culture, notion of knowledge creation activities and readiness to accept and adopt technology in academic institutions rely on the practicing behaviour of faculty member to enhance the academic discoursed in universities. This study emphasizes the aspects of teaching, learning, research, and publication activities of a faculty member to enhance academic discourses with the support of knowledge management in academia. In the era of the knowledge economy, knowledge utilization, dissemination, and presentation maximize the innovation behavior of faculty members which further impacts the knowledge economy of the Nation. The existing knowledge and created knowledge of the faculty member play a vital role in enhancing the overall intellectual capital of individuals along with institutional. Thus, the research concludes that knowledge management is the key component to enhance academic excellences of the universities with positive impacts on knowledge economy.

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Appendix: Tool for Data Collection

SECTION ONE

1. Name of your working Institution: …….
2. What is your academic position (Tick in one)?
   A. Professors
   B. Associate Professors/Readers
   C. Assistant Professors/Lecturers

SECTION TWO: KNOWLEDGE MANAGEMENT PRACTICES

For the questions in section two**,** please complete the following questionnaire by assigning numerical value to each of the statements where the meaning of the value is as follows:
1 = Very untrue for me 2 = Untrue for me 3 = Somewhat untrue for me 4 = Neutral
5 = Somewhat true for me 6 = True for me 7 = Very true for me

Very untrue for me **Very true for me**
|_____|_____|_____|_____|_____|_____|
1 2 3 4 5 6 7

1	I acquire knowledge from self-learning.	
2	The source of my knowledge is my experience.	
3	Interaction helps me acquire knowledge easily.	
4	I acquire knowledge through discussions.	
5	Modern technology is not much helping me to acquire knowledge.	
6	I acquire knowledge through external professional networks, e.g. Professors' Associations, Experts Forum and PhD associations, etc.	
7	Participating in the training sessions helps me acquire knowledge effectively.	

8	Inputs from external experts such as foreign educational expert, academicians, etc. play a vital role to acquire knowledge within institutions.	
9	Learning environment plays less role compared to individual's tendency in influencing the acquiring process of knowledge.	
10	Organizational leadership quality helps me to acquire knowledge easily.	
11	If the important sources of knowledge e.g. Journals, Research Report, Books etc. are not available, my institution buys them.	
12	By mentoring new faculty members, I transfer ideas and knowledge.	
13	Individual work performance is assessed regularly to increase the knowledge level of individual.	
14	Informal discussion plays a vital role to share my knowledge.	
15	Workshop and conferences help me to disseminate the knowledge.	
16	Social media like Viber, Skype, Twitter and Facebook, etc. help me to transfer information.	
17	Teaching is the best way to distribute knowledge to the seekers of knowledge.	
18	I disseminate knowledge through publishing in professional journals.	
19	Joint projects help me share the idea and concept among peers.	
20	I frequently use IT and ICT devices to share and disseminate knowledge.	
21	I have not shared knowledge among peers by conducting training sessions by myself.	
22	I generate knowledge by involving in the research work.	
23	I have not been successful in developing simulators to transfer knowledge.	
24	I share knowledge by presenting the paper at the conferences.	
25	Interaction with peers helps me to disseminate the knowledge and ideas easily.	
26	I apply knowledge while conducting trainings.	
27	Knowledge helps me to face the issues, problems that I face in my daily life.	
28	I use knowledge to improve my efficiency.	
29	I conduct research activities to produce knowledge that helps me address the issues of everyday life.	
30	I apply acquired knowledge to conduct research activities that enhance my capability to perform my work better.	
31	Knowledge application helps me to increase the level of my thought.	
32	Knowledge application helps me conduct market research before developing the courses.	
33	I prefer research conducted through institutions rather than the research conducted by individuals because institutions provide wider platform for dissemination/sharing.	
34	Publishing in professional journals enables individuals to reach the professional communities.	
35	Selling knowledge through consultancy doesn't increase the value of individuals and institutions.	
36	I encourage colleagues to use different types of e-portals to get valuable information.	

SECTION THREE: ACADEMIC PERFORMANCE

For the questions in section three**,** please complete the following questionnaire by assigning numerical value to each of the statements where the meaning of the value is as follows:

1 = Very untrue for me 2 = Untrue for me 3 = Somewhat untrue for me 4 = Neutral
5 = Somewhat true for me 6 = True for me 7 = Very true for me

Very untrue for me **Very true for me**

|_____|_____|_____|_____|_____|_____|

1 2 3 4 5 6 7

1	I prepare lesson plans for each Semester/Year before the commencement of academic calendar.	
2	I prepare my lessons before entering the classroom.	
3	I encourage students to use different e-portals to familiarize them with global trends of teaching and learning.	
4	During the class time, I manage interaction sessions among students.	
5	I use different types of information technology to make my lessons effective.	
6	I convert theoretical knowledge into the practical by designing activities.	
7	All my publications are based on my research studies.	
8	The classroom environment doesn't play a vital role in sharing knowledge among learners.	
9	I maintain quality information inside the classroom.	
10	I frequently use case-based learning method rather than lecturing.	
11	Market research is essential before developing the courses for students.	
12	Modern technology helps to mentor students easily.	
13	Interaction in the classroom helps me disseminate knowledge and ideas easily.	
14	Classroom without technology cannot make active participation of learners.	
15	Research helps me to generate new knowledge.	
16	I convert theoretical knowledge into practical through research.	
17	I involve my students in my research activities.	
18	I am involved in industry-based research.	
19	Involving in research activities helps me increase my problem-solving capacity.	
20	My classroom activities are student centric.	
21	Number of publications doesn't matter much for the academic excellence of an academician.	
22	Through research I generate knowledge, bring that knowledge to classroom.	
23	I transfer knowledge to the community by publishing articles in the journals and newspapers.	

SECTION FOUR: WRITE YOUR OPINION

How can knowledge management be enhanced in Higher Educational Institutions?

Thank you for your time and information!

Team Barriers to Tacit Knowledge Sharing in Software Development Project Teams

Emmanuel Samuel Mtsweni[1] and Koga Gorejena[2]
[1]University of South Africa, Florida Park, Republic of South Africa
[2]North West University, Mafikeng, Republic of South Africa

mtswees@unisa.ac.za
koga.gorejena@nwu.ac.za

Abstract: Software Development Projects (SDPs) are being conducted at a rapid rate in response to the Fourth Industrial Revolution (4IR), even though SDPs are associated with very high failure rates. Their failure rate of SDPs has been declared as an International Crisis. SDPs are knowledge intensive in nature, whereby knowledge is essential when performing socio-technical tasks within SDPs. One of the reasons for the failure of SDPs is limited sharing of tacit knowledge within SDP teams. Limited tacit knowledge sharing within SDP teams results in the teams not being in position to perform their socio-technical tasks to the required standards which leads to success of SDPs. The main purpose of this research study was to identify the team-oriented barriers that limit the sharing of tacit knowledge within SDP teams. The researchers conducted a qualitative study and relied on qualitative data to achieve the objectives of the study. The qualitative data were collected through interviews and thematic data analysis was conducted to generate the results. A total of seven team-oriented barriers were identified includes team-culture, team-orientation, team-dispersion, team-cohesion, team-characteristics, trust, and communication. These issues are related to each other and influence one another in a positive way. These barriers stem from the entire SDP team, which is responsible for ensuring the success of SDPs.

Keywords: Tacit knowledge, Knowledge, Software projects, Knowledge management, Barriers to knowledge sharing

1. Introduction

The current era of the Fourth Industrial evolution (4IR) relies heavily on different elements of Information Communications and Technology (ICT), and one of the essential elements is software (Jones and Pimdee 2017; Ayentimi and Burgess 2019). This era of the 4IR has resulted in a high number of Software Development Projects (SDPs) being conducted by different organisations, in different disciplines such as health, education, and banking to name few. The main aim of conducting SDPs is to develop software solutions that enable organisations to compete in the 4IR era. Software enables organisations to have efficient and effective ways of conducting their operations (Khan and Keung 2016). The biggest challenge with SDPs is the alarmingly high failure rate of SDPs, which has been declared an international challenge, as acknowledged by academia as well as the software development industry (Lehtinen *et al*. 2014; Niazi *et al*. 2016).

Despite the high failure rate of SDPs in the current era, different organisations are investing heavily in SDPs by commissioning more SDPs. The number of SDPs being conducted has increased significantly, to the extent that there is more investment in the form of financial resources. It is estimated that organisations in the Republic of South Africa (RSA) have invested a total of R14 billion on different SDPs in 2011. Joseph and Marnewick (2014), forecasted an investment of R150 billion in 2014 which would result in a total loss of R18 billions because of the high failure rate of SDPs. This conclusion was based on the failure rate documented in 2014 (Niazi *et al*. 2016; Marnewick 2016). This indicates that the failure of SDPs is a real challenge for different countries, including developing countries such as the Republic of South Africa (RSA). This is a global phenomenon.

SDPs are human oriented in nature, with the human beings who form the SDP team playing a crucial role in ensuring the success of SDPs. The SDP team members require a wide variety of resources to ensure the success of the SDPs (Sudhakar, Farooq and Patnaik 2011). One of the prominent resources required is knowledge, because SDPs are knowledge intensive. Knowledge is used to perform socio-technical tasks to the required standard, which lead to the success of SDPs. SDP teams require both explicit knowledge, and tacit knowledge to perform socio-technical tasks within ISDPs. Socio-technical tasks are the tasks that are conducted within SDPs which consists of technical elements and socio elements which are human oriented in nature. These two types of knowledge complement each other throughout the process of conducting socio-technical tasks within SDPs (Paraponaris *et al*. 2015; Lee, Park, and Lee 2020). SDP teams do not have a challenge with access to explicit knowledge, but there is a challenge of limited access to tacit knowledge within the SDP teams (Smith 2001). The

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challenge of tacit knowledge access becomes more evident where teams fail to perform socio-technical tasks to the required standard and ensuring the success of SDPs.

The limited access to tacit knowledge is an indication that there are barriers to sharing tacit knowledge within SDP teams which has not been uncovered. The limited access to tacit knowledge is more SDP team-oriented challenge in nature whereby SDP teams plays a role in the limitation of sharing of tacit knowledge. These challenges limit SDP teams from accessing sufficient tacit knowledge required for SDP team to perform socio tasks to the required standard which incorporates quality standards (Mtsweni and Mavetera 2018). Therefore, the main objective of this research study was to identify team-oriented barriers to sharing tacit knowledge within SDP teams.

It is evident that there are barriers of knowledge sharing, in the literature are the barriers formulated based on explicit knowledge and/or knowledge in general. This is because there is still limited sharing of tacit knowledge within SDP teams. This shows there is a lack of or limited research studies on the barriers of tacit knowledge sharing within SDP team. The main research question for this research study is: What are the barriers of tacit knowledge sharing within the SDP team? This article starts with a review of the existing literature, followed by an outline of the research methodology used to achieve the research objectives. The results of the study are then provided. The article is concluded by discussing the contribution of the study to research.

2. Literature Review

SDPs are characterised with a high failure rate. In the 1960s, the term "International Crisis" was coined to acknowledge this challenge of higher failure rate of SDPs. This was an agreement between industry experts and researchers (Zahid *et al.* 2018). It was an indication that the high failure rate of SDPs was a challenge for all countries irrespective of their economic status. This failure of SDPs is still a challenge in the current era, and it poses a risk to the success of the 4IR especially for different organizations that still want to be competitive in this era of 4IR (Ayentimi and Burgess 2019). SDP failures result in organisations not realising the full potential and benefits that are offered and exist within this era of the 4IR, where organisations rely on technology to be competitive (Khan and Keung 2016).

SDPs are human oriented in nature. This means that human beings ensure the success of SDPs by conducting socio-technical tasks to the required standards (Mtsweni, et al., 2016; Mtsweni and Mavetera 2018). These human beings are members of SDP teams who require a wide variety of skills and resources to perform their socio-technical tasks during the lifespan of SDPs. This is done to ensure the success of the SDPs. The required resources include knowledge, which is one of the reasons why the members of the SDP team are selected to be part of the SDP teams. The knowledge among members of SDP teams is an essential element that makes the members of SDP teams and its members to be competitive within their respective SDP teams (Chen *et al.* 2018). This indicates that members of the SDP team require some level of knowledge irrespective of the type of knowledge, to successfully perform socio-technical tasks (Chen *et al.* 2018; Dreyer, Wyn and Bown 2020).

SDPs are knowledge intensive, and knowledge is often equated to the success of SDPs. In other words, members of the SDP teams use knowledge to perform socio-technical tasks to the required standard. This makes knowledge essential, and the potential solution in addressing the high failure of SDPs (Mtsweni and Mavetera 2018; Chen *et al*. 2018). All the socio-technical tasks are conducted in SDPs require either tacit knowledge, or explicit knowledge, or both. This makes knowledge to be the driving factor, and essential resource in performing socio-technical tasks within SDPs to the required quality standard (Smith 2001; Ryan and O'Connor 2013). This makes it essential that all the members of SDP teams have access to both types of knowledge and have a balance between tacit knowledge, and explicit knowledge (Mtsweni and Mavetera, 2018).

In fact, it is imperative that SDP teams, and their members have access to both types of knowledge to perform their socio-tasks to the required standards. Explicit knowledge and tacit knowledge complement each other. Explicit knowledge and tacit knowledge focus on different elements of socio-technical tasks but are both needed to perform these tasks to the required standard. Explicit knowledge is strongly associated with technical tasks because explicit knowledge is technically oriented in nature while tacit knowledge is socially oriented. This indicates that explicit knowledge and tacit knowledge make a different contribution in ensuring socio-technical tasks are performed to the required standard (Mtsweni and Mavetera 2018; Chen *et a*l. 2018). Explicit knowledge and tacit knowledge contribute significantly to ensuring that socio-technical tasks are performed to the required standard especially quality standards, which is required for ensuring the success of SDPs. This is the main goal of any SDP team (Chen *et al.* 2018; Dreyer, Wyn and Bown 2020).

Access to explicit knowledge is not a challenge, because of the development of technology, which created different platforms for sharing and storing explicit knowledge. These platforms allow members of the SDP team to contribute and share explicit knowledge which is technical in nature and is required more so, to perform technical tasks of SDPs (Ryan and O'Connor 2013; Dreyer and Wynn 2016). This is evident because SDPs are not failing with reference to technical issues. Most SDPs are found to have good functional technically, but do not address the needs of the primary customer. This indicates that technical tasks are performed to the required standard but are not sufficient to ensure the success of SDPs (Ebad 2016; Gupta *et al.* 2019). This is a good indication that members of SDP team have access to adequate explicit knowledge, which is sufficient for them to perform their technical tasks for the success of the SDPs (Chen *et al.* 2018). Thus, it becomes evident that there is a challenge regarding the performance of socio-tasks, which is the result of access and sharing of tacit knowledge that is required to perform socio-tasks.

In an attempt to address the high failure rate of SDPs, new interactive methodology was introduced to SDP teams – known as the Agile methodology. Agile methodology had been in place for a limited period of time. Agile methodology relies heavily on tacit knowledge (as opposed to explicit knowledge), especially when it is used within SDP teams (Ryan and O'Connor 2013; Takpuie and Tanner 2016). Agile methodology relies on verbal communication, as opposed to written communication which is used within traditional methodologies. This approach has enabled SDP teams to share more tacit knowledge, which is required within SDP teams. This has resulted in SDP team that use Agile methodology having better opportunities of ensuring the success of SDPs. The Agile methodology has a better success rate than traditional methodologies which rely on written communication, while Agile methodology rely on tacit knowledge and verbal communication (Ryan and O'Connor 2013). This indicates that tacit knowledge is required to address the failure of SDPs.

Despite the existence and adoption of Agile methodology which its adoption is at a rapid rate in the current era, the higher failure of SDPs remains a challenge in the current era (Gupta *et al.* 2019). This indicates that there is still a challenge when it comes to the sharing of tacit knowledge within SDP teams, which contributes to the high failure of SDPs and is a global challenge. Thus, it becomes more evident that there is challenge in sharing of tacit knowledge because Agile methodology relies heavily on tacit knowledge (compared to explicit knowledge) and yet the failure of SDPs remains a challenge (Ryan and O'Connor 2013). This makes it essential to identify the barriers of tacit knowledge within SDP teams, because SDP teams need tacit knowledge on top of explicit knowledge to ensure the success of SDPs.

Tacit knowledge exists among the members of SDP teams, and they are the custodians of tacit knowledge. This makes tacit knowledge to be their personal asset (Takpuie and Tanner 2016). However, the only way that the members of SDP teams can make their tacit knowledge available to the entire SDP team is through sharing of tacit knowledge within SDP teams. The sharing of tacit knowledge is a responsibility and task of the entire SDP teams and its members to enable the SDP team and its members to perform all the tasks to the required standard, which leads to the success of SDPs (Ebad 2016; Dreyer, Wynn and Bown 2016). The high failure rate of SDPs indicates that there are barriers that limit the sharing of tacit knowledge within SDP teams.

There are numerous barriers of knowledge sharing that were identified that limits the sharing of knowledge such as trust, culture, personal, technology to name few. The limitation with these barriers were based on the context of knowledge in general. There was no separation between explicit knowledge and tacit knowledge. There are some of the barriers which were developed and tested in a context of explicit knowledge (Ghobadi and Mathiassen, 2016). Explicit knowledge has different attributes as compared to tacit knowledge. This indicates that they cannot be treated in a similar way (Mtsweni and Mavetera, 2018). This led to the gap whereby the barriers of tacit knowledge were not explored in detail especially with the team-oriented barriers especially where teams are used heavily in performing things such as SDPs team which rely on knowledge when performing socio-technical tasks.

3. Research Design and Methodology

The main objective of this study was to identify the team-oriented barriers of tacit knowledge sharing within SDP teams provided the direction on the nature of the research study. The researchers conducted qualitative research. The qualitative research approach was chosen because of the nature of the study. The objective of the study required the researchers to use qualitative data to achieve the research objective of the study (Singh 2006; Opoku, Ahmed and Akatia 2016). Most of the already conducted studies did not focus on SDP teams, but rather on organisational settings, especially knowledge-intensive organisations which do not have similar characteristics to SDP teams. This made the results not applicable to SDP teams. This also meant there was limited literature on the barriers to tacit knowledge sharing within SDP teams (Opoku, Ahmed and Akoita 2016).

A qualitative research approach was further appropriate because the researchers needed to uncover the issues or team-oriented barriers to tacit knowledge sharing within SDP teams (Silverman 2020). The researchers relied on qualitative data to achieve the research objectives of this study. The qualitative research approach enabled the researchers to uncover the team-oriented barriers that limit the sharing of tacit knowledge within SDP teams (Fletcher 2017).

3.1 Data Collection

The researchers had the option of conducting interviews or using an open-ended questionnaire to collect relevant primary qualitative data to achieve the research objectives of this study. The researchers conducted semi-structured interviews to collect the qualitative data. Semi-structured interviews were conducted because the researchers were able to interrogate in detail, issues raised during the interviews and were able to follow-up on issues of the great interest to the researchers, focusing on the objective of this study (Silverman 2020; Fletcher 2017). The researchers were able to apply flexibility during the interviews in that they rephrased questions to get clear answers which were required to achieve the research objectives (Opoku, Ahmed and Akotia 2016).

The researchers conducted a total of 28 face-to-face interviews. The interviews were between 30 and 55 minutes long. The interviews were conducted over a period of four months, which were consecutive months to ensure that the researchers had enough time to reflect on the available qualitative data. The interviews were conducted, recorded, and transcribed. The data was collected in the year 2019, towards the end of the year. The researchers used Atlas Ti software to analyse the qualitative data toachieve the results of the study. It was important for the researchers to use Atlas Ti as a tool because Atlas Ti has the capability of handling huge amounts of qualitative data. Atlas Ti enabled the researchers to organise large amounts of data into meaningful chunks of qualitative data, especially when the qualitative data increased during further interviews.

One of most important elements for the researchers was to know when to stop conducting further interviews as part of the qualitative data collection for this research study. It was imperative that the researchers collect sufficient and quality data to achieve the research objectives of this research study. The researchers relied on data saturation, or thematic saturation to stop conducting further interviews. Data saturation is when the interviews conducted by the researcher(s) do not yield any new information in the form of themes or concepts, as compared to the ones at the disposal of the researchers (Aldiabat and Navenec 2018). Data saturation was an indication that there was no need for the researchers to conduct further interviews with the intention of collecting qualitative data for this research study (Saunders *et al.* 2018). The researchers achieved data saturation after conducting a total of 28 interviews.

It was important for the researchers to interview participants who were in a good position to provide accurate and relevant information to achieve the research objectives of this research study (Opoku, Ahmed and Akoita 2016). The participants were individuals who were working on SDPs and had a minimum of two years being part of SDP teams at the time of conducting this research study. The participants were working within different SDP teams based in the RSA. The participants were invited from different organizations that were focusing on software development as their core-business and they were selected considering their work experience within SDP industry. This was done to ensure that the participants had experienced the phenomenon of interest of this research study. The researchers used purposive sampling, which enabled them to choose the type of participants, and outline the requirements for the participants before they could participate in this research study. It further enabled the researchers to collect accurate qualitative data with rigor required to achieve the research objective of this research study (Etikan and Bala 2017).

The researchers stopped collecting data after the achievement of thematic saturation. Thematic saturation occurred when the researchers were not able to develop new themes and observations compared to the ones that were existing in the repository in relation to the objective of the research study (Green and Thorogood 2018). Thematic saturation was achieved after conducting a total of 28 interviews. Thematic saturation was achieved without outlining or discovering the fullness of relationships among different themes identified during the thematic data analysis of this research study (Kerr, Nixon and Wild 2010).

3.2 Data Analysis

After the completion of the qualitative data collection, the researchers conducted thematic data analysis consisting of six phases/steps of data analysis. The researchers started reading the qualitative data to familiarise themselves with it. The main aim was to understand what was happening within the qualitative data (Braun and Clarke 2006; Hertzog, Handke and Hitters 2019). This included the researchers transcribing the qualitative data.

The researchers started performing theoretical thematic analysis by generating initial codes (Braun and Clarke 2006). The researchers then highlighted the qualitative data, which included organising the data, and generating meaning from the qualitative data. This led to the researchers reducing the qualitative data into small chunks of qualitative data that were relevant to this research study (Peel 2020)

The researchers started searching for themes that were relevant to this research study. They examined the initial codes generated during the thematic data analysis, which means they relied on the results of the previous phase of the thematic data analysis. The researchers ensured that the initial codes clearly fit into a theme generated from the data analysis. The end results of this phase were different codes within a particular theme of the research study (Terry *et al*. 2017; Spiers and Riley 2019; Braun and Clarke 2006). The researchers started to review the themes generated from the previous phase of the thematic data analysis. They reviewed and modified the themes to reflect the context of this research study (Braune and Clark 2006; Peel 2020). The phase included gathering relevant data supporting the themes identified in this research study. The researchers ensured that the relevant themes were used in this research study (Terry *et al.* 2017; Hertzog, Handke and Hitters 2019).

The researchers started by defining and naming themes generated in this research study. The researchers refined the themes, which was all about revising the results of the previous phase of the thematic data analysis. The researchers performed the final refinement of the themes and sub-concepts of the themes. Researchers concluded by creating relationships among different themes identified in this research study (Braun and Clarke 2006; Hertzog, Handke and Hitters 2019; Terry *et al.* 2017). The researchers concluded the thematic data analysis by producing the final report. This is where the researchers communicate the results to the community and the participants of this research study to validate the results of this research study (Terry *et al.* 2017).

3.3 Rigour of Research Results

It was important for the researchers to produce results that were not misleading to the population of this research study. The researchers relied on trustworthiness because this is a qualitative research study, and it is associated with evaluating the rigour of the results of a qualitative research study (König and Jucks 2019). The researchers relied on the elements outlined by Lincoln and Guba (1986), which include the confirmatory, transferability, authenticity, credibility, and dependability elements.

Confirmatory is the ability of the researchers to show that the qualitative data represent the views of the participants in the research study, which include ensuring that the researchers did not show any bias in the research study (Lincoln and Guba 1986). The researchers conducted member checking with the participants in this research study to ensure that they presented the views of the participants. They discussed the results of the research study in group discussions with professionals who had worked in SDP teams. The researchers also outlined the methodology used to generate the results of the study for other researchers to have way in which to validate how the results of the study were generated.

Transferability is the ability to apply the results of the research study in another environment with similar settings and characteristics of the original environment of the research study. Transferability is the replication of the results of the research study (Krefting 1991). The researchers conducted group interviews to validate the results and checking with other participants of the research study through a member checking process. The researchers discussed the results with other professionals that had experience working in different SDP teams.

Authenticity is the ability of the researchers to express the feelings, emotions, and experiences of the participants of the research study (Connelly 2016; Schwandt, Lincoln, and Guba 2007). The researchers relied on qualitative data to generate and support the results of this research study. The researchers quoted from the qualitative data to support the results of this research study. The researchers further discussed the results of this research study with members of other SDP teams who did not participate in this research study. The researchers observed the gestures as well as the reactions of the participants during the interviews, to see if they added any meaning and value to the results.

Credibility refers to the truth of the qualitative data and the expressing views of the participants of the research study in a coherent manner (Connelly 2016). The researchers relied on qualitative data to generate and support the results of this study. They conducted member checking and quoted from the qualitative data to support the results of the study. Quoting from the qualitative data made the researchers grounded in the qualitative data when generating the results of this research study.

Dependability refers to the consistency of the results of the research study, especially when reporting the results of the research study. Dependability ensures that one can rely on the results of the research study (Schwandt, Lincoln and Guba 2007). The researchers outlined the process followed to generate the results especially research methodology, including data collection and data analysis which were performed in this research study. This was done to ensure transparency in this research study so that other researchers can know how the results of the study were generated and so that they will be able to replicate the research study. This allows other researchers to critique the process followed to generate the results and whether the process was conducted in a proper way especially ensuring golden threat or there were any errors in generating the results of this research study.

3.4 Ethical Issues

The researchers conducted this research study in an ethical manner or complied with ethics or ethical requirements. Ethics were instrumental in protecting the participants in this research study and other stakeholders from harm in any form (Resnik 2018). The researchers started by applying for an ethical certificate to conduct this research study and it was granted. The researchers further ensured that the participants in the research study understood their rights as participants. The researchers requested the participants to sign the consent letter prior to conducting the interviews during the data collection or participating in this research study. Furthermore, the researchers explained the rights of the participants prior to conducting the interviews. The email message used to invite the potential participants to participate in this research study which outlined the rights of the participants. The researchers used pseudonyms when reporting the results of this research study to ensure the anonymity and privacy of the participants of this research study.

4. Results of the Research Study

The thematic data analysis yielded a total of seven team-oriented barriers to tacit knowledge sharing within SDP teams. These barriers were team culture, team orientation, team dispersion, team cohesion, team settings, trust, and team communication.

4.1 Team Culture

The SDP team culture encourages the members of the SDP teams to complete their work on time so that they can meet deadlines instead of encouraging the sharing of tacit knowledge. It makes the members of the SDP team to work as individuals at meeting their respective deadlines. This results in them prioritising meeting deadlines instead of doing other things such as tacit knowledge sharing. The elements of team culture that were identified in this research study were SDP team's attitude to sharing tacit knowledge, values, and social behaviour.

> *P2 said: "… I have worked in teams that were only concerned about meeting the deadlines and delivering the tasks. I am not even encouraged to share my knowledge … team leaders are only concerned with meeting the deadlines."*

The SDP team culture on its own drives the way things are being conducted within SDP teams. It becomes those practices that are inherited by other members of SDP team such as prioritizing meeting the deadlines. Most of the cultures of SDP teams encourages the members of SDP to meet their deadlines not giving any attention to other important things such as sharing of tacit knowledge. This leads to lack of sharing of tacit knowledge within SDP team which results in SDP team not being able to perform their socio-technical tasks to the required standard to ensure the success of SDPs. Culture within SDP teams should be structured in such a way that incorporates and encourages the sharing of knowledge especially tacit knowledge

4.2 Team Orientation

SDP teams are heavily oriented towards meeting the milestones and goals of SDPs, which leads to ignorance of other elements such as tacit knowledge sharing. The orientation is deadline driven, with SDP teams heavily focused on the goals of the SDPs and SDP teams. The elements of team orientation were collaboration, and SDP team goals.

> *P3 said: "… I have worked in teams that were only concerned about meeting the deadlines and delivering the tasks. I am not even encouraged to share my knowledge … team leaders are only concerned on meeting the deadlines."*

The orientation of SDPs is closely influenced by the culture of SDPs which became the culture of SDP teams. The orientation of SDP team is all about giving more emphasis, priority, and attention in completing the tasks on

time. It is all about prioritizing the performance of socio-technical tasks to completion because they were given more the notion that they are more important than other activities. This had led to be the culture within SDP teams. This had become well-known phenomenon within SDPs and SDP teams. This led to lack of sharing of tacit knowledge within SDP teams. This made the sharing of tacit knowledge and other things being less important and not given priority. The orientation of SDP team drives the direction on which elements are given more priorities as compared to others (Khan and Keung, 2016). If the orientation of SDP team does not include the sharing of tacit knowledge, the members of SDP team will not prioritize the sharing of tacit knowledge in SDP teams.

4.3 Team Dispersion

SDP teams are usually in different geographical locations such as different office blocks and other locations, which makes the SDP team to rely on written communication. It has become a norm for SDP team members to work from home because of the Covid-19 pandemic and lockdowns imposed in different countries such as RSA. This made it challenging for members of SDP teams to share tacit knowledge because they do not rely verbal communication, but they had started to rely on written communication within their respective SDP teams. The standard and most proven way of sharing tacit knowledge is through verbal communication, but SDP team dispersion of members of SDP team makes the SDP team to rely on written communication to share knowledge. The elements of SDP ,team dispersion were geographical separation and remote SDP teams.

> *P8 said: "I once worked in a big project team. It was impossible to share tacit knowledge because you can't write it down. It was impossible to share personal knowledge because the team was big, and it was distributed in three different buildings. We relied on emails to communicate."*

The outsourcing of SDPs is a well-known practice which resulted in members of SDP teams working in the foreign countries or cities even different building in the same vicinity to name few. This made the dispersion of SDP team members to be a norm and it grew more during the lockdowns during the Covid-19 pandemic where members of SDP team were working from home most of the time. This makes the members of SDP team to share limited tacit knowledge because the sharing of tacit knowledge relies on interpersonal relationships. The interpersonal relationships require face to face interaction among the members of SDP team. The members of SDP team are not able to do that because are working remotely all the time and that norm are adopted even after the lockdowns were removed.

4.4 Team Cohesion

The extent and the strength of the interpersonal relationships of the members of the SDP team are important in driving the sharing of tacit knowledge within SDP teams. Lack of cohesion among members of the SDP team results in a lack of tacit knowledge sharing. The strengths of the SDP team cohesion and interpersonal relationships especially among members of the SDP team increases the rate of sharing of tacit knowledge within SDP teams. The elements of team cohesion that were identified included common interest, team loyalty and satisfaction of SDP team members.

> *P16 said: "…. in one of the teams, I worked within, there was no good relations there then it was impossible to share knowledge. They were always ready to criticise each other's which were personal attacks."*

Tacit knowledge sharing is relational in nature which means personal relations needs to exist among the members of SDP team (Mtsweni and Mavetera, 2018). This indicates the relationships among the custodian of tacit knowledge and other members of SDP team is important and influence the sharing of tacit knowledge within SDP teams. It is important for the interpersonal relationships among the members of SDP team to have great strength. The more strength within interpersonal relationships among the members of SDP teams leads to improved sharing of tacit knowledge within SDP teams. This includes sharing quality tacit knowledge which is required by the members of SDP team to perform their socio-technical tasks to the require standard (Ghobadi and Mathiassen, 2016).

4.5 Team Properties

The settings and characteristics of SDP teams lead to a lack of tacit knowledge sharing especially on how the SDP teams are structured. This includes SDP teams being result oriented, big in size of SDP teams and having limited time to complete socio-technical tasks. SDPs are fast paced, which causes SDP team members not to focus on sharing tacit knowledge within SDP teams. The elements that were identified were size, structure, dispersion, communication, and methods.

> *P9 said: "Software development industry develops fast, and time is always an issue. I am not able to share my knowledge because I am chasing time and I am not sure about the relevance of my knowledge…….. The software project team was big to the extent that I did not know some of the member of team because they were based in other locations"*

The characteristics of SDP teams result in lack of sharing of tacit knowledge. The orientation of SDP team give emphasis on finishing the work within short period of time. The size, structure and dispersion of SDP team makes it challenging to share tacit knowledge because do not encourage verbal communication but encourages written communication. The bigger the SDP team and structure being complicated makes it challenging to have verbal communication. The SDP teams that are using traditional methods use written communication which does not permit the SDP team to share tacit knowledge which is also influenced by the dispersion of SDP teams.

4.6 Trust

Lack of trust among members of the SDP team and within SDP team limits the sharing of tacit knowledge within SDP teams. The members of SDP team do not share their tacit knowledge with another member of SDP team who they do not trust because they regard tacit knowledge as one of their personal assets. The custodian of tacit knowledge Trust is influenced by identification, openness and honesty, benefits, consistency, and relationships.

> *P13 said: "… I need to trust someone before I can start sharing my knowledge with that person because this knowledge is one of the most important assets in my life."*

Trust is one of the important elements when it comes to the sharing of tacit knowledge in general including within SDP teams. Trust needs to be part of the interpersonal relationships within SDP teams to drive the members of SDP team to share their tacit knowledge. The trust makes the source of tacit knowledge to have the assurance that the tacit knowledge will be utilised properly. On the hand the receiver of tacit knowledge also has the trust that the tacit knowledge being shared is accurate and the quality one. This further indicates that the tacit knowledge will yield accurate results when the tacit knowledge applied properly. The stronger the trust within SDP teams results in more tacit knowledge shared within SDP teams.

Lack of trust is one of the main barriers of knowledge sharing within organizations and SDP teams. Trust plays an important role in the sharing of tacit knowledge because members of SDP team regard tacit knowledge as their personal asset. The custodian of tacit knowledge needs to ensure that they share their tacit knowledge with someone whom they can trust. The other thing trust is important when it comes accurateness of tacit knowledge and yielding of accurate results when the tacit knowledge is being applied (Ghobadi and Mathiassen, 2016). This indicates trust is based on the tacit knowledge, custodian of tacit knowledge, the receiver of tacit knowledge and the results that are generated by tacit knowledge when it is being applied.

4.7 Communication

The nature of communication within SDP teams limits the sharing of tacit knowledge within SDP teams. SDP teams that rely heavily on written communication are not in good position to share tacit knowledge. SDP teams that use traditional teams methods SDP and SDP teams working remotely because of the Covid-19 pandemic. Written communication does not allow for the sharing of tacit knowledge. Communication elements identified were communication effectiveness, frequencies, tools, and type.

> *P11 said: "Traditional methods encourage communication to be in the form of written documents, which does not allow me to share my personal knowledge … traditional methods do not support collaboration and interaction … The interaction and collaboration allow me to get more knowledge from the member, since we will have more verbal communication and I can observe the way they are doing things and I can contribute my knowledge in the process."*

One of the important things when it comes to sharing of tacit knowledge is communication especially verbal communication. The most proven approach to share tacit knowledge is through verbal communication and it had not been disputed for long period of time. It is important for the receiver and the source of tacit knowledge to have good communication skills. Communication helps in the articulation of tacit knowledge which makes the receiver of tacit knowledge to understand the tacit knowledge and being able to use the tacit knowledge properly. The articulation enables the source of tacit knowledge to share quality tacit knowledge. This indicates communication result in limiting the sharing of tacit knowledge within SDP teams. This is because of the type of communication within SDP teams, tools that are used and prioritising the written communication within SDP teams.

Tacit knowledge relies heavily on verbal communication because verbal communication is one of the proven approaches of sharing tacit knowledge (Ghobadi and Mathiassen, 2016). This indicates the type of communication that is utilised within SDP team needs to be the one that drives and supports the sharing of tacit knowledge within SDP teams. The members of SDP team need to possess good communication skills especially verbal communication. This include understand the terms and jargons that are being used in the field of SDPs even during the sharing of tacit knowledge. This will enable them share tacit knowledge that is understood and can be applied properly which contributes to the quality of tacit knowledge. It is off utmost importance for tacit knowledge to yield accurate results when it is being applied when performing tasks within SDPs and that leads2 (Akguin et al., 2017).

Table 1 shows the team-oriented barriers to tacit knowledge sharing within SDP teams. They include the elements associated with the barriers of tacit knowledge sharing within SDP teams. The team culture barrier had three elements, namely attitude, value, and social behaviour. The second barrier was team cohesion, which had a total of three elements: common interest, loyalty, and satisfaction. The third barrier was team orientation, which had two elements: collaboration and team goals. The fourth element of team barriers that was identified was team properties, which originates from the characteristics of SDP teams. The fifth barrier was trust, especially lack of trust among the members of SDP teams. Trust had elements such as reliability, identification, openness and honesty, consistency, and relationships. The sixth barrier was communication. The elements of communication include communication effectiveness, communication frequencies, communication tools and communication type. The seventh and last barrier that was identified was SDP team dispersion, and the components of SDP dispersion were remote teams and geographical locations.

Table 1: Team Oriented Issues Limiting Sharing of Tacit Knowledge Within SDP Teams

Team Oriented Issues Limiting Sharing of Tacit Knowledge			
Themes	**Elements**	**Evidence (Participant)**	**Occurrence**
Team Culture	Attitude	P2, P3, P7, P13, P17, P18, P20, P23, P24, P26	10
	Values	P1, P3, P4, P7, P13, P16, P20, P23, P28	09
	Social behaviour	P1, P4, P6, P7, P8, P17, P19, P23, P27	09
Team Orientation	Collaboration	P1, P2, P3, P8, P10, P11, P12, P15, P16, P19, P23, P25	12
	Team goals	P3, P4, P7, P9, P10, P13, P14, P18, P21, P23, P25, P26, P28	13
Team Dispersion	Geographical Location	P2, P4, P5, P7, P9, P11, P12, P15 P18, P19, P20, P25, P28	13
	Remote teams	P1, P3, P6, P7, P8, P9, P11, P13, P12, P14, P18, P21, P23, P27	15
Team Cohesion	Common interest	P2, P3, P4, P6, P8, P12, P10, P13, P15, P19, P23, P25, P27	13
	Team loyalty	P3, P6, P8, P10, P12, P15, P16, P19, P23, P26, P27, P28	12
	Satisfaction within SDP team	P1, P4, P6, P13, P16, P18, P20, P23, P24, P26	10
Team Properties	Team size	P1, P2, P3, P7, P9, P10, P11, P13, P14, P17, P20, P23, P26, P27, P28	15
	Team structure	P3, P7, P8, P10, P11, P13, P14, P16, P24, P26	10
	Team dispersion	P4, P5, P7, P9, P11, P13, P15, P16, P17, P19, P21, P23, P25	13

Team Oriented Issues Limiting Sharing of Tacit Knowledge			
Themes	**Elements**	**Evidence (Participant)**	**Occurrence**
	Team orientation	P1, P3, P6, P8, P9, P11, P12, P14, P15, P19, P24, P28	12
	Team methods and practices	P2, P4, P5, P7, P8, P9, P11, P13, P16, P19, P20, P23, P28	13
Trust	Relationships	P1, P3, P5, P7, P8, P9, P11, P12, P16, P19, P23, P25, P28	13
	Consistency	P5, P9, P13, P15, P16, P23, P27	07
	Benefits	P3, P4, P8, P11, P12, P13, P16, P19, P20, P21, P23, P24, P27	13
	Openness and honesty	P2, P5, P7, P11, P13, P17, P19, P24, P25, P28	10
	Identification	P1, P2, P6, P9, P10, P11, P16, P19, P26	09
	Reliability	P2, P5, P9, P10, P13, P14, P21, P24, P27, P28	10
Communication	Communication type	P1, P2, P5, P6, P9, P11, P14, P20, P23, P25, P28	11
	Communication frequency	P1, P4, P8, P9, P10, P11, P12, P15, P16, P17, P20, P21, P25, P26	14
	Communication tools	P3, P4, P5, P8, P11, P12, P15, P16, P18, P19, P20, P23, P24, P26	14
	Effectiveness of communication	P1, P2, P3, P4, P5, P6, P7, P8, P9, P11, P14, P16, P19, P21, P22, P25, P27	17

5. Discussion of Results

Sharing of tacit knowledge within SDP teams enables the SDP teams to have access to sufficient tacit knowledge, which complements explicit knowledge when the SDP team perform socio-technical tasks (Lee, Park, and Lee 2020). Lack of sharing tacit knowledge within SDP teams became evident because of the high failure rate of SDPs which had been in existence for a long period of time. SDPs are failing because SDP teams do not have access to sufficient tacit knowledge which makes the entire SDP team perform socio-technical tasks to the required standard which are required to ensure the success of SDPs. This indicates that SDP teams are central and drivers of sharing of tacit knowledge because they rely on tacit knowledge to perform socio-technical tasks to a good standard.

These barriers have influence on each other and they have a role they play which leads to more lack of sharing of tacit knowledge within SDP teams. This indicates that these barriers of tacit knowledge sharing cannot be given attention as individual barriers of tacit knowledge instead they need to be treated as a single unit. Their impact result on one thing which is lack of sharing of tacit knowledge within SDP teams which leads to SDP teams not having access to sufficient tacit knowledge. The influence of these barriers on one another shows that there is a need to address all of them instead of focusing on selective barriers when addressing them to increase the sharing of tacit knowledge within SDP teams. This leads to different barriers of tacit knowledge having association among them.

The SDP team culture takes into consideration issues such as the SDP team's attitude to sharing of tacit knowledge, their values, and social behaviour of the members of SDP team. The SDP team culture drives members of SDP teams focus on meeting the deadlines, compared to prioritising other things such as sharing tacit knowledge within SDP teams. This is because SDPs are deadline driven by nature and it is always important meeting those deadlines since they are part of success criteria. SDP team culture makes the members of SDP teams work independently so that they can meet their deadlines because they are prioritizing meeting the

deadlines. Deadlines are given priority over other things such as sharing tacit knowledge which result in lack of sharing of tacit knowledge.

The orientation of SDP teams is heavily focused on meeting the deadlines which is associated with the SDP team culture. These deadlines have an element of time and an element of budget. These elements are part of the success criteria of SDPs. SDP teams want to complete their tasks within the allocated time and budget (financial resources). This makes SDP teams to focus on ensuring that these two elements are met all the time which include completing socio-technical tasks properly. This results in SDP teams not being able to focus on other important elements such as sharing tacit knowledge. In other words, the orientation of SDP teams to meet deadlines results in these SDP teams neglecting the sharing of tacit knowledge and placing more emphasis on meeting the deadlines. This results in SDP teams not having balance between tacit knowledge and explicit knowledge which makes the entire SDP teams not performing socio-tasks properly.

Most SDP teams have members who are based in different locations such as different buildings and different vicinities. Covid-19 pandemic made the current trend of the members of SDP teams working from home or working remotely. SDP team members are also based in different geographical places, even foreign countries, which is driven by outsourcing practices. This results in members of SDP teams not being able to share tacit knowledge because such sharing of tacit knowledge relies heavily on verbal communication and the human presence. It is easier to share tacit knowledge where the members of the SDP team are in the same physical space. A geographical distance between members of the SDP team results in a lack of sharing tacit knowledge within SDP teams. Remote working limits the interaction among the members of SDP teams which also results in lack of sharing within SDP teams.

SDP team cohesion is heavily dependent on the strength and extent of interpersonal relationships within SDP teams especially among the members of SDP teams. Interpersonal relationships within SDP teams are vital to sharing tacit knowledge because the sharing of tacit knowledge is relational in nature. This indicates the members of SDP team who are participating in the process of tacit knowledge sharing needs to have a relationship among them (Ryan and O'Connor 2013). Therefore, relationships are influential in the sharing of tacit knowledge within SDP teams. Interpersonal relationships mean the members of SDP teams need to have shared norms and values and a sense of belonging within SDP team, which makes it easier for them to share tacit knowledge. Therefore, it is important that SDP team members have strong interpersonal relationships because it strengthens the sharing of tacit knowledge within SDP teams and among the members of SDP teams.

Trust within SDP teams and among the members SDP team is an important element when it comes to the sharing of tacit knowledge within SDP teams. However, trust within SDP teams and among members of SDP team is limited because members of SDP team focus on their tasks most of the time whereby the priority is to complete the tasks within allocated time. The members of SDP teams do not to have time to create trust with other members of SDP teams because the priority is placed on completing their respective tasks. This is the result of the SDP teams not having enough social gatherings, which allow SDP teams to create trust and have interpersonal relationships. SDP teams lack of social gatherings because of working arrangements such as working from home because of the lockdown restrictions in different countries and members of SDP team focus on meeting their deadlines within allocated time not prioritizing the sharing of tacit knowledge within SDP teams. A lack of trust results in a lack of sharing tacit knowledge within SDP teams. The higher the trust within the SDP teams and among the members of SDP teams leads to higher of sharing of tacit knowledge within SDP teams (Lee, Park, and Lee 2020). This means that it is essential for SDP teams to have high trust to enable the sharing of tacit knowledge within SDP teams. The trust is further affected by a lack of team cohesion, which makes the SDP team not to have strong interpersonal relationships.

SDP teams that are using traditional methods, especially the waterfall method, and having remote SDP teams rely heavily on written communication. Traditional methods rely heavily on written communication, as opposed to verbal communication as a form of communication within SDP teams. However, written communication enables the members of the SDP team to share explicit knowledge because explicit knowledge can be written down rather than tacit knowledge which rely heavily on verbal communication to share it. The most proven approach to sharing tacit knowledge within SDP teams is through verbal communication, which is minimal within SDP teams that are using traditional methods and working from different locations (Takpuie and Tanner 2016). Therefore, the type of communication especially written communication can limit the sharing of tacit knowledge within SDP teams. SDP teams need to start to rely heavily on verbal communication and use interactive methods such as Agile methods that enable them to share tacit knowledge because such SDP teams rely on verbal

communication heavily. This will result in SDP teams having good SDP team cohesion and good relationships within the SDP teams which result in more sharing of tacit knowledge.

6. Conclusion

The main aim of this research study was to identify team-oriented barriers that limit the sharing of tacit knowledge within SDP team. A total of seven team-oriented barriers were identified namely SDP team culture, SDP team orientation, SDP team dispersion, SDP team cohesion, SDP team properties, trust within the SDP team and communication within the SDP team. All these team-oriented barriers are depicted in Figure 1. These elements were not given much attention in the literature, especially the focus on tacit knowledge within the context of SDP teams in a developing country in the continent of Africa, even though SDPs are knowledge oriented in nature and team members rely on tacit knowledge to perform socio-technical tasks to the required standard. Tacit knowledge complements explicit knowledge when SDP team members conduct their socio-technical tasks within SDPs.

A theoretical contribution of this research is the SDP team-oriented barriers that limit the sharing of tacit knowledge within SDP teams. These issues were developed based on the context of the developing country, which is the RSA on the continent of Africa. All these issues emanated from SDP teams which rely on tacit knowledge when they perform their socio-technical tasks. This indicates that the entire SDP team contributes to the lack of sharing tacit knowledge within SDP teams. Therefore, SDP teams has a role to play in addressing the limitations of tacit knowledge sharing within SDP teams. The strategies to overcome these issues need to arise from SDP teams and their members. This will enable SDP teams to adhere and ensure effectiveness in sharing tacit knowledge which will result in SDP team having access to sufficient tacit knowledge within SDP teams.

SDP teams need to start using interactive methods such as the Agile Methods. Interactive methods rely on verbal communication, which enable the sharing of tacit knowledge within SDP teams. Verbal communication is one of the best practices and methods that has been proven when it comes to sharing tacit knowledge within SDP teams. Interactive methods enable the SDP teams to have more interaction, collaborations, and interpersonal relationships which makes the sharing of tacit knowledge take place within SDP teams. The interaction and collaboration will result in SDP team members developing interpersonal relationships, which will improve cohesion and trust in the SDP team. The relationships and trust are essential for the sharing of tacit knowledge within SDP teams. The stronger the trust and relationships, the more tacit knowledge will be shared within SDP teams.

This research study was conducted in the RSA, which is a developing country on the African continent. Thus, the results represent a perspective of a developing country on the continent of Africa. This research study focused on SDP teams, which indicates the results reflect project teams especially SDP teams. This can be regarded as a limitation when it comes to the results of this research study. These results do not focus on all SDP teams in the current era of the 4IR. These results are limited to SDP teams in a developing country that conducts the highest number of SDPs on the continent of Africa. RSA further have more investment based on financial resources when it comes to conducting SDPs in the continent of Africa (Marnewick 2016). The results further represent an African perspective (i.e., of the African continent).

It is important to validate the results of this research study, especially team-oriented barriers, using a deductive approach which is used to validate the results because it relies on large numbers. This will result in the results being validated and generalised to a larger population in the current era. The generalisation will be possible because the deductive approach relies on large numbers to generate the results and strength to generalise the results to a particular population. This will result in the results of this research study being validated and accepted by a wider audience in academic research. These barriers will be used more often in the literature by other researchers with different perspectives, which will lead to validations of the results of this research study. This will give other researchers an opportunity to improve on them and make them applicable to the wider community of different project teams, not only SDP teams and giving more attention of tacit knowledge within SDP teams.

There is a need to conduct a research study that will clarify the role of tacit knowledge and the contribution of tacit knowledge within SDP teams, especially in ensuring the success of SDPs and improving the efficiency and effectiveness when performing socio-technical tasks within SDPs. This can be done by conducting an inductive research study. The researchers can rely on qualitative data and observation can be used as a method of collecting the qualitative data. This will ensure that the SDP teams become more aware of where and when tacit

knowledge is required when performing socio-technical tasks within SDP teams and at which stage of SDP tacit knowledge is more required. Therefore, SDP teams will be able to preserve tacit knowledge that is required within SDP teams and work towards turning tacit knowledge into explicit knowledge for documentation to which other members of the SDP team can have access without relying on verbal communication and having geographical location as a limitation of accessing the knowledge.

In conclusion, SDP teams play a role and contribute to the lack of sharing tacit knowledge within SDP teams. This results in SDP teams not having access to sufficient and required tacit knowledge to perform socio-technical tasks to the required standards which leads to the success of SDPs. Limited access to tacit knowledge in SDP teams results in SDP teams failing to perform their social tasks of the software development process to the required standard. The failure of SDP teams to perform these tasks to the required standard contributes significantly to the high failure rate of SDPs, which is the current challenge. Therefore, SDP teams contribute to the high failure rate of SDPs by sharing limited tacit knowledge within SDP teams. In return, lack of access to tacit knowledge contributes to higher failure rate of SDPs in the current era.

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Relationship Between Knowledge Creation and Open Innovation Applied Through Public Open Innovation Platforms

Areej Alqahtani[1], Igor Hawryszkiewycz[2] and Eila Erfani[2]
[1]College of Community at King Faisal University, Al Ahsa, Saudi Arabia
[2] University of Technology Sydney, Australia

afalqahtani@kfu.edu.sa
Igor.Hawryszkiewycz@uts.edu.au
Eila.Erfani@uts.edu.au

Abstract: Public online open innovation (OI) platforms, widely used across countries, allow communities to participate in OI processes by sharing innovative ideas about specific problems. Knowledge creation and OI are related. To implement an innovative solution, new knowledge must be created. Previous studies have discussed knowledge creation and OI in the context of organisational teams in business, but knowledge creation by communities in the context of public OI platforms has received little attention. The socialisation, externalisation, combination and internalisation (SECI) model is a well-known model that embodies the knowledge-creation process. The OI process involves determining community needs, identifying themes, identifying a community problem, posting that problem on a platform, sharing innovative ideas for solutions, selecting the best solutions and implementing and diffusing the solution to the community. This study applied a multi-case approach to investigate how knowledge was created by communities through an OI process based on the SECI model. Data were collected by conducting in-depth interviews with leaders of two different OI platforms in two countries. Deductive analysis was utilised to clarify the OI process used by each platform and the relationship between the processes and the SECI model. The findings revealed that the OI process applied by public OI platforms follows the SECI structure. This means that innovative solutions created by communities represent tacit knowledge, which is turned into explicit knowledge and then becomes tacit knowledge again. The developed conceptual framework can facilitate the application of OI through the knowledge creation model and enhance understanding of community knowledge creation.

Keywords: Open innovation process, Public open innovation platform,Knowledge creation, SECI model, Public sector

1. Introduction

Developing innovation capability is now increasingly seen as essential for any organisation. Although innovation has been an important trend for many years, organisational practices that encourage innovation have changed continually. Building multidisciplinary teams has become a common practice, as has acquiring ideas from outside organisations—a trend that is commonly called open innovation (OI).

Innovation is increasingly related to knowledge development. New ideas represent new knowledge, and knowledge is needed to convert ideas into practice. In any innovation process, organisations must develop or capture knowledge about their stakeholders and their needs. They must then develop ways to satisfy those needs using experts' knowledge and ideas. However, innovation has gone beyond organisations' innovation of their products and services and has been extended to innovation in a wider community context via services provided by governments or community developments, such as smart cities. Industry and governments use a wide variety of processes to foster innovation, but a distinction may be made between closed innovation and OI. The relationship between knowledge creation and innovation was clarified by Nonaka et al. (1996) knowledge creation cycle.

Initially, most organisations supported closed innovation, meaning that ideas were generated by employees inside an organisation's boundaries (Herzog, 2011; Bae and Chang, 2012). In closed innovation, needs are often collected from selected customers chosen by the organisation and innovative ideas are generated by internal organisational staff. In contrast, innovative ideas in OI can come from both inside and outside an organisation (Herzog, 2011), involving customers, university researchers or suppliers (West and Bogers, 2014). While closed innovation is a well-known concept in the literature, OI was first introduced by (Chesbrough, 2003) and has since become the focus of attention for many studies.

Recently, the concept of innovation has been widely applied in the public sector (Harris and Albury, 2009; Torfing, 2016; Sørensen and Torfing, 2017). According to Bommert (2010); (Kankanhalli et al., 2017), public sectors should open their closed innovation due to the policy challenges they face. Moreover, approaches that invite community participation in decision-making processes, which were previously handled completely by

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governments, should be covered more extensively in the literature (Bekkers et al., 2013; Kankanhalli et al., 2017), since communities are an important part of OI processes.

Understanding knowledge that comes *from* customers rather than merely gathered *about* customers, as is often the case in closed innovation, is important in OI, which invites customers to provide knowledge about their current and future needs. Understanding customers' needs is often a key indicator of successful product innovation. Instead of starting with idea generation as the initial phase of innovation, organisations should first gather knowledge from customers to understand their patterns of needs and wants (Katemukda and Sudasna-na-Ayudthya, 2015). Thus, OI and knowledge creation theory are related. This research applied the SECI model as a well-known knowledge creation model. The study explored how these concepts are related to each other in the context of public online OI platforms, then considered how knowledge is converted into ideas and, subsequently, solutions that satisfy needs in terms of knowledge development as posited by (Nonaka et al., 1996). The study focused on public OI platforms used by communities to post innovative ideas to develop ways to identify stakeholders' needs and satisfy them. The research examined whether there is a connection between the knowledge creation model (specifically, the SECI model) and the OI process used for public OI platforms.

The main research questions were as follows:

- What OI processes were followed by the Australian and the United Arab Emirates (UAE) OI platforms?
- Does the knowledge created by communities through the OI process using public OI platforms follow the common SECI knowledge creation model? If yes, how does it proceed?

The next section discusses our previous work, which revised the traditional OI process to be appropriate for use by public OI platforms. The following section discusses public OI platforms and provides a background to knowledge creation and OI. The subsequent sections demonstrate the research methodology, analysis and findings; discuss the findings; and present the conclusions.

2. OI Process

According to Salerno et al. (2015) who mentioned many studies that addressed the innovation process, a closed innovation process involves idea generation, idea selection, idea implementation and idea diffusion. Closed innovation starts with an idea (as is often the case with start-up organisations) and shows how this idea will satisfy needs. In the OI literature, the OI process starts by generating ideas from external sources, such as citizens, customers or researchers (West and Bogers, 2014).

Table 1 summarises the most common innovation processes, open or closed, with or without the use of online platforms. The focus of many papers is on finding solutions—the stage at which ideas are initially generated. Figure 1 describes how prior studies have addressed the OI processes used by OI platforms in both the private and public sectors.

Table 1: Common Processes Used for Open and Closed Innovation Processes

Reference	Innovation process	Focus
(Salerno et al., 2015)	Previous innovation models followed a linear innovation process: 1) idea generation, 2) idea selection, 3) idea implementation and 4) idea diffusion.	Closed innovation Private organisations New product development
(Gerke et al., 2017; Bergendahl and Magnusson, 2015; Roberts, 2007; Dougherty, 1992)	Phases of the innovation process: 1) idea selection; 2) invention phase, including the implementation process; and 3) exploitation phase, including the product/service launch.	Closed innovation Private organisations
(Hansen and Birkinshaw, 2007)	Innovation process as an innovation value chain: 1) idea generation, 2) idea conversation and 3) idea diffusion.	Closed innovation Value chain

Reference	Innovation process	Focus
(Yang et al., 2009)	Steps in the OI process using online contests: 1) Posting: when the innovation seekers post a description of the project that they want people to give innovative ideas or solutions for. 2) Bidding: when the users submit their ideas. 3) Feedback: when the innovation seekers give feedback to the platform users. 4) Awarding: when awards are provided for the selected best-posted ideas. 5) Extending: an optional stage for the innovation seekers if they want to extend the project post for additional time. 6) Evaluating: another optional stage where the innovation seekers can leave feedback on all of the users' ideas.	OI Online contest
(West and Bogers, 2014)	According to an analysis of many articles about OI, the process can follow these stages: 1) obtaining innovation from external sources; 2) integration of innovations; 3) commercialising of innovations; and 4) interaction mechanisms, which may occur at any phase of the innovation process.	OI Private organisations
(Durst and Ståhle, 2013)	Open innovation phases are as follows: 1) searching for innovations, 2) selecting the most appropriate innovation, and 3) implementing the chosen innovation.	OI
(Milutinović et al., 2018)	Process in online OI platforms: 1) collecting new or existing innovative solutions; 2) choosing the best solutions by experts or the community and 3) implementation and launching the selected solution, either product or service.	Online OI platforms
(Adamczyk et al., 2012; Bullinger et al., 2010)	1) generation of innovative ideas through the platform; 2) selection of the more appropriate ideas by evaluators who are experts in the field; and 3) application of the selected idea, including launching the innovative idea into the market.	OI Innovation contests

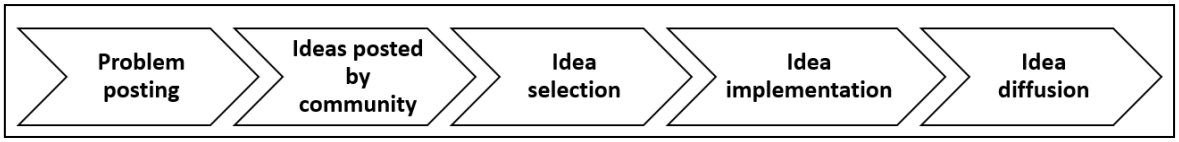

Figure 1: Traditional OI Process Through Public Online OI Platforms

The OI process shown in Figure 1, from our previous 2021 study, was revised to the one shown in Figure 2. The previous study proved that there was a missing step in the OI process for public online OI platforms (Figure 1)—how the problem was determined. It is found three methods used by one OI platform (platform A in the previous study) to capture community needs: community interviews, workshops (including consultations) and recent research on problems. The other platform used different methods, such as suggestion boxes, social media and the monitoring of country vision indicators. The revised process was divided into two parts—problem determination and the selection of an innovative solution. The main contribution of this study was to prove the viability of the existing procedure for capturing community needs, identifying themes and specifying problems through an OI process. Capturing needs can be divided into two parts: first, *what* is needed, such as improved transportation or educational services; and second, *how* solutions and services can be provided to meet the identified needs.

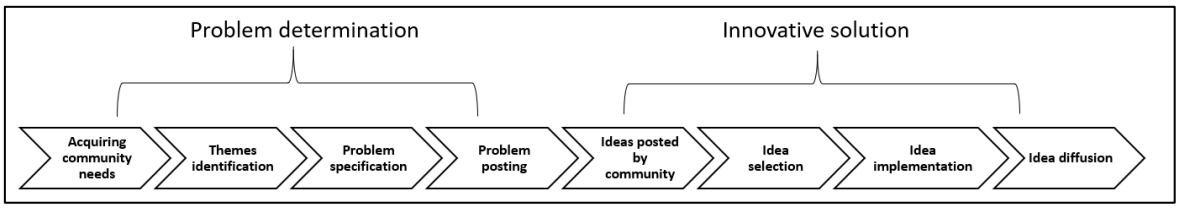

Figure 2: Revised Innovation Process Through Public Online OI Platforms (Previous Work)

3. Public Online OI Platforms

OI can be applied to either the private or public sector, though the implementation can be different in each sector. Application of OI in the private sector often focuses on particular products. For example, LEGO is a toys brand who faced a decreased in revenues, then, the company launched a philosophy said "people don't have to work for us to work with us" by establishing a LEGO Ideas where customers can share and votes for ideas. This was a turning point for the company which becomes "a global leader in toy innovation" (Markowitz, 2018). Therefore, The application of OI in the private sector leads to various benefits, such as high revenues and competitive advantage (Bommert, 2010). On the other hand, the public sector is usually aware of the delivery of innovative public services, specifically if the external sources of ideas are citizens (Bommert, 2010). Both public and private sectors benefit from including external ideas in their innovation processes. One general example here is the development of smart cities such as initiative of Melbourne as Smart City in Australia (Melbourne, n.d.).

Zhang et al. (2017) identified the factors that drive the implementation of OI in the public sector, namely 'support of top managers', 'the access and competence of IT personnel', 'the regional economic' and 'social environment'. According to Curtain (2003), several point important in OI, ,such involvement itself has options. For example, is citizen input only needed in defining needs or do citizens also get involved in generating ideas. Many smart city projects for example define needs in general terms and then issue challenges to the community to provide solutions. Some include citizens in the decision-making process in the context of government services like education or health. For example, citizens can play the teacher role to explain specific problems and their solutions in more detail. Citizens can also take the discovery role. Therefore, citizens can define the hidden principles for specific problems (Curtain, 2003).

Figure 3 presents a process that we have identified for applying OI using online platforms. This process is supported by governments to find innovative solutions for community problems, for example, in health or education. First, the platform posts a specific problem to be solved by the community. Next, the community shares its innovative solution through the platform. Afterward, the proposed solutions are analysed by an evaluation team to select the best solution that can be implemented for the problem.

The first external source of innovation that can play an essential role in the OI process is the customer. The inclusion of the customer has long been considered a valuable component in the innovation process. However, such inclusion was limited to getting the customer's requirements for product development; their participation

was not included throughout the innovation process. Katemukda and Sudasna-na-Ayudthya (2015) argued that customer involvement in the first phase of the innovation process (idea generation) is missing. Organizations focus on knowledge about customers, not from customers (Katemukda and Sudasna-na-Ayudthya, 2015). For example, they consider the customers' age and gender but not their needs. Although Katemukda and Sudasna-na-Ayudthya (2015) did not explicitly mention the concept of OI, their analysis led to companies acquiring more knowledge from customers as it is an important component of the innovation process, which in turn led us to the concept of OI. Moreover, Piller et al. (2011) stated that in the context of OI, 'customers become active participants in an innovation process of a firm and take part in the development of new products or services. Previous studies have shown that the integration of customers and suppliers can generate great ideas that can be considered in the innovation process (Lau et al., 2010). Overall, the involvement of customers' ideas throughout the innovation process can be a valuable external source.

Nowadays, the community also plays an essential role as an external source of knowledge for innovation (Lee et al., 2012). Seltzer and Mahmoudi (2013) indicated that the participation of citizens in the innovation process needs to be well managed and organised, as this involvement can contain several ideas. Most researchers linked the studies of community participation as an external source of knowledge with innovation in the public sector. This involvement is usually implemented through online platforms (Mergel, 2018). A community can assist governments in creating more innovative services faster (Lee et al., 2012). Many governments have recognised the importance of citizen participation and have therefore adjusted their strategy to include citizens as a valuable source of ideas (Lee et al., 2012). Previous studies have emphasised the customer as an external source of ideas specifically in the context of product innovation.

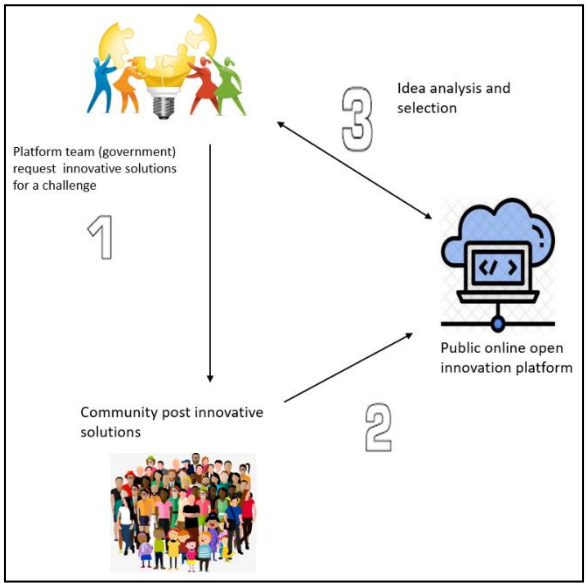

Figure 3: How Public Online OI Works

4. Knowledge Creation and OI

Knowledge management (KM) is 'the process of using meticulous steps to acquire, design, manage and share knowledge within an organization to achieve better performance such as reduced costly rework, faster work and use of best practices' (Abubakar et al., 2019). Knowledge creation is an important activity in the KM field. In the late 70s and 80s, knowledge creation in companies largely referred to the development of new products, but in the 90s, the knowledge creation theory emerged (Konno and Schillaci, 2021). Nonaka and Takeuchi (1995) stated that knowledge is initially created by individuals and then by groups of people. There are many definitions of KM. However, knowledge is created throughout the process of acquiring, transferring or sharing proposed solutions. According to Alavi and Leidner (2001); (Mardani et al., 2018), KM commonly focuses on five processes: 'acquisition, identification, development, diffusion, usage and repository of knowledge'. Other factors, such as knowledge implementation, creation and exploration, have also been studied widely in the literature. Mardani et al. (2018) concluded that knowledge creation and acquisition are the processes involved in knowledge production, involving the 'integration of knowledge, including knowledge storage and knowledge distribution' and the 'application of knowledge, including protection and use of knowledge'.

Nonaka studied knowledge creation from the 90s onwards, particularly examining the generation of knowledge by people in organisations. Nonaka (1994) stated that the creation of knowledge is not a sequential process; it is an ongoing spiral process. However, some studies have suggested a sequential process of knowledge creation involving creation, retrieval, transfer and application (Alavi and Leidner, 2001).

Nonaka and Konno (1998) divided knowledge into two types: tacit and explicit. Tacit knowledge resides in people's minds, experiences and actions. It is not visible; thus, it is hard to capture. Conversely, explicit knowledge is represented by numbers or words and can be captured in books, documents and models; therefore, it is effortless to acquire and easier to share between individuals and apply.

Knowledge creation has been embodied in many models, one of the most common and well known of which is Nonaka's SECI model. Nonaka and Takeuchi (1995) based the SECI model on the transformation between tacit and explicit knowledge. As shown in Figure 4, the model has four components relating to socialisation, externalisation, combination and internalisation:

Socialisation

This is the first component of the model. It appears in an organisation when tacit knowledge is shared through observations, brainstorming, talking, actions and employees' cooperation, but only at the individual level.(Eseryel, 2014).

Externalisation

Tacit knowledge is made explicit when it is demonstrated through group discussions, open dialogues, and the use of documents, images and models. It is expanded through groups at the individual level (Chatterjee et al., 2018).

Combination

This includes gathering, combining, systemising, categorising and editing existing explicit knowledge, besides diffusing it, to form new explicit knowledge (Eseryel, 2014; Nonaka and Toyama, 2015).

Internalisation

Internalisation means that previous explicit knowledge is put into practice. Simulations and experiments are used to convert explicit knowledge back into tacit knowledge (Kahrens and Früauff, 2018).

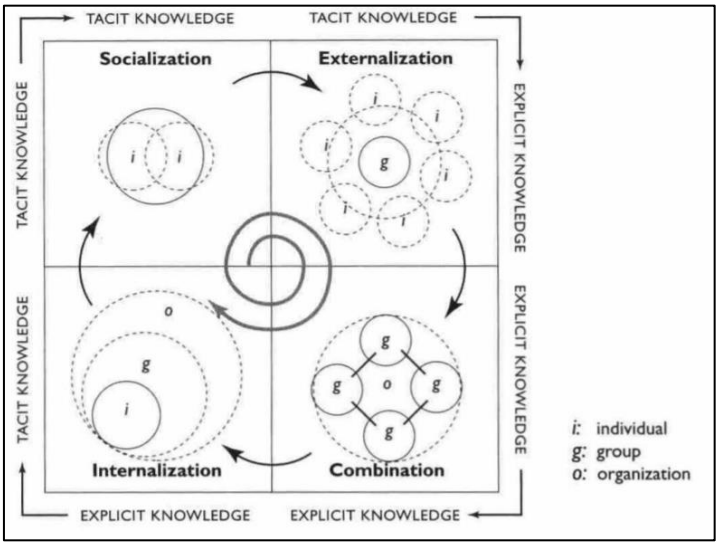

Figure 4: SECI Model (Nonaka and Konno, 1998)

Generally, there is a relationship between knowledge creation and innovation since knowledge creation is a source of innovation continuity, increasing competitive advantage (Nonaka and Takeuchi, 1995). Grimsdottir and Edvardsson (2018) stated that 'knowledge creation can be seen as the starting point of both KM and innovation'. Specifically, radical innovation is preceded by the process of knowledge creation (Forés and Camisón, 2016; Alshanty et al., 2019). Teixeira et al. (2019) indicated that knowledge is 'recognized as an arrangement of processes that facilitates innovation'. Also, Oliva and Kotabe (2019) indicated that an organisation's innovation is affected by individuals' interactions throughout the KM process. Andreeva and

Kianto (2011); (Lai et al., 2014) studied many companies in different countries and found a positive relationship between knowledge creation and innovation performance. Therefore, there is no doubt about the link between KM in general and knowledge creation and innovation in particular.

Regarding OI and the knowledge creation process, many studies have mentioned them together. Eseryel (2014) stated, 'The core of open innovation is knowledge creation' (Eseryel, 2014). Eseryel (2014) studied how open-source software development teams, such as OI teams, created knowledge by using technology. In this context, the author adapted the SECI model to the OI setting. Another study by Du Chatenier et al. (2009) investigated how knowledge was generated collaboratively by an OI team. The authors developed a conceptual framework based on 1) knowledge sharing, 2) interpretation, 3) negotiation and 4) combination. In a different context, Grimsdottir and Edvardsson (2018) studied two different small–medium companies, each with different products and each with its own OI knowledge creation model. They found that one company sought customers' knowledge in the early stages of OI, whereas the other company only engaged its customers at the end of the process.

Therefore, the OI process depends on the nature of the organisation and the source of the created knowledge. In this research, the community was the source of outside knowledge and the focus was on innovation and knowledge creation using public online OI platforms managed or monitored by governments. Based on the previous discussion, a conceptual framework was developed (see Figure 5).

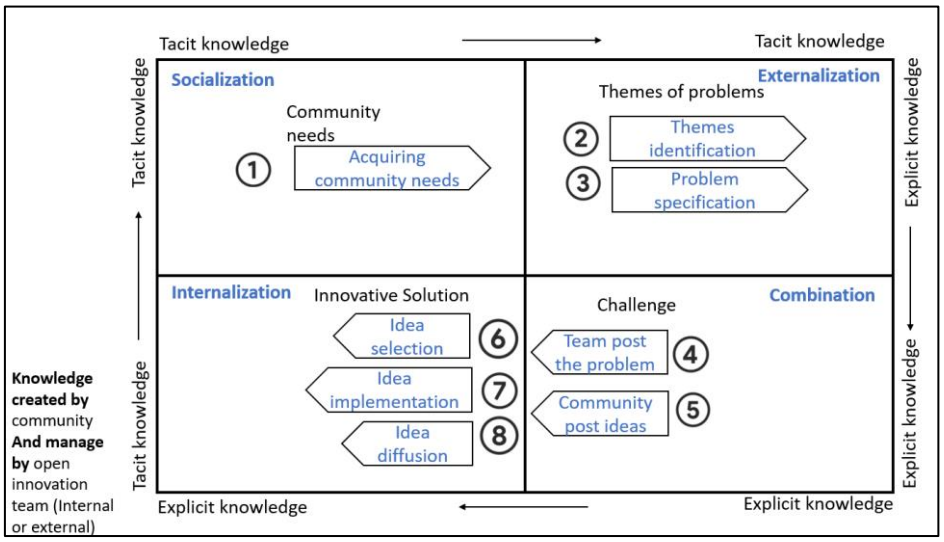

Figure 5: Conceptual Framework of Relationship of Knowledge Creation Model (SECI) and OI Process Applied Through Public OI Platforms

5. Methodology

Given its use of the 'how' question, this study constituted exploratory research, meaning that it investigated a particular part of a field to understand what was happening (Robson, 1993). Specifically, this study explored, from the perspective of the SECI model, the way communities create knowledge through OI processes using public OI platforms. To acquire deep knowledge and explore more than one culture using the same platform, we applied a multi case study design (Battistella et al., 2017) because it was the most appropriate method for answering the research question. We chose the qualitative multi case approach due to the need to examine the knowledge creation cycles followed by communities and managed by OI teams and compare them to the SECI model.

5.1 Case Selection

To obtain in-depth knowledge about the research question, we explored two platforms from different countries. Both of the studied organisations run OI platforms to allow their communities to solve problems by sharing innovative solutions. The two platforms function as follows:

- The platform raises a challenge faced by the community, such as a congested highway in the city.
- The platform asks the community for ideas for innovative solutions.
- The competition is closed and the ideas are evaluated.

- Candidates who provide innovative solutions are invited to presentations.
- Finally, winners are announced.

The two cases were limited to OI platforms established for the community and run by governments, not private organisations. An OI team for each platform managed the challenge, and a judging panel evaluated the ideas and selected the ideal solution.

The first case was an OI platform located in Australia, while the second was located in UAE. Despite the very different cultures, the two platforms worked similarly, as mentioned earlier. Innovative solutions were generated by communities. The Australian platform launched its first challenge in 2018 and has since presented one challenge annually on a different theme (e.g. for this year, the challenge was the city's recovery after the COVID-19 pandemic). The UAE platform covers many aspects of innovation, such as innovative educational tools and launches annual challenges, with themes relating to social issues in the UAE, such as the environment and climate change.

5.2 Data Collection

In-depth interviews were conducted with the leaders of the two OI platforms. Each interview lasted for one hour and all interviews were conducted online. To ensure the accuracy of the information, the Emirati interviews were recorded, transcribed and translated from Arabic into English. The interviews were conducted in 2020. The team leader for the UAE platform worked directly with decision-makers in the country to investigate community needs, using discovery methods such as suggestion boxes in government ministries. The leader also managed workshops that took place in an innovation laboratory (hereafter, 'lab') to identify challenge themes. The Australian leader managed all stages of the OI process across all challenge stages.

5.3 Data Coding

A deductive analytical approach was used to code the data. According to (Pandey, 2019), 'deductive content analysis is an analytical method that aims to test existing categories, concepts, models, theories or hypotheses in a new context'. Moreover, deductive content analysis is used when the analysis is based on previous knowledge, which in this case refers to the knowledge creation SECI model. According to Elo and Kyngäs (2008), the stages of deductive content analysis were as follows: (1) selecting the unit of analysis, (2) making sense of the data as a whole, (3) developing structured analysis matrices, (4) coding data according to categories, (5) testing hypotheses and comparing them with earlier studies and (6) developing a model, conceptual system, conceptual map, or categories.

After the interviews, the audio recordings were transcribed, and a deductive content analysis matrix was used to analyse the transcripts. As shown in Figure 3, based on the relationship between OI process and knowledge creation, a deductive content analysis matrix was developed (see Figure 5). As mentioned previously, the recommended phases of deductive content analysis were followed to analyse the transcripts (Elo and Kyngäs, 2008). The first and second stages were the preparation phases, while the following phase was the organising phase. The final stage was the reporting phase.

5.3.1 Preparation Phase

- Selecting the unit of analysis

The unit of analysis could be a word, one or more sentences or even a page (Polit and Beck, 2004; Elo and Kyngäs, 2008), based on the research question and what we needed from the data. In this work, the unit of analysis was examined to explain processes and approaches, with the aim of showing the relationship between knowledge creation and OI in communities.

- Making sense of the data

This meant reading the data, becoming familiar with them (Burnard, 1991) and generally making sense of them. Thus, the data were read many times to enable the researcher to thoroughly understand the transcripts. This is an important step before coding data using either an inductive or deductive approach (Polit and Beck, 2004).

5.3.2 Organising Phase

- Developing the analysis matrix and coding data according to categories

An analysis matrix can be structured or unstructured (Kyngäs et al., 2019). In this study, a structured matrix was chosen because of the nature of the analysis, which was based on the SECI model and the OI process, as shown

in Figure 5. Table 2 describes the structured analysis matrix based on this model. The columns represent the OI process: acquisition of community needs, theme identification, problem specification, posting the problem on the platform, community posting of ideas, and idea selection, implementation and diffusion. The rows represent the phases of the SECI model relating to the life cycle of knowledge creation: socialisation, externalisation, combination and internalisation. The coding process was carried out using NVivo 12 software. The structured analysis matrix and interview transcripts were entered into the software for analysis. The checkpoints represent where the codes (units of analysis) from the transcripts were placed during the coding process.

Table 2: Deductive Analysis Matrix

Open innovation process / SECI Model	Acquiring community needs	Themes identification	Problem specification	Team post the problem	Community post ideas	Idea selection	Idea implementation	Idea diffusion
Socialization	✓							
Externalization		✓	✓					
Combination				✓	✓			
Internalization						✓	✓	✓

5.3.3 Reporting Phase

- Case 1: Australian platform

Figure 6 provides a description of OI process map and answers the research question regarding the OI process applied by the Australian platform based on the general OI process shown in Figure 2. The process map in Figure 6 presents the first step of the OI process. The process started by capturing community needs through engagement with the community using surveys or applying research. Then, the OI competition team specified a list of themes. Thereafter, one problem was identified after conducting a series of workshops involving experts and the OI competition team. The specified problem was then posted on the platform as a challenge to the community, with a predetermined deadline. Meanwhile, sessions were held between the theme experts and participants to answer questions regarding the challenge. Moreover, a week called 'knowledge week' was used to allow theme experts to assist participants in incorporating their ideas and solutions. After the challenge closed, a list of participants' ideas and solutions was sent to the OI competition team. The evaluation process then started with the assessment panel reviewing the list to score and discuss the ideas for solutions. A showcase event was held to present the solutions of each of the top candidates for four minutes. Finally, the judging panel specified the winners and awarded prizes.

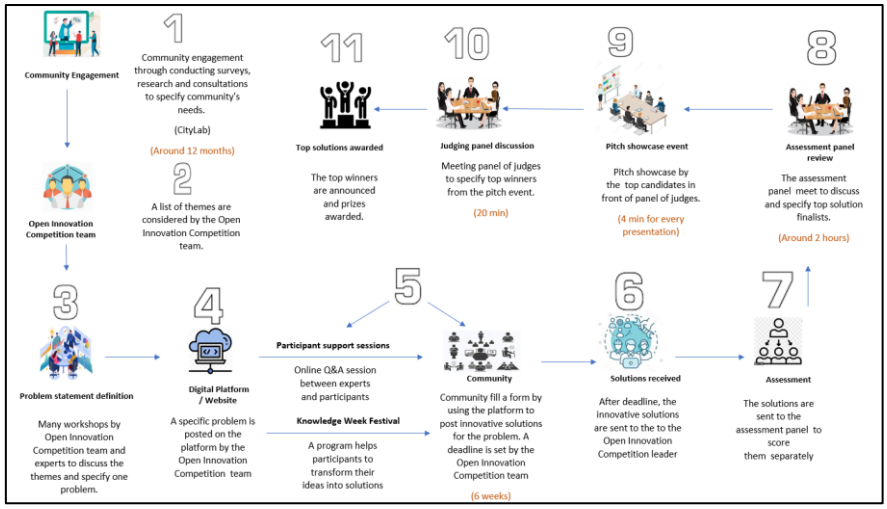

Figure 6: Process map of the Open Innovation Process in the Australian Platform

- Case 2: UAE platform

The OI process for the UAE platform (Figure 7) followed similar management to that of the Australian platform. In general, the operating of the challenges was the same; the challenge was posted and the community was asked to post ideas for solutions. Initially, the platform was based on an innovation lab, which was a series of workshops to discuss community needs and problems. As the platform leader stated, '*With this lab, we know why we want to engage with ideas from outside the institution, as we have groups in society who are benefitting from or affected by services in a particular sector*'. The government innovation lab was based on all government departments related to the community, such as the Ministry of Health. Any community needs or problems could be discussed in the innovation lab.

Generally, there is no specific way to acquire community needs or problems. One method, as shown in Figure 7, is the use of country vision indicators, such as the best education system. Suggestion boxes in ministries were checked in the innovation lab. Then, a problem statement was formed and posted to the community. The subsequent steps for selecting and evaluating the solutions were the same as those for the Australian platform.

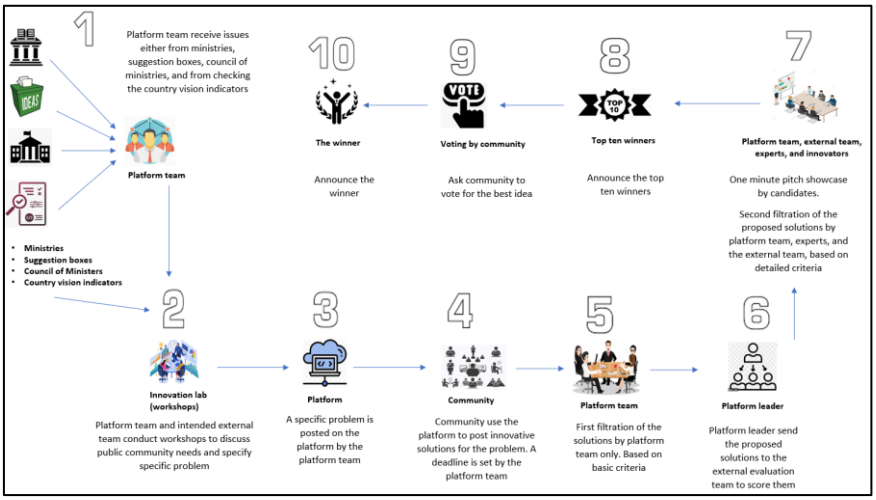

Figure 7: Process map of the Open Innovation Process in the UAE Platform

6. How Knowledge was Created During the OI Processes Applied by the Public OI Platforms (Based on the SECI Model)

The process map in Figures 6 and 7 shows the OI process approved in the previous study (Figure 2). To answer the second research question regarding the relationship between the knowledge created by the community and managed by the OI team and the SECI model, Figure 8 demonstrates the relationship.

Socialisation

Initially, the knowledge in the OI process was tacit, existing only in people's minds; for example, someone in the community had an idea for a solution to a specific social problem they faced. Community members might discuss ideas with their partners, consider the problem and solution, discuss a specific public service, suggest a solution for the problem or recommend another country's solution for adoption in their local community. These people may or may not have had experience with that solution. The OI team would then communicate with the community to identify their needs regarding specific social issues, such as the transportation system. Thus, the team socialised and interacted with the community. They might observe, interview, conduct research and/or conduct surveys with the community. Therefore, communication with the target community opened space for developing more themes on community needs. This interaction could be done in real life by interviewing people on TV channels or through social media exchanges. The suggestion boxes in the ministries were also checked, as for the UAE platform. Community knowledge was still tacit at this stage.

Externalisation

After socialising to determine the community's' knowledge, the OI team conducted workshops (the innovation lab of the UAE platform) to start transforming the extracted tacit knowledge into initial explicit knowledge.

External experts from the public sector, such as the Ministry of Education, joined the innovation lab. They studied the quality and effectiveness of new knowledge. As Chatterjee et al. (2018) stated, knowledge at this

stage 'becomes the basis of new knowledge'. This meant that community needs (community tacit knowledge) became explicit to the OI team, forming the basis of the innovative community solution.

Finally, another stage of the OI process (problem identification) occurred when the team specified one problem to be posted on the platform as a challenge and the identified problem was posted. Thus, external community knowledge became explicit.

Combination

The knowledge gathered from a community must be externalised to determine *what* must be provided to satisfy the needs and then combined with existing resources to determine *how* to provide it. As shown in Figure 8, the communities generated solutions for the challenge posted by the OI team, which meant that ideas for solutions were based on community needs. This meant that the community's previous knowledge (needs and ideas for solutions) was combined with solutions posted on the platform to form new knowledge. The evaluation and selection process was then conducted by the evaluation team and, sometimes, the OI team. The evaluation teams differed for each platform. For example, for the Australian platform, the evaluation team members were external individuals, chosen according to the challenge theme, such as university professors, international partners and Australian government partners: '*It's a team of our partners that gives prizes. So, there are usually … five or six on the final judging panel.'*

For the UAE platform, when the OI leader was asked about the formation of the evaluation team, he replied, *'I have been a member of it from the time the initiative was launched'.* There were criteria for evaluating each challenge. As the UAE platform leader explained:

> *There are approximately seven criteria, such as the feasibility of the idea and whether it is considered new, can work in a specific time and have an impact. The standards were studied with international organisations that had experience and selected the criteria.*

Internalisation

The idea selection process involved the two components of the model relating to combination and internalisation when the community's knowledge was put into practice. First, the selected ideas were presented to the judging panel. Second, by announcing the winner, the judging panel moved the process to the implementation phase. The judging panel tried to gain further understanding of the solution to the challenge by asking questions and holding discussions with the candidates. Explicit knowledge was embodied here by implementing and diffusing the solution back to the community. This knowledge was created by community stakeholders who evaluated how solutions would resolve the problems identified during externalisation. This included feedback from judges on the solution, especially when there were gaps in meeting the challenge. This knowledge was often tacit and could result in another cycle of improvement to the solution. In design thinking, such solutions are often presented as prototypes that are continually being improved.

Continuous improvement is part of the SECI model, with the cycle of socialisation, externalisation, combination and internalisation continually repeated as improved solutions are developed based on previous results.

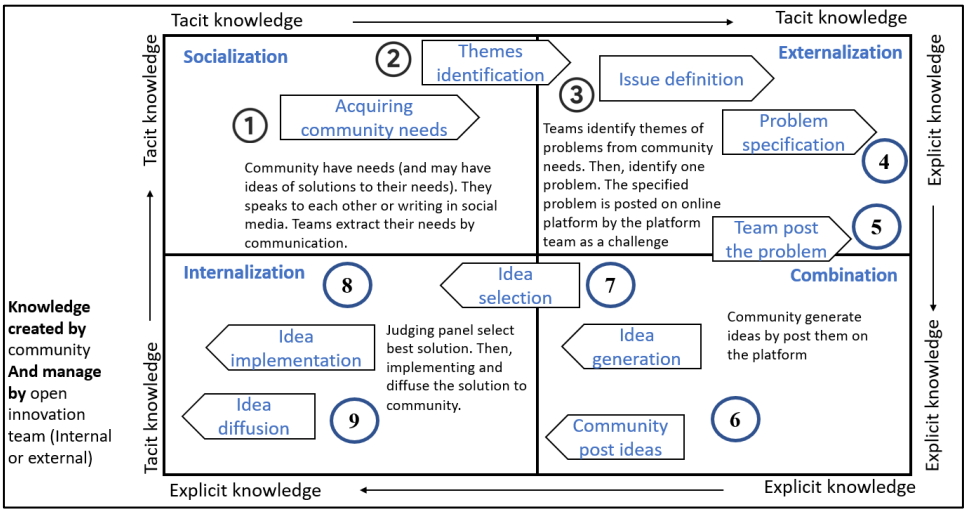

Figure 8: Revised Relationship Between SECI Model and OI Process Applied Through Public OI Platforms

7. Conclusion and Future Work

The main achievements of this research and its contributions included confirming the innovation process used by two OI platforms in two different countries (Australia and the UAE). The results support our previous work, which discussed the OI process applied by public online OI platforms. The earlier findings indicated that the five platforms (three platforms are not explained in this paper) followed the previously approved OI process (Figure 2). Second, it confirmed knowledge creation by the community during the OI process. The literature showed that there is a relationship between knowledge creation and closed innovation but also between OI and knowledge creation, as discussed previously. However, this paper argues that the OI process used by communities on public OI platforms follows the well-known SECI knowledge creation model developed by (Nonaka and Konno, 1998). After interviewing the platform leaders, the interviews were analysed using a deductive analysis matrix, as shown in Table 2.

The results support the claims made in the literature that the OI process can follow the SECI model. Based on the analysed data, the key findings in Figure 8 demonstrate that the first and second phases of the OI process (acquiring community needs and identifying themes for problems) gather tacit community knowledge. Regarding the first component of the SECI model, the platforms' OI teams extracted this tacit knowledge from the community using many approaches, such as interviews, suggestion boxes, research and surveys. Then, tacit knowledge was converted into explicit knowledge by sorting it into themes and identifying the most important problem to be posted on the platform (externalisation). This explicit knowledge was converted into further new explicit knowledge by the community when they posted their innovative ideas for solutions to the target problem (combination). The idea selection process started with the judging panel analysing and selecting the best ideas. The selection process could flow between the combination and internalisation components of the SECI model at this stage. Finally, the announcement of the winner for the best innovative solution to be implemented and diffused to the community represented internalisation.

This study provides a framework that public OI platform management teams and decision-makers can follow to operate public OI platforms. Future research can examine ways of extracting tacit knowledge from communities and converting it into explicit knowledge for implementation as innovative solution for communities. Future work could also expand the data collection phase to include other public online OI platforms and interview other teams in other countries.

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