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## THE IMPACTS OF KM-CENTRED STRATEGIES AND PRACTICES ON INNOVATION: A SURVEY STUDY OF R&D FIRMS IN MALAYSIA

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### ABSTRACT

Aim/Purpose	The aim of this paper is to examine the influences of KM-centred strategies on innovation capability among Malaysian R&D firms. It also deepens understanding of the pathways and conditions to improve the innovation capability by assessing the mediating role of both KM practices, i.e., knowledge exploration practices, and knowledge exploitation practices.
Background	Knowledge is the main organisational resource that is able to generate a competitive advantage through innovation. It is a critical success driver for both knowledge exploration and exploitation for firms to achieve sustainable competitive advantages.
Methodology	A total of 320 questionnaires were disseminated to Malaysian R&D firms and the response rate was 47 percent. The paper utilised structural equation modelling and cross-sectional design to test hypotheses in the proposed research model.
Contribution	This paper provides useful information and valuable initiatives in exploring the mediating role of knowledge exploration and knowledge exploitation in influencing innovation in Malaysian R&D firms. It helps R&D firms to frame their KM activities to drive the capability of creating and retaining a greater value onto their core business competencies.

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Findings	The findings indicate that all three KM-centred strategies (leadership, HR practices, and culture) have a direct effect on innovation. In addition, KM exploration practices mediate HR practices on innovation while KM exploitation mediates both leadership and HR practices on innovation.
Recommendations for Practitioners	This paper serves as a guide for R&D managers to determine the gaps and appropriate actions to collectively achieve the desired R&D results and national innovation. It helps R&D firms frame their KM activities to enhance the capability of creating and retaining a greater value to their core business competencies.
Recommendations for Researchers	This paper contributes significantly to knowledge management and innovation research by establishing new associations among KM-centred strategies, i.e., leadership, HR practices, and culture, both KM practices (knowledge exploration and knowledge exploitation), and innovation.
Impact on Society	This paper highlights the important role of knowledge leaders and the practice of effective HR practices to help R&D firms to create a positive environment that facilitates both knowledge exploration and knowledge exploitation in enhancing innovation capabilities.
Future Research	Further research could use a longitudinal sample to examine relationships of causality, offering a more comprehensive view of the effect of KM factors on innovation over the long term. Future research should also try to incorporate information from new external sources, such as customers or suppliers.
Keywords	KM-centred strategies, knowledge exploration, knowledge exploitation, innovation

## INTRODUCTION

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Knowledge management (KM) is essential in ensuring firms are able to create a sustainable competitive advantage and economic wealth of the country. In the past few decades, the importance of knowledge for firms has been proven by the increasing interest in KM practices. It has been found that using, managing, and sharing knowledge is an important task in firms, and good practices for managing knowledge can affect performance, growth, and innovation (Del Giudice & Peruta, 2016). In other words, effective KM is essential throughout organisational strategic planning and strategic management because it provides superior economic development.

Previous studies indicate that knowledge is the main organisational resource that is able to generate a competitive advantage through innovation (Gonzalez & de Melo, 2018; Torugsa et al., 2016). This finding is corroborated by recent surveys which show that KM influences the performance of firms, as it offers an effective framework for implementing innovation strategies (Lee et al., 2013; Lin, 2014; Moustaghfir & Schiuma, 2013).

Innovation is crucial for companies to adapt to dynamic environments and to create strategic flexibility (Gonzalez & de Melo, 2018). It has also been recognised as a direct result of KM effectiveness and one of the main objectives for knowledge-creating companies in order to obtain competitive advantages (Torugsa et al., 2016). Previous researchers also reported that KM and intellectual capital influences the performance of companies as it offers an effective framework for implementing innovation strategies (Lee et al., 2013; Lin, 2014; Moustaghfir & Schiuma, 2013). Moreover, technological innovation is considered a strategic success factor for both knowledge exploration and exploitation as these practices are essential activities for companies in order to achieve competitive advantages (Gupta et al., 2006; He & Wong, 2004).

Despite its importance, the majority of KM practices failed to be implemented. This may be due to technology-bound reasons and ignorance of the consequences of KM implementations (Mohamad

et al., 2017), particularly in the context of Malaysia. Moreover, little empirical evidence addressed the interrelationship between KM and innovation (Leal-Rodríguez et al., 2013). Hence, it is important to investigate the possibility of KM influencing innovation in R&D firms in Malaysia today. However, many of these knowledge management-innovation studies are based on a Western framework and setting. Furthermore, KM studies in Malaysia are limited to investigating the extent of KM awareness and practice, exploring the perception of KM issues, and determining KM's relation to competitiveness and employees' attitudes. An empirical study on the KM approach among electrical and electronic (E&E) firms in Malaysia revealed that most firms were lacking a clear KM strategy (Sharma, 2003). Additionally, there is also a dearth of studies that investigate empirical findings of the implications of the innovation outcomes of the knowledge base.

The present study, therefore, attempts to identify and examine knowledge-centered strategies that facilitate KM practices, i.e., knowledge exploration and knowledge exploitation, and their association with innovation capability in the context of Malaysian R&D firms. The remainder of this paper is organised as follows. The next section presents a literature review of the key concepts (i.e., three KM-centered strategies, knowledge exploration, and knowledge exploitation practices) and is followed by a list of hypotheses tested in the paper. The methodology and results of an empirical examination of the proposed model in the context of R&D firms in Malaysia are then presented followed by a discussion of the significance of the findings and implications of the study. The paper concludes with a summary of the major conclusions.

## LITERATURE REVIEW

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The following is the brief literature review conducted on the KM practices (knowledge exploration and knowledge exploitation) and KM-centred strategies (leadership, HR practices and culture).

### ***KM PRACTICES: KNOWLEDGE EXPLORATION AND KNOWLEDGE EXPLOITATION***

According to the knowledge-based view, knowledge is a vital resource for increasing and stimulating innovation. Previous studies pointed out that the combination of knowledge exploration and exploitation is the ideal strategy for innovation since it would lead firms to access new technologies and refine and improve the dominant technology through the exploitation of primary knowledge (Gonzalez & de Melo, 2018; Kane & Alavi 2007).

Exploration refers to new opportunities captured through the acquisition of new external and tacit knowledge (Tushman & O'Reilly, 1996). It leverages existing knowledge through the application of pre-established procedures, technologies, and solutions. It is developed to meet the emerging demands of customers or new markets, promoting the introduction of new technology in products, services, and processes that are not yet operable. It underpins the search for new external knowledge to boost discontinuous innovation (Ferraris et al., 2017). Exploratory innovation requires new knowledge and information, which in turn requires a consolidated primary knowledge base. The absence of primary knowledge would restrict the acquisition of new knowledge that supports the process of innovation through exploration (Grant, 1996).

In comparison with exploration, exploitation is related to existing knowledge (Lubatkin et al., 2006; Nonaka, 1994) and linked to incremental innovation, thus resulting in more certain outcomes (Oborn et al., 2013; Tushman & O'Reilly, 1996). It is conducted to meet the needs of customers and current markets, expanding the existing products and services, and also refining and improving the efficiency of the processes. Exploitation underpins service improvement and implementation activities, being explicitly concerned with applying new knowledge to change current practice. It is based on knowledge and information associated with primary knowledge and skills, and thus can lead to novel products, new procedures, and innovative solutions to problems.

Prior and recent studies have emphasized the differences between old and new knowledge. Ganzaroli et al. (2016) argued that it is important for R&D companies to maintain an appropriate balance between exploration and exploitation to increase competitiveness. If too much investment is placed on exploring new knowledge, it may cause inefficiency in R&D gains and thereby relinquish the competitive advantage of the firms. On the other hand, if the firms focus too much on exploiting old knowledge, it will be difficult for them to develop core capabilities (Chong et al., 2018; Martini et al., 2013). As such, both exploration and exploitation are important for R&D firms and need to be implemented to stay competitive in the market. As reported by Benitez et al. (2018), it is equally important for R&D firms to both explore new knowledge and exploit existing knowledge to innovate more and better.

R&D firms should be involved in sufficient exploitation to guarantee its current viability while devoting sufficient attention to exploration to ensure the organisation's future viability (Levinthal & March, 1993). In addition, Vargas et al. (2021) also reported that R&D firms should use their knowledge in the search for improvements within an established framework (i.e., exploitation) to pursue an orientation based on refreshing knowledge towards exploration. Some studies have used the notion of ambidexterity to refer to the balance between exploration and exploitation (D'Souza et al., 2017; Hill & Birkinshaw, 2014; O'Reilly & Tushman, 2013). Hence, both the exploration and exploitation elements are crucial to the success of R&D firms (Nonaka et al., 2014; Von Krogh et al., 2012), with the condition that short-term focus on efficiency (based on the exploitation of existing knowledge) needs to be coherent with the long-term focus on knowledge exploration and strategic development to ensure sustainable business growth of the R&D firms (Chong et al., 2018; Eriksson, 2013). This study also would provide further insight into the tensions and challenges of leveraging research to deliver successful improvements in R&D firms, thereby achieving an ambidextrous balance between creating and using knowledge (Oborn et al., 2013). Even though all the above-mentioned studies revealed the importance for R&D companies to maintain an appropriate balance between exploration and exploitation to increase competitiveness, none of these studies has examined the impact of knowledge exploration and knowledge exploitation on R&D innovation.

### ***KM-CENTRED STRATEGIES (LEADERSHIP, HR PRACTICES, AND CULTURE)***

Amar and Hlupic (2016) emphasise three KM-centred strategies that are critical to any organisation: (1) leadership support; (2) HR practices; and (3) an organisational culture based on trust and openness. Specific to R&D firms, leadership support is concerned with the amount of time employees are given to innovate and cultivate new ideas and/or products. HR practices refer to how an R&D firm involves employees in daily business transactions as well as in establishing long-term goals and vision of the firm (Wahid et al., 2015). An organisational culture based on trust and openness refers to how employees in the firms establish their relationship with management (Echajari & Thomas, 2015).

Unfortunately, most of the research investigated the influence of these contextual factors in isolation in relation to KM and innovation (Gonzalez & de Melo, 2018). To name a few, Corfield and Paton (2016) and Marouf (2016) investigated the influence of organizational culture and KM, whilst Martins and Meyer (2012) and Zangiski et al. (2013) investigated the influence of human resources and KM. However, a recent study by Gonzalez and de Melo (2018) looked into the influence of five contextual factors (i.e., HRM, collaborative leadership, learning culture, autonomy, and IT systems) with innovation through knowledge exploration and knowledge exploitation. Their study reported that knowledge exploration was more impacted by the use of IT systems, autonomy, and learning culture whilst knowledge exploitation was more related to the learning culture and supportive leadership. The following sections review the relevant literature on leadership, HR practices, and culture.

Effective leaders can encourage experimentation and facilitate knowledge sharing through empowerment, coaching, and trust (Bollinger & Smith, 2001; Haas & Hansen, 2005; Roth, 2003). Exclusive leadership support enables employees to focus on the productive use of their past and current

knowledge to improve organisational systems of circulation of documents that facilitate the process of outlining organisational vision and mission, designing and developing new products and/or services, and solving daily problems (Goel et al., 2012). In addition, supportive leadership was found to be significantly related to knowledge exploitation in the study of Gonzalez and de Melo (2018), as these practices are focused on the refinement and improvement of the same primary knowledge base, while exploration requires actions geared towards research, discovery, and development of new knowledge. Since most of the previous studies were unable to prove that effective leadership will direct knowledge exploration and exploitation activities, it is interesting in this paper to investigate the influence of leadership on R&D innovation.

Next, KM-centered HR practices are considered as those which contribute to developing an environment that allows the firm to take advantage of knowledge exploration and exploration initiatives. High-level HR practices offer a high level of freedom to employees in their choices of working methods that stimulate creative approaches to organisational learning and enhance exchange of experience amongst employees within the organisation (Evans, 2012). HR practices will favor the interaction of people and ideas, the sharing of knowledge, and greater willingness to codify, transfer and apply knowledge (Cabrera & Cabrera, 2005). Also, the development of HRs is the key element for increasing the absorptive capacity and knowledge utilization (Sparkes & Miyake, 2000). It is important to note that the capacities of individuals built and sustained through HR practices are difficult to imitate because these practices are specific to a company, socially complex, and context-dependent (Collins & Clark, 2003). Research on HR management revealed that practices related to the development of individuals can increase the performance of the company and facilitate the creation and flow of knowledge (Cabrera & Cabrera, 2005; Collins & Clark, 2003; Evans, 2012; Pandey & Dutta, 2013; Sparkes & Miyake, 2000). Furthermore, Gonzalez and de Melo's (2018) study indicated that HRM practices were more positively related to knowledge exploitation that focuses more on training and development of problem-solving methods and incentives and awards for work in groups, targeting incremental improvements, whilst the knowledge exploration is more dependent on HRM actions aimed at employee exchanges between units, formation of communities of practices, and training courses on new technologies for qualifying employees.

As revealed by Burrell and Brauner, (2021), a psychological safety environment that reflects a climate where people feel safe enough to take interpersonal risks by speaking up and sharing concerns and that blends trust and respect, is very important to generate creativity. Employee participation in making decisions enhances their involvement in knowledge creation in order to fulfil their needs of self-realisation. At the same time, an increase in participation in knowledge creation is always accompanied by an increase in responsibility for decision making and collective responsibility for the achievement of long-term organisational goals. If management welcomes unconventional ideas from employees, they are more willing to share their thoughts and opinions. Likewise, if employees can choose their tasks and the way the tasks are performed, they will also be more likely to share ideas with others. In this context, if the manager of an R&D firm encourages employees to take part in discussions and ask inquisitive questions, or gives employees adequate time and resources to solve organisational problems, it will motivate employees to share knowledge creatively (Echajari & Thomas, 2015). In addition, if employees are given full access to organisational information to fulfil their tasks with openness in organisational task communication, they will also be more comfortable sharing knowledge (Donate & Guadamillas, 2010; Garvin et al., 2008). Irani et al. (2009) point out that failures are inserted into the creative context of firms and it is up to the management to support employees so that they feel safe and encouraged to create knowledge. People feel comfortable in generating new ideas and thus creating a positive culture to promote innovation. Employees are not afraid of making mistakes as their voices are valued and supported, and they feel able to show and employ themselves without fear of negative consequences. Management values mistakes, as lessons can be learned from these productive failures for further improvements and future potential innovation (Wang et al., 2018). In contrast, in a psychologically unsafe environment, people are more likely to develop defensive orientations and are less likely to show creativity at work (West & Richter, 2008).

Managerial action to punish their employees for not generating the expected results discourages the creative process and the use of organisational knowledge (Martin et al., 2014; Škerlavaj et al., 2007). Hence, the promotion of values such as openness and confidence, tolerance of errors, or shared objectives will favor behaviors that influence KM and their outcomes, among which the improvement of innovation capacity is included (DeLong & Fahey, 2000; Donate & Guadamillas, 2011). Unfortunately, very limited studies have looked into the association of organisational culture with knowledge exploration and knowledge exploitation. Nevertheless, a recent study by Gonzalez and de Melo (2018) reported that learning culture is the factor with the greatest impact in relation to the processes of knowledge exploration and exploitation.

In summary, the success of KM initiatives in R&D firms depends on human behaviour (Von Krogh et al., 2012), which is conditioned upon close relationships between subordinates and superiors, awareness of mutual dependence, and mutual exchange of experiences amongst firm managers and subordinates, organisational culture, as well as HR practices (Argote & Miron-Spektor, 2011). When an organization adopts a knowledge management system without worrying about the cultural development that fosters it, KM efficiency is limited (Zheng et al. 2010). In relation to effective KM implementation in an organisation, both the company leader and employees need to be exposed to new ideas and adapt to new conditions. Both must also be intellectually flexible to master knowledge in which the level is higher than the current business task requirements (Cummings & Worley, 2014). Table 1 shows a summary of the research gap from past literature.

**Table 1. Summary of research gap from past literature**

<b>Literature</b>	<b>Finding</b>	<b>Research Gap</b>
Chong et al., 2018; D'Souza et al., 2017; Hill & Birkinshaw, 2014; Martini et al., 2013; Nonaka et al., 2014; O'Reilly & Tushman, 2013; Von Krogh et al., 2012	It is important for companies to maintain an appropriate balance between exploration and exploitation to increase competitiveness.	No holistic examination on both knowledge exploration and knowledge exploitation in R&D innovation.
Burrell & Brauner, 2021; DeLong & Fahey, 2000; Donate & Guadamillas, 2011; Martin et al., 2014; Škerlavaj et al., 2007; Wang et al., 2018; West & Richter, 2008)	A positive culture is crucial to promoting innovation.	No examination on how organisational culture affects knowledge exploration and knowledge exploitation in R&D firms.
Cabrera & Cabrera, 2005; Collins & Clark, 2003; Evans, 2012; Pandey & Dutta, 2013; Sparkes & Miyake, 2000	Practices related to the development of individuals can increase the performance of the company and facilitate the creation and flow of knowledge.	No examination on how HR practices affect knowledge exploration and knowledge exploitation in R&D firms.
Bollinger & Smith, 2001; Haas & Hansen, 2005; Roth, 2003	Effective leaders can encourage experimentation and facilitate knowledge sharing through empowerment, coaching, and trust.	Previous studies were unable to prove that effective leadership will direct knowledge exploration activities for R&D innovation whilst propelling greater willingness to transfer, codify and apply knowledge exploitation for further R&D innovation.

## HYPOTHESES

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Based on the literature discussed above, the following hypotheses were examined in this study:

H1: Leadership significantly affects innovation.

H2: HR practices significantly affect innovation.

H3: Culture significantly affects innovation

H4: Knowledge exploration practices mediate the relationship between leadership and innovation.

H5: Knowledge exploration practices mediate the relationship between HR practices and innovation.

H6: Knowledge exploration practices mediate the relationship between culture and innovation.

H7: Knowledge exploitation practices mediate the relationship between leadership and innovation.

H8: Knowledge exploitation practices mediate the relationship between HR practices and innovation.

H9: Knowledge exploitation practices mediate the relationship between culture and innovation.

## RESEARCH METHOD

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### *SAMPLING*

R&D firms refer to companies that undertake systematic or intensive study in the field of science and technology with the objective of using the results of such studies for the production and/or improvement of materials, devices, products, and/or processes (Malaysian Investment Development Authority, 2021). According to the Ministry of Science, Technology and Innovation (2019), there is a total of 1,136 R&D firms with 12,3362 research personnel focusing on product and service innovation in Malaysia. If too much investment is placed on exploring new knowledge, it may cause inefficiency in R&D gains and thereby relinquish the competitive advantage of the firms. On the other hand, if the firms focus too much on exploiting old knowledge, it will be difficult for them to develop core capabilities (Chong et al., 2018; Martini et al., 2013). Although the study of Gonzalez and de Melo (2018) reported that most service-based firms give more prominence to knowledge exploitation, while product-based firms give more prominence to knowledge exploration, our study does not distinguish the type of R&D firm, as both exploration and exploitation are considered important for R&D firms in Malaysia. R&D firms in Malaysia place equal research emphasis on product and service innovations. As stipulated in the National Policy on Industry 4.0 (Ministry of International Trade and Industry, 2019), both product and service innovations are equally important in boosting productivity and reducing dependency on low-skilled labour in the Fourth Industrial Revolution (IR 4.0).

According to the Ministry of Science, Technology and Innovation (2019), one-third of the total 1,136 R&D firms in Malaysia are located in the Klang Valley area. A total of 320 survey invitations were sent to R&D firms in Klang Valley, with 183 companies participating in this study. Convenience and snowballing sampling techniques were used to contact the targeted R&D firms.

Since the questions were designed to be answered from the perspective of the organisation, the organisation was thus the unit of analysis. Hence, each R&D firm was invited to provide only one response. The researchers contacted the Human Resource Department of each targeted R&D firm via a phone call. The Human Resource Department was responsible for identifying the most suitable knowledge officer or engineer in the company to answer the survey. The completed survey was returned via email. After filtering responses with missing values, 149 responses were used for analysis. Table 2 shows the demographic profiles of the R&D firms as well as the respondents.

**Table 2. Demographic profiles**

Profile	<i>f</i>	%	Profile	<i>f</i>	%
<i>Age of company</i>			<i>Gender</i>		
• < 1 year	1	0.7	• Male	84	56.4
• 1-3 years	4	2.7	• Female	65	43.6
• 3-5 years	12	8.1	<hr/>		
• 5-10 years	26	17.4	<i>Age</i>		
• > 10 years	106	71.1	• 20-29	51	34.2
<hr/>			• 30-39	80	53.7
<i>Number of employees</i>			• 40-49	11	7.4
< 10	4	2.7	• Above 50	7	4.7
11-100	16	10.7	<hr/>		
101-200	5	3.4	<i>Race</i>		
201-500	36	24.2	• Malay	127	85.2
501-1000	34	22.8	• Chinese	15	10.1
> 1000	54	36.2	• Indian	5	3.4
<hr/>			• Others	2	1.4
			<i>Years of working experiences</i>		
			• < 1 year	2	1.3
			• 1-3 years	13	8.7
			• 3-5 years	36	24.2
			• 5-10 years	51	34.2
			• > 10 years	47	31.5

The majority of the R&D firms are mature firms, having been in operation for more than 10 years. About 36.2% of the firms have more than 1,000 employees. The majority of respondents are male, between 30 and 39 years old. About 85.2% of them are Malays, with 65% of them having more than five years of working experience. Only 10% of them have less than three years of work experience.

**QUESTIONNAIRE**

The questionnaire consists of three sections. The first section comprises six questions about the demographic profiles of respondents as well as organisational demographic characteristics. In the second section, there are 15 items measuring both knowledge exploration and knowledge exploitation practices, and 19 items measuring KM-centred strategies, using a scale ranging from 1 (not implemented) to 5 (extensive implemented). Section 3 comprises two questions on the innovative results using a scale of 1 (very ineffective/very low) to 5 (effective/very high).

The scales for measuring these constructs were adopted from Donate and Guadamillas (2011): “leadership” (composite reliability = 0.834), “HR practices” (composite reliability = 0.817), “knowledge exploration” (composite reliability = 0.825), and “knowledge exploitation” (composite reliability = 0.883). In addition, the scale for measuring the construct “culture” (composite reliability = 0.832) was adopted from Meddour (2016), and the one for “innovation” (composite reliability = 0.905) was adopted from Wijekoon and Galahitiyawe (2015) (see Table 3).

Prior to dissemination, the questionnaire was pre-tested on five senior engineers to check for appropriateness, readability, and comprehensiveness, particularly in the context of Malaysian R&D firms. Minor amendments were made to the instrument. Content validity refers to the representativeness and comprehensiveness of the survey instrument. The content validity of this study is confirmed through the assessment of the expert panel of reviewers which consists of three academicians from



local universities during the pre-testing stage of this research. It can be concluded that the face validity and content validity of the instrument supported the adequacy of measurement used in this study.

## RESULTS

Structural equation modelling (SEM) is used to examine the direct and indirect effects on causal relationships between KM-centered strategies (Leadership, HR Practices, Culture), KM Practices (Knowledge Exploration and Knowledge Exploitation), and innovation in the Malaysian R&D firms. SEM allows researchers to test several indicator variables per construct simultaneously, which leads to a more valid result. Using other methods of analysis would require several separate analyses (Hair et al., 2010). There are two key stages involved in SEM analysis. The first stage is to assess and develop a measurement model to demonstrate how well the items come together to represent the constructs with Confirmatory Factor Analysis (CFA). The second stage involves assessing and developing a structural model to identify how well the variables are associated with each other.

At the first stage of SEM, confirmatory factor analysis is carried out to obtain measurement model validity (Hair et al., 2010). The researchers located the sources of misfits by assessing the standardized regression weights. Standardized regression weights are found to be greater than 0.60, indicating an adequate level of construct validity. In addition, the researchers also made reference to the modification indices for possible cross-loading items. The results indicate that no cross-loading item needs to be dropped from the analysis. The final CFA model statistics showed an adequate model fit of  $\chi^2(df=260), n=149) = 383.190, p<0.001; CFI= 0.938, IFI= 0.939, TLI= 0.928, \chi^2/df= 1.474, RMSEA= 0.057$ . Hair et al. (2010) suggested three or four fit indices for the overall model fit. Therefore, the measurement model meets the acceptable range and can be considered as a fit model. Table 3 shows the CFA results.

**Table 3. Measurement scales and regression weight**

Indicator	Standardized regression weight
<b>Leadership (3 items)</b>	
L1. Managers are accustomed to assuming the role of knowledge leaders which is mainly characterized by openness, tolerance to mistakes, and mediation for the achievement of the firm's objectives.	.748
L2. Managers behave as advisers, and controls are just an assessment of the accomplishment of objectives.	.769
L3. Managers promote the acquisition of external knowledge.	.855
<b>HR Practices (3 items)</b>	
HR1. Programs of internal rotation have been developed, which make the employees pass through different departments or develop diverse functions.	.796
HR2. Participative mechanisms for the resolution of problems have been carried out.	.869
HR3. Methods have been put into practice to assess and control KM processes (creation, storage, transfer, application...).	.644

<b>Indicator</b>	<b>Standardized regression weight</b>
<b>Culture (4 items)</b>	
CU1. There has been a common language to support knowledge exchange and sharing between employees and departments.	.777
CU2. An effort is made to encourage employees to experiment and implement new ideas in their working day.	.741
CU3. Culture is based on confidence and openness.	.734
CU4. The employees are encouraged to share knowledge at an informal level.	.723
<b>Knowledge Exploration Practices (3 items)</b>	
KEX1. There has been a strong commitment to depend on internal activities of R&D to develop or improve technologies.	.695
KEX2. There has been a strong commitment to using proprietary technology to develop or improve products/processes.	.847
KEX3. There has been a strong commitment to maintaining a highly qualified R&D unit to develop or improve technologies.	.798
<b>Knowledge Exploitation Practices (7 items)</b>	
KEL1. It is possible to access knowledge repositories, databases, and documents through some kind of internal computer network (such as an intranet or similar).	.805
KEL2. There are formal mechanisms that guarantee best practices are shared in the form (e.g., among departments or business areas).	.624
KEL3. There are projects with interdisciplinary teams in order to share knowledge.	.688
KEL4. There are employees who compile suggestions from other employees, customers, and suppliers and who then make elaborated structured reports for distribution within the firm.	.674
KEL5. There are communities of practices or groups of learning to share knowledge and experiences.	.833
KEL6. There are interdisciplinary teams with the autonomy to apply and integrate knowledge.	.693
KEL7. Suggestions from employees, customers, or suppliers are frequently incorporated into products, processes, or services.	.714
<b>Innovation (5 items)</b>	
IN1. Development of new production methods and procedures.	.706
IN2. Introduction of more new (improved) methods and procedures than its major competitors.	.741
IN3. Development of new products.	.885
IN4. Modification and/or improvement of existing products.	.871
IN5. Introduction of more new (or improved) products than three years ago.	.836

A normal distribution assessment is a vital assumption in SEM analysis with the use of Maximum Likelihood Estimates (MLE). The two components of normality assessment are skewness and kurtosis. The researchers evaluated the univariate normality assumption in which the threshold value of skewness (+/-1.0) and kurtosis (+/-3.0) are met.

Next, construct validity is assessed through convergent and discriminant validity, which show satisfactory results. The convergent validity is measured by using standardised factor loading, average variance extracted (AVE), and construct reliability (CR). All the standardised factor loadings in the measurement model are above 0.50. All AVE values obtained are above 0.50, while all CR values obtained are above 0.70. This signifies a good convergent validity between all items measuring the same construct in this study.

The discriminant validity of all constructs is achieved when a diagonal value in bold is higher than the values in its rows and column. The diagonal value (in bold) is the squared root of AVE of the construct and the remaining values are the correlation between the respective constructs. Referring to Table 4, it can be concluded that the convergent validity and discriminant validity of all constructs are achieved.

**Table 4. Convergent validity and discriminant validity of all constructs**

Construct	Item	AVE	CR	1	2	3	4	5	6
<b>Leadership</b>	3	.627	.834	<b>.792</b>					
<b>HR practices</b>	3	.601	.817	.586	<b>.775</b>				
<b>Culture</b>	4	.544	.832	.632	.674	<b>.738</b>			
<b>Knowledge exploration practices</b>	3	.612	.825	.442	.517	.575	<b>.782</b>		
<b>Knowledge exploitation practices</b>	7	.521	.883	.548	.574	.594	.711	<b>.722</b>	
<b>Innovation</b>	5	.658	.905	.553	.483	.643	.584	.628	<b>.811</b>

Note: Bold/Italics = square root of AVE

### ***STRUCTURAL MODEL***

The purpose of presenting the structural model is to identify the relationships among all constructs. Figure 1 shows the structural model of this research. This research has three independent variables, leadership, HR practices, and culture, and one dependent variable, innovation. The relationship between independent and dependent variables is mediated by knowledge exploration practices and knowledge exploitation practices.

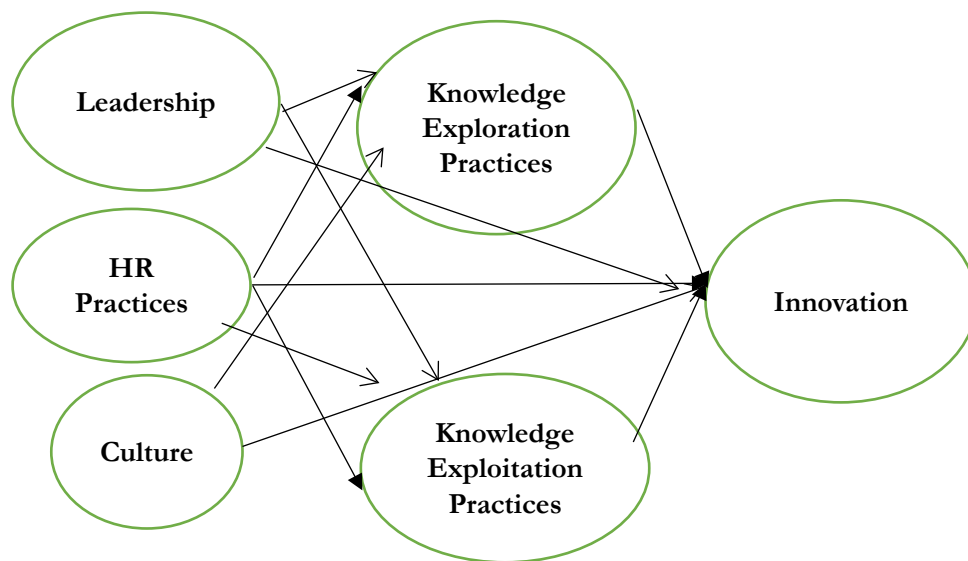


Figure 1. Structural model

### *ANTECEDENTS OF INNOVATION*

Table 4 shows the following hypotheses testing results. Leadership, HR practices, and culture significantly affect innovation of R&D firms. HR practices is the most important factor that positively affects innovation of R&D firms (standardized beta coefficient = .461), followed by leadership (standardized beta coefficient = .210) and culture (standardized beta coefficient = .174). The R-square value is 0.395, indicating that 39.50% of the total variation in the innovation of R&D firms is well explained by HR practices, leadership, and culture.

#### **H1: Leadership significantly affects innovation.**

Leadership is found to positively influence innovation (standardized beta coefficient = .210, significant at 0.05 level). Hence, H1 is supported.

#### **H2: HR practices significantly affect innovation.**

HR practices are found to positively influence innovation (standardized beta coefficient = .461, significant at 0.05 level). Hence, H2 is supported.

#### **H3: Culture significantly affects innovation.**

Culture is found to positively influence innovation (standardized beta coefficient = .174, significant at 0.05 level). Hence, H3 is supported.

### *MEDIATING EFFECT OF KNOWLEDGE EXPLORATION PRACTICES*

Mediating effect refers to the degree of influence knowledge exploration practices have towards a direct cause-effect relationship. This study adopted four steps of necessary conditions to test the mediating effect:

- 1) A significant direct relationship between independent (HR practices, leadership, and culture) and dependent variable (innovation);
- 2) A significant indirect relationship between independent (HR practices, leadership, and culture) and mediating (knowledge exploration practices) variables; and
- 3) A significant indirect relationship between mediating (knowledge exploration practices) and dependent (innovation) variables; and

- 4) Evidence of an insignificant direct relationship between independent and dependent variables after the mediating of knowledge exploration practices.

Full mediation is evident when the standardized beta coefficient shows an insignificant p-value after the mediating of knowledge exploration practices. Partial mediation is present when the standardized beta coefficient has reduced after mediation occurs while still remaining significant. Knowledge exploration practices are found to mediate the relationship between HR practices and innovation. In contrast, knowledge exploration practices do not mediate the relationship between leadership and innovation as well as culture and innovation.

**H4: Knowledge exploration practices mediate the relationship between leadership and innovation.**

Since there is an insignificant relationship between the independent (leadership) and mediating (knowledge exploration practices) variables, it can be concluded that knowledge exploration practice does not mediate the relationship between leadership and innovation. Hence, H4 is not supported.

**H5: Knowledge exploration practices mediate the relationship between HR practices and innovation.**

Since there are significant relationships between HR practices and innovation, HR practices and knowledge exploration practices, and knowledge exploration practices and innovation, it can be concluded that knowledge exploration practices mediate the relationship between HR practices and innovation. Full mediation occurs as the direct effect is not significant after the mediator enters the model. Hence, H5 is supported.

**H6: Knowledge exploration practices mediate the relationship between culture and innovation.**

Since the standardized beta coefficient between culture and innovation increases after knowledge exploration practices are inserted into the model, it can be concluded that knowledge exploration practice does not mediate the relationship between culture and innovation. Hence, H6 is not supported.

***MEDIATING EFFECT OF KNOWLEDGE EXPLOITATION PRACTICES***

Mediating effect refers to the degree of influence that knowledge exploitation practices have towards a direct cause-effect relationship. This study adopted four steps of necessary conditions to test the mediating effect:

- 1) A significant direct relationship between independent (HR practices, leadership, and culture) and dependent variable (innovation);
- 2) A significant indirect relationship between independent (HR practices, leadership, and culture) and mediating (knowledge exploitation practices) variables.
- 3) A significant indirect relationship between mediating (knowledge exploitation practices) and dependent (innovation) variables; and
- 4) Evidence of an insignificant direct relationship between independent and dependent variables after the mediating of knowledge exploration practices.

Knowledge exploitation practices are found to mediate the relationship between leadership and innovation, and HR practices and innovation. In contrast, knowledge exploitation practices do not mediate the relationship between culture and innovation.

**H7: Knowledge exploitation practices mediate the relationship between leadership and innovation.**

Since there are significant relationships between leadership and innovation, leadership and knowledge exploitation practices, and knowledge exploitation practices and innovation, it can be concluded that knowledge exploitation practices mediate the relationship between leadership and innovation. Full

mediation occurs as the direct effect is not significant after the mediator enters the model. Hence, H7 is supported.

**H8: Knowledge exploitation practices mediate the relationship between HR practices and innovation.**

Since there are significant relationships between HR practices and innovation, HR practices and knowledge exploitation practices, and knowledge exploitation practices and innovation, it can be concluded that knowledge exploitation practices mediate the relationship between HR practices and innovation. Full mediation occurs as the direct effect is not significant after the mediator enters the model. Hence, H8 is supported.

**H9: Knowledge exploitation practices mediate the relationship between culture and innovation.**

Since the standardized beta coefficient between culture and innovation increases after knowledge exploration practices are inserted into the model, it can be concluded that knowledge exploitation practice does not mediate the relationship between culture and innovation. Hence, H9 is not supported. Table 5 shows the summary of the SEM results.

**Table 5. Structural equation modeling result**

Causal Path	Direct model	Mediation model
Leadership → Innovation	.210*	.141
HR Practices-> Innovation	.461*	.008
Culture-> Innovation	.174*	.290*
Leadership → Knowledge Exploration Practices		.039
HR Practices-> Knowledge Exploration Practices		.311*
Culture-> Knowledge Exploration Practices		.450*
Knowledge Exploration Practices -> Innovation		.206*
Leadership → Knowledge Exploitation Practices		.186*
HR Practices-> Knowledge Exploitation Practices		.386*
Culture-> Knowledge Exploitation Practices		.363*
Knowledge Exploitation Practices-> Innovation		.284*
R <sup>2</sup> of Innovation		.395
χ <sup>2</sup>	271.210	664.993
df	87	264
χ <sup>2</sup> /df	3.117	2.140
RMSEA	.120	.088
CFI	.852	.848
TLI	.821	.827

Note: \* Standardised path coefficients significant at  $p < 0.05$ .

**FINDINGS, DISCUSSION, AND IMPLICATIONS**

This research is a pioneer study in Malaysia that focuses on knowledge exploration and knowledge exploitation, and their association with innovation capability in the context of Malaysian R&D firms. This research is important for the sustainable development of R&D firms as innovation is essential for R&D firms in Malaysia to survive in challenging global business environments. Effective exploitation of current knowledge and exploration of new knowledge through active research and experiments are essential for innovation in R&D firms. Knowledge exploration is essential for R&D firms

to meet the emerging demands of customers in promoting new products, services, and processes that are yet to be operable in Malaysia, while knowledge exploitation is needed for continuous process and technological improvement.

One of the most remarkable findings of this study is knowledge exploration and exploitation mediates HR management practices and innovation in R&D firms. Active employee engagement enhances knowledge exploration and knowledge exploitation, which will, in turn, boost innovation in R&D firms. Since it is important for R&D firms to maintain an appropriate balance between exploration and exploitation to increase competitiveness (Chong et al., 2018; D'Souza et al., 2017; Hill & Birkinshaw, 2014; Martini et al., 2013; Nonaka et al., 2014; O'Reilly & Tushman, 2013; Von Krogh et al., 2012), a strong organizational team with diverse expertise inspires knowledge workers and engineers to explore more existing knowledge for product, service and process enhancement, better manpower empowerment stimulates greater commitment to design and develop new products and services. As adequate HR practices can increase the performance of the R&D firms and facilitate the creation and flow of knowledge (Cabrera & Cabrera, 2005; Collins & Clark, 2003; Evans, 2012; Pandey & Dutta, 2013; Sparkes & Miyake, 2000), it is also important for programs of internal rotation that have been developed, which make knowledge workers and engineers pass through different departments at R&D firms to develop diverse functions. Fair delegation of tasks and power will also facilitate a collaborative environment among knowledge workers and engineers to share new and existing knowledge for innovative ideas, products, and processes.

In order to attain better innovation, participative mechanisms for the resolution of problems need to be carried out at R&D firms. Active participation of all knowledge workers and engineers in product, process, and technology development and enhancement is favourable to R&D firms while strong bureaucratic control is definitely not conducive to innovation. In order to encourage innovation (Burrell and Brauner, 2021; DeLong & Fahey, 2000; Donate & Guadamillas, 2011; Martin et al., 2014; Skerlavaj et al., 2007; Wang et al., 2018; West & Richter, 2008), R&D firms should introduce sustainable HR practices, characterized by dynamic and flexible manpower, fast adaptation to changing conditions, and non-stereotypical to standard working hours and procedures. A key success factor to innovation in an R&D firm is to empower every knowledge worker and engineer to seek and discover unconventional ways of achieving job objectives and goals. Knowledge workers and engineers should be given greater responsibility and bigger motivation to perform beyond carrying out a superior's order. They should also be embodied with a stronger sense of job security, less fear of criticism for unintended mistakes at the workplace, and less fear of infringement of new ideas by co-workers. A transparent incentive system, taking into account the initiative of knowledge workers and rewarding for their active participation in product, process, and technological innovation, impractical solutions, mistakes, and risk associated with daily tasks should be allowed in R&D firms and knowledge workers who produce impractical innovation will not be penalized.

R&D firms have to take the best care of instruments used to acquire, create, and retain knowledge at workstations. All knowledge workers and engineers should be given access to knowledge acquisition facilities and knowledge management systems evaluating in R&D firms and they should be given a chance to propose improvements to existing knowledge acquisition facilities and knowledge management systems.

Another key finding of this study is that knowledge exploitation mediates leadership and innovation in R&D firms. When existing knowledge from both inside and outside the organisation is widely and systematically collected, easily and quickly accessible and clearly communicated by the firm managers and management, it will foster greater product, process, and service innovation. Effective leaders can encourage experimentation and facilitate knowledge sharing through empowerment, coaching, and trust (Bollinger & Smith, 2001; Haas & Hansen, 2005; Roth, 2003). When leaders of R&D firms give a clear signal to knowledge workers and engineers that innovation is highly desirable, by setting ambitious goals and establishing motivated teams to implement the goals, it will be easier for R&D firms to attain innovation. Therefore, in order to improve innovation-based effectiveness, leaders must

consider how to build capability and core competency in employees who are aware of methods of creative thinking and effective management, and implementation of existing knowledge and ideas. A collaborative working environment could be established by accepting different ways of thinking, different viewpoints, and diversity in providing a strong basis for innovation. Transformative leadership can effectively promote an exchange of existing knowledge, experience, and ideas. Firm managers should not exercise excessive formalization and bureaucratization of R&D processes because it will delay the decision-making processes and inhibit the creativity of knowledge workers and engineers. R&D firm managers should focus on both the technical processes of knowledge management, as well as instilling enthusiasm for work in knowledge workers and engineers, helping them to find and face the difficulties at work.

Malaysia is a multicultural society. Most knowledge workers and engineers at R&D firms use bilingual (Bahasa Malaysia and English) information to support knowledge exchange and sharing between employees and departments. They have high confidence and openness to share knowledge formally and informally with colleagues from different ethnicity. Therefore, culture is not a major challenge for knowledge exploration, knowledge exploitation, and innovation at R&D firms.

## CONCLUSION AND LIMITATION

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This paper provides significant implications for the literature on knowledge management and innovation that can be used to analyse the associations among KM-centred strategies, i.e., leadership, HR practices, and culture, both KM practices, i.e., knowledge exploration and knowledge exploitation, and innovation. The findings verify the hypotheses that leadership, HR practices, and culture have positive significant roles in enhancing innovation. The findings also provide empirical evidence of the mediating mechanism of knowledge exploration and knowledge exploitation between HR practices, leadership, and innovation.

This study is not without limitations. First, the use of a cross-sectional sample limits the explanation of the hypothesized relationships. The relatively small initial sample (28% of the population) for survey distribution and subsequent low response rate (57%), resulted in only 13% of the population being represented in the data. Further research could use a longitudinal sample with a larger sample size, which would allow studying relationships of causality, offering a more comprehensive view of the effect of KM factors on innovation over the long run. Second, although the main informant in the study was the knowledge officers or engineers and possibly the most reliable source of information for the constructs under investigation, there is still a possibility of bias in the data collected due to a single informant. Future studies should try to incorporate information from new external sources, such as customers or suppliers.

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