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The Role of Governments in Driving Industry 4.0 Adoption in Emerging Countries:
Mediating Effect of Organizational Structure

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ABSTRACT

Industry 4.0 contributes to the virtualization of production system and enhances capabilities. However, the adoption process poses substantial challenges for SMEs in emerging markets due to institutional voids, resources, and public supports. This study explores the role of government in adopting Industry 4.0 by the SMEs and how organizational structure influences the process. It employed a quantitative approach and surveyed 225 managers. Industry 4.0 adoption is significantly influenced by government policy and subsidies. Government policy and subsidy transform organizational structure to be more transparent and flexible, streamlining them in adopting Industry 4.0. The organizational structure substantially mediates the relationships between government policy, subsidy, and Industry 4.0 adoption. This study implies that governments are vital in helping SMEs to adopt Industry 4.0 in emerging markets. Thus, governments should make policies that support technology adoption by offering sufficient funding/subsidies to boost innovation and technological transformation.

KEYWORDS

Adoption, Emerging Market, Government Role, Industry 4.0, Organizational Structure,

THE ROLE OF GOVERNMENTS IN DRIVING INDUSTRY 4.0 ADOPTION IN EMERGING COUNTRIES: MEDIATING EFFECT OF ORGANIZATIONAL STRUCTURE

Industry 4.0 will likely disrupt the industrial environment and change how global value chain activities shape global production networks. The emergence of the Internet of things, cloud computing, big data analytics, and the cyber-physical system (CPS) have fostered the development of Industry 4.0 (Dalenogare et al., 2018; Reza, Malarvizhi et al., 2021). The CPS contributes to virtualizing the

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physical environment and changes the manufacturing paradigm from physical and human-centric to mechanized, flexible, and system-centric production. Policymakers, industrialists, and academics are increasingly preoccupied with this phenomenon (Chiarello et al., 2018; Liao et al., 2017). The approach includes integrating the manufacturing system into the product lifecycle and business operations for distribution networks (Dalenogare et al., 2018) and streamlining the organization's entire value chain (Stock & Seliger, 2016). Industry 4.0 uses smart technologies to collect and analyze data in real-time and provide them to the industrial system with relevant information (Wang et al., 2016). The underpinning digital transformation through the evolution of Industry 4.0 offers numerous advantages for small and medium enterprises (SMEs) (Li et al., 2022). Some benefits include higher productivity, lower operating costs, better product quality, and product customization, which are crucial for SMEs' competitiveness and survival (Moeuf et al., 2018).

Despite the advantages and competitive prospects of Industry 4.0, the complexity, ambiguity, advanced resource requirements, and skill intensity of digital transformation deprive SMEs of adopting Industry 4.0 (Horváth & Szabó, 2019). SMEs in emerging countries are privately owned and lack formalization of their legal status. They do not have adequate access to commercial lending and/or government support. Due to the novelty of Industry 4.0 and the lack of knowledge of this technological revolution, adequate public policy guidance and supports have yet to be developed. SMEs must have access to or build the essential procedures, tools, techniques, and knowledge to accelerate the digital transformation by adopting Industry 4.0 (Al-Azad et al. 2022; Colli et al., 2019; Müller et al., 2018). Public policy plays a significant role in speeding up Industry 4.0 adoption processes among SMEs. This technological innovation promises to bring back outsourced manufacturing activities to the home country and spur reindustrialization in high-cost countries. Many emerging countries with considerable manufacturing industries are now introducing government-supported Industry 4.0 initiatives to move towards high-tech manufacturing and attract foreign investors and strategic collaborations from developed markets. Such initiatives focus on overall strategic programming and promotion to develop a favorable environment for Industry 4.0, establishing a standard system and accelerating the transformation of organizational structure and flexibility towards adopting smart tools and technologies. The initiatives also include launching a wide-ranging broadband infrastructure, improving safety and security measures, reforming the work environment, developing human resources, and enhancing supply chain logistics (Zhou et al., 2015). These initiatives encourage SMEs to embrace new technologies for sustainable manufacturing, improving performance, and contributing to the nation's sustainable development (Ramdani et al., 2021).

However, few studies have explored government involvement in influencing SMEs to adopt Industry 4.0. In the existing literature, several empirical studies explored government initiatives in technology adoption, including government support and regulation; however, most studies focused on adopting a single technology. For example, Park and Kim (2021) studied the impact of government support and policy on big data adoption. In contrast, Janssen et al. (2020) examined the effect of regulations and legislation on blockchain adoption. On the other hand, Hwang et al. (2016) assessed the influence of government regulation on green supply chain adoption, and Wei et al. (2015) tested the impact of regulatory support on RFID implementation. Only a few studies considered the effect of government support, policy, and subsidy on Industry 4.0 adoption. For instance, Lin et al. (2018) explored Industry 4.0 from its adoption perspective, showing the impact of government policies on the fourth industrial revolution; however, operationalization of the constructs was unclear. Therefore, researchers have recommended exploring the factors related to government support and initiatives that will facilitate the digital transition (Bakar et al., 2020). Moreover, policy research on Industry 4.0 technologies has also been scarce (Lee et al., 2017). Consequently, governments and policymakers are unaware of their roles in realizing prospective Industry 4.0 advantages (Lee, 2019). In this regard, Ghobakhloo et al. (2022) claimed that SMEs in developing countries struggle with technological transformation due to governments' inability to recognize particular requirements or inadequate assistance and incentive delivery systems. Therefore, the authors invited future studies to clarify how governments might expedite, improve, and support SMEs' transition to Industry 4.0.

On the other hand, researchers have identified organizational structure as another critical aspect in Industry 4.0 adoption (Dedahanov et al., 2017; Haseeb et al., 2019). Innovative and flexible SMEs are more receptive to new ideas and technologies. Thus, public policy, support, and subsidy can influence SMEs to restructure and become flexible and adaptable to the market dynamics. This process can also help firms to become more innovative (Wilkesmann & Wilkesmann, 2018). SMEs, especially family-owned ones, have rigid structures and face challenges in adopting new technologies and moving to higher value-added business activities (Fettig et al., 2018). A flexible organization may have flat and weak hierarchies and decentralized procedures, enabling them to make faster decisions and facilitating the adoption of new techniques and procedures (Veile et al., 2020).

However, Mintzberg's (1993) organizational structure theory has been extensively applied in organizational studies; there is a lack of research that explores its applicability in the context of Industry 4.0 adoption. In addition, limited research has been conducted on the interplay between government support, regulation, and subsidies concerning the adoption of Industry 4.0, especially in the context of SMEs (Ghobakhloo et al., 2022). Further, most existing research on Industry 4.0 adoption tended to focus on technological aspects, with limited attention paid to the role of organizational and managerial factors (Kamble et al., 2020). Moreover, most previous research on Industry 4.0 adoption was qualitative, with limited quantitative studies examining the impact of government support, regulation, and subsidies on organizational structure and technology adoption. Thus, there is a need to investigate the mechanisms through which government support, regulation, and subsidies may influence the adoption of Industry 4.0 and the extent to which these mechanisms may be mediated by organizational structure (Bakar et al., 2020; Ghobakhloo et al., 2022). Therefore, to fill the research gap, in this study, the authors explored the impact of government initiatives on organizational structure, assisting SMEs in preparing for technological transformation and adopting Industry 4.0. Notably, the authors measured government initiatives through three significant constructs, namely, policy, support, and subsidy. Accordingly, the authors addressed the following research questions:

1. Do government support, policy, and subsidy influence Industry 4.0 adoption?
2. Do government support, policy, and subsidy influence organizational structure?
3. Does organizational structure accelerate Industry 4.0 adoption?
4. Does organizational structure mediate the relationship between government support, policy, subsidy, and Industry 4.0 adoption?

To answer the research questions, the authors devised a framework and validated it with the survey data they collected from 225 SMEs. The results evidenced that government-offered suitable subsidies and supporting policies can motivate SMEs to become flexible, decentralized, transformational, and open to new ideas and technologies.

The paper is structured as follows. In the second section, the authors elucidate the pertinent literature on government initiatives and Industry 4.0 adoption. In the third section, they describe the research framework with the hypothesized relationships. In the fourth section, they illustrate their approach for data collection. In the fifth section, they explain quantitative analysis and key factors influencing Industry 4.0 adoption with structural equation modeling (SEM) results. In the sixth section, they present the findings and implications of the study. Finally, in the last section, they illustrate the limitations of this study and provide future research suggestions, followed by the concluding remarks.

LITERATURE REVIEW

Findings of the Existing Literature

The authors conducted a comprehensive literature review addressing the factors of Industry 4.0 and its adoption, emphasizing government involvement. Table 1 shows the findings of the review. The search for the relevant literature resulted in only a few studies, as extant literature did not adequately explore the government's involvement in fostering technological transformation. Several studies identified the government's role as one of the success factors for Industry 4.0 adoption; however, most are conceptual, qualitative or other methodological approach oriented. For instance, Ghobakhloo et al. (2022) and Raj and Jeyaraj (2022) conducted systematic literature reviews, Majumdar et al. (2021) and Lin et al. (2018) employed interpretive structural modeling, Raj et al. (2020) adopted the decision-making trial and evaluation laboratory approach, and Lin et al. (2019) applied a probit model in addressing the factors of Industry 4.0 adoption. Thus, the review demonstrates that the research exploring the impact of government involvement on Industry 4.0 adoption lacks empirical validation, which motivated the authors to conduct an empirical study.

However, the literature review shows that research on Industry 4.0 is rapidly growing to address the factors, methods, and applications for its successful implementation, highlighting government initiatives. For example, Raj and Jeyaraj (2022) recommended that governments offer incentives and legal protection to implement Industry 4.0, stimulating the technological transformation in the industry. Ghobakhloo et al. (2022) acknowledged government support as an essential external factor for facilitating technological transformation. Majumdar et al. (2021) identified significant barriers and suggested creating a blueprint, including subsidies or tax rebates for Industry 4.0, to transform traditional business practices into cutting-edge, intelligent procedures. Raj et al. (2020) identified the crucial barriers while recommending supportive government regulation and adequate standardization that might make it easier for developing countries to implement Industry 4.0 technology. Lin et al. (2019) found an insignificant effect of government subsidies on firms' Industry 4.0 adoption decisions, due to the unfair industrial strategy among Chinese companies. Lin et al. (2018) studied the impact of government support on technological transformation and suggested providing legal support, tax deduction, industrial standards, information and communication technologies infrastructure or media publications.

Global Scenario of Industry 4.0 Adoption

Industry 4.0 establishes connectivity between the CPS and contributes to the transformation of the whole industrial environment. However, the adoption rate of Industry 4.0 among SMEs is low (Agostini & Nosella, 2020). Yu and Schweisfurth (2020) examined the SMEs within the Dutch-German borders and found that many firms had not adopted Industry 4.0 technologies. On the other hand, Spena et al. (2016) studied flexibility and transformability in production and assembly systems in northern Italian SMEs, and indicated a low degree of automation among the firms evaluated. Ghobakhloo and Ching (2019) researched Malaysian and Iranian firms, showing an Industry 4.0 adoption rate below 20% among SMEs. In a comparative study of SMEs in China, Germany, and the United States, Kuo et al. (2019) found that SMEs' low technology adoption rate is a significant concern for these nations. According to a EU4Digital's (2020) report, technological adoption among larger companies is relatively promising, while European SMEs have yet to catch their larger peers using digital technologies. The study revealed that their adoption process of Industry 4.0 differs from the larger companies due to some distinct features of SMEs. SMEs lack financial and human capital (Müller et al., 2018) and have inadequate access to market data (Pergelova et al., 2019). In developing countries, SMEs inadequately employ strategic management approaches such as financial analysis, forecasting, and strategic planning (Bellamy et al., 2019). More recent studies showed that SMEs tend to be very cautious in approaching digitization (Ghobakhloo & Fathi, 2020). As the speed of global integration increases in manufacturing, focusing on digitization and prioritizing customers, organizations that fail to keep pace will lose their competitive position (Nadkarni & Prügl, 2021). The recent COVID-19 pandemic also showed how uncertainty and market volatility significantly influence SMEs' survival, and how digital transformation and organizational adaptability and agility can support them overcoming such challenging circumstances (Khalid & Naumova, 2021; Reza, Jayashree et al., 2021).

The Malaysian government has developed a comprehensive program to assist organizations in identifying their abilities and preparedness to adopt Industry 4.0 technologies and procedures, known

Table 1. Findings of the literature review

Literature	Method	Theory	Factors Studied	Sample	Country	Findings, Limitations, and Gaps
	SLR	N/A	Technological: Perceived benefits, user-friendliness, compatibility, complexity, cost, cyber-security, and investment risk. Organizational: Absorptive capacity, business properties, technical and management competency, digital knowledge and expertise, organizational culture and structure, resource availability, social capital, and top management characteristics. Environmental: Competitive environment, stakeholder pressure, external partnership and collaboration, external support, infrastructural and regional properties, and technology provider properties.	37 journal articlesz	N/A	The study categorized 27 factors for the successful adoption of Industry 4.0, where government support was identified as one of the vital success factors. The authors sustained that inadequate government support in addressing infrastructural and financial gaps, tax redemption and incentives, upskilling human capital, and cyber-security regulation might create barriers to digital transition. The authors recommended investigating the relationships between the factors and Industry 4.0 adoption.
	SLR	N/A	Technological: Perceived usefulness, ease of use, and perceived compatibility. Organizational: Management support, absorptive capacity, lean principles, infrastructure support, expertise, and trust. Environmental: Social influence, government support, and external support.	22 journal articles	N/A	The authors identified 12 success factors essential for Industry 4.0 adoption, among which they determined government support as necessary. However, the relationship between government support and Industry 4.0 must be validated through empirical support.
	ISM	N/A	Top management commitment, digital culture, organizational and process changes, employees' skills, trained staff, employment disruption, implementation cost, internet coverage and IT facilities, cybersecurity issues, legal and contractual uncertainty, seamless integration and compatibility issues, R&D, maintenance support system, knowledge management systems, methodical approach, coordination and collaboration, time, experience and budgeting, risk management tools, clear apprehension of benefits, fear of failure, and government support and policies.	52 respondents	India	Based on the respondents' opinions, the authors identified and prioritized barriers to Industry 4.0 adoption in the clothing and textile industries. They identified the lack of government support and policies as a significant barrier. However, the impact of government support and policies on Industry 4.0 adoption needs empirical investigation.
	DEMATEL	N/A	High Investment cost, lack of clarity regarding economic benefit, challenges in value-chain integration, risk of security breaches, low maturity, level of preferred technology, inequality, disruption to existing Jobs, lack of standards, regulations, and forms of certification, lack of infrastructure, lack of digital skills, challenges in ensuring data quality, lack of internal digital culture and training, resistance to change, ineffective change management, lack of a digital strategy, and resource scarcity.	6 experts	India and France	The authors identified the significant barriers to Industry 4.0 adoption, and indicated supportive government regulation and adequate standardization as important factors. However, to understand the phenomena clearly, the impact of supportive government regulation and adequate standardization on Industry 4.0 adoption requires empirical investigation.
	Probit model	N/A	Ownership, equipment, the shareholding ratio of major shareholders, institutional investors, firm profitability, firm size, leverage, and subsidies.	N/A	China	The authors identified eight driving forces and their impact on organizations' performance. The authors integrated government subsidies into the research and found an insignificant impact on Industry 4.0 and firm performance. This contradicting result needs empirical investigation to understand the concepts comprehensively.
	ISM	TOE	IT maturity, technological incentives, perceived benefits, company size and nature, external pressure, and government policies.	165 companies	China	The authors integrated technological, organizational, and environmental factors affecting Industry 4.0, and considered government policies as vital for technological transformation. However, the causal relationship between these constructs needs to be validated with empirical findings.

Note. SLR = Systematic Literature Review; ISM = Interpretive Structural Modeling; DEMATEL = Decision-Making Trial and Evaluation Laboratory

as Industry4WRD Readiness Assessment (Ministry of International Trade and Industry, 2018). SMEs face many challenges in their digital transformation drive, including high investment costs, knowledge gaps, inadequate information technology (IT) experts, and poor information and communication technologies infrastructure (Khin & Kee, 2022a; Mohiuddin et al. 2022; Tay et al., 2021).

Industry 4.0 Adoption

Industry 4.0 transforms the industrial pattern into a novel industrial era by developing a networked platform and real-time connectivity among the different production systems (Dalenogare et al., 2018). These systems are changing paradigmatic shifts by reconfiguring entire production processes (Raj et al., 2020). These cutting-edge technologies have great potential to boost manufacturing productivity and sustainability (Jayashree et al., 2022). Implementing these technologies allows organizations to closely monitor and manage their equipment, products, and services, leading to enhanced decision-making through real-time insights. The main impact of Industry 4.0 lies is its capability to detect any change in the value chain and notify relevant parties, resulting in precise prediction, improved transparency, optimized resource management, and better utilization of assets (Ed-Dafali et al., 2023). Thus, by bringing together humans, machines, and systems, Industry 4.0 facilitates the development of more flexible and adaptable production systems (Machado et al., 2020).

However,the implementation procedure of Industry 4.0 is built on three types of integration: Horizontal integration, vertical integration, and end-to-end integration (Sony & Naik, 2020b). Horizontal integration is networking incorporation that facilitates collaboration across organizations (Stock & Seliger, 2016). Vertical integration modifies the multiple hierarchical systems within the organization to build a flexible, dynamic, effective, and reconfigurable production system (Gabriel & Pessl, 2016). Integration of end-to-end engineering helps organizations create customized products and services throughout the value chain (Stock & Seliger, 2016). These three integrations enable organizations to implement Industry 4.0 successfully.

Organizational Structure

The organizational structure determines the information and action flow among the different nodes of the organization and distributes the roles and responsibilities of various organizational actors. The organizational structure refers to formalization, decentralization, and integration (Mintzberg, 1993). Formalization denotes the extent to which particular norms, laws, policies, and procedures regulate strategic planning, work environment, and operational practices (Spanos et al., 2001). An organization with a low formalization level and broader principles allows creativity and innovation (Oltra et al., 2018) and is open to change (Shamim et al., 2016; Wilkesmann & Wilkesmann, 2018). Decentralization implies the degree to which the power and control for the decision-making, assessment of tasks, policy-shaping, and resource allocation within the organization are distributed among the different nodes (Schumacher et al., 2016; Stock & Seliger, 2016). Decentralization empowers employees to take decisions in time, that fit with the context, and that create a conducive environment facilitating the organization’s adoption of new ideas, technologies, and entrepreneurship (Shamim et al., 2016; Sivathanu & Pillai, 2018). Integration involves the degree to which various departments of an organization operate together (Sony, 2018). Organizations can self-regulate, monitor, and optimize organizational resources by integrating the manufacturing system and the cyber-physical world, determining the accomplishment of Industry 4.0 (Sony & Naik, 2020a).

The Role of the Government

Industry 4.0 adoption is capital and knowledge-intensive. The return on investment is unpredictable due to uncertainty, cyber security risks, and the possibility of trickle-down effects of those vulnerabilities on the CPS system (Bosman et al., 2020). SMEs are mostly privately owned firms with limited resources; they do not have adequate access to financial and knowledge capital in a developing country context with institutional voids. Governments can play a significant role in programming and promoting critical infrastructure and institutions (Kuo et al., 2019) to help SMEs to undertake technological transformation. A wide range of challenges can be addressed to accelerate Industry 4.0 adoption, including interoperability, bandwidth accessibility, cybersecurity, and personal data protection. Joint efforts by the stakeholders related to the public and private sectors are necessary to identify the difficulties (Lee, 2019). Proactive governments can face the challenges and are likely to succeed in adopting Industry 4.0. Governments can encourage technological transformation and remove obstacles to Industry 4.0 adoption by establishing an appropriate regulatory atmosphere and protocols. In addition, government support and subsidization can be helpful for resource-strapped SMEs for digital transformation.

Hypotheses Development and Research Framework

Government roles are essential enablers for Industry 4.0 adoption. Institutions and regulations have implications for both businesses and society as a whole. In this study, the authors considered three variables to measure government involvement: Policy, support, and subsidy. Government policy includes all rules and regulations introduced to create a level playing field for Industry 4.0 adoption by SMEs. Government support refers to monetary and resource-related support to firms, such as various types of incentives and the promotion of SMEs. Government subsidy refers to the subsidization of inputs SMEs use to produce goods and services. The subsequent sections describe the development of the hypotheses and the construction of the research framework.

Government Policy, Organizational Structure, and Industry 4.0 Adoption

Government policy plays a crucial role to support SMEs adopting and implementing Industry 4.0 (Bag et al., 2018; Bonilla et al., 2018). Government policies can transparently shape the organizational structure and promote organizations for upcoming opportunities. Pearce et al. (2009) claimed that government policy and capability could significantly impact companies' organizational structure. For example, whereas COVID-19 has seriously affected the developing-country economy, government policy supports are vital for economic resurgence. Within the current economic volatility, governments have initiated comprehensive measures to facilitate the adoption of digital technologies such as Industry 4.0 to enhance the digital transformation of the industrial sector. Advanced technology can enable SMEs to function smoothly under the COVID-19 safety measures applied in most affected countries. Public policy, collaboration with an international organization with sectoral expertise, knowledge-intensive business services, technical institutions, manufacturing companies, local authorities, and labor unions can generate momentum for adopting Industry 4.0 inside the country (Chauhan et al., 2021). Policymakers must ensure compliance requirements associated with R&D, and new technologies are not costly, complex, and lengthy. Establishing a "single window" for all the relevant services for SMEs can benefit SMEs in adopting Industry 4.0. Luthra et al. (2020) conducted an empirical study reporting government policy as a significant driver of Industry 4.0 adoption. In addition, Kuo and Smith (2018) indicated that the adoption and accomplishment of Industry 4.0 require significant government support. Public policy can influence firms' decisions in various ways and helps through the development and enforcement of regulations on security and privacy. Information and implementation guidance can promote digitalization and Industry 4.0 adoption among SMEs (Ciffolilli & Muscio, 2018; Lin et al., 2018). It is also essential to understand the threats related to Industry 4.0 technologies and establish policies empowering firms for better management, organization, and mitigation of these threats. As a result, depending on the supportive policy type, Industry 4.0-supportive governments can foster the appropriate degree of Industry 4.0 adoption (Klitou et al., 2017). Thus, the authors' associated hypotheses are as follows:

Hypothesis 1: Government policy significantly influences organizational structure.
Hypothesis 2: Government policy significantly influences Industry 4.0 adoption.
Hypothesis 3: Organizational structure mediates the relationship between government policy and Industry 4.0 adoption.

Government Support, Organizational Structure, and Industry 4.0 Adoption

Government support is another crucial driver of Industry 4.0 adoption (Khin & Kee, 2022b). Such support may include promotion and awareness programs, resource allocation, financial assistance, tax incentives, IT infrastructure development, and high-speed Internet connectivity (Majumdar et al., 2021). Bakar et al. (2020) identified the significance of government support in educating SMEs regarding Industry 4.0 technologies, changing organizational culture toward sustainable practices, and building awareness and sustainability. Developing countries encounter various obstacles when investing in Industry 4.0, and they are concentrating on identifying the barriers and taking initiatives to resolve the challenges. Lin et al. (2018) and Osakwe et al. (2015) showed that adopting Industry 4.0 among SMEs highly depends on government support. In contrast, a lack of support is viewed as a significant obstacle to Industry 4.0 adoption; organizations with inadequate knowledge and expertise tend not to adopt it. Organizations tend to be more innovative if they think the government appreciates such endeavors (Bakar et al., 2020). With an Industry 4.0-supportive government, SME managers are encouraged to form a decentralized, integrated, and flexible organizational structure, enabling Industry 4.0 adoption. Considering the above discussion, the authors' associated hypotheses are as follows:

Hypothesis 4: Government support significantly influences organizational structure.
Hypothesis 5: Government support significantly influences Industry 4.0 adoption.
Hypothesis 6: Organizational structure mediates the relationship between government support and Industry 4.0 adoption.

Government Subsidy, Organizational Structure, and Industry 4.0 Adoption

Government subsidies are generally seen as a strong driving force for technological transformation (Švarcová et al., 2019) in emerging countries that help developing pioneers act as models to follow. SMEs in emerging countries need government subsidies such as grants, loans, quotas, and incentives to move up the value ladder. Subsidies can be helpful for resource-strapped SMEs and provide relevant business services to promote Industry 4.0 adoption (Bakar et al., 2020; Švarcová et al., 2019). Governments and industry players should cooperate through subsidies to establish a favorable environment for Industry 4.0 adoption, eliminating fears surrounding entrepreneurship. Governments must promote skills programs and encourage digitalization by subsidizing the implementation costs of Industry 4.0 (Majumdar et al., 2021). Adopting Industry 4.0 requires a supportive policy that promotes and incentivizes SMEs' use of sustainable technologies. Aalbers et al. (2009) examined the influence of subsidies on investment decisions and concluded that subsidies motivate organizations to seek and implement expensive technologies, even though the subsidy itself is not enough to make the technologies profitable. Thollander et al. (2015) reviewed industrial energy and climate policies in Japan and Sweden, revealing that the two countries provide subsidies to their SMEs for technology adoption and sustainable development. Further, Sung (2018) found that government subsidies significantly influence organizational structure and firm-level innovation. Therefore, the authors' associated hypotheses are as follows:

Hypothesis 7: Government subsidy significantly influences organizational structure.
Hypothesis 8: Government subsidy significantly influences Industry 4.0 adoption.
Hypothesis 9: Organizational structure mediates the relationship between government subsidy and Industry 4.0 adoption.

Organizational Structure and Industry 4.0 Adoption

It is essential to consider organizational structure in creating an appropriate strategy for successfully managing the transformation toward Industry 4.0 adoption (Cimini et al., 2021). Most of the existing literature focuses more on the technological influences on firm competencies; very few studies examined the effect of organizational structure on technology adoption (Gehrke et al., 2015). In fact, the macrolevels, including organizational design and structure, and how they influence technology adoption have not been sufficiently studied, so far (Cimini et al., 2021). Therefore, the relationship between organizational structure and technology adoption decisions such as Industry 4.0 should be explored.

In this study, the authors adopted a sociotechnical approach, focusing on how organizations have refashioned their structures based on the review of the suggested constructs while technological transformation occurs. The constructs are formalization, decentralization, and integration. Formalization includes written rules and regulations, processes, directions, and supervision organizations impose to increase coordination and control (Bartezzaghi et al., 2019). Cimini et al. (2021) demonstrated that a low degree of formalization is more appropriate for a dynamic and innovative atmosphere, particularly for Industry 4.0 environments. Decentralized organizational design inspires employees to develop knowledge and enables them to make supportive decisions toward Industry 4.0 adoption (Islam et al., 2017). In a decentralized organizational system, lower managers and nonmanagerial employees are empowered to make decisions (Giotopoulos et al., 2017). Integration of Industry 4.0 signifies the system's capacity for interconnection and functioning in a coordinated and independent way (Castelo-Branco et al., 2019). Integration can be seen from CPS networks concerning vertical or horizontal integration (Brettel et al., 2017; Pérez-Lara et al., 2020). Vertical integration involves integrating multiple hierarchical systems in the organization to build flexibility, agility, efficiency, and reconfiguration in the production system (Sony & Naik, 2020b). Horizontal integration combines value networks to facilitate cooperation in the value chain across organizations (Foidl & Felderer, 2015). When organizations engage in vertical and horizontal integration, they have the opportunity to improve their industrial competencies (Dalenogare et al., 2018). Based on this discussion, the authors formulated the following hypothesis:

Hypothesis 10: Organizational structure significantly influences Industry 4.0 adoption.

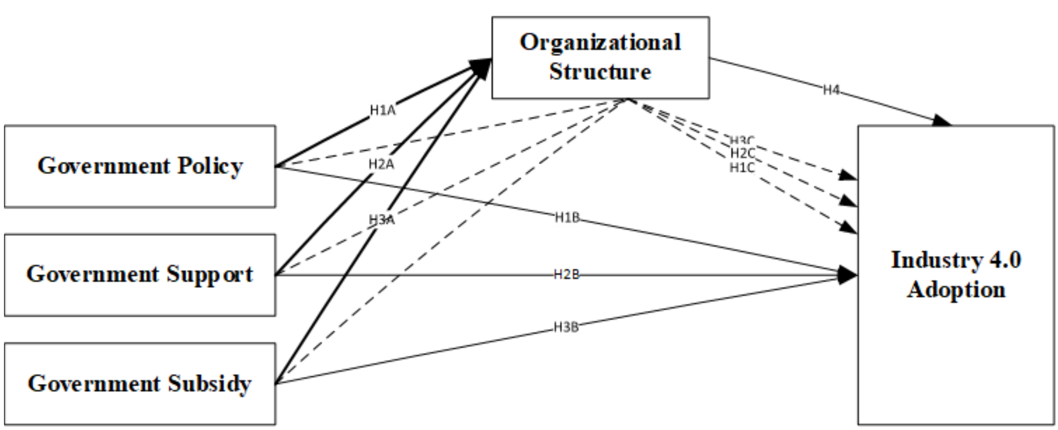
RESEARCH FRAMEWORK

Based on the above discussion, the authors devised their research framework (Figure 1). The framework shows the hypothesized relationships between government roles (i.e., policy, support, and subsidy), organizational structure, and the Industry 4.0 adoption process.

METHODOLOGY

The authors employed a quantitative approach because it produces data that can be subject to rigorous statistical analysis, relationship testing, and generalization beyond the sample being examined (Leedy & Ormrod, 2015). The authors investigated whether the government's involvement influences establishing

Figure 1. Research framework



an organizational structure favorable for Industry 4.0 adoption. They measured government involvement using the three latent variables, namely, government policy, government support, and government subsidy.

Sampling Technique and Data Collection

The authors conducted a cross-sectional study with data collected from SMEs in Kuala Lumpur, Selangor, and Penang. They employed a purposive sampling approach to obtain the data from the IT managers of the organizations. This sampling technique is confined to a particular type of respondent, able to provide the required information; either they know about the research topic or meet specific criteria established by the researchers (Sekaran & Bougie, 2016). Furthermore, purposive sampling is suitable when a researcher utilizes a sample to meet particular criteria (Taherdoost, 2016). This criterion ensures that respondents have adequate knowledge of IT or Industry 4.0 projects, as they are responsible for implementing operational procedures for their firms to accomplish business goals.

The researchers collected the manufacturing SMEs list from SME Corporation Malaysia (2021) and the Federation of Malaysian Manufacturers (2020), for data collection. They selected IT-implementing SMEs to reach the target respondents with digital innovation knowledge. Initially, the authors selected 800 SMEs and emailed these companies' HR departments to obtain their IT experts' permission to participate in the study. In the mail, they also included a cover letter stating the research topics. As a result, of the 800 contacted, 712 managers agreed to participate in the survey, so the authors sent the questionnaire (Appendix 1) to all of them. After sending three consecutive friendly reminders, they received 237 questionnaires. They discarded 12 of the 237 completed questionnaires, due to repetitive answers. As a result, they selected 225 questionnaires for final data analysis, with a response rate of 34.89%. Table 2 shows the demographic statistics of the respondents.

Measurement Items

The authors used a questionnaire as the instrument for data collection. They measured the government's involvement by three latent variables, namely, government policy, government support, and government subsidy. Each of the constructs included five survey items; the authors adapted all the items from Bakar et al.'s (2020) study. The organizational structure included ten measurement items; the authors adapted these items from Chen and Huang's (2007) and Pérez-Lara et al.'s (2020) studies. The authors measured Industry 4.0 adoption through 14 items, and adapted the items from Stentoft et al.'s (2021), Jayashree et al.'s (2021), and Pérez-Lara et al.'s (2020) research.

DATA ANALYSIS

The authors used partial least square structural equation modeling (PLS-SEM) to analyze the data. SmartPLS assists researchers in working effectively with lower demand for data distribution and normality assumptions, small sample sizes, and variables measured with single and multiple items (Hair et al., 2021). SmartPLS involves excellent predictions based on verifiable data (Hair Jr et al., 2014). Table 3 shows the descriptive statistics of the constructs the authors adopted in the study.

The authors employed a two-stage approach (Becker et al., 2012), measurement, and structural model analysis to evaluate the proposed framework. The authors performed the measurement model analysis to assess the correlation among the measurement items and constructs, followed by structural model analysis to determine the relationships between the variables, as Hair et al. (2019) suggested.

Measurement Model Analysis

The authors analyzed the measurement model by assessing the validity and reliability of items and latent variables by obtaining internal consistency, reliability, convergent validity, and discriminant validity. In determining the reliability of the items, the authors first looked at the loadings between the items and the intended constructs. Table 4 shows the constructs' loadings, composite reliability

Table 2. Demographic statistics of the respondents

Sample Characteristics	Frequency	Percentage
Gender		
Female	56	24.89
Male	169	75.11
Age		
< 25 years old	58	25.78
26 - 35 years old	120	53.33
36 - 45 years old	32	14.22
> 46 years old	15	6.67
Education		
Diploma	12	5.33
Bachelor	161	71.55
Master	46	20.44
PhD	6	2.66
Location of the organization		
Kuala Lumpur	98	43.55
Selangor	97	43.11
Penang	30	13.33
Number of employees		
50 and below	79	35.11
51 to 100	111	49.33
101 and above	35	15.55
Annual turnover (MYR)		
Less than 300,000	66	29.33
300,000 to 15 million	128	56.89
16 million to 50 million	31	13.78

Table 3. Descriptive statistics of the constructs

Constructs	Mean	Std. Deviation	Skewness	Kurtosis
Government policy	4.119	0.635	-0.643	0.576
Government support	3.241	0.842	0.308	-0.411
Government subsidy	4.165	0.621	-0.931	1.268
Organizational structure	3.856	0.635	-0.978	2.072
Industry 4.0 adoption	3.916	0.616	-1.270	2.165

(CR), and average variance extracted (AVE). Hair Jr et al. (2014) suggested retaining loading values equal to or greater than 0.708. Accordingly, the authors removed one item from the organizational structure and five items from Industry 4.0 adoption, due to a loading value of less than 0.708. Then, the researchers assessed the reliability of latent variables by scrutinizing the CR and convergent validity by AVE (CR ≥ 0.7; AVE ≥ 0.5) (Fornell & Larcker, 1981). As Table 4 shows, all the measurement items attained the cut-off value of outer loading (≥ 0.708), AVE ≥ 0.5, CR ≥ 0.7, and Cronbach alpha (α ≥ 0.7), meeting all the requirements of reliability of the measurement items. The measurement model (Figure 2) includes the outer loading and Cronbach alpha values.

The researchers then assessed the discriminant validity by evaluating the Fornell and Larcker (1981) and Heterotrait-Monotrait correlations (HTMT). According to the Fornell-Larcker criterion, discriminant validity would be achieved when the AVE of an item is greater than the correlation coefficients with other constructs. Accordingly, the higher diagonal numbers (i.e., 0.759, 0.740, 0.799, 0.771, and 0.836) in Table 5 indicate the value of the square root of AVE, meeting the requirement and establishing discriminant validity.

In addition, the discriminant validity was also assessed based on the Monte Carlo simulations (or HTMT), in which the threshold value should be less than 0.90 (Henseler et al., 2015). Table 6 demonstrates that the largest HTMT correlation ratio is 0.81, which produces an adequate discriminant validity level and indicates a reasonable quality level.

Structural Model Analysis

In this stage, the approach began with assessing multicollinearity concerns in the model. Then, the authors evaluated the path coefficients and the corresponding significance level.

Initially, the authors examined the multicollinearity by assessing the variance inflation factors (VIFs) of the constructs they used in the research model. According to Hair et al. (2011), the cut-off value of VIF is less than 5. Table 7 shows that all the VIFs are less than 5, indicating that the model is free from multicollinearity.

Figure 3 illustrates the direct hypotheses testing, and Table 8 presents the results. The authors used the t value of 1.96 as a cut-off point to accept or reject the hypotheses. The results in Table 8 show that, except for the relationship between government support and organizational structure, all the direct relationships have achieved t values over 1.96, indicating significant relationships. In addition, all the relationships have achieved positive beta values, specifying the direct relationships. The results demonstrate that government policy and subsidy positively correlate with organizational structure and Industry 4.0 adoption simultaneously. The relationship between government support and Industry 4.0 adoption is accepted, as the t value is above 1.96. However, the relationship between government support and organizational structure cannot meet the expected t value above 1.96; therefore, the relationship between government support and organizational structure is not significant. The relationship between organizational structure and Industry 4.0 adoption is significant.

The effect of government policy and government subsidy on organizational structure found β(0.195, 0.480), t(3.118, 7.943), and p(0.002, 0.000), respectively; hence, the hypotheses are accepted. Instead, the effect of government support on organizational structure found β(0.041), t(0.676), and p(0.499), thus, this hypothesis is not accepted. Additionally, the effect of government policy and government subsidy on Industry 4.0 adoption found β(0.206, -0.116, 0.233), and p(0.001, 0.026, 0.001), respectively; thus, these hypotheses are accepted. In addition, the effect of government support on Industry 4.0 adoption was found to be significant t(3.406, 2.231, 3.421); however, the negative beta value β(-0.116) indicated a negative relationship between these constructs. Finally, the effect of organizational structure on Industry 4.0 adoption showed β(0.525), t(8.873), and p(0.000); therefore, the hypothesis is accepted.

Table 9 and Figure 3 illustrate the R squared (R^2) value of 0.639 for Industry 4.0 adoption. Cohen (2013) described R^2 values for endogenous latent variables in the inner path model of 0.75, 0.50 or 0.25 as substantial, moderate or small, respectively, in terms of predictive accuracy. All the constructs bring a 63.9% change in Industry 4.0 adoption, which shows a promising path for adoption.

Next, the authors assessed the predictive relevance (Q^2) of the model. According to Henseler et al. (2009), the redundant commonality should be greater than zero for endogenous variables to have significant predictive relevance. Table 10 depicts the value of Q^2 as greater than zero, meeting the criterion of Q^2.

Table 4. Reliability and validity of the measurement items

Construct	Item	Outer Loading	AVE	CR	rho_A	Alpha
Government policy (GP)	Policy1	0.826	0.638	0.898	0.858	0.858
	Policy2	0.831				
	Policy3	0.820				
	Policy4	0.769				
	Policy5	0.745				
Government support (GST)	Support1	0.811	0.699	0.921	0.990	0.897
	Support2	0.834				
	Support3	0.830				
	Support4	0.831				
	Support5	0.873				
Government subsidy (GS)	Subsidy1	0.760	0.595	0.880	0.832	0.830
	Subsidy2	0.771				
	Subsidy3	0.749				
	Subsidy4	0.762				
	Subsidy5	0.812				
Organizational structure (OS)	OS1	0.737	0.547	0.916	0.900	0.897
	OS2	0.717				
	OS3*	-				
	OS4	0.725				
	OS5	0.776				
	OS6	0.753				
	OS7	0.706				
	OS8	0.754				
	OS9	0.715				
	OS10	0.769				
Industry 4.0 adoption (IA)	IA1	0.753	0.576	0.924	0.909	0.908
	IA2*	-				
	IA3*	-				
	IA4*	-				
	IA5	0.743				
	IA6	0.788				
	IA7	0.789				
	IA8	0.712				
	IA9*	-				
	IA10*	-				
	IA11	0.769				
	IA12	0.777				
	IA13	0.754				
	IA14	0.742				

Note. *Item removed.

Figure 2. Measurement model

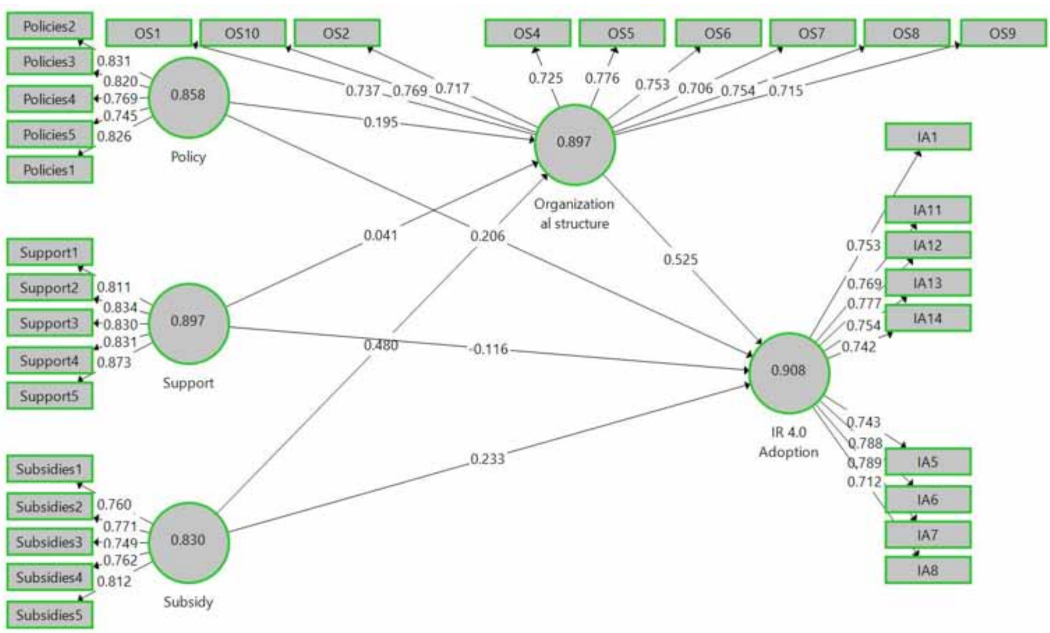


Table 5. Fornell-Larcker criterion

Constructs	IA	OS	GP	GS	GST
Industry 4.0 adoption (IA)	0.759				
Organizational structure (OS)	0.742	0.740			
Government policy (GP)	0.565	0.502	0.799		
Government subsidy (GS)	0.647	0.609	0.605	0.771	
Government support (GST)	0.151	0.241	0.390	0.259	0.836

Table 6. Heterotrait-Monotrait correlations (HTMT)

Constructs	IA	OS	GP	GS	GSt
Industry 4.0 adoption (IA)					
Organizational structure (OS)	0.811				
Government policy (GP)	0.637	0.561			
Government subsidy (GS)	0.738	0.688	0.714		
Government support (GSt)	0.159	0.257	0.433	0.273	

The authors also evaluated the effect size of the constructs. Cohen (2013) proposed 0.35, 0.15, and 0.02 as high, medium, and small-scale thresholds. Table 11 shows the values of F squared (F^2) for government policy as 0.035 (small), government subsidy 0.258 (medium), and government support 0 (none). Based on this result, the authors concluded that government subsidy has the biggest effect on the endogenous construct.

Table 7. Multicollinearity test

Construct	Industry 4.0 Adoption	Organizational Structure
	VIF	VIF
Organizational structure	1.667	
Government policy	1.801	1.737
Government subsidy	1.964	1.58
Government support	1.183	1.18

Figure 3. Structural model

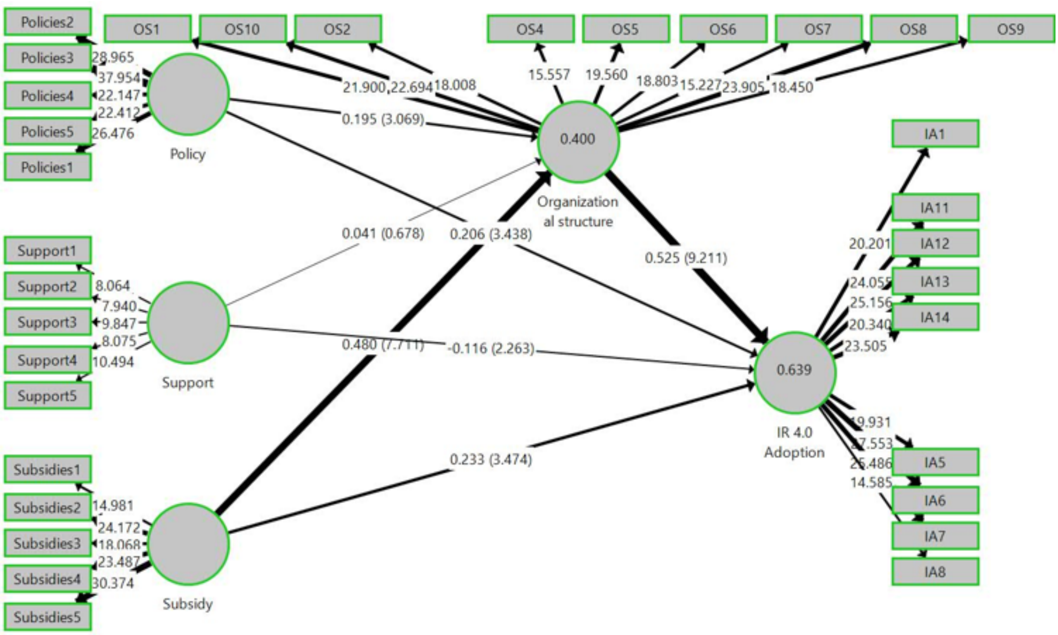


Table 8. Path coefficient

Hypothesis	Beta value	Mean	Std. deviation	T statistics	P value	Findings
Policy → Industry 4.0 adoption	0.206	0.207	0.060	3.406	0.001	Supported
Policy → Organizational structure	0.195	0.195	0.063	3.118	0.002	Supported
Subsidy → Industry 4.0 adoption	0.233	0.232	0.068	3.421	0.001	Supported
Subsidy → Organizational structure	0.480	0.480	0.060	7.943	0.000	Supported
Support → Industry 4.0 adoption	-0.116	-0.114	0.052	2.231	0.026	Supported
Support → Organizational structure	0.041	0.047	0.060	0.676	0.499	Rejected
Organizational structure → Industry 4.0	0.525	0.523	0.059	8.873	0.000	Supported

In addition, the authors tested the model fitness by assessing the standardised root mean square residual (SRMR) and normed fit index (NFI) (Lohmöller, 2013) (Table 11). The SRMR is a measure that helps researchers identify the difference between the observed and model-predicted correlation

Table 9. Variance explained in the endogenous latent variable

Constructs	R^2	R^2 Adjusted
Industry 4.0 adoption	0.639	0.632
Organizational structure	0.400	0.392

Table 10. Predictive relevance

Constructs	SSO	SSE	Q^2 – 1 - SSE/SSO)
Industry 4.0 adoption	2016.000	1294.645	0.358
Organizational structure	2016.000	1611.045	0.201

data, with a range of values from 0 to 1. However, a well-fitting model should have an SRMR below 0.08, according to Hu and Bentler's (1998) criteria. The model validation for this study was confirmed with an SRMR value of 0.074. Moreover, Bentler and Bonett (1980) introduced the NFI as an incremental fit measure, another index of model fit evaluation. According to this criteria, an NFI value within 0 to 1 is appropriate. However, a value higher than 0.9 indicates a well-fitting data model. In this study, the NFI value of 0.726 was slightly below the suggested range of 0.9; however, the difference was not significant. Therefore, the data in the study were a good fit for the model, as the SRMR and NFI values evidence. Overall, these results suggest that the model was appropriate for the data and can be used to draw meaningful conclusions.

In addition, the authors used bootstrapping in SmartPLS to examine the indirect effect and analyze mediation according to Preacher and& Hayes's (2008) method. Bootstrapping is a nonparametric resampling process known to be more rigorous and robust in testing the mediating effect of a construct in a path model. Table 12 demonstrates the mediation effects. The results show that the relationships between government policy and subsidy with Industry 4.0 adoption are mediated by the organizational structure. In contrast, the organizational structure does not play any role in the relationship between government support and Industry 4.0 adoption.

Table 11. Effect sizes (f^2)

R^2	Included	Excluded	F^2	Effect Size	Model Fit
Government policy	0.400	0.379	0.035	Small	SRMR = 0.074 NFI = 0.726
Government subsidy	0.400	0.254	0.258	Medium	
Government support	0.400	0.400	0	None	

Table 12. Mediation effects

Hypothesis	Beta Value	Mean	Std. Deviation	T Statistics	P Value	Findings
Government policy → Organizational structure → Industry 4.0 adoption	0.102	0.102	0.034	2.982	0.003	Supported
Government subsidy → Organizational structure → Industry 4.0 adoption	0.252	0.252	0.045	5.561	0.000	Supported
Government support → Organizational structure → Industry 4.0 adoption	0.021	0.026	0.032	0.661	0.509	Rejected

DISCUSSION

In this study, the authors empirically examined the impact of government initiatives (i.e., policy, support, and subsidy) on Industry 4.0 adoption. They also analyzed the mediating effect of organizational structure between government initiatives and Industry 4.0 adoption. In the following subsections, the authors discuss the findings and implications of the study.

Findings

As posited, favorable government policy significantly affects SMEs' organizational structure as the latter function within an institutional void in an emerging country context, and public policy can contribute to making them flexible and agile. The finding resonates with Wieczorek (2018), who showed that free trade and investment policies might reshape organizations as flexible and innovative by leveraging the interplay between global markets and production processes. Political-economic systems, standards, and regulations shape an economy and its actors. Fu et al. (2018) supported the same view. Therefore, the finding of the current study corroborates that supportive government policies and regulations assist organizations in reconfiguring themselves into flexible, adaptive, and innovative structures and make them open to adopting new ideas and technologies, such as Industry 4.0. In addition, government policy influences Industry 4.0 adoption significantly, which aligns with Bakar et al.'s (2020), and Weng and Lin's (2011) studies. Bakar et al. (2020) observed that government policy significantly impacted Industry 4.0 adoption. Weng and Lin (2011) found that government policy positively affected firms' adoption of green innovations. The findings indicate that, in a turbulent and dynamic market atmosphere, companies consider Industry 4.0 technologies to capture opportunities and accomplish goals, when supporting government policies are in place. The government initiatives introducing new policies that generate a conducive business environment among organizations are vital to adopt Industry 4.0. Weng and Lin recommend that governments develop favorable policies to ensure technological transformation.

Moreover, in this study, the authors found the effect of government subsidy on organizational structure to be significant, supporting the research by Guo et al. (2016), who showed that government subsidy could assist organizations in establishing participative, decentralized, and innovative organizational structures in emerging markets. Sung (2018) found a similar result, revealing that government subsidies stimulate organizational structure and firm-level innovation. The finding indicates that the higher the subsidies offered by the government, the more SMEs tend to be flexible, informative, and decentralized. Government subsidy is also observed to influence Industry 4.0 adoption significantly, supporting the same view obtained by existing studies (Bakar et al., 2020). Triguero et al. (2015) found that the influence of subsidies is more important for adopting green technologies. Similarly, Liu et al. (2020) used longitudinal data from Chinese organizations and found that government subsidies boost organizations' innovation capabilities, leading them to adopt Industry 4.0. Peng and Liu (2018) also investigated the impact of government subsidies beforehand and government subsidies afterward in promoting the growth of SMEs in the green energy industry. They found government subsidies beforehand to have a negative effect and government subsidies afterward to have a positive effect. Guo et al. (2016) also found a positive impact of government subsidies on firm innovation and technological adoption. However, the result contradicts the study conducted by Lin et al. (2019), who found that government subsidies do not affect whether companies implement Industry 4.0.

Furthermore, the effect of government support is revealed to have an insignificant impact on changing the organizational structure or no effect on transforming the organizational structure. The finding substantiates the study conducted by Ramayah et al. (2016), who came to the same conclusion. This is because, in many cases, SMEs may have achieved advanced technology adoption by themselves and tend to be more independent. Alternatively, government supports are inadequate to make a significant difference. Therefore, their continued intention to adopt technology has no relationship with government support. However, government support demonstrates a negative relationship with Industry 4.0 adoption, indicating that higher government support for Industry 4.0 may hinder organizations' adoption. The results contradict Lin et al.'s (2018) and Safari et al.'s (2015) studies, where the researchers considered government support as a significant enabler for Industry 4.0 adoption. However, this unexpected finding may have several explanations. Firstly, it could be that the government support provided is not aligned with the specific needs of the organizations, resulting in a lack of effectiveness. Alternatively, the support may come with too many restrictions or bureaucratic processes, making it difficult for organizations to take advantage of the benefits of Industry 4.0. Moreover, it is possible that the COVID-19 pandemic could have influenced the results of the study, as the data were collected during the pandemic. The pandemic has disrupted many aspects of the global economy, including the adoption of Industry 4.0 technologies. Some industries may have experienced a slowdown in adopting new technologies due to financial constraints or the need to focus on immediate operational challenges posed by the pandemic. Overall, it is important to carefully consider the type and form of government support provided to ensure that it aligns with the needs and priorities of the organizations and does not inadvertently discourage adoption.

On the other hand, the organizational structure significantly impacts Industry 4.0 adoption, supporting the findings of past studies. For instance, Haseeb et al. (2019) revealed organizational structure as a strong predictor of Industry 4.0 technologies adoption, indicating that a supportive organizational structure for technology adoption would positively influence the adoption of Industry 4.0. Dedahanov et al. (2017) made similar findings demonstrating that flexible organizational structure improves innovation performance, allowing organizations to adopt Industry 4.0.

Finally, the findings of this study indicate that organizational structure mediates the relationships between government policy, subsidy, and Industry 4.0 adoption. A flexible, less formalized, and decentralized SME is more receptive to government policies and subsidies, and open to adopting Industry 4.0. Favorable governmental policies, regulations, and adequate subsidies make SMEs more open to new processes, technologies, techniques, and ideas. This, in turn, increases the abilities of SMEs to adopt Industry 4.0. The subsidies assist SMEs in following their objectives of adopting innovation, fostering technological transformation. Thus, the organizational structure mediates the relationship between government policy, subsidy, and Industry 4.0 adoption. However, the study shows that the organizational structure does not mediate the relationship between government support and Industry 4.0 adoption.

Theoretical Implications

This study significantly contributes to the existing Industry 4.0 adoption and policy research. It integrates government involvement with organizational structure streamlining SMEs for technological transformation. The model combines government policy, support, and subsidy with the organizational structure, characterized by formalization, decentralization, and integration, in the context of technology adoption. This study stands out from other research on Industry 4.0 as it comprehensively assesses the alignment of government involvement and organizational structure, which is often overlooked in most technology adoption studies (see the literature review in Table 1). In addition, by demonstrating the mediating role of the organizational structure, this study shows how government involvement and organizational design interact to promote or hinder the adoption of Industry 4.0. This can help refine existing theories and models of technology adoption and diffusion, particularly in emerging economies. Mintzberg's (1993) organizational structure theory provides a framework for understanding the roles and responsibilities of different organizational components and how they can be aligned with the goals of Industry 4.0 adoption. By investigating the impact of organizational design and structure on the effectiveness of government support, regulation, and subsidies, the study can provide insights into the most effective ways to structure organizations to adopt Industry 4.0.

Based on the data (n=225) the authors collected from an emerging economy, this study contributes to the policy research, aligning with the organizational design and processes required for Industry 4.0.

Furthermore, the authors employed SEM, a statistically robust approach requiring a large sample size to achieve high levels of accuracy. This study bridges the gap in understanding the adoption of Industry 4.0 by organizations demanding strong government involvement. Previous studies identified this area, calling for further exploration, despite the notable progress in Industry 4.0 advancements. In this study, the authors took a significant step in filling the research gap by developing an integrative research model and evaluating it using the empirical dataset to comprehensively assess the government's initiatives in the context of Industry 4.0 adoption, focusing on organizational design and structure. This study addresses the research gap and raises organizations' awareness of the factors affecting Industry 4.0 adoption among SMEs. It also highlights the direct and indirect effects of the factors and their impact on the Industry 4.0 adoption process.

Managerial Implications

This study provides practical recommendations for professionals and policymakers seeking to promote technology adoption in emerging economies. The study offers the development of more effective policy interventions by identifying the most effective strategies for promoting Industry 4.0 adoption, such as providing targeted support for organizational restructuring. This can help to accelerate the adoption of Industry 4.0 in developing countries, which may have substantial economic and social benefits, such as increased productivity, competitiveness, and job creation.

Nonetheless, existing studies report that the current state of Industry 4.0 adoption among SMEs is still low. The high complexity and knowledge requirements mainly cause the problem, the intrinsic constraints in financial and human resources, and the shortage of technical expertise. As Industry 4.0 technologies require important financial investment, SMEs in emerging markets are relatively disadvantaged in bearing the costs and availability of adequate resources for technological transformation. As a result, government programming and promotion are needed to transition toward adopting Industry 4.0. In this regard, the findings of the study demonstrated that favorable government policy, adequate support, and subsidy would transform them as flexible and less formalized, which are more adept at digital transformation. The results revealed that SMEs begin their journey toward digital transformation with initial funding from the government. Because of the complexity of Industry 4.0 and the scarcity of resources available to SMEs, governments should develop rules and regulations to ensure that the firms know these policies and have access to the necessary service channels and incentives.

Thus, governments should implement adequate supports and initiatives to assist SMEs in technological transformation. Favorable government policies would enhance the confidence level of SME managers to adopt Industry 4.0. Emerging markets should also promote foreign investors and develop collaborations for technology transfer in the high-tech sector (Dolmark et al., 2022). Further, awareness programs for Industry 4.0 are also vital to encourage SMEs to invest. Thus, technological transformation is higher in nations with governments whose policies are supportive of adopting new technologies. Furthermore, inadequate cybersecurity is a significant concern in Industry 4.0 environments; therefore, governments should focus on policies for cybersecurity and data protection laws assuring a safe and secure industrial atmosphere. It is imperative that governments address regulatory barriers and create a robust accountability system to implement policies successfully. Governments should also create a national productivity culture and use an efficient mechanism to boost productivity.

Since SMEs lack sufficient resources, they require adequate governmental support. In some countries, the market-based strategy is followed by giving direct final support through tax incentives or loans. Financial support for the transition and migration of companies to Industry 4.0 is also essential for SMEs. In addition to information and implementation consulting for Industry 4.0, governments can subsidize industry-academia collaborations to promote digital transformation among SMEs. As Industry 4.0 calls for a high-skilled workforce, governments should have policy support to increase the number of skilled workers.

Moreover, governments should focus on subsidies, including grants and loans, to promote Industry 4.0 adoption. Governments and industry participants should work together to build favorable national policies for Industry 4.0 through subsidies and taxes, reducing the fear of failed entrepreneurship. Instead of relying on noncritical subsidies, governments should tie financial support and regulatory liberalization initiatives to productivity gains and refocus the sector on higher value-added areas of the value chain.

Finally, a flexible, innovative, and decentralized organization is required for Industry 4.0 adoption. The more the organizational structure supports adopting new technologies, the more it influences technological transformation. Therefore, SME managers should establish a flexible and supportive corporate culture and design to embrace the revolution driven by Industry 4.0. Organizations receiving adequate support and subsidies tend to reconfigure their structure to adopt new technologies. Hence, governments should make industry-oriented policies and offer sufficient funding/subsidies to encourage SME managers to create a flexible and decentralized organizational structure for Industry 4.0 adoption.

Limitations and Future Suggestions

Despite its significant contribution, this study includes several limitations. One potential limitation of using cross-sectional data in this study is that they do not allow for the analysis of trends or changes in the variables, over time, since they are collected at a single point in time. This can be particularly problematic in the context of technology adoption (e.g., Industry 4.0), where the pace of change can be rapid. Thus, future studies may consider incorporating a mixed-methods approach to address this limitation. Combining quantitative and qualitative data, the mixed-methods approach can provide a more nuanced understanding of the dynamics of government involvement, organizational structures, and technology adoption.

Moreover, the fact that the study focuses on SMEs can be considered another limitation. In particular, SMEs may have different capabilities, resources, and priorities from larger organizations, affecting their ability and willingness to adopt Industry 4.0 technologies. As such, the findings of the study may not be generalizable to larger organizations or other contexts. Nonetheless, focusing on SMEs can also have advantages, such as providing insights into the challenges and opportunities SMEs face in adopting Industry 4.0 technologies and highlighting the potential benefits of targeted policy interventions and organizational strategies to support SMEs.

However, future studies can consider large organizations as the sample, which may offer exciting findings. Indeed, large organizations have more resources, capabilities, and bargaining power than SMEs, affecting their ability and willingness to adopt Industry 4.0 technologies. In addition, large organizations may have different organizational structures and decision-making processes, which can influence the mediating role of organizational structure between government support and policies and technology adoption. Further, integrating organizational culture as the mediating variable in future work would be interesting to understand how different organizational cultures may facilitate or hinder technology adoption and how government policies can be tailored to address these dynamics.

Finally, future research should explore the underlying reasons for the negative relationship between government support and Industry 4.0 adoption, as it contradicts the widely held belief that government support is essential for promoting organizations' adoption of new technologies.

CONCLUSION

Despite the potential financial, environmental, and social advantages, Industry 4.0 adoption faces substantial challenges due to SMEs' constraints (i.e., lack of institutions, limited resources, and insufficient support). In this regard, government policy, support, and subsidies can remedy constraints to a certain extent and create an Industry 4.0-friendly atmosphere for rapidly adopting these technologies. However, only a few studies focused on the interplay between government support, regulation, and subsidies concerning the adoption of Industry 4.0, integrating Mintzberg's organizational structure theory, especially in the context of SMEs. Further, most of previous research on Industry 4.0 adoption was qualitative, with limited quantitative studies examining the impact of government support, regulation, and subsidies on organizational structure and technology adoption. Thus, to fill these research gaps, in this study the authors analyzed government involvement in contributing to Industry 4.0 by reshaping the SMEs' organizational structure to support digital transformation. The findings showed that government policy and subsidy significantly influenced Industry 4.0 adoption. Surprisingly, government support resulted in a negative relationship with Industry 4.0 adoption; thus, future research is necessary for further validation. However, government policy and subsidies substantially boosted SMEs to reshape their organizational structure to adopt new ideas and technologies, including Industry 4.0 adoption. In addition, flexible and less formalized structures play a significant role in adopting Industry 4.0. The mediating effect of organizational structure is revealed to have a substantial role. The study confirmed that Industry 4.0 supportive policies and adequate government subsidies will encourage SME managers to establish a flexible, decentralized, and innovative organizational structure, accelerating technology adoption and digital transformation. Hence, governments should make technology-friendly policies and offer sufficient funding to boost innovation and digital transformation through Industry 4.0.

COMPETING INTERESTS

The authors of this publication declare there are no competing interests.

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APPENDIX 1: QUESTIONNAIRE

The Government's Role in Small and Medium Enterprises' Adoption of Industry 4.0 in Emerging Countries: The Mediating Effects of Organizational Structure

Section A: Demographic Profile

Gender
☐ Male ☐ Female
Age
☐ ≤ 25 years old ☐ 26 - 35 years old
☐ 36 - 45 years old ☐ ≥ 46 years old
Education
☐ Diploma ☐ Bachelor
☐ Master ☐ PhD
Location of the organization
☐ Kuala Lumpur ☐ Selangor
☐ Penang ☐Other states
Number of employees
☐ 50 ≤ ☐ 51-100
☐ ≥ 101
Annual turnover (MYR)
☐ Less than 300,000 ☐ 300,000 - 15 million
☐ 16 million - 50 million

Table 13. Section B1: Role of the government

No.	Questions	1	2	3	4	5
B1: Role of the Government						
Government Policies						
RG 1	Government policy can attract more foreign investors to invest in Industry 4.0.					
RG 2	Government policy can encourage Industry 4.0 adoption.					
RG 3	Government policy can improve Industry 4.0 efficiency.					
RG 4	Government policy can educate SMEs on the benefits of Industry 4.0.					
RG 5	Overall, government policy helps SMEs to adopt Industry 4.0.					
Government Support						
RG 6	Government support can equip managers with skills to adopt Industry 4.0.					
RG 7	Government support can educate employees to adopt Industry 4.0.					
RG 8	Government support can encourage conservation and pollution prevention efforts through Industry 4.0 adoption.					
RG 9	Government support can provide information on Industry 4.0 adoption.					
RG 10	Overall, government support can help SMEs understand Industry 4.0 adoption.					
Government Subsidies						
RG 11	Government subsidies will decrease SMEs' investment costs in Industry 4.0 adoption.					
RG 12	Government subsidies will influence more SMEs to adopt Industry 4.0.					
RG 13	Government subsidies can fund the development in Industry 4.0 adoption.					
RG 14	Government subsidies can reduce the risks in Industry 4.0 adoption.					
RG 15	Overall, government subsidies increase SMEs' interest in adopting Industry 4.0.					

Table 14. Section B2: Organizational structure

No.	Questions	1	2	3	4	5
B2: Organizational Structure						
Formalization						
OS 1	The organization has many work rules and policies on Industry 4.0 adoption.					
OS 2	The employees follow the clearly defined task procedures made by the firm in Industry 4.0 adoption.					
OS 3	The organization relies on strict supervision in controlling day-to-day operations on Industry 4.0.					
Integration						
OS 4	The organization's departments can access relevant data through a shared information system in Industry 4.0.					
OS 5	The organization's horizontal integration enables cyber-physical interaction through automation in production lines.					
OS 6	The organization's inventory-related information is visible throughout the supply chain in Industry 4.0.					
OS 7	The organization maintains product order management through an online platform in Industry 4.0.					
Decentralization						
OS 8	Our employees have the autonomy to do their work in Industry 4.0 adoption.					
OS 9	Our employees participate in the decision-making process regarding Industry 4.0 adoption.					
OS 10	Our employees search for problem solutions from many channels on Industry 4.0 adoption.					

Table 15. Section B3: Industry 4.0 adoption

No.	Questions	1	2	3	4	5
B3: Industry 4.0 Adoption						
Organizational Strategy						
IA1	The organization has effective Industry 4.0 adoption strategies.					
IA2	The organization is aware of competitors' Industry 4.0 practices.					
IA3	The organization allocates adequate resources for Industry 4.0 adoption.					
IA4	The organization allocates resources to train the employees.					
IT Infrastructure						
IA5	The organization uses hardware and modern equipment.					
IA6	The organization encourages employees to use sophisticated hardware and equipment to adopt Industry 4.0.					
IA7	The organization uses software applications to achieve its objectives through Industry 4.0 adoption.					
IA8	The organization's IT manager understands the policies and goals of the organization towards Industry 4.0 adoption.					
IA9	The organization's IT manager supports Industry 4.0 adoption.					
Employees' Adaptability						
IA10	The organization's employees are willing to take risks to experiment with Industry 4.0.					
IA11	The employees are competent to work with Industry 4.0.					
IA12	The employees are motivated to work with Industry 4.0.					
IA13	The employees generate new ideas for Industry 4.0.					
IA14	The employees collaborate to solve technical problems during Industry 4.0 adoption.					

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