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The moderation role of Industry 4.0 towards business performance in manufacturing firms in Malaysia

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Abstract

This paper studies the pilot test process on a proposed new model of research and sustainable manufacturing practices for business performance, which is moderated–by Industry 4.0. The aim of this pilot study is to assess the usability and reliability of the survey questionnaire. An online survey method was used to collect 116 data from manufacturers in Malaysia. The integration between NRBV and RBV theory used which will provide a more comprehensive model to evaluate manufacturing industries' competitiveness. The results agreed that all the constructs in the proposed model have Cronbach alpha ranges from 0.662 to 0.901, which is evidence of constructs having good reliability and can used for future research with higher intensity. The result provides useful information for sustainable manufacturing practices which is adopted by manufacturing industries that could affect their usage and further improvement for their business performance during industry 4.0. This study focused on the sustainability in manufacturing practices with Industry 4.0 as a moderator in the Malaysian manufacturing industries. This pilot study is beneficial for the researchers focusing on Industry 4.0 in manufacturing practices.

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1. Introduction

The challenges in manufacturing firms have become extreme because of globalization and the development of quality prerequisites for their customers. Manufacturers must expand their profitability power with a specific end goal to survive and succeed (Hanelt et al., 2015). Malaysia posted a 4.3 percent growth in the gross domestic product (GDP) in 2019, slowing down from the 4.7 percent logged in 2018. This was the slowest pace in GDP growth since the 2009 global financial crisis (Department of Statistics Malaysia, 2021). The economy, however, remained in expansionary mode though it continued to face downside risks from negative external factors, especially the coronavirus (COVID-19) outbreak in China, given Malaysia's exposure to the country as its biggest trading partner (Huang et al., 2020). Industry 4.0 is changing the way the world of business functions, says Vaidya et al. (2018). The new revolution influences not only just the production but also the way of creating and designing products, processes, and organizations (Atiya and Alkindi, 2017).

Many previous types of research show how sustainable development fits with an unidentified and unique environment. However, there is a lot of importance shown in research relating to sustainability in manufacturing and it focuses more on their business performance (Hong et al., 2012). The reason for continuous research on sustainable manufacturing practices is to identify the best approach to implementing better business performance without harming the environment, people, and economy (Svensson et al., 2018).

Many organizations are using sustainability to differentiate themselves from their competitors. As a result, implementing effective sustainable manufacturing practices can now be a valuable method for gaining a competitive edge and boosting an organization's productivity (Abdul-Rashid et al., 2017). Despite this, there is no empirical evidence in the literature validating a positive relationship between business performance and sustainable manufacturing practices, despite its frequent promotion as an approach to enhancing industry 4.0. Since sustainability practices, business performance, and industry 4.0 are all linked with each other, there is always whether there is a direct positive relationship between all three variables.

As of now, it has been more than a decade since Nordin et al. (2014) pointed out that corporations, particularly manufacturing ones, are increasingly being pressured to reduce the environmental impact of their products and activities. Since then, environmental performance management has emerged as a strategic concern for businesses (Lucato et al., 2017). Further, environment performance also should include in business performances as well. Besides, Sustainable Product and Process Design, Lean Practices, Agile Practices and Customization, Sustainable Supply Operation and Distribution, and Product Returns and Recovery Practices are the direct motivation for companies to engage in sustainable practices, according to (Gupta et al., 2018).

Firms may take action to expect more efficient use of resources and a better corporate image (Ali et al., 2019). Many firms are looking at sustainability to gain a competitive edge, regardless of the motivation. In the existing literature, it is not so clear how much sustainability practices affect business performance and competitive advantage. This is because research in this area has yielded mixed results in several empirical studies, leading to conflicting conclusions. Several studies have found a favorable correlation between sustainable manufacturing practices and business performance (Chege and Wang, 2020; Gupta et al., 2018; Hong et al., 2012; Shahi et al., 2020). The industry 4.0 adoption of manufacturing business and their competitiveness are at the beginning stages and need more research conduct, according to other researchers such as Haseeb et al. (2019), Hubert Backhaus and Nadarajah (2019), Lin et al. (2019), and Telukdarie et al. (2018). The existing literature sends a mixed message to business leaders, policymakers, and other stakeholders interested in implementing industry 4.0 in the manufacturing business (Hervas-Oliver et al., 2019).

There are a variety of reasons given by researchers for the discrepancies in the findings of these empirical studies. First, different research employed different factors used different ways is used to quantify them, and second, given some variables just partially or isolated treatment done which can cause a discrepancy in results. In addition, Tortorella et al. (2019) cited the difficulties in comparing empirical studies because their findings can provide managers and practitioners with a sign of the right balance between the adoption of Industry 4.0 technologies and practices for driving performance improvement within their companies. They added that there is a lack of business performance resulting from industry 4.0 adoption, hence it is legitimate to state that some researchers employ similar methods to describe industry 4.0 in business performance. The inconsistent results of empirical investigations may be because of the lack of a defined theoretical framework to explore the relationships between industry 4.0 and business performance (García and Landeros, 2020).

In this technological era, researchers, economic authorities, and manufacturers are increasingly paying attention to the Fourth Industrial Revolution (Mohamad et al., 2018; Yunus, 2020). To describe this new industrial era of networking machines, intelligent systems and goods, and interconnected solutions, the German 2011 Hannover Fair coined the name, "Industry 4.0" according to Tortorella et al. (2018) and Vaidya et al. (2018). Smart and dynamic manufacturing systems, as well as the mass production of highly customized items, are the goals of Industry 4.0. (Bergström and Venema, 2018). This includes integrating digital elements that monitor and control the physical devices, sensors, information and communication technologies (ICT), and Internet of Things (IoT) applications (Ancarani et al., 2019; Gai et al., 2020). Despite its growing popularity, many businesses are still unsure about how to integrate high-tech techniques from Industry 4.0 into their operations (Cividino et al., 2019). Integration of Industry 4.0 technology into existing industrial management systems is still mostly untested (Tortorella et al., 2019).

An overall lack of technological intensity, limited investment capital, and a lack of human resources may impede the adoption of Industry 4.0 in manufacturing enterprises in underdeveloped economies (Hamzeh et al., 2018). Investing in Industry 4.0 presents unique challenges for emerging economies. Several organizations, like the Federation of Malaysian Manufacturers (FMM) and the Ministry of International Trade and Industry (MITI), have outlined a strategy for the adoption of the Fourth Industrial Revolution (Industry 4.0) in their respective countries (Mohamad et al., 2018). There is still a lack of data on whether Industry 4.0 technology adoption will have a positive impact.

Even if both industries have their unique qualities, it is uncertain whether they can implement them at the same time and produce better results. However, sustainable manufacturing practices imply an underlying business performance in which it turned difficulties and anomalies into opportunities for everyone (Nawanir et al., 2013; Ali et al., 2016; Caldera et al., 2018; Gaikwad and Sunnapwar, 2020). The interconnectivity, data acquisition, and analysis inherent in Industry 4.0 technologies may further reinforce this psychological support for business performance (Haseeb et al., 2019). In addition, sustainable manufacturing practices and Industry 4.0 both favor decentralized frameworks that are basic and straightforward (Sartal et al., 2020). For this reason, sustainable manufacturing practices may conflict with the high levels of capital expenditure and technological skills required by industry 4.0 adoption because it involves daily socio-cultural changes that are encouraged by fast and simple work-floor experiments (Tortorella et al., 2021). Many believe that these incompatibilities will emerge when the emerging economy implements both sustainable manufacturing practices and industry 4.0 strategies, but there is little empirical evidence to support this claim (Tortorella et al., 2021; Tortorella et al., 2018; Tortorella et al., 2019).

2. Literature review and hypothesis development

2.1. Industry 4.0

The fourth industrial revolution encompasses a wide range of technology. To create sets and implementation frameworks, many scholars have attempted to group these ideas (Bag and Pretorius, 2020; Cezarino et al., 2019; Gupta and Palsule-Desai, 2011). While these frameworks and the categorization of Industry 4.0 technologies differ, the latter's overarching goal is to help firms improve their value streams by addressing both process and product/service-related concerns (Dalenogare et al., 2018; Chen et al., 2020). They can automate quality control procedures that take a long time to complete by hand using technology. In order to ease product/service-related challenges, such as inefficiencies that result in delayed production in the market, technologies may also be useful. Because there is still no consensus on which technologies make up Industry 4.0, Soomro et al. (2021) consulted the results of the cross-sector Industry 4.0 survey of 238 manufacturers conducted in Malaysia. Their research output is insightful as it will gauge the ability of non-technology companies as opposed to technology companies towards embracing Industry 4.0, and prove if there are any similar patterns or observations. These technologies are the most likely to be embraced by the Malaysian industry, according to this survey. The adoption of Industry 4.0 may affect organizational models, products, and services technology in the manufacturing sector (Imran et al., 2018; Haseeb et al., 2019). However, some studies on the factor of organizational age and organizational type, from other countries and cultures, to further validate the existing findings (Wahl, 2015; Imran et al., 2018; Borangiu et al., 2019). Therefore, the adoption of industry 4.0 as a mediator should be considered for future studies in manufacturing industries.

2.2. Business performance

Maximizing profits is the main aim of business performance, which considers its shareholders' interests (Gaikwad and Sunnapwar, 2020). When analyzing a company's success, both market and financial indicators are should consider (Nawanir et al., 2013). Financial performance is defined as the degree to which a company accomplishes its profit-oriented outcomes, e.g. return on investment (ROI) and sales returns, and market-valued achievements, such as sales and market expansion. Examples of financial and market performance metrics used by Padavano (2005), Chi et al. (2009) and Kakhki and Palvia (2016) include ROI, return on asset (ROA), and profit margins on sales, and sales growth. Measures for market and financial success are like previous research. Sales and export growth used as examples of the market and financial performance. However, the adoption of industry 4.0 between sustainable manufacturing practices and business performances needs more research conducted because still new in the Malaysian manufacturing context.

2.3. Purpose of the pilot study

The term "pilot study" refers to a smaller study that was undertaken before a bigger one (Chigwendere, 2018). Pilot studies are properly carried out tests conducted on a lesser scale to ensure the proper research. A pilot study, according to Ibrahim et al. (2020), can aid researchers in fine-tuning their data collection strategies depending on both the substance of the data and the applicable methodologies. The primary goal of pilot research is to test the questionnaire. There are several reasons to perform a pilot study: (a) to determine if research instruments are adequate; (b) to determine whether a whole project is workable; (c) to determine whether the research protocol is practicable; and (d) to uncover logistical concerns. gathering preliminary data (e) verifying the sampling frame and procedure are successful (f) setting sample size (g) convincing funding organizations that the big research is practical and worth sponsoring. Pilot studies strongly recommended in the literature because they can uncover potential issues with

sample size, data collecting technique, and sample selection and management and analysis of the results of the pilot research (Ibrahim et al., 2020).

The medical area (TenBarge and Riggins, 2018) had the most published pilot studies, whereas other disciplines (Yew et al., 2019) were severely weak, particularly in business performance for sustainable manufacturing. As a result, they recommended that more pilot studies published in order to disseminate knowledge.

To achieve the following goals, we conducted a pilot study:

- To design a questionnaire that conveys the three primary areas: the influence on corporate performance, sustainable manufacturing methods, and industry 4.0.
- Question reliability and validity should be evaluated.
- A secondary research aim of the pilot project is to address:
- Does the questionnaire's design address the goals?

3. Method

We drew up a plan based on the past study, which you can see in Figure 1. RBV and Natural Resources Based View (NRBV) have integrated into a new model for this investigation.

A single variable (sustainable manufacturing practices) in the model below has the potential to have an influence on business success. The suggested model's performance is its result. Industry 4.0 serves as a moderator in the above concept. Sustainable manufacturing practices and business performance are said to be moderated by the concept of "Industry 4.0." As a result, the model below proposes two constructions.

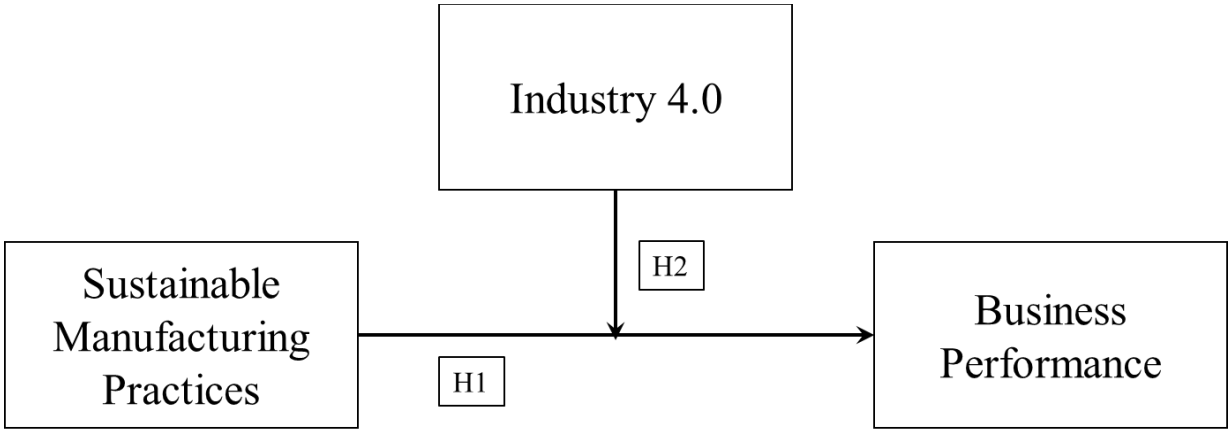

Figure 1. Conceptual framework

Purposive sampling will used to choose participants for this pilot project, which will then analyze the results. Since we wanted data from respondents who were able to supply it, the purposive sampling approach used (Hair et al., 2020). Malaysian manufacturing company owners and managers make up the sample. As a result, we gathered samples for the pilot research from owners and managers of manufacturing companies. Because of this, the participants were Malaysian business owners and managers. The following criteria were used to choose participants: Respondents must be owners of their own firm and managers in the manufacturing industry in order to take part.

A preliminary test preceded the pilot test. During the pre-test, we ask a group of experts and respondents to fill out the questionnaire in order to identify any problems with the instruments or questionnaire design (Zikmund et al., 2013). Pre-testing the questionnaire ensures that the respondents clearly understand the questions they are being asked.. This might

assist the researcher in identifying and correcting any flaws in the questionnaire before distributing it to the intended audience, hence minimizing the likelihood of survey subjectivity (Hair et al., 2020). With the help of three specialists and three students, we could detect an issue with our data gathering tools. A panel of specialists evaluated instrument 4.0's content validity in sustainable manufacturing practices and business performance. Several doctorates panelists in the fields of sustainable manufacturing practices and industry 4.0 for their work in evaluating the questionnaire's content validity in this study. At the time of the evaluation, the institution employed all members of the panel full-time. Members of the panel were required to provide their evaluations of the items and instruments through email. This panel of experts offered their insights and recommendations on the questions' substance in relation to each of the aspects. In addition, the researcher timed students while they completed the draught questionnaire. Finally, the questionnaire reworked based on the comments from those who completed it. We made some changes to the questionnaire after the pre-test. Following the pre-test findings, we updated items to enhance the validity and reliability of both the face and substance of the items.

We derived all of the concepts from already published works of literature. Section A has six questions about grit, whereas the first section asks for basic demographic data. Section B: sustainable manufacturing methods comprised five subsections. For the sake of this section, we'll divide company performance into four subsections. The last component D, which includes 10 questions, focuses on the latest developments in industry 4.0. When conducting the pilot research, the questionnaire included a closed-ended question. Respondents in a closed-ended questionnaire must select from a list of options provided by the researcher. Closed-ended questions are any that use a nominal, ordinal, Likert, or ratio scale (Hair et al., 2020). Respondents benefit from making rapid selections when faced with a variety of options in closed-ended questions. In addition, they make it easier for the researcher to code the data for a later study. The double-barreled inquiry is a type of question that elicits two alternative answers. Such questions will either avoided or deleted. It's best to avoid questions that are unclear, as they might lead to an inaccurate answer.

Respondents asked to identify their level of agreement with statements in the following sections using a five-point Likert Scale (1 = strongly disagree, 5 = strongly agree): Sections B, C, and D. It was important to think about five things while creating the questionnaire for this pilot study: the content, wording, complexity, type/form/sequence/personal data requested from respondents, all of which were all considered when creating the questionnaire. Hair et al. (2020) and Zikmund et al. (2013) urged researchers to make statements/questions brief, and only 20 words per phrase in the current study. The questionnaire items in this study adhere to the above rule of thumb. A further recommendation made by Hair et al. (2020) was that the questionnaire's language and phrasing adjusted to the comprehension level of the survey participants.

Over the course of two weeks, we carried the pilot test out at production facilities. An internet link (Google form) included in emails addressed to manufacturing firm owners, who, in turn, shared it with their supervisors. Detailed information about the study's aim, eligibility requirements, and confidentiality assurances will included in a cover letter that accompanies the online survey. To make sure all of their registered business, owners had received the emails, we also contacted the FMM. In addition, the researcher distributed via social media the online poll. Facebook, Twitter, Telegram, and WhatsApp groups linked to we also uploaded the industrial business with the permission of the administrator. This social media site also belonged to one of the industrial organizations. In addition, we sent a private message to each respondent who is a management in the manufacturing business with the same internet link. First, a follow-up email or message will sent after 7 days, followed by a second email or message after another week, and so on. If you click on the link, you'll be told that answering

the survey's questions is completely up to you and that it'll take you between eight and ten minutes to finish it. If those who got it, and if sent and received a suitable email or text the online survey completed on time, the researcher tested this procedure. The online survey received 116 replies, however, seven questions deleted because they were incomplete or did not meet the pre-requisites. Hence, 109 usable replies from a total population of over 3000 manufacturing companies possibly employed for further study.

4. Results and discussions

We analyzed the 109 data using SPSS software (Statistic Package for the Social Sciences). A frequency test was used to analyze the information provided by the respondents. Most of the participants were mainly male (75.8%) while the female (24.2%). Most of the respondents were in the age group of 51-60 years (52.5%) followed by 41-50 years (22%), 31-40 years (16%), and above 61 years (9.5%). 42% of the respondents were Chinese, followed by Malay (38.8%), Indian (12.1%), and others (7.1%). 40.8% of the respondents were from the central region while 29.6% of respondents were from the southern region and the remaining 29.6% were from other regions including the North, East, and West regions.

We decided that an online survey (Google form) would be the best way to collect data from manufacturing business owners and managers. Reminder emails or messages sent to participants suggested this step is critical in the bigger data-gathering process later. A quick eight to ten-minute time estimate provided via the online survey. As a result, we believe that participants will respond to the survey within the allotted period. In order to eliminate unanswered questions, we did not permit respondents to go on to the following question in the online poll. It's possible that this might help prevent missing data in future studies, as well.

Table 1. Descriptive and reliability results

Construct	Number of items	Cronbach alpha
Sustainable manufacturing practices		
Sustainable product and process design	8	0.888
Lean practices	6	0.901
Agile practices and customization	5	0.838
Sustainable supply operation and distribution	6	0.739
Product returns and recovery practices	6	0.794
Business performance		
Profitability	5	0.815
Sales	8	0.687
Customer satisfaction	6	0.662
Environmental performance	10	0.818
Industry 4.0	10	0.877

According to Hair et al. (2010), reliability defined as a measure of the consistency of one variable regarding another. Reliability is a prerequisite for validity, hence we should evaluate the reliability of any instrument for its suitability for assessing validity (Hair et al., 2020). Cronbach's alpha used in this study to examine the overall consistency of the scale. Statistically, Cronbach's Alpha may examine the dependability of study constructs. In most investigations, an alpha value of 0.7 or above is acceptable. According to Table 1 of this study, most of the constructs have a Cronbach alpha of between 0.662 and 0.990. Cronbach's alpha values for all constructions are more than or equal to 0.650, showing high levels of internal consistency. As a result, it was unnecessary to refine the items in order to improve the reliability of the measurements. Using Cronbach's alpha coefficient, we found the results of this questionnaire to be satisfactory. We show the number of components and Cronbach alpha for all structures in Table 1 above.

5. Conclusion

It is critical to do a pilot study on sustainable manufacturing practices before moving on to the major study of industry 4.0's influence on company performance. We checked the questionnaire for usability and received a high response rate, which proved the validity of the wider inquiry. In addition, the pilot research showed that data collecting was easier with an online survey. Pilot studies are critical to the establishment of best practices in sustainable manufacturing research, and this paper aims to emphasize the value of pilot studies. The instruments' suitability for the main research needed to be validated by owners and managers throughout the pilot study. Finally, the results of this pilot study showed that RBV theory and NBRV theory might be useful research frameworks for gaining access to sustainable manufacturing practices and corporate performance. Pilot studies can enhance research design and contribute to the knowledge base on sustainable manufacturing methods, according to this report.

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