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Knowledge Management, Innovation Capability, and Manufacturing Performance in the Era of Industry 4.0: A Proposed Model

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Abstract
Purpose: The advent of Industrial Revolution 4.0 (ID 4.0) has changed the manufacturing industry's global landscape. Challenged by neighbouring countries with lower labour costs, the Malaysian manufacturing sector needs to improve its manufacturing performance by adopting new technologies. Still, many of the manufacturing firms lack the know-how to embrace it. A higher innovation capability reflects a greater adoption of new technologies that will improve manufacturing performance. Despite the literature indicates a positive linkage of knowledge management, innovation capability, and manufacturing performance, the relationship is vague due to a composite view of knowledge management. This study aims to study the interrelationship with three critical aspects of knowledge management: external knowledge sourcing, knowledge mobility, and knowledge protection. A theoretically grounded conceptual model that reflects the nexus between the key constructs will be presented as part of the study.
Design/Methodology: This is a conceptual paper focusing on developing a conceptual framework grounded by the theory of resource-based view, knowledge-based view, and dynamic capabilities. It intends to fill the gaps of earlier research by extending the understanding of external knowledge sourcing, knowledge mobility, and knowledge protection on innovation capability and manufacturing performance.
Findings: The study closes the mentioned gaps by offering seven testable hypotheses for further empirical studies based on this proposed conceptual framework. It also provides a more comprehensive understanding of the primary constructs' interrelationship by breaking down the three critical aspects of knowledge management.
Originality/value: This study provides a fresh perspective on an issue facing many manufacturing firms, especially in developing countries with the advent of Industry 4.0. Understanding the right knowledge management approach will enable the firm to focus on enhancing its innovation capability or increasing its manufacturing performance. The inclusion of knowledge protection that other studies often left out also provides awareness of the importance of protecting one's newly gained knowledge and setting a new pathway for further studies in this new context highlighted by the conceptual model.
Paper type: Conceptual paper

Keywords: Knowledge Management; Innovation Capability; Manufacturing Performance; Malaysia's manufacturing firms; Industry 4.0

Introduction

The manufacturing sector has been the forefront contributor to economic growth for Malaysia (MITI, 2018). It continuously generates 22% of the overall GDP for the last five years (DOSM, 2019). However, its annual growth rate is on a declining trend for the past three consecutive

years (MITI, 2018). At the same time, in 2018, the World Economic Forum and A.T. Kearney published a report on the readiness assessment of 100 countries in confronting Industry 4.0. The report states that Industry 4.0 and emerging technologies such as artificial intelligence, robotic and additive manufacturing will affect the cost-benefit of the global value chain and, if adequately adopted, will enable a country to gain a competitive advantage. The report also states that it is paramount for each country to analyse and understand the enablers and gaps in adopting these technologies and develop the right policy actions to close these gaps, failing which will be left out.

Furthermore, there is a shift in the global value chains and production base from China and other Northeast Asian countries to lower-cost competitors (MITI, 2018). Malaysia needs to transform fast, as having low labour cost alone is no longer competitive. Despite the cost and complexity of adopting Industry 4.0 technologies are on the downtrend. Still, the manufacturing firms' adoption rate is low, especially among the small and medium enterprises, with approximately 20% embraced digitalization. The majority of the firms are using less than 50% automation (MITI, 2018).

According to the national policy report by the Malaysia Ministry of International Trade and Industry (MITI) called *Indusrty4Fwrd*, one of the problems is the manufacturers' stagnant global innovation index ranking. Innovation capability measures a firm's ability to react to market demand dynamism by improving its manufacturing processes or introducing a new product type (Al-Sa'di et al., 2017). Naturally, a higher innovation capability rate means the manufacturer's performance will improve. The ability to gauge such performance is essential for the manufacturer (Adebanjo et al., 2017) to identify the right technologies to be adopted. According to Potdar & Routroy (2017), manufacturing performance refers to a manufacturer's ability to operate in a lower makespan (time to settle all processes) with shorter order fulfilling time, quick production line switchover, faster cycle time, and a high level of customization.

The report also states that many firms still have an inadequate understanding of where to source the right knowledge and share and protect their intellectual properties. One of the innovation capability's essential aspects is the firm's ability to manage and identify new technology for its product or process innovation needs (Abdallah et al., 2016; Prajogo & Ahmed, 2006). Extant literature in organizational learning and operational management has also indicated that knowledge management is the innovation capability's antecedent, which subsequently impacts manufacturing performance (Aboelmaged, 2014; Noruzy et al., 2012).

This paper aims to examine the systemic relationship between knowledge management, innovation capability, and manufacturing performance. Extant literature mostly shows a direct connection between a composite view of knowledge management and innovation capability. There is a lack in detail of which aspect of knowledge management impacts innovation capability and what kind of innovation capability related activities will affect manufacturing performance. The studies of knowledge management and manufacturing performance are also limited (Tan & Wong, 2015) and even rarer to locate studies with these three constructs, especially in a developing country setting. All these have resulted in contradictory or partial findings in their respective field of research. No existing research has managed to combine these three key core areas from organizational learning and operational management into one comprehensive study for a richer understanding of how a firm can enhance its manufacturing performance. This paper intends to break down and examine knowledge management's aspect and its relationship to innovation capability. Further, this paper also covers the mediating factor of innovation capability on knowledge management and manufacturing performance. All the hypotheses are grounded with theory from the resource-based view, knowledge-based view, and dynamic capabilities**.**

Literature Review

Manufacturing Performance

In a dynamic manufacturing environment, the firm performance assessment is critical to developing the organization's strategies. It provides a means to quantify its production systems' efficiency and effectiveness (Antunes et al., 2017). However, the literature on manufacturing organizations showcases different types of indicators to measure manufacturing performance (Cheah & Tan, 2020). For example, according to Vázquez-Bustelo et al. (2007), the change in the market condition, customer preference, and technology advancement will impact the manufacturing practices, and there is a need for multifaceted performance measure that able to capture the accomplishment of all these factors. Some scholars claimed that measuring the effectiveness or performance of its manufacturing practices is through its operational performance as it will reflect how well the organization transforms the knowledge into product and process innovation initiatives (Al-Sa'di et al., 2017). As a result, the legacy ways of measuring manufacturing performance that focus on cost and quality (Patel et al., 2012) will need to adopt a multifaceted performance measurement that consists of cost, flexibility, quality, and delivery (see Al-Sa'di et al., 2017; Tamayo-Torres et al., 2017). Abdallah et al. (2016) even consider innovative performance as another subjective measurement with the argument that advanced technologies will enable companies to produce new products with innovative features.

Tandemly, some scholars also believe that measuring firm through their patent counts or citation-weighted patents is also a reflection of the number of new products, processes, or technologies the firm introduced (Hagedoorn & Cloodt, 2003; Rothaermel & Alexandre, 2009). Furthermore, extant literature also indicates that innovation capability positively impacts manufacturing performance through process innovation and product innovation (Adebanjo et al., 2017). Linton (2015) also suggested that product innovation will lead to process innovation in the product assembly environment. However, Al-Sa'di et al.'s (2017) study on Jordanian manufacturing firms indicated that only the process innovation positively impacts the manufacturing performance but not product innovation. They argue that product innovation will result in variations in production processes that may affect manufacturing performance. In general, it appears that innovation capability can be served as one of the predictors for manufacturing performance.

Simultaneously, knowledge management was found to significantly impact manufacturing performance via innovation capability's mediating factor (Aboelmaged, 2014). This finding is substantiated by the study of Tan & Wong (2015) that indicates the similar positive relationship between knowledge resources, knowledge management processes, and knowledge management factors on manufacturing performance. Al-Sa'di et al. (2017) also stated in their study that a strong relationship exists between knowledge management, process innovation, and product innovation. Concurrently, having access to knowledge resources will not guarantee the practical implementation of ambidextrous activities; the firm must be equally capable of managing the knowledge resources to gain ambidexterity and better performance (Dezi et al., 2019). Knowledge management appears to be the primary key predictor that significantly influences the innovation capability's effectiveness on manufacturing performance.

Knowledge Management

Furthermore, Grant's (1996) pioneering work on the knowledge-based view states that the fundamental of all human productivity is knowledge dependent. The primary source of input for production to produce an output resides in the value of knowledge. Today, knowledge of all forms plays a vital role in all the economic process. It has been termed a "knowledge-based economy," and nations, firms, or individuals who can manage their knowledge assets will

outperform the rest (OECD, 2005). This belief has led to burgeoning studies of knowledge management across multiple research fields.

Many of these scholars support a general view that knowledge management typically consists of knowledge creation or acquisition, knowledge transfer or sharing, and knowledge utilization or application for the organization to generate value-added business proposition (Al-Sa'di et al., 2017; Liu, 2012; Patel et al., 2012; Zhou & Li, 2012). Based on this view, there is a consensus among the researchers that external knowledge sourcing plays a crucial role in determining the level of innovation capability for the company (Brunswicker & Vanhaverbeke, 2015; Lin et al., 2013; Liu, 2012; Zhou & Li, 2012). The firms will need to compensate for internal knowledge resource limitations by exploring external knowledge for technology transfer and business growth (Drivas et al., 2016). When the firms receive all this newfound knowledge, they need to quickly mobilize and share it across the organization so that their members can start to adopt this knowledge and their tacit knowledge to generate an extensive impact on the organization's innovativeness (Voelpel et al., 2006). The ability to mobilize and utilize this acquired knowledge for its capability enhancement is termed knowledge mobility (Liu, 2012). In response to Brunswicker & Vanhaverbeke's (2015) request for future research to consider the issue of knowledge leakage, especially in the area of intellectual property, this study will consider another aspect of knowledge management, which is knowledge protection. However, the literature on knowledge protection within the context of knowledge management is scarce. Few scholars even dictate that knowledge protection should not be studied together with other aspects of knowledge management as it might restrict knowledge acquisition and knowledge mobility of the firm (Liao & Wu, 2010; Liu, 2012). However, the firm's resource-based view states that rare and valuable resources will put the firm in a favourable market position (Barney, 1991), thereby protecting knowledge resources warrant more studies, especially in an emerging market for these new technologies.

According to OECD (2005), in a "knowledge-based economy," knowledge is an essential element for national economic expansion and international trade. As such, many policies about innovation had been co-developed with science and technology policy and industrial policy, e.g., the distinct *Industry4Fwrd* by MITI. These policies address the complex and systemic nature of innovation and how relevant institutions work in tandem to generate new knowledge, diffuse and apply them. A manufacturing company's performance reflects the effectiveness of its knowledge management capability to enable the organization to churn out more products and process-related innovation (Al-Sa'di et al., 2017; Ruiz-Jiménez & Fuentes-Fuentes, 2013). Thus, deciphering knowledge management's impact on innovation capability and manufacturing performance will enable the firm to determine the right approach to stock up its knowledge base.

Given such importance of knowledge management in these areas, this study extends it further by examining the mediating relationship of innovation capability on knowledge management and manufacturing performance. Furthermore, incorporating knowledge protection as one of the elements that are often left out in knowledge management studies has enabled a more comprehensive understanding of how the firm protects its knowledge asset to gain sustained competitive advantage.

Innovation Capability

As pointed out in the introduction to this paper, innovation capability is regarded as a business process of identifying and creating new value and integrating the initiative into existing operations and processes to gain a competitive advantage (Liao & Li, 2019). In many instances, scholars in the field of manufacturing performance research regard that the capability for the firm to innovate is reflected by its ability to produce either product innovation or process

innovation or both (Adebanjo et al., 2017; Doran & Mccarthy, 2019; Mohamad et al., 2015; Vega-Jurado et al., 2009). OECD's (2005) Oslo Manual defines product innovation as the implementation or commercialization of a product with improved performance characteristics to deliver objectively new or enhanced services to the consumer. Therefore, product innovation is likely to enable the firm to have a competitive edge through its technological newness that will ameliorate the product (Kafetzopoulos & Psomas, 2015).

Meanwhile, Adebanjo et al. (2017) and Camisón & Villar-López (2014) indicate that process innovation requires product innovation to affect the firm performance positively. They argued that such an outcome aligns with the resource-based view. Both product innovation and process innovation are valuable and rare assets of the firm to achieve competitive advantage (Camisón & Villar-López, 2014). This argument is consistent with the OECD's (2005) definition of process innovation: implementing or adopting new or significantly improved production or delivery methods. Process innovation may involve changes in equipment, human resources, working methods, or a unique combination to each firm. To further expand on that, a successful innovative product's development is a continuous effort to fuse multiple internal and external capabilities through a cross-functional process (Al-Sa'di. et al., 2017). This paper will focus on product innovation and process innovation as the base to measure firms' innovation capability.

Knowledge Management and Innovation Capability

Urgal et al. (2013) noted that obtaining knowledge from external is an essential factor that will dictate whether the firm will eventually gain a competitive advantage. They stated that strategic alliances or cooperation agreement methods tend to be more relevant for innovation-related activities than the direct acquisition of the technology from the open market. Such cooperation allows the firm to gain access to a partner's implicit and explicit knowledge simultaneously. Firms that can cooperate more externally can utilize the knowledge gained to stimulate new thought that will lead to more new ideas and improved operation practice in return for more significant innovation capability and unparalleled competitive advantage (Sánchez et al., 2019). Other authors also confirmed that increasing the number of external sources of cooperation will not necessarily bring forth better innovation capability outcomes. There will be a lack of strong cooperative relationships with other entities to ensure their external technical knowledge source (Tang et al., 2019). Therefore, Zhou & Li (2012) emphasized that the manager must understand the firm knowledge base because a firm with an in-depth knowledge base and expert in its core field should renew its knowledge resources externally. This argument suggests that a firm maximize its benefits through the production of radical innovation. In line with this finding, Santoro et al. (2017) claimed that firms in a highly competitive market with dynamic customer needs and a low level of R & D investment could develop radical innovation via external science-based knowledge sources such as universities and technology institutions. They also asserted that knowledge from a market-based source such as customers, suppliers, competitors, and firms from other industries is vital for achieving incremental innovation to the existing product. Urgal et al. (2013) put forth a similar argument, which stated that knowledge resources could influence innovation performance. However, it is the firm's innovation capability that converts such resources into new product and process innovation. This further cement the notion of external knowledge sourcing having a positive effect on innovation capability.

In a knowledge-based economy, knowledge mobility plays a central role in preventing tacit knowledge, the know-how, and innovative ideas from being confined to a specific spatial and temporal boundary that will result in knowledge waste (Mohamed, 2012). Meanwhile, few scholars suggested that knowledge sourcing alone will not bring about notable improvement in

the innovation performance of a firm, but sharing of knowledge is vital for the development of technical and administration related innovation (Aboelmaged, 2014; Oorschot et al., 2018; Segarra-Ciprés et al., 2014). Aboelmaged (2014) and Oorschot et al. (2018) further stressed the importance of companies sharing and collaborating on common ground to increase innovation.

Likewise, Liu (2012) empirically tested and opined that knowledge mobility consists of two processes: knowledge acquisition and knowledge utilization. Knowledge is first obtained externally and then utilized within the organization through inter-unit sharing and exchanging new product development. Furthermore, knowledge mobilizes through the organization will enhance decision-making quality (Al-Sa'di et al., 2017). A study by Ruiz-Jiménez & Fuentes-Fuentes (2013) suggests that an organization's ability to acquire and exchange knowledge between the employees will positively impact its innovation capability. This finding is in line with the study of Zhou & Li (2012), which states that a company with diverse knowledge backgrounds will achieve a breakthrough in radical innovation by mobilizing the knowledge across its different divisions. In certain studies that analyze the effectiveness of external knowledge sourcing and internal knowledge sourcing on firm's continuous innovation, suggests that internal knowledge sourcing has a more significant effect toward innovation activities through mobilizing and sharing of the knowledge gain from external source among the departments (Segarra-Ciprés et al., 2014; Xie et al., 2019).

Thus far, the literature points towards the positive effect of external knowledge sourcing and knowledge mobility on innovation capability. However, in a highly volatile environment, competition for primacy is raison d'être for the organization (March, 1991). The ability to speed up innovation generation is critical for a firm to achieve a competitive advantage. As mentioned earlier, collaboration with external partners is one of the quicker ways to enhance innovation capability. Still, it comes with certain risks in unnecessary knowledge leakages to the partner to gain a competitive edge. Knowledge protection is one legitimate way to prevent unlawful knowledge appropriation through legal protection measures such as patents, trademarks, copyright, and contractual agreements (Olander et al., 2014).

Nevertheless, too much knowledge protection may hinder the development of inter-firm innovations. From Jean et al.'s (2014) empirical study, knowledge protection will instead facilitate innovation generation within inter-firm in the market whose legal system is immature to protect novel knowledge. As such, proper knowledge protection will encourage knowledge mobility and stimulate product innovation. When a firm possesses knowledge protection capability, it will give the firm an advantageous position through more innovative outputs (Cheung et al., 2012). **Table 1** highlights some empirical findings of knowledge management and innovation capability, as has been discussed earlier. Based on the arguments above, the following hypotheses are posited:

H1. External knowledge sourcing has a positive effect on innovation capability
H2. Knowledge mobility has a positive effect on innovation capability
H3. Knowledge protection has a positive effect on innovation capability

Table 1: Empirical Findings of Knowledge Management and Innovation Capability

Authors	Knowledge Management Types	Main Findings
Tang et al. (2019)	External Knowledge Sourcing	External search depth positively affects innovation capability, exploratory innovation, and exploitative innovation.
Zhou & Li (2012)	External Knowledge Sourcing	An in-depth knowledge base is capable of more radical innovation with external knowledge acquisition
Liu (2012)	Knowledge Mobility	Knowledge mobility has a positive influence on the enhancement of innovation capability.
Aboelmaged (2014)	External Knowledge Sourcing, Knowledge Mobility	Knowledge acquisition, sharing, and application positively and significantly impact innovation performance
Jean et al. (2014)	Knowledge Protection	Knowledge protection is positively related to product innovation
Olander et al. (2014)	Knowledge Protection	There is a positive relationship between preserving innovation and the use of informal protection

Innovation Capability and Manufacturing Performance

A significant number of past literature have indicated the strong positive relationship of innovation capability on the firm's manufacturing performance (Abdallah et al., 2016; Adebanjo et al., 2017; Antunes et al., 2017; Kafetzopoulos & Psomas, 2015; Mohamad et al., 2015). According to Al-Sa'di et al. (2017), process innovation that results in new production techniques will enable a manufacturer to achieve significant manufacturing performance with higher efficiency and productivity. Likewise, empirical results show that an organization with the ability to carry out the new and improved method in their work practices will eventually improve operational performance (Doran & Mccarthy, 2019; Mohamad et al., 2015). In a recent study, Sahoo (2019) explored quality management strategy on small-medium enterprises and discovered that innovation-related activities could revive its product, process, and administrative standard to positively affect the firm performance. At the same time, Kafetzopoulos & Psomas (2015) also found out that for a firm to positively gain from its operational performance, the inclusion of innovation strategy as part of its business plan is a cardinal step. However, other scholars discovered that only process innovation could improve operational and financial performance through their research. At the same time, product innovation can only improve financial performance, but without dwelling much of the reason behind it (Antunes et al., 2017).

Interestingly, the recent study of Möldner et al. (2018) on the impact of lean manufacturing practices on process innovation also reveals positive outcomes for incremental and radical process innovation, positively affecting the firm's operation management. In contrast, a much earlier study by Damanpour & Gopalakrishnan (2001) indicates that organizations emphasize product innovation's adoption over process innovation. They claim that product innovation usually involved technologies that are easier to be protected via patents or other legal means and, as a result, will allow the organizations to gain a first-mover advantage. Thus far, literature is showing debatable arguments from both perspectives, as shown in **Table 2**. Hence, the present work will further expand on these arguments by developing a notion for a firm that seeks to enhance its manufacturing performance in a developing country manufacturing setting. From this perspective, the following hypothesis is proposed:

H4. Innovation capability has a positive effect on manufacturing performance

Table 2: Empirical Findings of Innovation Capability and Manufacturing Performance

Authors	Innovation Capability Types	Main Findings
Adebanjo et al. (2017)	Product Innovation, Process Innovation	Both product innovation and process innovation have a positive effect on manufacturing performance
Al-Sa'di et al. (2017)	Product Innovation, Process Innovation	Process innovation significantly affect operational performance, but product innovation has no significant effect on operational performance
Mohamad et al. (2015)	Product Innovation, Process Innovation	Product and process innovation capability has a positive effect on operational performance
Antunes (2017)	Product Innovation, Process Innovation	Process innovation has a positive influence on operational performance but not product innovation
Kafetzopoulos & Psomas, 2015)	Product Innovation, Process Innovation	Innovation capability directly contributes to operational performance

The Mediating Effect of Innovation Capability

Aboelmaged's (2014) study on 124 firms within the UAE's manufacturing and services sector revealed that knowledge management positively affects the firm's innovative performance, leading to improvement in its operating performance. Adding on to Aboelmaged's view, Urgal et al. (2013) claimed that through innovation capability, knowledge resources might improve the firm's innovation performance and stressed that proper knowledge management is critical for its innovation capability development. As part of his study on the quality management strategy for firm performance, Sahoo (2019) discovered that knowledge acquired through routinized information could enable a firm to establish a learning base for further innovative and creative activity generation that supports its firm performance. Likewise, Al-Sa'di et al. (2017) claimed that the external knowledge sourcing, coupled with the firm's internal ability to generate new knowledge, would invigorate the level of product innovation and process innovation capability. They further stressed that process innovation would enable the firm to reduce its cost by eliminating non-value-added activities. A study has also confirmed that innovation capability plays a crucial role in mediating external knowledge sourcing and the manufacturing firm's exploratory innovation capability. In return, the firm will react and adapt to the environment's changes by reorganizing and renewing their existing knowledge structure and organizational practices, which will lead to product and process improvement (Tang et al., 2019). Meanwhile, an empirical study by Noruzy et al. (2012) also revealed knowledge management as a critical antecedent of innovation, and it even indirectly and positively influences organizational performance via organizational innovation. In summary, there is a strong inclination of the positive mediating effect of innovation capability on knowledge management and manufacturing performance, and as such, the following hypotheses are posited:

H5. Innovation capability mediates the relationship between external knowledge sourcing and manufacturing performance

H6. Innovation capability mediates the relationship between knowledge mobility and manufacturing performance

H7. Innovation capability mediates the relationship between knowledge protection and manufacturing performance

Conceptual Framework

Based on the hypotheses derived earlier, this study's conceptual framework is conceived, as shown in **Figure 1**. The interaction of the constructs and their relationship are grounded with the resource-based view, knowledge-based view, and dynamic capabilities theories, which will be discussed in the subsequent section**.**

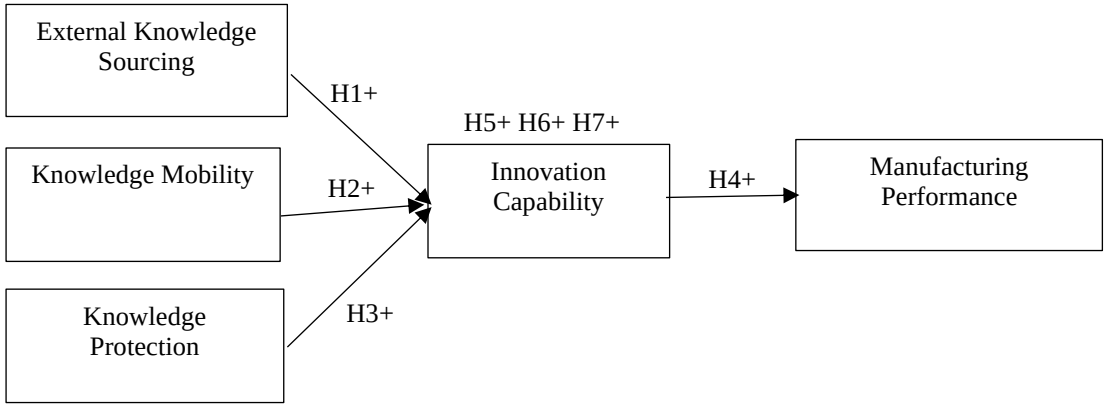

Figure 1: Conceptual Framework

Underlying Theory

With the growing literature on innovation operation management, many researchers have also referred to resource-based view to ground their theoretical position (Camisón & Villar-López, 2014; Sánchez et al., 2019). The resource-based view suggests that a firm can achieve sustainable competitive advantage by fully exploiting its resources, which are valuable, rare, not able to emulate, and non-substitutable (Barney, 1991; Camisón & Villar-López, 2014; Tang et al., 2019). Barney (1991) noted that a dynamic change to an industry's economic structure might render a once competitive advantage resource worthless and vice versa due to the new industry setting's different needs. Drawing upon this, sustaining a competitive advantage will depend on three key factors: the rate of resource obsolescence, the availability of substitutes for the resource, and the resource's inimitability (Godfrey & Hill, 1995). As a result, many researchers started to leverage the theory of dynamic capabilities that emphasizes a firm's ability to remain competitive at the turn of a new environment (Qamar et al., 2019; Sánchez et al., 2019). The literature of dynamic capabilities states that a firm may not necessarily achieve a competitive edge by accumulating many resources. If it does not possess the right abilities to capitalize on these resources for its operation to respond rapidly to the changing needs in the business environment (Teece et al., 1997). However, at this point, all these theories seem to emerge as an idiosyncratic reaction within the conceptual framework. Given such a position, a firm's knowledge-based view is considered the core theory to synthesize them for further conceptual understanding of the integrated framework. According to the seminal work of Grant (1996), on the knowledge-based view of the firm, knowledge application is the primary role of an organization, and the ability for the organization to transfer and aggregate the knowledge resources is important for the firm to make a key decision.

In conclusion, all three theories emphasize the importance of obtaining the appropriate knowledge and using it at the appropriate time to enhance manufacturing performance. However, there is a lack of understanding on better managing this knowledge (Tan & Wong, 2015). Grant's (1996) groundbreaking work on the knowledge-based view highlights the idea that an organization's key goal is to better leverage knowledge through transferring and protection, which will contribute to creating the right decision for it to gain a sustainable

competitive advantage. Grant (1996) also stresses the importance of preserving one's knowledge capital for a firm to gain a longer competitive advantage. Such a notion is consistent with the resource-based view theory, emphasising the importance of a firm having unique and hard to imitate resources (Godfrey & Hill, 1995).

Similarly, Leonard-barton (1992) argued that a firm's effectiveness depends on its ability to control the evolution of its abilities in response to environmental dynamism in her thesis on the firm's core capabilities. Building on this, the use of dynamic capabilities theory in this analysis would offer more insight into how a company can handle its expertise under the influence of external variables such as ID4.0 and achieve a boost in manufacturing performance. As shown in Figure 1, knowledge is the firm's core resources, and the proper management and utilization of knowledge align with the theory of resource-based view and knowledge-based view. Such unique knowledge is perceived to increase the firm's capability to innovate and eventually enhance its manufacturing performance, which highlights the core value of dynamic capabilities.

Discussion and Conclusion

Malaysia's manufacturing sector faces challenges and needs to regain its competitive edge by upskilling its workforce and applying Industry 4.0 technologies (Cheah & Tan, 2020). However, various factors are compounding its progress, and understanding them serves as the basis of this study. Extant literature shows that proper knowledge management will lead to a better manufacturing performance (Tan & Wong, 2015) but do not satisfactorily inquire into the contingent factors that modulate the relationship between them. Furthermore, most studies look upon the composite view of knowledge management and leave out knowledge protection as the key aspect of knowledge management. This study intends to fill the gaps by extending the understanding of external knowledge sourcing, knowledge mobility, and knowledge protection on innovation capability and manufacturing performance. Doing so will further advance the knowledge and research line within the mentioned fields by enriching it with a new link between the constructs. Thus, this study provides the manager with a deeper understanding and practical application recommendation on both technology sourcing and implementation for productivity improvement. Secondly, this study also references three theories to ground all the theoretical reasoning and confirm the results from the previous finding. Resource-based view, knowledge-based view, and dynamic capabilities theory provide the foundation of the theoretical framework that supports this empirical study.

Those states with a significant number of manufacturing companies classified as innovative by the National Survey of Innovation 2015 will serve as the research's population (MASTIC, 2015). Following that, the sample will be chosen from the 2018 Federation of Malaysian Manufacturers (FMM) Directory. Large corporations will be the sample for this study as the firm's size matter in terms of the adoption of advanced technologies (Cooper, 1998). A structured questionnaire will be used due to the quantitative nature of this study. The questionnaire will be pretested by a panel of experts from both the industry and academia. Both e-mail and conventional mail will be chosen as a delivery method and will target operation manager, leaders, COO or CEO. The questionnaire set consists of four main sections and thirty-one items that measure knowledge management, innovation capability, and manufacturing performance. A six-point Likert Scale will be adopted for each of the items. Twelve measurement items for manufacturing performance will be adopted from Tamayo-Torres et al. (2017). Ten items will be adopted from Zhou & Li (2012) and Jean et al. (2014) for measuring external knowledge sourcing, knowledge mobility, and knowledge protection. A nine measurement items from Al-Sa'di et al. (2017) will be used for measuring innovation

capability. Finally, the measurement model will be assessed for construct validity, and reliability before the structural model's relationship is analyzed using Smart-PLS.

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