



**THE INVESTIGATION OF ENVIRONMENTAL SUSTAINABILITY  
ON INDUSTRY 4.0 READINESS CONSIDERING MALAYSIA  
CULTURAL PREFERENCE**



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**Faculty of Mechanical and Manufacturing Engineering  
Technology**



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**A thesis submitted  
in fulfillment of the requirements for the degree of  
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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**Faculty of Mechanical and Manufacturing Engineering Technology**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2023**

## DECLARATION

I declare that this thesis entitled “The Investigation of Environmental Sustainability on Industry 4.0 readiness considering Malaysia Cultural Preference” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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## APPROVAL

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Date : 20/01/2023

## DEDICATION

This thesis is dedicated to my dear parents, my supervisor, and all those whose unfailing compassion, wisdom, and support have filled my spirit and motivated me to begin and finish this work.



## ABSTRACT

Greater manufacturing efficiency is made possible by the fourth industrial revolution, often known as Industry 4.0. This revolution will also have a substantial influence on the economic, environmental, and social sustainability of our society. However, adoption of Industry 4.0 is still very limited in developing nations. This research intends to analyse the dynamics of Industry 4.0 adoption in relation to fulfilling sustainability objectives. As a result, a complete strategy is offered to increase productivity and sustainability measures among SMEs via the digital revolution caused by Industry 4.0. A quantitative analysis was done using Structural Equation Modelling (PLS-SEM). The study was based on a simple random sample. The findings reveal that IT resources, managerial leadership, collaboration, and external assistance all have a substantial impact on Industry 4.0 adoption and sustainability. On the other hand, the impact of the pressure from the market is negligible. Additionally, the implementation of Industry 4.0 will have a huge impact on the environment and sustainability. Lastly, Industry 4.0 adoption is the link between all of the success factors of Industry 4.0 and sustainability, except market pressure. This research expands the link between the success criteria and the adoption of Industry 4.0 to include sustainability, and it experimentally supports the mediating influence that Industry 4.0 adoption has between the success elements and sustainability. The findings of the research offer a contribution to the growing body of written material on Industry 4.0 and give useful insights for both policymakers and practitioners. This article provides a synopsis of the Hofstede model of national culture, which consists of six dimensions: power distance, uncertainty avoidance, individualism/collectivism, masculinity/femininity, long-term orientation/short-term orientation, and indulgence/restraint. It demonstrates the conceptual and research work that came before it and led up to it, as well as the research activities that came after it became a paradigm for comparing cultures and expanded on it after it had achieved that status. The article emphasises that dimensions depend on the degree of aggregation; it discusses the six fully separate dimensions revealed in the study on organisational cultures conducted by Hofstede et al. (2010). This should serve as a warning to avoid confusing individual value differences with other types of differences. The discussion comes to a close with a look forward at what the future of research into the many aspects of national cultures and the places where different nations stand in relation to those cultures may hold. As a result, a questionnaire is being distributed as part of this research in order to collect responses from users' perspectives on the significance of environmental sustainability on industry 4.0 preparedness via the lens of Malaysian cultural preferences. After that, the data that was gathered is subjected to an analysis and evaluation with the help of Smart-PLS.

## ABSTRAK

Kecekapan pembuatan yang lebih besar dimungkinkan oleh revolusi perindustrian keempat, sering dikenali sebagai Industri 4.0. Revolusi ini juga akan mempunyai pengaruh yang besar terhadap kemampuan ekonomi, alam sekitar dan sosial masyarakat kita. Walau bagaimanapun, penggunaan Industri 4.0 masih sangat terhad di negara membangun. Penyelidikan ini berhasrat untuk menganalisis dinamik penggunaan Industri 4.0 berhubung dengan memenuhi objektif kemampuan. Hasilnya, strategi lengkap ditawarkan untuk meningkatkan produktiviti dan langkah kemampuan dalam kalangan PKS melalui revolusi digital yang disebabkan oleh Industri 4.0. Analisis kuantitatif dilakukan menggunakan Structural Equation Modelling (PLS-SEM). Kajian ini berdasarkan sampel rawak mudah. Penemuan ini mendedahkan bahawa sumber IT, kepimpinan pengurusan, kerjasama dan bantuan luar semuanya mempunyai kesan yang besar terhadap penerimaan dan kemampuan Industri 4.0. Sebaliknya, kesan tekanan daripada pasaran boleh diabaikan. Selain itu, pelaksanaan Industri 4.0 akan memberi impak yang besar kepada alam sekitar dan kemampuan. Akhir sekali, penggunaan Industri 4.0 adalah penghubung antara semua faktor kejayaan Industri 4.0 dan kemampuan, kecuali tekanan pasaran. Penyelidikan ini memperluaskan hubungan antara kriteria kejayaan dan penggunaan Industri 4.0 untuk memasukkan kemampuan, dan ia secara eksperimen menyokong pengaruh pengantara yang diterima pakai oleh Industri 4.0 antara elemen kejayaan dan kemampuan. Penemuan penyelidikan menawarkan sumbangan kepada badan bahan bertulis yang semakin meningkat mengenai Industri 4.0 dan memberikan pandangan berguna untuk kedua-dua penggubal dasar dan pengamal. Artikel ini menyediakan sinopsis model budaya kebangsaan Hofstede, yang terdiri daripada enam dimensi: jarak kuasa, pengelakan ketidakpastian, individualisme/kolektivisme, maskuliniti/kewanitaan, orientasi jangka panjang/orientasi jangka pendek, dan indulgensi/pengekang. Ia menunjukkan kerja-kerja konsep dan penyelidikan yang datang sebelum dan membawa kepadanya, serta aktiviti penyelidikan yang datang selepas ia menjadi paradigma untuk membandingkan budaya dan mengembangkannya selepas ia mencapai status tersebut. Artikel itu menekankan bahawa dimensi bergantung pada tahap pengagregatan; ia membincangkan enam dimensi berasingan sepenuhnya yang didedahkan dalam kajian mengenai budaya organisasi yang dijalankan oleh Hofstede et al. (2010). Ini harus menjadi amaran untuk mengelak daripada mengelirukan perbezaan nilai individu dengan jenis perbezaan lain. Perbincangan diakhiri dengan melihat ke hadapan tentang masa depan penyelidikan ke dalam banyak aspek budaya kebangsaan dan tempat di mana negara berbeza berdiri berhubung dengan budaya tersebut. Hasilnya, soal selidik sedang diedarkan sebagai sebahagian daripada penyelidikan ini untuk mengumpul maklum balas daripada perspektif pengguna tentang kepentingan kelestarian alam sekitar terhadap kesediaan industri 4.0 melalui lensa keutamaan budaya Malaysia. Selepas itu, data yang dikumpul tertakluk kepada analisis dan penilaian dengan bantuan Smart-PLS.



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## LIST OF SYMBOLS AND ABBREVIATIONS

IR 4.0	-	The Fourth Industrial Revolution 4.0
Industry 4.0	-	Industrial Revolution 4.0
ES	-	Environmental Sustainability
SEM	-	Structural equation modelling
CFA	-	Confirmatory factor analysis
EFA	-	Exploratory factor analysis
CR	-	Composite reliability
Smart-PLS	-	Smart partial least square software
software		
CVSCALE	-	Cultural value scale
CPS	-	Cyber-physical systems
IoT	-	Internet of Things
RQ	-	Research questions
CC	-	Cloud computing
H	-	Hypothesis
HTMT	-	Heterotrait-monotrait
AVE	-	Average variance extracted
SEM	-	Structural equation modelling
PLS	-	Partial least square
KMO	-	Kaiser Meyer Olkin
R2	-	Coefficient of determination; value amount of explained variance of endogenous latent variables in the structural models
EM	-	Expectation maximization
IBM	-	International Business Machines
SMEs	-	Small and medium-sized enterprises
Q2	-	Predictive relevance, to predict model accuracy
q2	-	a measure to assess the relative predictive relevance of a predictor construct on an endogenous construct
VIF	-	Variance inflation factor; quantifies to severity of collinearity

- f2
- among the indicators in formative construct
  - Effect size: a measure to assess the relative impact of predictor construct on an endogenous construct.



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# CHAPTER 1

## INTRODUCTION

### 1.1 Background

In the context of Industry 4.0, environmental sustainability is an essential topic that has garnered a lot of attention. There is no general agreement on whether Industry 4.0 will have a long-term impact on environmental sustainability (Oláh et al., 2020). As a direct consequence of this, this article will investigate research that focuses on characteristics that are notably connected to environmental sustainability. The fourth industrial revolution, also known as Industry 4.0, is a concept that was birthed in German industry (Suleiman et al., 2022). At its foundation, Industry 4.0 is focused on the application of technology to optimise production. Due to pollution, waste disposal, and intensive use of raw materials, knowledge, and energy, the emergence of Industry 4.0 for manufacturing and the technologies that are associated with it, such as the Internet of Things (IoT) and cyber-physical systems, amongst others, has a significant impact on the environmental sustainability of today's businesses (Jayashree et al., 2022).

Nature has an incredible ability to care for itself when left alone. Things change, however, when man enters the scene and utilises many of the natural resources offered by the environment (Schweitzer & Noblet, 2018). Human actions can deplete natural resources, and long-term survival can be jeopardised if environmental sustainability strategies are not used. Environmental sustainability is described as interacting with the environment in a responsible manner to minimise depletion or deterioration of natural resources and to allow for long-term environmental quality (Oláh et al., 2020). Environmental sustainability helps

to guarantee that today population demands are addressed without affecting future generation capacity to satisfy their own.

The future is essential to sustainability. However, there is another scenario in which knowing the future or making predictions about the future necessitates a thorough comprehension of the past. In terms of the environment, population growth and changes in the Earth's temperature provide crucial insights on how our species has survived over time and what its prospects are (Goodland, 2017). In other words, biodiversity and sustainability are unavoidable in our drive to rescue the earth. The extraordinary increase in human population over the last century has caused substantial and hopefully reversible harm the ecosystems all around the planet. As people seek food, shelter, and natural resources, we endanger the delicate balance of animals natural (Goodland, 1995).

## 1.2 Problem Statement

Many attempts have been made in recent years to promote Industry 4.0 in Malaysia. The smart industry system concept, Internet of Things (IoT), and integrated cyber physical systems (CPS) of Industry 4.0 may contribute to the improvement of industrial performances such as reduced lead time of production, increased product quality, effectiveness of quality management system, higher efficiency, and so on. However, the implementation of the industry 4.0 idea is not primarily concerned with the benefits to the industry. Manufacturers must also consider the long-term impact of Industry 4.0, particularly on the environment. According to Liao et al. (2017), industry 4.0 may potentially have a detrimental influence on environmental sustainability. Moreover, the environmental sustainability impact of Industry 4.0 has yet to be assessed (Bonilla., et al 2018). Higher energy use, resource depletion, global warming, and climate change are all possibilities (Tseng et al., 2018). The implementation of Industry 4.0 in one nation may differ from that in another. Different

cultural values, the readiness of current technology, the ability of human resources, and the management structure will all make it difficult for the manufacturing industry to implement the industry 4.0 idea. Furthermore, the notion of industry 4.0 is difficult to accept because it is relatively new in developing countries (Luthra, 2018). As a result, considering cultural value effects as a strategy to identifying environmental sustainability in industry 4.0 can be utilized to address this issue.

Finally, the suggested study will highlight two major issues:

- a) In terms of the environment, Industry 4.0 is still fairly new in developing countries, and the effects on the environment are not well understood, especially in Malaysia.
- b) In terms of cultural value considerations - Distinct nations may have different cultural viewpoints when it comes to industry 4.0. In Malaysia, no research has been conducted to evaluate the effects of cultural value on environmental sustainability impact on industry 4.0.

### 1.3 Research Objective

The main aim of this research is to investigate the environmental sustainability on industry 4.0 readiness considering Malaysia cultural preference. Specifically, the objectives are as follows:

- a) To identify a conceptual framework of cultural value effects on environmental sustainability in readiness for Industry 4.0.
- b) To develop a guideline strategy for assessing environmental sustainability in industry 4.0 readiness based on Malaysian cultural values.
- c) To identify the influence of cultural values on environmental sustainability in Malaysian industry 4.0 readiness.

#### 1.4 Scope of Research Proposal

Concern for environmental sustainability is a vital issue that should be carefully examined for all types of industries, as well as for Industry 4.0. However, it has been discovered in the literature that the evaluation of environmental sustainability in Industry 4.0 preparedness is still ambiguous. This is due to the fact that worry over Industry 4.0 may be regarded differently in each region. Many elements can impact it, including the availability of resources, the quality of human potential, technological capabilities, and the natural context of cultural value. Currently, no study has been conducted to investigate the cultural value impacts on environmental sustainability toward Industry 4.0 readiness, particularly in Malaysia. When companies seek to implement the industry 4.0 system, it is critical that it be undertaken as an approach to understanding the pattern of environmental awareness behaviours and determining relevant solutions. As a result, the purpose of this research is to look at the effects of cultural value on environmental sustainability and industry 4.0 preparedness in Malaysia. This research will investigate the IT sectors as suitable samples. The data will be gathered in two stages: a questionnaire and a semi-structured interview. The partial least squares structural equation modelling technique will be used to analyse the questionnaire data, and content analysis will be used to evaluate the interview data. The flowchart of research activities can be found in Appendix B.