ANTECEDENTS AND OUTCOMES OF GREEN INFORMATION SYSTEMS PRACTICES AMONG MALAYSIAN HIGHER EDUCATION INSTITUTIONS: THE ROLE OF ENTERPRISE RISK MANAGEMENT

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UNIVERSITI SAINS MALAYSIA

2025

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by

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Thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

August 2025

ACKNOWLEDGEMENT

I am immensely grateful to have reached this significant milestone in my academic journey. I would like to express my gratitude and appreciation to all those who have supported and contributed to the completion of my thesis.

First and foremost, I extend my deepest gratitude to my principal supervisor, Professor Dr. Azlan Bin Amran and co-supervisor, Assoc. Prof. Ts. Dr. Teoh Ai Ping for their invaluable guidance, expertise, and encouragement throughout this journey. Their dedication to academic excellence has been a constant source of inspiration. Their insightful feedback, constructive criticism, and patient mentoring have been instrumental in shaping the quality and depth of this thesis.

I am thankful to the lecturers and faculty members of Graduate School of Business, USM for providing me with an enriching academic environment and offering resources for research and learning. I am also grateful to the external examiner and internal examiners. Their extensive knowledge and expertise in the field have been crucial in shaping this study.

Last but not least, I would like to express my gratitude to my family and friends. My heartfelt thanks go to my dearest mother, Mrs. Yeoh Sock Kheng and my sister, Ms. Khaw Tze Shuang, thanks for their unconditional love, support, and understanding. Their belief in my abilities, understanding during times of stress, and words of encouragement have given me the strength and motivation to overcome challenges during my research journey.

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LIST OF SYMBOLS

$\pm$	Plus Minus
$<$	Less Than
$>$	More Than
$\rightarrow$	Relationship
$\leq$	Less Than or Equal to
$\geq$	More Than or Equal to
f^2	Effect Size
R^2	Coefficient of Determination
α	Alpha
β	Beta

LIST OF ABBREVIATIONS

BDA	Big Data Analytics
BAO	Belief-Action-Outcome
CMB	Common Method Bias
CMV	Common Method Variance
ERM	Enterprise Risk Management
ERP	Enterprise Resource Planning
GDP	Gross Domestic Product
GIS	Green Information Systems
GIT	Green Information Technology
HEIs	Higher Education Institutions
HTMT	Heterotrait-Monotrait
ICT	Information and Communication Technologies
IS	Information Systems
IT	Information Technology
LM	Linear Regression Model
MSMEs	Micro, Small, and Medium Enterprises
PLS-SEM	Partial Least Squares-Structural Equation Modeling
RBV	Resource-Based View
RFID	Radio Frequency Identification
RMSE	Root Mean Square Error
SDGs	Sustainable Development Goals
SMEs	Small and Medium-Sized Enterprises
SMMEs	Small, Medium and Micro-sized Enterprises
SPSS	Statistical Package for the Social Sciences
TAM	Technology Acceptance Model
TEIs	Technical Education Institutes
TMS	Top Management Support
TOE	Technology-Organization-Environment
TPB	Theory of Planned Behavior
UTAUT	Unified Theory of Acceptance and Use of Technology

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ANTESEDEN DAN HASIL AMALAN SISTEM MAKLUMAT HIJAU DALAM KALANGAN INSTITUSI PENDIDIKAN TINGGI MALAYSIA: PERANAN PENGURUSAN RISIKO PERUSAHAAN

ABSTRAK

Amalan sistem maklumat hijau (GIS) adalah penting bagi institusi pendidikan tinggi (IPT) untuk mencapai pengurangan kos, inovasi kelestarian, dan kelebihan daya saing sambil mengurangkan kesan negatif alam sekitar yang berkaitan dengan aktiviti teknologi maklumat, seperti pelepasan karbon dan penggunaan tenaga. Amalan hijau dalam IPT juga meningkatkan reputasi intitusi, menarik lebih ramai pelajar antarabangsa, dan mencapai kelestarian. Walau bagaimanapun, mencapai kelestarian melalui amalan hijau dalam IPT Malaysia masih mencabar disebabkan faktor teknologi, organisasi, dan persekitaran (TOE). Selain itu, terdapat kekurangan bukti penyelidikan mengenai hasil prestasi kelestarian (prestasi alam sekitar, prestasi sosial, dan prestasi ekonomi) daripada amalan GIS dalam industri pendidikan tinggi Malaysia, yang memerlukan penilaian empirikal. Untuk menangani isu-isu ini, kajian ini mengenal pasti faktor-faktor yang mempengaruhi amalan GIS di IPT Malaysia, dengan memberi tumpuan kepada factor TOE. Kajian ini juga menilai hasil prestasi kelestarian amalan GIS. Selain itu, IPT beroperasi dalam persekitaran yang dicirikan oleh ketidakpastian dan risiko. Oleh itu, peranan pengurusan risiko perusahaan (ERM) sebagai pembolehubah moderator antara amalan GIS dan hasil prestasi kelestarian turut dikaji. Kajian ini menggunakan soal selidik dalam talian untuk mengumpul data daripada 166 IPT di Malaysia. Kaedah pemodelan persamaan struktur kecil kuasa (PLS-SEM) digunakan untuk menganalisis hubungan yang dihipotesiskan. Hasil kajian menunjukkan bahawa amalan GIS dipengaruhi oleh keserasian, keperluan keselamatan (faktor-faktor teknologi), kesediaan organisasi, sokongan pengurusan atasan, kemampuan pekerja (faktor-faktor organisasi), sokongan kerajaan, dan tekanan persaingan (faktor-faktor persekitaran). Selain itu, amalan GIS dengan ketara meningkatkan hasil prestasi kelestarian (prestasi alam sekitar, sosial, dan ekonomi) IPT Malaysia. ERM mengukuhkan hubungan antara amalan GIS dan prestasi ekonomi. Kajian ini menyumbang kepada teori dengan memperkenalkan model bersepadu TOE-RBV bagi amalan GIS yang mengkontekstualisasikan anteseden dan hasil secara unik dalam IPT. Model novel ini mengembangkan rangka kerja TOE dengan ERM sebagai pembolehubah moderator, serta mengoperasionalkan hasil prestasi kelestarian yang disesuaikan untuk sektor pendidikan tinggi. Kajian ini memberikan wawasan berharga kepada penggubal dasar, pemimpin akademik, dan pengamal untuk memperkukuh sokongan pengurusan tertinggi bagi memecut amalan GIS serta melaksanakan amalan GIS secara berkesan dalam sektor pendidikan tinggi.

ANTECEDENTS AND OUTCOMES OF GREEN INFORMATION SYSTEMS PRACTICES AMONG MALAYSIAN HIGHER EDUCATION INSTITUTIONS: THE ROLE OF ENTERPRISE RISK MANAGEMENT

ABSTRACT

Green information systems (GIS) practices are essential for higher education institutions (HEIs) to achieve cost reduction, sustainability innovation, and competitive advantages while mitigating the negative environmental impacts associated with information technology activities, such as carbon emissions and energy consumption. Embracing green practices in HEIs also enhances institutional reputation, attracts more international students, and promotes sustainability. However, achieving sustainability through green practices in Malaysian HEIs remains challenging due to a combination of technological, organizational, and environmental (TOE) factors. Moreover, there is a lack of research evidence concerning the sustainable performance outcomes (environmental performance, social performance, and economic performance) of GIS practices in the Malaysian higher education industry, necessitating empirical evaluation. To address these issues, this study investigated the antecedents influencing GIS practices in Malaysian HEIs across TOE factors. It also examined the sustainable performance outcomes of GIS practices. Additionally, HEIs operate within an environment characterized by uncertainties and risks. Thus, the role of enterprise risk management (ERM) as a moderator between GIS practices and sustainable performance outcomes was examined. The study utilized an online survey questionnaire to gather data from 166 HEIs in Malaysia. It employed partial least squares structural equation modeling (PLS-SEM) to analyze the hypothesized relationships. The results indicated that GIS practices were influenced by compatibility, security concerns (environmental factors), organizational readiness, top management support, employee capability (organizational factors), government support, and competitive pressure (environmental factors). Moreover, GIS practices significantly improved the sustainable performance outcomes (environmental, social, and economic performance) of Malaysian HEIs. The findings also suggested that ERM strengthened the relationship between GIS practices and economic performance. This study contributes to theory by introducing an integrated TOE–RBV model of GIS practices that uniquely contextualizes adoption and outcomes within HEIs. The novel model extends the TOE framework with ERM as a moderating mechanism, and it operationalizes sustainable performance outcomes tailored to the higher education sector. It offered valuable insights for policymakers, academic leaders, and practitioners to strengthen top management support to accelerate GIS practices and effectively implement GIS practices within the higher education sector.

CHAPTER 1

INTRODUCTION

1.1 Chapter Introduction

This chapter provides a comprehensive background that outlines the research study. Subsequently, the problem statement presents the main issues that occur in the higher education industry and addresses the needs for conducting this study. The research design is driven by the research objectives and questions. Additionally, the significance of this study is underscored, highlighting its valuable contributions to both academic knowledge and practical application. Key terms used throughout are defined for clarity. Lastly, the organization of the thesis is outlined in detail.

1.2 Research Background

The IS/IT industry, while significantly contributing to economic and social well-being, has faced criticism for its negative environmental impact (Dwivedi et al., 2022). Technological advancements have been found to substantially increase greenhouse gas emissions (He et al., 2022). All the countries, including developed nations bear the responsibility to discover solutions for the problems they have caused, with a particular emphasis on responsible digitalization to foster sustainable change (Dwivedi et al., 2022). Malaysia has accepted the Paris Climate Agreement and prioritized funding in the Eleventh (2016-2020) and Twelfth (2021-2025) Malaysia Plans to achieve the goal of reducing carbon emissions (Ministry of Economy, 2021), aiming to decrease carbon intensity per unit of economic output by 45% by 2030 and attain net-zero greenhouse gas emissions by 2050 (Hishan et al., 2024; Iskandar, 2023).

Due to the urgent need to tackle environmental concerns associated with climate change and global warming, sustainability is continuously evolving on the global agenda (Anthony Jnr et al., 2019a). To improve workplace conditions and overall industry productivity, there is a need for technological innovation that is both efficient and environmentally friendly, particularly in emerging economies to achieve sustainable development goals (SDGs) (Habiba et al., 2023; Song & Wang, 2018). Incorporating cutting-edge technology and renewable energy sources in developing nations can reduce the negative consequences associated with financial inclusion and reduce ecological footprint (Saqib et al., 2023).

Malaysia's Secretary General Minister of Environment and Water highlighted that to attain environmental sustainability and strengthen climate resilience, more environmentally friendly technologies and systems should be used (Suhaidi, 2022). The experts also highlight the crucial need for decision-makers to recognize green IT/IS to effectively achieve net zero emissions by 2050 as technology becomes increasingly embedded in our daily lives (Dwivedi et al., 2022). As a result, companies in Malaysia, including higher education institutions (hereafter HEIs), are increasingly looking for methods to gain a competitive edge through greening initiatives and innovations, including green information systems practices (Nanath & Pillai, 2017).

1.2.1 The Crucial Roles of the Higher Education Sector

The sharp rise in tertiary education enrolment demonstrates the expanding significance of the higher education market globally. In 2023, this market was valued at USD736.80 billion and is expected to generate USD1569.37 billion by 2030, with an annual growth rate of 12.1% driven by increasing demand (Grand View Research, 2024). The impact of the higher education sector extends beyond academia, making it an essential contributor to the global economy.

The curriculum for higher education is continually improved by HEIs to educate students and provide them with work experience, thereby creating a skilled workforce for a competitive labour market and advancing a country’s economic development (Lin, 2004; Maneejuk & Yamaka, 2021). HEIs are centres for innovation and entrepreneurship, fostering creation of new goods, services, and technologies that boost competitiveness (Kandakatla et al., 2021; Mok, 2012). Partnerships between universities and companies for research have also grown, developing human capital, and directly impacting a country’s economic development (Jonbekova et al., 2025; Scandura, 2016; Valero & Van Reenen, 2018).

HEIs contribute to sustainable development and climate change education by promoting diversity, critical thinking, ethical responsibility, and civic engagement (Alfirević et al., 2023; Dryjanska et al., 2022; Rushton & Walshe, 2025; Sengupta et al., 2020). By integrating sustainability into education, research, and institutional practices, HEIs exemplify and promote sustainable behaviors, fostering environmental stewardship among future leaders (Platitsa et al., 2024; Purcell et al., 2019). HEIs disseminate knowledge, shape future generation, and train professionals for a sustainable future (Mendes et al., 2025; Žalėnienė & Pereira, 2021). Their support for lifelong learning (UNESCO, 2023) are vital for societal and economic advancement.

HEIs are seen as important agents of change in achieving SDGs. Smart campuses initiatives, such as enhancing educational technologies for innovative classroom models and the efficient management of campus infrastructure, primarily support SDG 4 and SDG 9 (Dalla Gasperina et al., 2022). Decarbonization efforts of a campus to combat climate change align with the SDG 13 (da Silva et al., 2023). The incorporation of energy consumption and renewable energy sources for NetZero buildings can decrease emissions and enhance cost efficiency, contributing to SDG 7 (Matana Júnior et al., 2023). HEIs have an obligation to implement sustainable practices, teach sustainability-related skills, and raise awareness about sustainable development and green practices to achieve SDGs (Matana Júnior et al., 2023). By promoting sustainability, integrating it into curricula and operations, and encouraging environmentally responsible behaviours among students and staff, HEIs equip future leaders to tackle global sustainability challenges (Purcell et al., 2019).

1.2.2 Overview of Higher Education Institutions (HEIs) in Malaysia

The Ministry of Higher Education Official Portal (2020) presented the Malaysia Education Blueprint 2015-2025 for Higher Education as an initiative aimed at transforming the higher education system in Malaysia. Malaysia is actively advancing its higher education sector to establish itself as a premier international education hub in Southeast Asia. This vision was outlined by the Ministry of Higher Education in 2007 under the National Higher Education Strategic Plan (Knight, 2024).

However, it is important to highlight that the number of HEIs in Malaysia has decreased drastically since the year 2000, from 747 to 543 in year 2025 (Table 1.1). According to the Malaysia Ministry of Higher Education Official Portal (2024a), the number of enrolled students declined significantly from 1.346 million in 2016 to 1.247 million in 2023. Furthermore, from a peak of 103,198 in 2017, the number of international student enrolment dropped to 58,063 by 2021 (Katherine, 2023).

Table 1.1 Number of Higher Education Institutions in Malaysia (2000-2025)

	Type of Institutions	2000	2005	2010	2020	2021	2022	2023	2024	2025
Public	Public University	11	12	20	20	20	20	20	20	20
	Polytechnic	11	20	25	36	36	36	36	36	36
	Community College	105	105	105	105	105	105	105	105	105
	Sub-total:	107	137	150	161	161	161	161	161	161
Private	Private University	5	11	23	54	51	53	56	62	64
	Private University College	0	11	21	37	39	39	34	32	36
	Foreign Branch Campus	3	5	5	10	10	10	10	10	11
	Private College	632	532	470	342	335	332	316	284	271
	Sub-total:	640	559	519	443	435	434	416	388	382
	Overall total HEIs:	747	696	669	604	596	595	577	549	543

Source: Ministry of Higher Education Official Portal (2025)

HEIs in Malaysia, as well as in China, Korea, and Singapore, are facing increased competition for students from countries like Australia and Japan (Ministry of Higher Education Official Portal, 2020). Factors such as the COVID-19 pandemic significantly impacted international student enrolment in Malaysia due to travel restrictions and concerns related to exams and lessons (Michael et al., 2021; Nathan, 2023). The pandemic has accelerated progress in the digitalization of higher education, including the shift to distance education, online learning, and remote work.

To address the challenges brought about by the pandemic, universities are recognizing the necessity of integrating technological innovation into education beyond conventional methods. The new era of learning involves a combination of traditional and online methods, utilizing global collaboration platforms and new teaching and learning techniques to increase engagement and promote deep learning (Ministry of Higher Education, 2022). Malaysian HEIs are also expected to play a vital role in adapting and developing innovative technology approaches to meet economic and social demands and advance towards internationalization (Suguku, 2023).

However, some institutions are hesitant to adapt to this rapidly evolving landscape. Elderly faculty members from some HEIs exhibited hesitancy in transitioning to e-learning platforms due to their discomfort and reluctance towards this new method of teaching (Qazi et al., 2024). Furthermore, many HEIs are ill-prepared to embrace uncertainties, have been forced to reduce their budgets, face financial constraints in enhancing their infrastructure, and lack of understanding of how e-learning settings operate (Babulal & Solhi, 2020; Makina, 2016).

To drive the transformation of higher education through technology, the Ministry of Higher Education Malaysia actively promotes digitalization in HEIs. A fund of RM35 million was allocated by the Malaysian government to enhance Internet accessibility in Malaysian universities (Koshi, 2023). Malaysia's Secretary General Minister of Environment and Water stated that Malaysia must embrace the ecological philosophy concerning environmental policy and systemic solutions to create a greener ecosystem (Suhaidi, 2022). At the same time, Rosak-Szyrocka and Tiwari (2023) highlighted the growing importance of sustainability and environmental factors for international students when choosing a study destination. A group of international students has also expressed their desire for universities to become more environmentally friendly (Bothwell, 2021; University World News, 2019). They are calling on universities to prioritize sustainability by implementing eco-friendly practices and reducing their carbon footprint. In addition, according to Times Higher Education (2023), the sustainability credentials of a university have become a crucial factor for students when deciding which institution to enrol in. Saleh et al. (2021) conducted a case study in Malaysia, revealing that sustainability can be utilized as a branding tool for universities to promote their commitment to environmental and social responsibility as well as enhance their reputation to attract more environmentally and socially conscious students. With a strong emphasis on environmental initiatives, universities have a chance to enhance their sustainability reputation, achieve substantial savings in both costs and time, as well as producing graduates who are responsible and active in ensuring sustainable development (Anthony Jnr et al., 2019a; Trevisan et al., 2024).

Tariq et al. (2021) confirmed that environmentally-friendly actions by HEIs positively influence students' attitudes toward environmental issues. Identifying emissions and quantifying carbon footprints raise environmental awareness among students and the community (Valls-Val & Bovea, 2021). Environmental knowledge fosters pro-environmental attitudes and behaviors, motivating HEIs to lead in sustainability practices and inspire green practices among students, staff, and society (Mendes et al., 2025; Žalėnienė & Pereira, 2021). The integration of green-sustainable digital transformation upholds students' leadership in sustainable, creative innovation, and Industry 5.0 literacy (Mohamed Hashim et al., 2024). Hence, Malaysian HEIs are pivotal in advancing green initiatives, especially GIS practices, for a sustainable future.

1.2.3 Green Information Systems Practices

The ICT sector's carbon emissions have increased significantly, with its development driving a tenfold increase over time (Ma et al., 2025). Microsoft reported a nearly 30% increase in its CO_2 emissions, while Google's greenhouse gas emissions in 2023 were 50% higher than in 2019, due to the rising energy demands of its data centres (Kemene et al., 2024). By 2030, data centres are projected to account for 13% of global electricity consumption (Gupta & Gupta, 2025). Acknowledging the environmental impact of digital technologies, global forums such as the World Economic Forum, Asia-Pacific Economic Cooperation (APEC) Summit, and the 2015 United Nations Climate Change Conference have prioritized addressing the negative effects of information systems (IS) (Singh & Sahu, 2020). Green information systems (GIS) are considered as a partial solution for various environmental challenges (Dedrick, 2010). GIS reduce the carbon footprint of organizations and society to achieve environmental sustainability (Singh & Sahu, 2020).

The interplay between information technology (IT) and environmental concerns encompassing both primary and secondary effects (Basaglia et al., 2009). Primary effects pertain to the direct environmental consequences stemming from the production, utilization, and disposal of IT resources (Berthon & Donnellan, 2010). IT encompasses components such as computer hardware, software, and peripheral devices (Ijab et al., 2010). Efforts to address the adverse consequences have led to the emergence of green IT (GIT), aimed at reducing the environmental footprint associated with IT operations (Ali et al., 2021b). Murugesan (2008) defines GIT as the systematic approach to the development, utilization, and disposal of computer systems, servers, and their related components with a primary focus on reducing environmental impact.

Secondary effects describe the indirectly influence of IT on the environment through changes in behaviours and processes. It involves the use of information systems (IS) to improve the ecological sustainability of organizations and communities, termed green information systems (GIS) (Gholami et al., 2013). IS extend beyond IT components like physical servers, computers, network peripherals, and shared services (like databases or storage). They also include business applications (like management software and customer relationship management systems), the human resources aspect of IT including skills and knowledge, and managerial capabilities related to IS, which are crucial for organizational processes and facilitating business transformation (Loeser et al., 2017). GIS involves the strategic utilization and advancement of IS to support environmental sustainability efforts, thereby promoting sustainable business practices (Jenkin et al., 2011b; Watson et al., 2010). Specifically, GIS encompasses both “Greening of IT”, which involves developing and utilizing green IT products, and “Greening by IT”, which leverages IT infrastructure to optimize organizational processes and practices (Singh & Sahu, 2020), aiming to enhance energy efficiency, minimize environmental impacts, and develop more environmentally friendly products and services (Brooks et al., 2012).

Organizations striving to reduce their environmental footprint typically incorporate both GIT and GIS practices (Loeser et al., 2017). This integration is crucial because GIT practices alone, like energy-efficient server and cloud solutions, confine the environmental benefits within the IT function and fail to capitalize on the broader potential of IS to address enterprise-wide environmental and social impacts. Scholarly articles explore the strategic integration of GIT and GIS practices within organizations (Anthony et al., 2018; Loeser et al., 2017; Nanath & Pillai, 2017; Raisinghani & Idemudia, 2019). GIT is regarded a subset of the broader GIS, suggesting that GIS encompasses the fundamental principles of GIT (Watson et al., 2010).

The integration of GIS within organizations revolves around leveraging technological solutions to streamline operations, thereby promoting energy efficiency, material conservation, and the reduction of waste generation (Anthony, 2019). Dell Inc. designs its products to be energy efficient, manufactures products made of recycled materials, innovates green packaging, and provides trade-in and recycling services for old electronics to create new products (Jeevan & Bhargav, 2016). Apple employs 100% renewable energy to power all the companies, retail outlets, and data centres, and designs its products with energy efficiency in mind (Apple, 2023; Bhat & Bhardwaj, 2025). For client devices, Intel has achieved a 70% reduction in energy consumption per user by transitioning from desktops to low-power laptops, equipped with energy-efficient solid-state drives (SSDs) instead of traditional hard drives (Curry et al., 2012). Moreover, Intel extensively utilizes collaboration technologies like videoconferencing to minimize the necessity for travel (Curry et al., 2012). Similarly, Microsoft encourages its employees to use virtual meetings rather than travel for business (Magas, 2021). Teleconferencing and video conferencing help to reduce travel-related emissions and increase the productivity of employees when a healthier work-life balance is achieved (Coroama et al., 2012; Lakshmi et al., 2017). In recent times, there has also been a notable surge in the demand for enhanced energy efficiency within data centres (Katal et al., 2023). Data centres produce heat that necessitates cooling, and the equipment needed for this cooling can consume a substantial amount of power (Curry et al., 2012). Alibaba Group, a leader in China's cloud computing sector, utilizes cutting-edge AI-driven technologies to manage its cooling systems. It employs advanced techniques such as immersed liquid cooling and incorporates green energy and natural cooling solutions in its power supply systems (Lin et al., 2024). Green data centres aim to achieve high power usage effectiveness, significantly reducing energy consumption, cutting costs, lowering greenhouse gas emissions, and minimizing environmental impact (Uddin & Rahman, 2011). GIS practices are crucial in mitigating the carbon footprints associated with organizational operations and safeguarding the environment through the adoption of IT/IS practices with minimal or no adverse impacts (Mat Nawi et al., 2024; Singh & Sahu, 2020).

In Malaysia, the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) in Malaysia established the Malaysian Green Technology and Climate Change Corporation (MGTC) to drive green growth, promote climate change mitigation, and encourage the adoption of sustainable practices across all economic sectors (MGTC, 2023). The National Green Technology Policy includes strategies to enhance public awareness of ICT advancements (Ramli et al., 2021) and promote green consumerism (Surianshah et al., 2025). The Malaysian government also developed various programs and incentives, such as the Green Technology Financing Scheme (GTFS) and green technology initiatives incentives (Mohlis et al., 2020). In 2023, the Malaysian government further promoted green technology by increasing the financing scheme to RM3 billion until 2025 for businesses (Niresh, 2023). Besides offering RM2 billion in funds to start-ups and small and medium-sized businesses that implement green practices, they prolong the Green Investment Tax Allowance (GITA) and Green Income Tax Exemption (GITE) from three years to five years (Nor Ain et al., 2023).

1.2.4 Green Information Systems Practices in Higher Education Institutions

GIS practices are closely aligned with the fundamental principles of GIT (Watson et al., 2010). Patón-Romero et al. (2021) carried out a multi-case study across Colombian, Mexican, and Spanish universities, revealing that GIS incorporates various aspects of GIT management into decision-making processes. Including insights from different GIT areas in managerial decisions is a key part of GIS practices (Mines, 2008). GIS practices are essential for HEIs to achieve cost reduction, sustainability innovation, competitive advantages, and enhanced corporate reputation while mitigating the negative environmental impacts associated with IT activities, such as carbon emissions and energy consumption (Anthony Jnr, 2020; Gholami et al., 2013; Loeser et al., 2017; Nanath & Pillai, 2017).

The Malaysian Higher Education Action Plan 2022-2025 emphasizes integrating technology within HEIs to enhance the quality of course offerings and increase access to global-class education. Times Higher Education (2023) suggested several information technologies and systems for HEIs, such as cloud computing, remote working, and desktop virtualization, to support sustainable development. HEIs are increasingly gaining awareness of the importance of sustainable development, and this drives the adoption of GIS practices (Suryawanshi & Narkhede, 2015).

Hernandez (2019) noted a growing trend in HEIs towards consolidating and virtualizing IT equipment and systems. The concept of desktop virtualization enables the sharing of resources through the use of thin client devices. Cloud-based desktop virtualization reduces energy consumption and infrastructure costs compared to individual physical desktops while also decreasing electronic waste (Agarwal et al., 2014; Erskine & Füstös, 2013). It enables convenient access to and seamless sharing of files across various mobile and desktop devices, contributing to reduced paper usage and printing requirements (Bolton et al., 2017). Furthermore, a study by Suryawanshi and Narkhede (2013) within HEIs discovered that consolidating printers plays a significant role in reducing paper consumption and streamlining IT infrastructure, thereby reducing the carbon footprint and increasing energy savings.

Okai et al. (2014) stressed the significance of cloud computing as a priority in developing environmentally friendly IT infrastructure. GIT for cloud-based sustainable learning environments offers capabilities such as maintaining digital journals, accessing online services, and facilitating online communication (Vakaliuk et al., 2020). Cloud computing reduces the number of active machines needed, optimizes resource utilization, and consumes less electricity per service provided compared to traditional server setups (Di Salvo et al., 2017; Turek et al., 2021). It significantly minimizes energy consumption and carbon emissions by utilizing energy-efficient data centres powered by renewable sources, free cooling systems, and waste heat recovery techniques (Di Salvo et al., 2017; Turek et al., 2021). Cloud computing also facilitates extensive applications in organizing remote work and telecommuting, thereby decreasing the necessity for employees to commute to physical workplaces and consequently lowering carbon dioxide emissions (Turek et al., 2021).

HEIs have significantly advanced the integration of Information and Communication Technologies (ICT), particularly e-learning, to support and enrich the learning experience, both on and off campus (Lin et al., 2012). E-learning, as an example of GIS, has profoundly transformed the educational landscape while concurrently diminishing paper usage, thereby contributing to a reduction in overall carbon footprint (Agarwal et al., 2013). The energy consumption rate in the e-learning system in Malaysia, as influenced by green computing, experienced a notable reduction of approximately 30% in energy consumption (Ullah et al., 2017). Online teaching and learning have become a trend, and the potential for students to learn from anywhere could lead to reduced carbon emissions from commuting.

As electronic waste (e-waste) releases hazardous substances and greenhouse gases, it poses threats to occupational safety, public health, and the environment (Ahirwar & Tripathi, 2021), HEIs have shown increased attention to the responsible management of e-waste, emphasizing disposal, recycling, and reuse options (Alazaiza et al., 2024; Hernandez, 2019; Saldaña-Durán & Messina-Fernández, 2021). For example, Gomes et al. (2017) highlighted the promotion of e-waste donation within the HEIs for refurbishment and recycling purposes. A UK-based university has implemented a responsible e-waste disposal approach by allowing suppliers to collect e-waste (Chai-Arayalert & Nakata, 2011). The Green Initiatives Team was established by University of North Carolina to address the increasing challenges related to e-waste and other sustainability requirements (Shea et al., 2017). These initiatives encourage employees and students to actively participate in managing the generated e-waste (Alazaiza et al., 2024; Hernandez, 2019). Recovering and reusing valuable materials from e-waste for renewable energy technologies addresses resource scarcity and reduces environmental impact from non-renewable energy reliance (Seif et al., 2024).

In the United States, the University of Michigan emphasizes best GIS practices on campus, encompassing student and staff awareness, energy consumption management, use of energy-efficient devices, server virtualization, and data centre consolidation (Stuenkel, 2009). University of Arizona and Hampshire College are actively engaged in green computing initiatives (Tarraya et al., 2025). Stanford University collaborates with scientists to create innovative green energy solutions like advanced batteries and solar panels (Engel, 2015). UK HEIs advocate for green ICT applications to support remote work and enable the transition to online education

(Chai-Arayalert & Nakata, 2011). Reducing travel helps to reduce carbon footprint. HEIs in the Philippines have digitized work procedures, employing electronic approval systems and payment processing for real-time information access (Hernandez, 2018).

According to Patón-Romero et al.'s (2021) study, the Colombian University procures IT equipment that meets Energy Star standards for energy efficiency, implements automatic shutdown procedures for computers, and optimizes screen brightness settings to minimize energy consumption. The Mexican University's green initiatives include using recycled paper for printing and photocopying, establishing protocols for proper disposal of computer equipment, and striving to reuse hardware from obsolete equipment (Patón-Romero et al., 2021). Additionally, it embraces digital solutions for administrative tasks, issuing digital documents, certificates, vouchers, and using electronic registration and presentation of academic theses. The Spanish University recycles unused electronic and electrical material, centralized printing service to reduce printer usage, and employs print monitoring software that requires double confirmation before printing (Patón-Romero et al., 2021). It also ensures automatic shutdown of computers and performs IT maintenance remotely.

In Malaysian HEIs, GIS practices is being utilized to embed sustainability initiatives such as digital learning, curriculum development, research, operations, and community engagement (Goni et al., 2017; Kumar et al., 2020). The ICT office in some government HEIs have embraced laptops for note-taking during meetings and brainstorming sessions, significantly reducing paper usage, and promoting a more sustainable workplace (Anthony Jnr et al., 2019b). At Universiti Utara Malaysia, GIS practices encompass energy conservation, paperless procedures, and recycling initiatives. Universiti Teknologi Malaysia has actively involved Green Managers to oversee programs focused on sustainable meetings, paper conservation, and recycling practices, aimed at optimizing the green office initiative (Zen et al., 2016). Alongside introducing a green office program to promote sustainable development, Universiti Sains Malaysia has incorporated sustainable GIS infrastructures, utilizing e-learning and online quizzes as well as other high-technology tools to enhance students learning (Nasruddin et al., 2012; Rahim, 2024). Universiti Malaya has focused on energy-efficient measures, include smart building systems and replacing traditional lights with LEDs, to reduce greenhouse gas emissions (Muhiddin et al., 2023). Telecommuting has become an alternative work arrangement in International Islamic University Malaysia with the extensive development of telecommunication infrastructures (Ismail et al., 2016). E-waste management has also been implemented in Universiti Teknologi MARA (Mohamed Nazree et al., 2022). Despite these efforts, Malaysian HEIs still encounter obstacles in fully incorporating GIS practices into their operations, indicating the need for further progress in this area (Anthony Jnr, 2021).

1.2.5 Factors Affecting Green Information Systems Practices

Technological challenges such as insufficient ICT infrastructure, limited connectivity, and unstable power supply prevent African HEIs from adopting online teaching and learning (Mugimu, 2021). Malaysian Investment Development Authority (2021) stressed the importance of having sufficient hardware and high-speed internet access for e-learning systems to be effective. Besides that, users' security and privacy concerns about technologies are the challenges in the digital age (Romansky & Noninska, 2020; Waqar et al., 2023). The emergence of technology security and privacy issues has disrupted the adoption of digital technologies (Quach et al., 2022).

Organizational challenges, including rules and strategies, significantly impact GIS practices (Kirchner-Krath et al., 2024). Strategically adopting eco-innovation practices promotes environmentally friendly policies (Ning et al., 2022). The absence of GIT experts hinders GIT practices, necessitating the establishment of expert teams (Ab Rahim & Samuri, 2018). In Malaysia, the perception of IT professionals plays a pivotal role in influencing GIS implementation (Anthony, 2019). Factors such as insufficient human resources, inadequate technical knowledge, poor planning and strategic management skills (Hamdan et al., 2016), and insufficient awareness and understanding of the importance of GIT and GIS (Ab Rahim & Samuri, 2018; Ahmad et al., 2014; Kirchner-Krath et al., 2024) are organizational factors affecting GIS implementation.

Environmental factors significantly influence GIS practices in diverse business sectors, driving technological advancements. The business technological environment has transformed how organizations operate (Tushman & Anderson, 2018), replacing traditional data storage methods like registers and files with data servers and cloud technology. Additionally, climate change issues have influenced business operations and policies (Polonsky et al., 2011), necessitating preparedness to manage climate risks and the adoption of sustainable practices to mitigate climate impacts. Government policies have been implemented in China and they are found to have a significant direct influence on green technology innovation (Wu et al., 2022).

The incorporation of technological advancements in Malaysia’s digital transformation journey faces several challenges. Based on prior technology-adoption-related studies conducted in Malaysia, technological factors including technology complexity (Shanmugam & Shanmugam, 2021), compatibility (Roszelan & Shahrom, 2025), relative advantage (Roszelan & Shahrom, 2025; Ngah et al., 2022), security concerns (Romansky & Noninska, 2020; Waqar et al., 2023); organizational factors such as top management support, employee knowledge (Hassan, 2017), organizational readiness (Ngah et al., 2022), organizational planning and strategic management

(Hamdan et al., 2016); and environmental factors including competitive pressure, regulatory support and issues (Roszelan & Shahrom, 2025; Ramli et al., 2021) and governance support (Zailani et al., 2014) are found to be the factors affecting technology implementation in Malaysia.

Within the higher education context, Woldu et al.'s (2019) semi-structured interviews at South African universities highlighted the importance of IT resource optimization (technological factor) for GIT solutions. Gan et al.'s (2013) study found organizational factors such as high adoption expenses, insufficient environmental awareness and knowledge, a deficit in trust, scepticism regarding adoption, institutional adoption rates, and issues related to switching barriers are prominent obstacles of green technology adoption in Malaysian HEIs. Similarly, Mustaffa et al.'s (2023) case study revealed that limited funding and high costs associated with green and energy-efficient technologies (organizational factors) are barriers to the adoption of GIS within Malaysian public HEIs. The survey conducted by Suryawanshi and Narkhede (2015) in Indian HEIs also indicated that the lack of motivation among implementers poses a significant obstacle to the successful implementation of green or sustainable ICT initiatives. The implementation of GIT within South African HEIs is influenced by organizational factors and environmental factors including general institutional perception and beliefs, external pressures, governmental and professional influences, economic advantages, as well as the perception of an institution's readiness for GIT adoption (Thomson & van Belle, 2015). Overall, GIS adoption in HEIs is influenced by a combination of technological, organizational, and environmental (TOE) factors. Further comprehensive research is needed to determine whether the TOE factors, which affect technology implementation in various industries, also influence the adoption of GIS practices in the higher education industry in Malaysia.

1.2.6 Sustainable Performance

The United Nations General Assembly introduced the 2030 Agenda for Sustainable Development in September 2015 as a collaborative framework aimed at addressing global sustainability issues. Sustainability refers to a development that satisfies present needs without compromising the capacity of future generations to fulfil their own needs (Brundtland, 1987). A comprehensive university sustainability approach entails environmentally responsible, socially equitable, culturally equitable, and economically sustainable institutional activities (Bekessy et al., 2003).

Sustainable performance refers to an organization's ability to achieve its goals while minimizing negative environmental and social impacts and ensuring long-term economic viability (Eccles et al., 2014; Zhou et al., 2023). It is divided into three pillars: environmental, social, and economic sustainability (Purvis et al., 2019). These pillars are also known as planet, people, and profits (the 3Ps), and the Triple Bottom Line framework (Aragon-Correa et al., 2017; Gimenez et al., 2012). This framework delineates the planet as addressing environmental concerns, people for social considerations, and profits regarding economic factors. The correlation between environmental and social performance is positive with economic performance, suggesting that a company's economic success is interconnected with its capacity to create societal value (Alsayegh et al., 2020). Sustainable practices involve balancing these three aspects for the benefits of current and future generations within the environment, society, and the economy (Geissdoerfer et al., 2017).

Goodland (1995) defines environmental sustainability as a framework of restrictions governing human economic activities across four main areas: the use of renewable and non-renewable resources (source side), and the management of pollution and waste (sink side). Environmental sustainability is about fulfilling the resource and service requirements of both present and future generations while ensuring the integrity of the ecosystems that support them (Chen et al., 2020). It goes beyond just environmental benefits by highlighting the interdependence between human welfare and environmental health (Vandyck et al., 2018). The quality of the environment has a profound impact on human health, making the health of people and the state of the environment closely intertwined (Zhang et al., 2022).

Social sustainability focuses on creating lasting conditions for human well-being, emphasizing support for vulnerable groups (Ajmal et al., 2018). It pertains to a company's commitment to social responsibility, ethical labour practices, health and safety practices, community engagement, equality and diversity, and the well-being of people (Baid & Jayaraman, 2022; Thomas, 2019). Social sustainability comprises both internal and external aspects. Internally, it involves investing in corporate governance, employee welfare, health and safety, improved maternity and family policies, flexible scheduling, work-life balance, and educational opportunities (Gálvez et al., 2020). These efforts enhance employee motivation and productivity, yielding economic benefits (Morais & Silvestre, 2018; Thomas, 2019). Externally, it involves engaging with stakeholders, conducting ethical community interactions (Thomas, 2019), and achieving a positive image in the eyes of stakeholders (Yildiz Çankaya & Sezen, 2019).

Economic sustainability involves ensuring a company's financial health and stability, creating long-term economic value for its shareholders while also fostering environmental and social sustainability (Alsayegh et al., 2020). A sustainable business must be profitable without sacrificing the other pillars. The economic pillar concerns compliance, proper governance, and risk management, so it is sometimes referred to as the governance pillar, focuses on aligning the interests of boards of directors, shareholders, management, community, value chains, and customers (Mooneeapen et al., 2022; Rajesh, 2020). Incorporating sustainable practices can significantly enhance a company's financial performance reputation, attract new customers, and provide a competitive edge (Hossin et al., 2021; Hu et al., 2019). Supported by Loeser et al. (2017), GIS adoption reduces costs and enhances reputation, thereby improving financial performance. Investors are increasingly interested in companies that adopt sustainable practices (Unruh et al., 2016), with numerous studies confirming that firms with sustainability practices show better financial performance (Al Amosh et al., 2023; Lee & Isa, 2023; Linnenluecke, 2022; Sandberg et al., 2023; Xie et al., 2018).

Green practices are increasingly significant in addressing climate change concerns, crucial for achieving sustainable performance across industries (Fok et al., 2022; Umar et al., 2022). Investments in green and renewable technologies promote sustainable economic development (Chen & Bian, 2023). The significance of GIS practices has grown in prominence as the IT sector significantly contributes to global greenhouse gas emissions (Liu et al., 2019). The concept of GIS involves a diverse range of potential strategies aimed at promoting sustainable business practices (Watson et al., 2010). Organizations are integrating GIS into their operations to gain a competitive advantage (Nanath & Pillai, 2017). In line with the Malaysia Educational Blueprint for Higher Education 2015–2025, which prioritizes sustainability, Malaysian HEIs are also adopting GIT and GIS practices, to reduce greenhouse gas emissions and support sustainable development (Anthony Jnr, 2021).

1.2.7 Green Information Systems Practices and Sustainable Performance

Various activities conducted using technology result in high electricity expenditures (Salahuddin & Alam, 2016). The Malaysian higher education sector has emerged as a major consumer of energy, with electricity consumed by existing universities accounting for 38% of the total electricity generated in Malaysia (Latif et al., 2019). Thus, Malaysian HEIs have actively embarked on the energy-saving initiatives, including the implementation of GIS, with the goal of mitigating their carbon footprint (Ahmad et al., 2023; Anthony Jnr, 2021; Uddin et al., 2017).

Tan and Palanichamy (2018) reported that a university reduced its energy consumption by 176 million kWh within nine months and decreased greenhouse gas emissions by 20% after implementing energy efficiency measures. The University of Wisconsin saved nearly $80,000 annually by managing 2,900 computers in low-power sleep mode (Mike, 2015). Smart campus technologies such as cloud computing, IoT, and sensors enhance energy efficiency in HEIs through environmental monitoring and automation (Kourgiozou et al., 2021). These energy-efficient technologies, along with reduced energy use, lower carbon footprint, improve environmental quality, and promote sustainability (Habiba et al., 2023; He & Wang, 2017). Additionally, greening data centres, personal computers, and printing systems effectively reduce carbon emissions in HEIs (Uddin et al., 2017). The adoption of e-learning and paperless exams eliminates the need for physical classroom spaces, reduces travel for teachers and students, and minimizes the use of physical textbooks and other materials, further mitigating environmental impact (Uddin et al., 2017).

GIS practices can enhance the social performance of HEIs by raising awareness and education among students, faculty, and staff. Incorporating sustainable practices into campus operations, curricula, and community engagement raises awareness of environmental issues and promotes sustainable behaviours (Mokski et al., 2023; Ribeiro et al., 2021). For Malaysian HEIs, such initiatives can attract and retain students who are increasingly concern about sustainability issues (Saleh et al., 2021). Social contributions, along with research and development, are key drivers of institutional reputation and student satisfaction (Qazi et al., 2021). With the rise of telecommuting (working remotely), Times Higher Education encouraged HEIs to offer remote working options to attract and retain top-tier talent (McNaughtan et al., 2022). While work-life conflict can negatively impact employee well-being, job satisfaction, work engagement, productivity, and turnover rates (Badri, 2019), telecommuting can improve work-life balance (Gálvez et al., 2020; Uresha, 2021), and maintain productivity during disruptions such as vehicle issues, childcare responsibilities, and adverse weather (McNaughtan et al., 2022). University-industry collaborations in GIS adoption foster environmental innovation and enhance economic performance (Di Maria et al., 2019). These partnerships allow HEIs to share knowledge, resources, and best practices, improving sustainability and reducing carbon footprints. Such efforts are essential for developing a workforce committed to inclusive sustainable development and achieving SDGs (Jing et al., 2023).

Adopting GIS practices can lead HEIs to financial benefits, including cost savings through reduced waste, emissions, and energy consumption, and enhance their reputation to attract more students. In the UK, HEIs’ expenditure on ICT-related energy costs totalled £116 million, with annual budgets for printing and copying expenses exceed £1 million (James & Hopkinson, 2009). Increasing digitalization and reducing printing in universities can help save costs (Saarti et al., 2017). Implementing energy management strategies in universities also leads to reduced electricity consumption, which in turn results in significant cost savings on electricity bills (Opoku et al., 2020). Malaysian organizations are also adopting GIS practices to reduce IT usage costs and promote sustainability (Anthony, 2019; Anthony Jnr, 2020). The use of virtual learning in HEIs can reduce education delivery costs and broaden educational access for a wider audience (Maatuk et al., 2022). GIT and GIS practices streamline administrative processes and increase operational efficiency, leading to better resource management, cost savings and reputation enhancement (Anthony Jnr, 2021; Hernandez, 2018; Loeser et al., 2017). Incorporating sustainable practices into HEIs' IT strategies demonstrates commitment to sustainability and social responsibility, fostering an environmentally friendly learning environment that appeals to environmentally conscious students and employees, thereby enhancing institutional competitiveness (Times Higher Education, 2023).

1.2.8 Risks in the Higher Education Industry

The Ministry of Higher Education faces the challenge of navigating the unpredictable and uncontrollable evolution of higher education globally (Ministry of Higher Education, 2022). Like all other industries, higher education is subject to some risks that could influence its day-to-day operations, financial viability, and reputation. Higher Education Funding Council for England (HEFCE) (2005) defines the risks that HEIs face as any potential threat hindering HEIs from attaining their goals.

HEIs face various financial risks, including the decline in enrolment rate, insufficient government funding, public funding cuts, financial mismanagement, rising operational costs, and increasing competition (Mustaffa et al., 2023; Jesry et al., 2022). The initial investments required for adopting GIS, such as infrastructure upgrades or energy-efficient technologies implementation, also pose financial risks for institutions. In addition to upfront costs, technological implementation involving financial commitments, such as operational licensing, maintenance costs, software updates, training costs, and unexpected expenses (Isa et al., 2021; Mustaffa et al., 2023), potentially impacting a HEI's financial stability and performance. Financial risks can result in asset loss and impact the institution's ability to deliver quality education and research (Jesry et al., 2022). Some universities place the responsibility for managing financial risks at the highest administrative level (Huber, 2011).

HEIs rely heavily on their day-to-day operations to support core functions like research, teaching, and learning (Jesry et al., 2022; Sum & Saad, 2017). Disruptions to management processes can cause operational risks, such as infrastructure damage, research activities disruption, infectious diseases, natural disasters, adverse weather conditions, and power outages (Jesry et al., 2022; Sum & Saad, 2017). Additionally, HEIs are exposed to global competition, evolving technologies, strategic alliances, institutional restructuring, substantial infrastructure investments, and expansion initiatives (Perera et al., 2020; Sum & Saad, 2017). Operational risks within IS in HEIs relate to faculty proficiency in eLearning, the quality of the Learning Management System, resistance to change, destruction, or theft of IT and IS resources (Sipior et al., 2021; Syed et al., 2021). Inefficient business processes, insufficient IT experts, and systems failures are also common operational risks for HEIs (Syamsia et al., 2021).

With the increasing reliance on technology in the higher education industry, technological risks are receiving more attention in HEIs. The increasing frequency of cyber incidents targeting educational institutions and technology platforms poses significant threats to the privacy of students and staff (Fouad, 2021). With the rise of technological risks in ICT adoption, HEIs face physical damage, intellectual property theft, data loss, data breaches, cyber-attacks, and disruptions to systems (Dioubate et al., 2022; Fouad, 2021; Syed et al., 2021). The risks of digitization in HEIs can also be attributed to insufficient security awareness among users (Dioubate et al., 2022; Ulven & Wangen, 2021) and the inadequate proficiency of educators in utilizing digital learning technologies (Ulven & Wangen, 2021; Yureva et al., 2020). Cybersecurity risks not only affect the reputation of HEIs but also endanger students and staff, because HEIs possess large amounts of sensitive data including valuable intellectual properties, research data, and their personal information (Cheng & Wang, 2022).