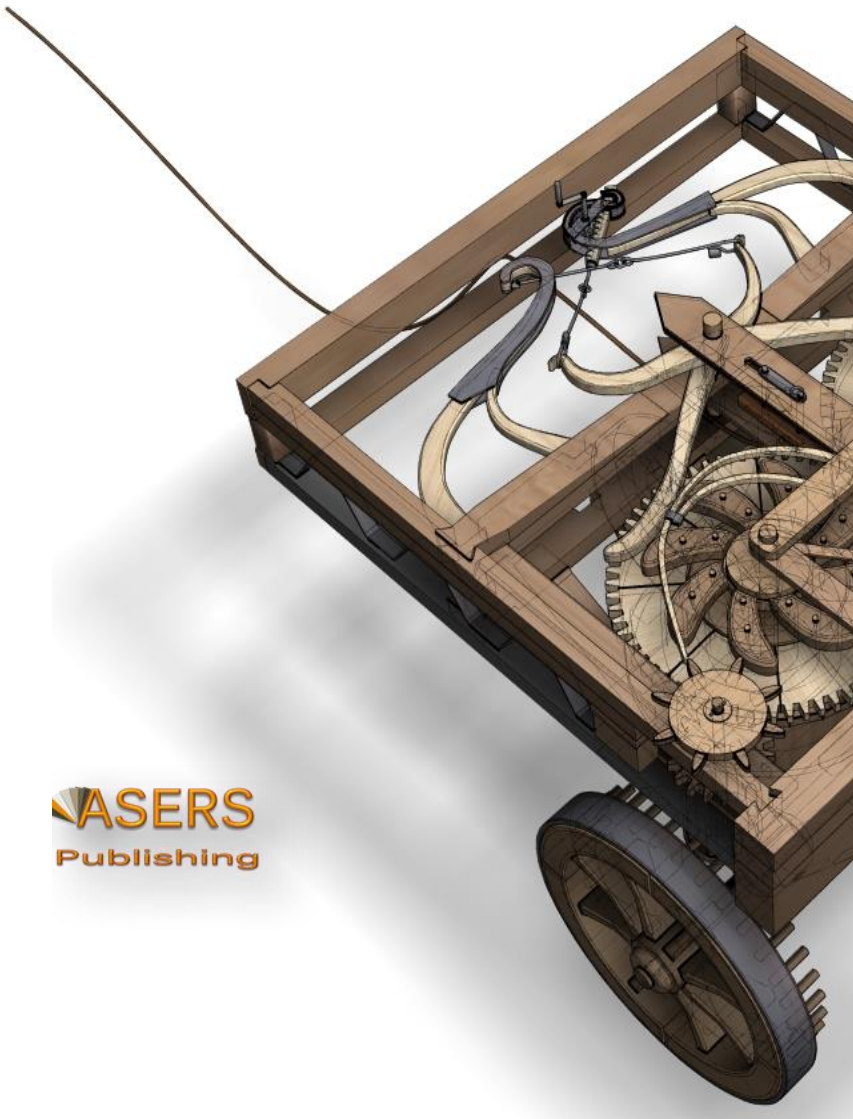
Theoretical and Practical Research in Economic Fields



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A Conceptual Analysis of the Technology, Organisation, Environment, Readiness and Industry 4.0 Adoption in Malaysia Small and Medium Enterprises

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Abstract: Technology advancement is a primary element in differentiating Industry Revolution 4.0 (IR 4.0) from previous Industrial Revolutions. This revolution changes the nature of workforces, and the way people work. As a result of rapid technological advancement through Industry 4.0, SMEs are finding it more difficult to innovate and adopt. SMEs have difficulty adopting Industry 4.0; hence they tend to remain inactive. They can, however, reap greater benefits if they are more active and open to this new revolution. The current paper aims to examine the potential for reviewing to investigate, in the context of Malaysian SMEs and the adoption of Industry 4.0, whether the relationships between technology, organisations, environment, and Industry 4.0 adoption are mediated by readiness. Also, the paper analysed the various issues and concepts related to the study through various literatures. The study's results are expected to demonstrate that the relationships between technology, organisations, and environmental aspects are mediated by a readiness to adopt Industry 4.0. This finding will provide information to SMEs on which aspects for the company to improve to be ready and adopt Industry 4.0. It will also be useful to policymakers who create strategies and support systems to encourage the growth of Malaysian SMEs.

Keywords: industry 4.0; small and medium enterprises; adoption, technology, organization, and environment framework; diffusion of innovation theory; Malaysia.

JEL Classification: M13; M31; M37; O32; R11.

Introduction

SMEs play a crucial role in Malaysia's economic landscape. Based on the Department of Statistics Malaysia report, SMEs' Gross Domestic Product (GDP) contribution shows a significant increase from 2015 with 36.3% to 2016 with 36.6%. It continues to increase to 37.1% in the year 2017 and year 2018 with an increment to 38.3% (Department of Statistics Malaysia Press Release Small and Medium Enterprises (SMEs) Performance 2018, 2018). The GDP contribution continued to increase in 2019 to 38.9%, with a nominal term recorded RM586.9 billion (Department of Statistics Malaysia, 2020). As a result, Malaysian SMEs are key players in the country's economic expansion and must meet the challenge of promoting and managing Industry 4.0 adoption. Since

Industry Revolution has systematically gone through different phases, the fast phase has brought us to Industry 4.0 today. Industry 4.0 introduced a smart manufacturing and production method involving various technologies, such as the Internet of Things (IoT) and the Internet of Services, also called IoS. The technologies implemented in Industry 4.0 have changed business operations and management.

Therefore, on October 31, 2018, Malaysia's Ministry of International Trade and Industry (MITI) announced the official Industry 4.0: Industry4WRD policy to keep pace with the technological revolution. This policy aims to develop a comprehensive transformation plan for Malaysia's manufacturing industry and related services towards Industry 4.0 adoption. However, after one year of launching the National Policy on Industry 4.0: Industry4WRD, Malaysia faces a slow adoption rate, with only 15 to 20% of companies migrating to Industry 4.0. The 15 to 20% of companies were tier-one companies obliged to adopt because they had no other choice. Industry 4.0 Malaysia Association President Raja Teagarajan said only 90 of the government's 500 target companies had gotten assistance with the transition to Industry 4.0 (Kaur, 2019). It was emphasised by Malaysia's position in the 'Leader' quadrant, according to the 2018 Readiness for the Future of Production Report issued by the World Economic Forum (WEF). Nonetheless, the leader quadrant countries have the most current economic value at stake for future disruptions if they fail to accelerate the transformation towards Industry 4.0 (World Economic Forum, 2018).

Nevertheless, the adoption decisions were influenced by various factors that businesses must consider. The most common contexts are technology, organisational and environmental. Technology, organisation, and environmental contexts influence company decisions on whether they need to initiate and adopt Industry 4.0 into their business. It has origins from the TOE Framework and has been integrated with the Diffusion of Innovation Theory (DOI) in numerous research works examining the adoption of technology and innovation (Paydar and Endut, 2013), (Amini and Bakri, 2015), (Bhattacharya and Wamba, 2015), (Al-Hujran et al., 2018), (Usman et al., 2019), (Skafi et al., 2020), (Kaminski, 2011).

1. Relationships between Technology, Organization, Environment, and Industry 4.0 in Malaysian SMEs

1.1 Relationship between Technology, Organization, Environment, and Industry 4.0 Readiness

Technology and readiness are common discussion topics among researchers. In one research work, technology readiness was referred to as being ready to enhance the standards of the currently used technology and to embark on the higher-level use of technology (Nugroho et al., 2017). Four traits of the human personality - optimism, innovativeness, discomfort, and insecurity are generally used to measure technology readiness. Optimism implies positivity towards technology and perceiving that technology offers benefits, such as making life more controllable, flexible, and efficient. Innovativeness is seen as eager to be a pioneer and front liner in trying new technology and a thought leader. Discomfort implies that a person perceives that technology will be problematic to control and that they are afraid of and concerned about new technology, which reduces their self-esteem. Meanwhile, insecurity involves doubt and wariness about the workability of the technology (Nugroho & Andryzal Fajar, 2017).

Readiness for Industry 4.0 is always highly related to the technology, which is the driving aspect of the adoption. The research found that the process's flexibility in production or services and stability is key to technological readiness as part of the industry 4.0 implementation (Samaranayake et al., 2017). According to (Vize et al., 2013), the technical readiness of a company impacts its ability to adopt new technology. Still, the technical complexities of dynamic web technologies necessitate both technical capabilities and knowledge of the technology. Where these are insufficient, managers may feel increasingly exposed to being exploited, heightening their risk perceptions and lowering their trust in adopting or employing technology. Therefore, readiness plays a pivotal role in fortifying the Industry 4.0 adoption. The readiness is mostly based on the company's digital preparedness for Industry 4.0 technologies. Research indicates that Industry 4.0 can be uniquely characterised by assessments of particular technologies, implying that the technology readiness of organisations is enhanced considerably to facilitate their readiness for Industry 4.0 (Hizam-Hanafiah et al., 2020).

Meanwhile, the organisation has a role in ensuring the business formation is well established. In the various roles accountable to the organisation, readiness is one element that must be administered. Knowing the Industry 4.0 readiness in the organisation is important to know how well to prepare the organisation to undergo a major change. It is to ensure that the organisation is aware of the efficiency based on their resources and to avoid any potential failure. Factors in the organisation, information intensity, top management support, organisational competency, and absorptive capability indicate the importance of elements in the organisation that can determine Industry 4.0 readiness and adoption. Industry 4.0 readiness in the organisation most likely rely on continuous support from top management. Numerous relationships will be changed due to Industry 4.0, such as

organisations with environmental aspects, the community, the value chain, and humanity. Therefore, organisations must design their strategy considering these changing relationships (Sony & Naik, 2019). Researchers have argued that a key dimension of readiness for Industry 4.0 is the appropriate degree of support from the senior managers (Stentoft et al., 2019), who are also the drivers of IT trend-related knowledge. Organisations only reach the point at which they can expand further and become ready for the inherent risk through the initiative of the leading managers (Nair et al., 2019). Hence, organisations must strategise and align the new technology's readiness and adoption.

Due to the rapid changes and great competition in the market, organisation transformations and strategies are crucial. It is because, with the transformation, organisations can develop sustainability and efficiency and adapt to the changes and challenges. Therefore, the commitment from the organisation to ensuring the readiness for adopting Industry 4.0 will enhance business sustainability. On the other hand, environment and Industry 4.0, readiness are closely related. Environments provide threats and opportunities that require the organisation to tackle them positively, adapt to the environmental requirements, and change operations accordingly. Interaction between the environment and business, internally or externally, will affect business sustainability and Industry 4.0. Organisations often thrive and become economically sustainable due to the influence of the elements of their external environment, such as the pressure from competitors, business partners, support from outside the business and governmental assistance. In contrast with external factors, organisations have great control over internal environmental factors. They can make business decisions based on their strategies and where they see fit. It indicated that the readiness to adopt Industry 4.0 is considerably influenced by the environmental factors that can be the source of either barriers or drivers.

Researchers have revealed that the readiness to face Industry 4.0 is positively and significantly affected by the external environment, the dynamic of which is at least as crucial as any other aspect, like technology (Maria et al., 2019). The government also need to foster and educate business, especially SMEs, in forms of guidance in the managerial aspect, technological aspect as well as organisational readiness in adapting the Industry 4.0 (Sari & Santoso, 2020). Since the external environmental factors are beyond the organisation's control, they must continuously study the environmental aspects and adapt to any possible changes. Therefore, a smooth adoption process can take place.

1.2 Relationship between Technology, Organization, Environment, and Industry 4.0 Adoption

Technology and Industry 4.0 is an intertwine phrase that is notable accompaniment. The evolution and advancement of technology itself have brought us to Industry 4.0. Today. The most common or based technologies applied in Industry 4.0, especially in manufacturing, are the Internet of Things (IoT), Cloud Computing, Big Data, Smart Manufacturing, Smart Products, et cetera. These technologies are the main adoption elements of Industry 4.0. Technological factors are linked to the firm's technological infrastructure and capabilities and those available on the market (Arcidiacono et al., 2019). The findings of the existing studies have generally demonstrated that technology and Industry 4.0 adoption are significantly and positively related. At the same time, this might not be universally applicable, but this relates in part to the technologies of Industry 4.0. For example, the results of one work illustrate that Industry 4.0 is connected to front-end technology being more widely adopted, in which a major role is played by Smart Manufacturing (Frank et al., 2019).

Besides that, a study in Indonesia found that technology's relative advantage is vital in determining the intention to adopt Industry 4.0 (Hidayatno et al., 2019). Research into the adoption of IIoT by manufacturers in Germany demonstrated that of all the factors of TOE affecting Industrial Internet of Things (IIoT) adoption. The greatest influence was found to come from technology relative advantage (Arnold & Voigt, 2019), which was also the case with Canadian SMEs regarding their Internet and e-business technologies (IEBT) adoption (Ifinedo, 2011). Other researchers have demonstrated that manufacturing professionals must adopt Industry 4.0 technologies. At the same time, companies must undertake technologies-related projects so their competitive edge can be maintained or strengthened (Chiarini et al., 2020). Additionally, Thong (1999) found that technology and organisations are significantly related to adoption. The adoption capability of an SME and a better-resourced company that has greater opportunities are not the same. Integrating IT, the IoT, and the general idea of Industry 4.0 is highly challenging for most SMEs. However, all enterprises require numerous technological developments and innovations through the adoption of Industry 4.0 to maintain market competitiveness (Sevinç et al., 2018).

In other aspects, Industry 4.0 will certainly affect how one organisation works, up and running, contrasting with the traditional practices, especially in most SMEs that are known with the conventional managerial system. During the Industry 4.0 adoption process, major transformations will be experienced due to substantial workforce skills changes, new business structures, new mechanisms of leadership, and new cultures of corporations. So

that an organisation can disseminate Industry 4.0 practices that focus on being sustainable, it must ensure that it is more capable regarding the expertise within its workforce, the strategic policies by which it organises itself, its instruments of leadership and its business culture of friendliness (Cevik Onar et al., 2017). An existing study examined how the technology of Industry 4.0 was associated with the processes used by businesses to create, maintain, and internally transfer knowledge. Their findings indicated that if a company systematically supports organisational-level learning and the exchange of knowledge, implementing the technology of Industry 4.0 will enhance its advantages (Tortorella et al., 2020).

Meanwhile, researchers exploring how SMEs had adopted Industry 4.0 discovered that those with internally and externally stronger forms of social capital were more likely to adopt the technologies of Industry 4.0. This association was strengthened with the managers' support and a greater capacity to absorb. Furthermore, social capital and the adoption of Industry 4.0 were positively and significantly related to higher levels of absorptive capacity and managerial support (Agostini & Nosella, 2019). Another study suggested that leadership must initiate organisational culture changes so that they do not cause internal conflicts, such as encouraging a learning and innovation culture, knowledge upgrades, and rewarding unconventional thinking (Sivathanu & Pillai, 2018). The more senior management backs innovative technology, the more likely these innovations will be adopted (Sevinç et al., 2018). Meanwhile, according to one study, when a company is undertaking the development process of adopting Industry 4.0, it must ensure the changes are generally understood and initiate innovative programs to train employees, so their competencies improve. Moreover, such companies must have leaders with open minds, creativity, and the capacity to think from the perspective of the organisation and the overall network (Horváth & Szabó, 2019).

Meanwhile, external and internal environmental factors undeniably influence the adoption decision. Organisations tend to be conscientiously aware of environmental conditions, especially in their respective industries. Internal environmental factors usually provide strengths and weaknesses within the organisation for them to grasp the whole business environment. In addition, external factors will mostly bring opportunities to seize and threats to the organisation to control. Competitive pressure, business partners, external support and government support, are among the environmental factors influencing the adoption of Industry 4.0. For example, researchers found RFID technology adoption intentions within companies were most significantly affected by competitive pressure; this had a positive association with adoption intention (Paydar et al., 2014). A study on the adoption of Blockchain among SMEs indicated that competitive pressure significantly impacts the adoption intention. It implies that SMEs are determined to stay relevant and competitive, and technological innovation, as in Industry 4.0, is the driving force (Wong et al., 2019).

Additionally, increasing numbers of consumers are anticipating business outcomes being delivered as Industry 4.0 advances, so organisations are coming to recognise that their services must be reinvented, their innovation accelerated and broadened, and their solutions delivered in a way that focuses on outcomes alongside their ecosystem partners. With substantial changes on the way, companies and partners will need to collaborate more closely. They may be left behind in the Industry 4.0 ecosystem if they fail to do so (Schroeck et al., 2020).On the other hand, government support and policies can help to create a favourable environment for businesses to adopt the technology. The reason is that a company is more likely to respond to this type of appeal and attempt to use new technologies when the authorities employ the media or introduce policies involving allocating additional social resources to an innovative tool. Therefore, all government initiatives contribute to beneficially adopting Industry 4.0 technology (Lin et al., 2018).

1.3 Relationship between Industry 4.0 Readiness and Industry 4.0 Adoption

The readiness and decision to adopt certain innovations or technologies greatly influence various factors. For instance, through the context of technology, companies will need to identify if they can acquire any advantages from the adoption of innovation of technologies in their business operation and processes. It is because neither a single event nor a limited number of discrete events constitute technological innovation. It entails a complex web of events involving numerous activities, decisions, and actions on the part of individuals and social units, most of whom are not even aware that they are part of such a process (Tornatzky & Fleischer, 1990). According to Hammer & Champy (2002), technology can manoeuvre business processes and organisational performance towards improvements with ongoing efforts. In order to succeed, companies need to explore the technological potential of one of their core competencies. Hence they will enjoy a continuing and growing advantage over their competitors. In this situation, technologies used internally and externally were involved, with the former referring to the organisation's existing technology it now uses and the latter referring to the available technologies offered in the market but not adopted or used by the business (Al-Hujran et al., 2018).

Past studies showed that influential factors derived from the aspects of technology, organisation and environment affect the adoption of innovation or technologies adoption, such as cloud ERP by SMEs (Usman et al., 2019), CRM adoption (Cruz-Jesus et al., 2019), Social commerce adoption (Abed, 2020), and SMEs' adoption of Cloud Computing Services (Skafi et al., 2020). In addition to this, readiness may influence the adoption decision through the technology, organisation, and environmental contexts. Readiness in this study refers to the causes and effects and links between technology, organisation and environment aspects towards the adoption and explains the relationships between them. It is because readiness often leads to adoption. Before the adoption, the whole implementation process was due to the readiness factors that drove the decision to adopt. To take the example of Denmark, despite being regarded as highly ICT-intensive compared to many other OECD countries, its readiness level is relatively low. The implication is that this low level applies in most OECD countries, so all organisations - not SMEs - require the allocation of resources so their preparation to adapt and change to accommodate the digital environment can be successful (Stentoft et al., 2019).

Moreover, countries with the ability and readiness at the forefront of digitalisation tend to be more advanced in adopting Industry 4.0. (Castelo-Branco et al., 2019). Therefore, according to the practitioners, the priority readiness aspects would allow for a smooth implementation of Industry 4.0 in SMEs. (Sriram & Vinodh, 2020). The readiness for adoption has been constantly studied and examined by researchers, hence the development of readiness models across various fields. In a review of this topic, Industry 4.0 readiness was evaluated using 158 model dimensions by various authors and businesses. From that, the six most important dimensions were identified: technology, people, strategy, leadership, process and innovation (Hizam-Hanafiah et al., 2020). For instance, a study on the different dimensions affecting Industry 4.0 readiness suggests it is positively and significantly affected by those elements related to the economy and the environment. Meanwhile, Industry 4.0 readiness is positively but insignificantly impacted by the dimensions of culture and technology but negatively and insignificantly by the social dimension (Maria et al., 2019). Besides that, the level and degree of readiness will also determine the company's adoption decision and lead to a higher degree of practising Industry 4.0 (Stentoft et al., 2019).

1.4 Readiness of Industry 4.0 Mediates Relationship between Technology, Organization, Environment and Industry 4.0 Adoption

Due to the limited research and findings on Industry 4.0 adoption, this study mostly relies on the previous literature related to IT adoption research. It is because Industry 4.0 is closely connected with IT and technology innovation. Those research and studies often relate adoptions with readiness. The author identified that adoption readiness had potential associations with the elements of technology examined: the relative advantage offered and how compatible, complex, available, and observable the technology was. Readiness is often seen as crucial in implementing and adopting any technology or innovation into the business operation. Most companies hesitate to adopt due to readiness issues. In addition, companies need to contemplate the risk should the adoption fail. For instance, one study found that one of the major causes of the failure of ERP implementation is a lack of readiness (Ali & Miller, 2017).

Additionally, adoption decisions are considerably influenced by readiness levels since higher readiness levels lead to technologies being regarded as of greater business relevance and hence more widely deployed (Stentoft et al., 2019). Other researchers proposed that the circumstances needed for readiness to be acquired wide international disparities. However, this demonstrates that a country's prominence in closing the digital gap should correspond to the likelihood of adopting Industry 4.0 (Castelo-Branco et al., 2019). Hence, the readiness can potentially mediate the technology towards adopting Industry 4.0. It is significant to note that adopting and transforming a company's technology does not solely rely on technology investment but also involves the whole organisation's commitment and business strategies. This gradual transformation requires well-prepared planning and readiness. Organisation elements in this study which involve information intensity, top management support, organisational competency, and absorptive capability, might be influenced by the readiness aspect towards the adoption.

For example, in order to employ Advanced Manufacturing Technology (AMT), the organisation's readiness must be well established throughout the implementation process (Rahardjo & Yahya, 2010). It is because the readiness and commitment from the organisation can enhance the advancement of Industry 4.0 (Jayashree et al., 2019). Besides that, a study indicated that readiness is considered a great assistance to the organisation in identifying the obstacles in the Industry 4.0 execution (Ślusarczyk, 2018). From these findings, it can be considered that readiness can mediate the organisation towards Industry 4.0 adoption. Besides technology and organisation, the environment has been acknowledged as one of the significant influences towards the adoption

decision. This study looks at elements of company pressure, business partners, external support, and government support within the environment factor. Since environmental elements are beyond the organisation's control, readiness plays an important role in the embarkment of Industry 4.0. Therefore, it is seen that Industry 4.0 readiness is positively and significantly affected by environmental factors (Maria et al., 2019). The company's readiness in preserving and improving the changes in environment towards the adoption of Industry 4.0 is indeed crucial. Moreover, the fast-changing and new dynamic environment presents huge challenges to companies. Thus, the readiness can mediate the environment towards Industry 4.0 adoption.

2. Underlying Theories

2.1 The DOI Theory and Technology, Organization, and Environment (TOE) Framework

The foundations for the current study are the DOI Theory, also called the Innovation Diffusion Theory (IDT), and the Technology, Organisation, and Environment (TOE) framework. These two prominent theories are widely used in technology adoption studies and research. DOI Theory consists of two aspects which are diffusion and innovations. The former can be defined as how particular routes and processes convey innovations to those belonging to social systems across time. Every message relates to a new idea, which makes this form of communication unique. Communication can be defined as a way of establishing a general understanding through the production and sharing of information by individuals. Since the messages focus on novel ideas, communication involving diffusion is unique. Its specific nature is the newness of ideas delivered through communication messages. Innovation can be defined as ideas, practices, or objects that individuals or other adoption units perceive as new. Whether or not an idea counts as an innovation is determined by its newness, which it is possible to express by knowing about it, persuading others to use it, and the decisions to adopt it. However, not all innovations are necessarily desirable since some innovations may be relevant to certain adopters, but in other situations, it is irrelevant to others (Rogers, 1983).

Tracing back to the beginning of the theory was created about a century ago. The theory was based on the three great foundations by the forefather of sociology and anthropology: the Frenchman Gabriel Tarde, the German Georg Simmel, and a group of anthropologists, the German-Austrian and British diffusionist. Since then, the theory has emerged and researched in different scientific disciplines. As the current research developed, the author identified eight principal forms of diffusion research: (1) How early innovations were known about, (2) The rate at which different innovations were adopted in social systems, (3) How innovative technology was, (4) The opinions of leaders, (5) Networks of diffusion, (6) The rate at which innovations were adopted in different social systems, (7) The use of communication channels, and (8) the outcomes of innovations (Rogers, 2003). Five categories of adopters are identified in the Innovation Diffusion Theory: the innovator, the early adopter, the early majority, the late majority, and the laggard. Each category has different characteristics and a different pace in adopting certain innovations. An innovator is someone wishing to be the original trialist of innovations. The early adopter is a thought leader. Rarely taking the initiative characterises those in the early majority. Those who are sceptical of adopting innovation are the late majority. Laggards are traditionalists bound by their beliefs (Diffusion of Innovation Theory, n.d.).

Rogers utilised the theory to propose five principle attributes explaining how innovations are adopted in organisations and how innovation-related uncertainty can be alleviated. Any innovation was deemed to comprise five characteristics. Firstly, relative advantage refers to its comparative improvement over previous generations. Second, compatibility refers to the relative ease of assimilating it into a business's current processes, methods, and value systems. Third, complexity refers to how difficult innovations are to use. Fourthly, observability means the degree to which others can see the innovation; fifthly, trialability refers to how easily the innovation can be experimented with (Oliveira et al., 2014). The attributes listed above describe how an organisation adopts innovation. At the time of writing, those researching IT and technology adoption have extensively used the DOI Theory and model, which have also been utilised by various types of social scientists, including educationalists, marketers, healthcare experts, and industrial engineers. Therefore, through this study, the above five attributes will be combined with the TOE Framework to explain the adoption of Industry 4.0. These attributes will be included in the context of technology under the TOE Framework.

Meanwhile, the TOE framework is a theory developed to delve into organisations' adoption decision through three perspectives or contexts: technology, the organisation, and the environment. In the 1990 work by Tornatzky and Fleischer, The Process of Technological Innovation, the authors proposed a key framework depicting the full process by which companies approached innovations. This included conception, adoption, and user implementation (Baker, 2012). The three contextual factors in TOE Framework influence a company's intention to adopt or not adopt the innovations. The concept of technology refers to the existing technologies used

internally by a company and externally available in the marketplace that may be relevant to particular organisations. The internal factors primarily comprise the organisational context, including the size of firms and their management, workforce, and formalisation structures. Meanwhile, the environmental context relates to the industry, suppliers, competitors, partners, and government (Tornatzky & Fleischer, 1990).

Since then, numerous researchers have utilised these ideas by testing the innovation adoption framework in their own fields, particularly regarding the adoption of technology. For example, this approach has been used to test EDI, KM, online business operations, RFID, online commerce, systems of the enterprise, and e-procurement (Awa et al., 2016). Furthermore, the adoption of online commerce by SMEs in developing nations could be explained by the TOE framework (Idris et al., 2017). Whether in the form in which it was created or its later IT adoption-related extensions, the TOE framework is highly useful for conducting analyses of how different IT innovations have been adopted and assimilated (Oliveira & Martins, 2010).

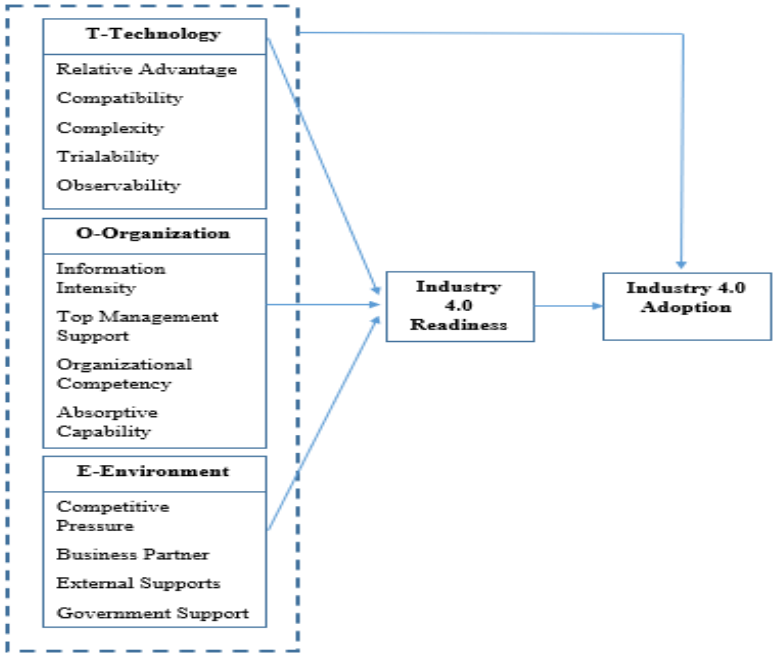
Previous researchers have employed integrated versions of the TOE framework and DOI theory when examining the adoption of different innovations and technologies. These include the internal and external elements involved in decisions to adopt Cloud Computing (Sayginer & Ercan, 2020), the retail industry's adoption of Radio Frequency Identification (RFID) technology (Paydar & Endut, 2013), the way that operations and supply chain management have adopted blockchain (Wong et al., 2019), as well as readiness factors identification for Industry 4.0 (Sari & Santoso, 2020). Instead of being one of the commonly used theories in innovation adoption study, DOI theory has its limitation: it does not include the environmental context, in contrast with TOE Framework, which also considers environmental aspects. Therefore, the combination of the TOE Framework and DOI theory will be able to explain innovation adoption at a firm level (Amini & Bakri, 2015). Hence, the TOE Framework and DOI theory integration complement each other (Puklavec et al., 2018).

In addition, TOE and DOI theories have been generally recognised to explore technological adoption as they have some parallels, such as both the theories include technology and organisation context. The TOE model typically aims to define appropriate categories for the determinants, while the DOI model helps to recognise a particular determinant within each category (Reza et al., 2021). Besides that, as compared to other technology acceptance and adoption models such as the Theory of Planned Behaviour (TPB) and Theory of Reason Action (TRA), DOI theory concentrates on the adoption decision through the organisational characteristic rather than individual roles (Taherdoost, 2018).

2.2 Framework

This conceptual paper seeks to ascertain the relationship between technology, organisation, environment, and adoption of Industry 4.0 as mediated by readiness.

Figure 1 - Research Framework



Source: adapted from Ramdani et al. (2009) and Meuter et al. (2005)

A study was conducted on several models developed by other authors. A study combination from Ramdani et al. (2009) and Meuter et al. (2005) was further explored. Ramdani et al. (2009) developed a model which determined

the relationship between technology, organisation, and environmental context towards the SMEs' adoption decisions. Meanwhile, Meuter et al. (2005) conceptual model consists of innovation characteristics, individual differences, consumer readiness and adoption. Thus, the conceptual model depicted in Figure 1 below results from a combination of those studies.

Therefore, the study proposed as below:

H1(a): There is a positive relationship between Technology and Industry 4.0 Readiness.
H1(b): There is a positive relationship between Organization and Industry 4.0 Readiness.
H1(c): There is a positive relationship between Environment and Industry 4.0 Readiness.
H2(a): There is a positive relationship between Technology and Industry 4.0 Adoption.
H2(b): There is a positive relationship between Organization and Industry 4.0 Adoption.
H2(c): There is a positive relationship between Environment and Industry 4.0 Adoption.
H3: There is a positive relationship between Industry 4.0 Readiness and Industry 4.0 Adoption.
H4: Industry 4.0 Readiness will positively mediate the relationship between Technology, Organization, Environment, and Industry 4.0 Adoption.

Conclusion

Industry 4.0 has become the talk of the town, and everyone races together and against each other to be part of it. Since the inception of Industry 4.0, it has emphasised the need for organisations to upgrade their whole business operation towards implementing and adopting technological advancement. In order to gain business sustainability, the business must keep pace with market trends and market pressures, especially SMEs. Thus, the current paper proposes to examine how technology, organisation, the environment, readiness for Industry 4.0, and the adoption of Industry 4.0 are related. The expectation is that the problems SMEs face in adopting Industry 4.0 will be addressed. In addition, this conceptual paper can contribute to supplementing literature for scholarly reference. However, a broader range of literature must be further examined with an astute assessment to gain more information to move forward with the empirical research. Once the current research is complete, the study results should impact policymakers and SMEs about Industry 4.0 adoption. Therefore, the current study proposes that readiness for Industry 4.0 has a mediating effect on technology, organisations, and environments concerning the adoption of Industry 4.0. Additional empirical studies are needed to conduct an assessment of the proposed framework about its efficacy.

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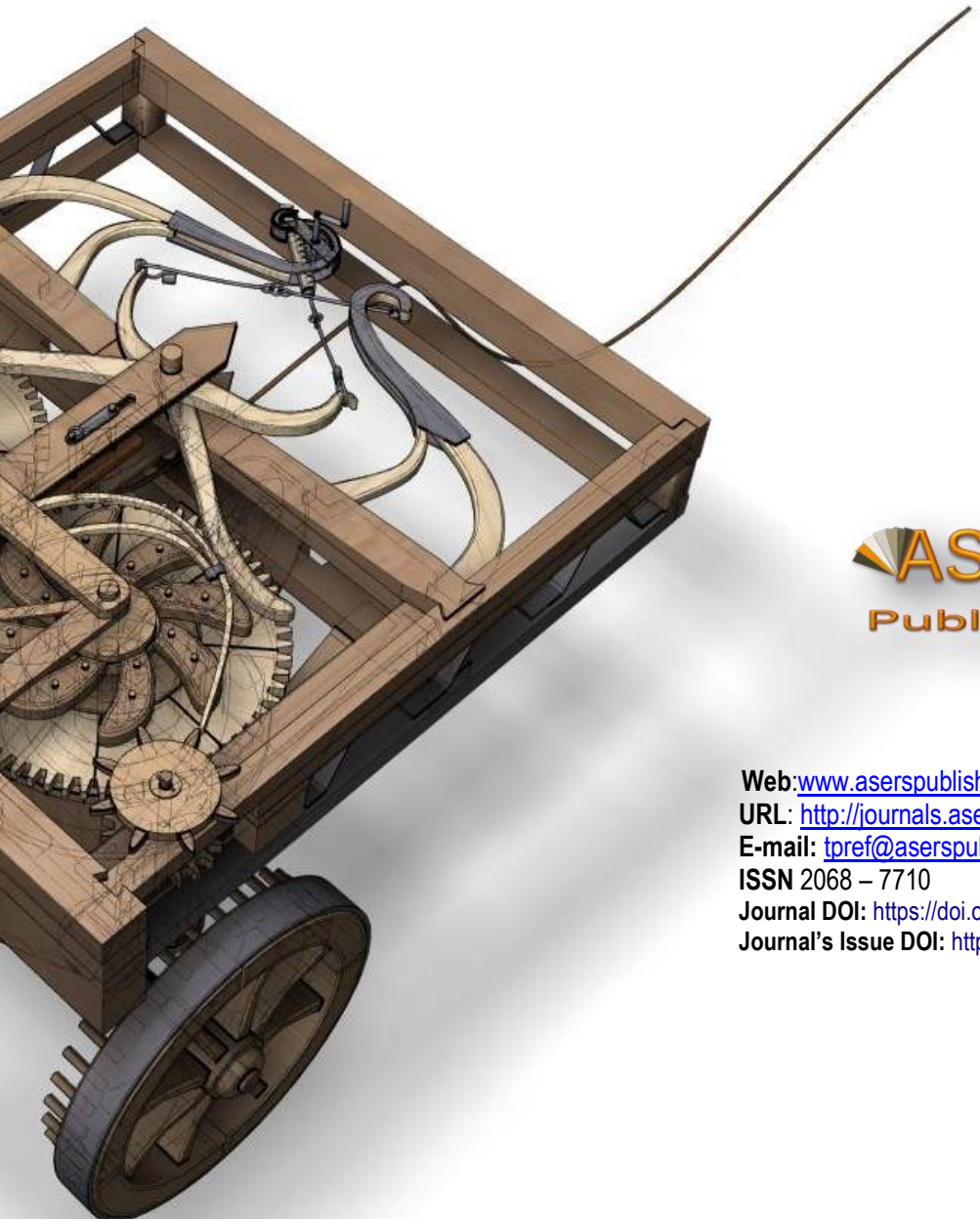

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