

State Effectiveness at Managing the Fourth Industrial Revolution and Innovation in Vietnam

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ABSTRACT

This article examines state effectiveness in the context of globalization and the Fourth Industrial Revolution with Vietnam as its case study. Through mixed methods including surveys with public servants, it evaluates perceptions of state effectiveness at managing resources, promoting sustainable development, and facilitating social participation in governance. Additionally, it explores how government policies and management systems are adapting to modern challenges, including digital transformation, environmental sustainability, and socioeconomic changes. Surveys focused on several factors—human resources, businesses, digital transformation, the environment, and social welfare. Data was collected from 481 public servants at different levels of government, and analyzed using SPSS 20 software to identify correlations and impacts. My results reveal that human resources, businesses, digital transformation, and environmental factors significantly contribute to perceptions of state performance, driving improvements in governance efficiency and sustainable development. Conversely, social welfare was found to have an insignificant effect. While economic and environmental considerations are crucial, more research is needed to explore the indirect impacts of social welfare on governance. Based on these results, the paper offers several recommendations for improving government management, emphasizing the need for advancing digital transformation, enhancing human resource capacity, supporting businesses, and strengthening environmental policies to ensure long-term sustainable development and effective state performance.

Keywords: Industrial revolution 4.0, State effectiveness, Innovation, Sustainable development, Vietnam.

INTRODUCTION

The new Fourth Industrial Revolution (also referred to as the period of Industry 4.0) not only brings significant changes to production but also profoundly impacts areas such as public services, education, healthcare, and the environment. In the context of Vietnam, Industry 4.0 poses an urgent requirement for the state to coordinate, formulate policies, and support fundamental elements such as human resources, businesses, digital transformation, the environment, and social welfare. To achieve high efficiency in this context, the state must make timely adjustments in development strategies and management.

Technological advancements from Industry 4.0, including the Internet of Things (IoT), Artificial Intelligence (AI), and smart production systems, have opened up new opportunities for a circular economy. According to Awan et al. (2021b), these technologies optimize processes, recycle resources, and minimize waste, contributing to sustainable development. This is particularly meaningful in a context where businesses and governments must leverage advanced technologies to improve resource efficiency, reduce carbon emissions, and promote a green economy (Awan et al., 2021b). However, implementing these technologies depends on the state's management capacity, especially in creating a clear legal framework and specific support policies. The state not only plays a role in resource coordination but also in crafting policies that encourage businesses to adopt new technologies. To support digital transformation and foster innovation, the state needs to propose appropriate data management, cybersecurity, and intellectual property solutions, helping businesses develop sustainably in a high-tech environment (Awan et al., 2022). Green blockchain solutions are also an area that the state should focus on, aiming to monitor environmental impacts and reduce energy consumption. This not only enhances transparency in environmental management but also encourages businesses to apply technology to protect natural resources.

In the context of Vietnam's development and the challenges posed by the Fourth Industrial Revolution, state effectiveness plays a key role in maintaining economic stability, enhancing competitiveness, and ensuring sustainable development. The state must not only plan and implement appropriate policies but also effectively coordinate resources such as human capital, businesses, digital transformation, the environment, and social welfare. According to Painter & Pierre (2005), state effectiveness is measured through an ability to execute policies and build relationships with society, enabling societal participation in state activities to ensure sustainable development. Effective governments can improve governance, reduce corruption, and promote innovation, particularly in the area of digital transformation. Koeswayo et al. (2024) suggest that an effective government not only enhances business capabilities but also develops a high-skilled workforce and effectively manages environmental challenges. Vaccaro (2023) emphasizes the importance of selecting appropriate metrics to accurately assess state capacity, thereby improving governance and development. On the other hand, Li & Wright (2023) warn of the risks of politicizing the administrative apparatus, which reduces objectivity and effectiveness, thereby hindering the implementation of innovation policies. In this context, building a state apparatus with flexible coordination capabilities, close

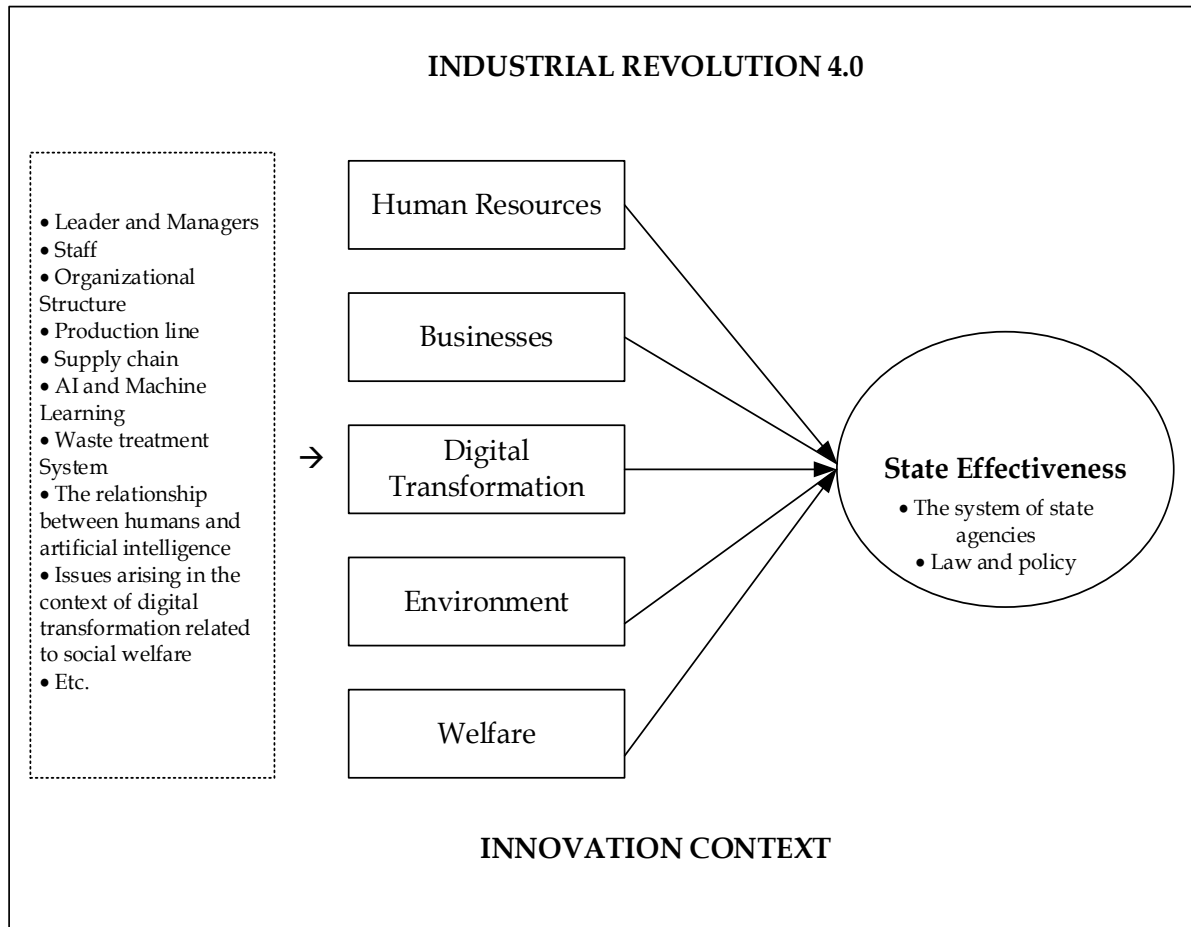
collaboration with stakeholders, and a commitment to transparency and objectivity is crucial to promoting state effectiveness. The government must ensure that policies supporting innovation and digital transformation not only foster economic development but also improve social welfare and protect the environment, thereby achieving sustainable development.

However, to achieve this, Vietnam must confront a series of challenges in improving the quality of its human resources, supporting businesses in digital transformation, all the while maintaining a balance between economic development and protection of the environment. These factors require the state not only to implement sound policies but also to have the ability to coordinate them closely, ensuring the consistency and effectiveness of the transformation programs. The state's ability to coordinate elements such as human resources, businesses, digital transformation, environmental protection, and social welfare not only will determine the success of the digital transformation process but also profoundly impacts Vietnam's long-term sustainable development.

This article aims to clarify the state's role in coordinating these foundational elements, while also providing specific solutions for Vietnam in the context of the Fourth Industrial Revolution. With the rapid development of technology, ensuring an efficient, transparent, and professional administrative apparatus has become a mandatory requirement for Vietnam to maximize the opportunities presented by this revolution. At the same time, the state must address challenges related to resource allocation and how policies can not only support economic growth but also ensure sustainable development, environmental protection, and improve quality of life for people. So, how can the Vietnamese state enhance its management and coordination of factors such as human resources, businesses, digital transformation, the environment, and social welfare, to innovate and best capitalize on the opportunities provided by the Fourth Industrial Revolution?

Figure 1

An overview of the research context and factors affecting state effectiveness.



The development of human resources in the context of the Fourth Industrial Revolution brings both opportunities and challenges. While emerging technologies such as AI, automation, and IoT can enhance workforce efficiency, they also raise concerns about job displacement (Piwowar-Sulej, 2020). Trompisch (2017) argues that the rise of Industry 4.0 technologies does not necessarily mean all work will be automated but rather it requires more collaboration between humans and machines. In fact, human resources departments are expected to take on a more strategic role through the concept of “smart human resources” utilizing context-aware technologies to anticipate employee needs and enhance decision-making processes (Ammirato et al., 2023; Sivathanu & Pillai, 2018). Employee adaptability also contributes to fostering innovation (Kumi et al., 2024). However, the lack of skilled labor necessary to apply these technologies poses a significant challenge, especially in emerging markets. Thus, effective human resources are crucial for success in the Fourth Industrial Revolution (Alshahrani, 2023). On another front, Zhou & Zheng (2023) highlight that support from senior management also plays a decisive role in ensuring resource allocation for technology and enhancing employee capabilities. Although many studies have pointed out the importance of human resources in driving technological innovation, few have focused on measuring the specific impact of human resources on state effectiveness, especially in developing countries like Vietnam, where there is still a shortage of high-skilled technical workers. This leads to the hypothesis that human resources have a positive impact on state effectiveness in the context of the Fourth Industrial Revolution and innovation.

Businesses are at the forefront of Industry 4.0 transformations, with many companies adopting digital tools to optimize production and reduce costs. The integration of AI and IoT in smart factories allows for remote control, minimizes manual intervention, and improves product quality (Arnold et al., 2016), while big data analysis enhances flexibility and business performance (Awan et al., 2021a). In turn, open business models and collaboration foster innovation and adaptability to technological changes (Bogers et al., 2019). These models provide flexibility and competitiveness as companies collaborate with partners across the value chain to create customized products and services that meet customer expectations while maintaining efficiency and cost-effectiveness (Santos et al., 2017; Brasseur et al., 2017; Awan et al., 2022). Additionally, new business models like open innovation are essential for companies facing crises such as pandemics or global disruptions (Grabowska & Saniuk, 2022). As companies transition to smart technologies, the role of the state becomes crucial in creating a favorable legal and financial environment. Supportive policies for data protection, cybersecurity, intellectual property rights, and tax incentives for technological investment help businesses thrive in the competitive 4.0 landscape (Bašić, 2023; Moradi et al., 2021). Investment in digital skills (Bikse et al., 2022), minimizing business risks (Alshahrani, 2023), and fostering a culture of learning to develop new skills aligned with Industry 4.0 are also key (Ivaldi et al., 2022). However, high investment costs and lack of infrastructure pose challenges for small and medium-sized enterprises (SMEs) (Despoudi et al., 2023). Another challenge, as highlighted by Aregawi & Patnaik (2023), is the slow pace of business innovation relative to the current context. While the role of businesses in digital transformation and innovation has been discussed, there is still limited research on the relationship between businesses and state effectiveness. In particular, the role of SMEs in enhancing state performance remains underexplored. This leads to the hypothesis that businesses have a positive impact on state effectiveness in the context of the Fourth Industrial Revolution and innovation.

Digital transformation, often seen as synonymous with e-government, is at the core of modern governance. It involves the application of information technology to streamline government processes and improve service delivery. According to Mergel et al. (2019), the term "digital government" may limit the scope of transformation, as it also requires new frameworks for interaction between the state, businesses, and citizens. The ultimate goal of digital transformation is not just to digitize existing processes but to fundamentally restructure public sector operations for better efficiency (Alvarenga et al., 2020; Schallmo & Williams, 2018). Digital transformation in the public sector also necessitates new service transaction frameworks and partnerships, facilitating citizen participation and transparency in government activities (Mergel et al., 2019). The state must implement policies that support businesses within industrial clusters to enable Industry 4.0 and foster innovation (Mackiewicz & Götz, 2024; Tsakalerou & Akhmadi, 2021), particularly through local-level government support (De Propriis & Bailey, 2021).

Ye et al. (2022) emphasize the serious consequences of excessive government intervention in the digital transformation of businesses. While digital transformation is considered a key factor in improving state management capacity, research has primarily focused on its impact on businesses and public administration systems, without sufficiently examining how digital transformation affects state effectiveness

from a policy-making and social interaction perspective. Therefore, there is the case for a hypothesis that digital transformation positively impacts state effectiveness in the context of the Fourth Industrial Revolution and innovation.

In addition to promoting business innovation and digital transformation, the state plays a critical role in addressing environmental concerns related to Industry 4.0. Technologies such as AI, cloud computing, robotics, big data, and blockchain hold significant potential to drive sustainable development (Ferreira et al., 2023). AI can assist companies in managing risks and moving toward greener production by enabling error detection and early warning systems (Cioffi et al., 2020; Mao et al., 2019). Cloud computing offers value to organizations by reducing operational costs and optimizing natural resource usage through energy-efficient systems, contributing to sustainable development efforts (Chang et al., 2010). Robotics applications also allow companies to optimize production processes, reduce emissions, and enhance the efficient use of raw materials, supporting more sustainable production methods (Ajwani-Ramchandani et al., 2021; Gadaleta et al., 2019; Ogbemhe et al., 2017; Yamamoto et al., 2020). Big data analytics, with its capacity to process large and diverse datasets, is transforming supply chains and helping companies optimize resource use, reduce waste, and minimize harmful emissions (Awan et al., 2022; Fosso Wamba et al., 2017). Blockchain technology, with its ability to track and monitor environmental impacts, offers additional opportunities for sustainable production (Parmentola et al., 2022). While environmental factors and green technologies have been emphasized in numerous studies on sustainable development, there is still limited research clarifying the role of environmental policies and green technologies in influencing the effectiveness of state management and policy enforcement. Hence, this article proposes the hypothesis that the environment has a positive impact on state effectiveness in the context of the Fourth Industrial Revolution and innovation.

Finally, another crucial factor in state performance within the context of Industry 4.0 is social welfare. The automation of repetitive tasks, improvement in working conditions, and promotion of human rights are some of the recognized social benefits of new technologies (Khakurel et al., 2018). However, the widespread adoption of advanced robotics and AI also raises concerns about unemployment and social inequality (Alshahrani, 2023; Ammirato et al., 2023; Bikse et al., 2022; Frey & Osborne, 2017; Gonese & Ngepah, 2024; Lloyd & Payne, 2019). Blockchain technology has been identified as a tool for promoting social sustainability by improving working conditions and ensuring compliance with safety and labor standards (Khanfar et al., 2021; Venkatesh et al., 2020). Additionally, cloud computing can support sustainable social development through data-sharing platforms that foster innovation and improve social outcomes in production (Joung et al., 2013). While social welfare in the context of automation and digital transformation is widely discussed, there remains a lack of in-depth studies analyzing how welfare policies impact state effectiveness, particularly in maintaining social stability and mitigating the negative effects of automation. Therefore, the hypothesis that social welfare has a positive impact on state effectiveness in the context of the Fourth Industrial Revolution and innovation is also proposed to fill this research gap.

In Vietnam, state effectiveness is often understood as the effectiveness of public administrative management, evaluated based on compliance with the law and the use of resources. The state's performance is measured through the outcomes of public

administrative actions, considering economic, political, and social factors, and balancing short-term and long-term goals as well as central and local interests (Koeswayo et al., 2024; Painter & Pierre, 2005; Vaccaro, 2023). However, in the context of the Fourth Industrial Revolution, the scope of state effectiveness needs to be expanded to include evaluation of the state's capacity to manage and support digital transformation, innovation, and sustainable development in areas such as human resources, businesses, the environment, and social welfare. This study introduces a novel approach by examining not only the individual impact of these factors but also their interactions. By exploring these interrelationships, the study aims to determine how the Vietnamese state can optimize its management capacity to promote sustainable development and enhance state effectiveness in the modern technological context. This research specifically evaluates the policies and effectiveness of the Vietnamese state in supporting these factors, while providing policy recommendations for improvement. The article presents five key hypotheses (H1, H2, H3, H4, H5), expanded in the literature review, which assess the impact of human resources, businesses, digital transformation, the environment, and social welfare on state effectiveness in the context of Industry 4.0 and innovation. The article is structured as follows: First, an overview of the factors influencing state effectiveness is provided, from which the research hypotheses are developed. The research methods are then detailed, followed by an analysis of the results, which demonstrate that human resources, businesses, digital transformation, and environmental factors have a positive impact on state effectiveness, while the role of social welfare is less pronounced. Finally, the article concludes with policy recommendations and suggests future research directions to explore the indirect effects of these factors, particularly focusing on the role of social welfare and SMEs in the digital transformation process.

LITERATURE REVIEW

STATE EFFECTIVENESS

In the context of the Fourth Industrial Revolution, factors such as human resources, businesses, digital transformation, the environment, and social welfare are closely interconnected and mutually influential, profoundly impacting state effectiveness. According to Painter & Pierre (2005), state effectiveness depends on two key aspects: the ability to formulate and implement policies, and the relationship between the state and society. The state's management capacity is linked to its ability to make decisions, allocate resources, and garner public support for its actions. At the same time, the relationship between the state and society is considered crucial, as the state must build institutions that allow society to participate in state activities, ensuring that these institutions are not influenced by local political interests. This emphasizes that state effectiveness is not only based on internal factors but also depends on its ability to interact with society, leading to prosperity and sustainable development.

Studies by Koeswayo et al. (2024), Vaccaro (2023), and Li & Wright (2023) focus on the issue of state effectiveness from different perspectives, creating a comprehensive picture of the relationship between state governance, innovation policies, and digital transformation in the context of the Fourth Industrial Revolution.

Koeswayo et al. (2024) emphasize the role of government effectiveness in improving governance and reducing corruption, thereby supporting digital transformation and innovation to improve public services and enhance transparency. An effective government not only positively impacts business capacity but also determines the development of a highly skilled workforce for emerging technologies such as AI and IoT, while contributing to environmental protection and social welfare through e-governance and equitable policies. Vaccaro (2023) notes that choosing appropriate metrics to assess state capacity is crucial, as different metrics can lead to varying results in governance effectiveness and business innovation. In the context of the Fourth Industrial Revolution, policies that support businesses and human resource development through digital transformation and social welfare are critical to ensuring sustainable development and competitiveness. On the other hand, Li & Wright (2023) provide a perspective on how individualist political parties can undermine state capacity by politicizing the administrative apparatus, leading to the loss of objectivity and efficiency. This negatively affects policies related to digital transformation, business development, and social welfare, making their effective implementation more difficult. In the context of Industry 4.0, where innovation and digital transformation are core factors, an objective and professional administrative apparatus is required to execute sustainable development strategies. These three studies when taken together clarify the importance of effective governance and a strong administrative apparatus in driving innovation and socioeconomic development in the digital age.

From another perspective, Mora et al. (2023) propose evidence-based strategic recommendations for governments to better manage smart urban development, including improving innovation-supporting policies and strengthening stakeholder collaboration. In addition, the dynamic capabilities of governments play a key role in leading and promoting smart city projects, helping them adapt to changes and innovate effectively. These projects not only improve the efficiency and effectiveness of public services but also create public value by addressing social challenges such as sustainable growth and social welfare. However, one of the main challenges governments face in managing smart city projects is how to effectively manage partnerships between experts, citizens, and the government, ensuring that innovative initiatives have a positive impact (Barrutia et al., 2022).

FACTORS AFFECTING STATE EFFECTIVENESS

In the context of the Fourth Industrial Revolution, the interaction between factors such as human resources, business, digital transformation, the environment, and social welfare plays a decisive role in state effectiveness. An effective government not only promotes innovation and digital transformation but also ensures sustainable development by improving the quality of human resources and supporting businesses in adopting advanced technologies. At the same time, policies must focus on environmental protection and enhancing social welfare. However, without objectivity and transparency within the state apparatus, it becomes difficult to implement policies effectively, leading to weakened governance. Therefore, maintaining a professional administrative system and fostering societal participation are key factors for achieving governance effectiveness and sustainable development in the digital age.

The development of human resources in the Fourth Industrial Revolution is a key factor in ensuring the success of digital transformation and the adoption of new technologies. The workforce must adapt to technological changes, as the integration between humans and technology will inevitably become a future trend. To meet these demands, significant investment in human resources and digital skills development is required. One important solution proposed is to foster collaboration between educational institutions and businesses to equip workers with the necessary skills to compete and adapt in the new labor market (Bikse et al., 2022). Furthermore, Kumi et al. (2024) emphasize that employees' career adaptability plays a crucial intermediary role between technological readiness and adaptive work behaviors, enabling them to effectively leverage new technologies in the workplace. Adaptive behaviors, such as integrating work-life boundaries and job crafting, are seen as essential for improving work performance during digital transformation. Additionally, technological readiness not only enhances performance but also helps develop professional skills, which is key for organizations to successfully implement innovation initiatives. According to Piwovar-Sulej (2020), failing to keep up with this trend may lead to job losses. However, in the early stages, technologies like AI, automation, and IoT will support human labor, increasing productivity and accelerating the progress of the Fourth Industrial Revolution. While AI and robotics may reduce the number of jobs, technology cannot entirely replace humans (Trompisch, 2017). Sivathanu & Pillai (2018) and Ammirato et al. (2023) emphasize that technologies like IoT and AI will automate human resource processes, transforming traditional human resources into "smart human resources" and helping managers make data-driven decisions. The state must play a role in investing in education and training to ensure that the workforce possesses the skills needed to meet market demands (Trompisch, 2017).

Under the impact of the Fourth Industrial Revolution, human resources play a crucial role in achieving digital transformation goals. However, in many emerging markets, one of the significant challenges is the shortage of skilled labor to apply new technologies such as AI, big data analytics, and the IoT. This lack of knowledge and skills not only hinders the deployment of new technologies but also makes it difficult for many businesses to maintain their competitive edge. In particular, SMEs often struggle to find and retain highly skilled employees specialized in Industry 4.0 (Alshahrani, 2023). Zhou & Zheng (2023) focus on the support from senior management in businesses. Senior management can facilitate the digital transformation process by allocating resources appropriately, ensuring that businesses have sufficient financial, human, and time resources to implement technology. This not only helps overcome technical barriers but also enables companies to adapt to changes in management and production processes. Moreover, a company's technological capability, including its technology infrastructure and employee skills, is a key factor in preparing for digital transformation. Technology infrastructure provides a supporting foundation, while employee skills ensure that new technologies are applied effectively to optimize productivity (Zhou & Zheng, 2023). Enhancing technological capability is not only about investing in new technologies but also requires companies to invest in training their workforce, helping them familiarize themselves with modern tools and processes, thereby ensuring the success of digital transformation.

While many studies have highlighted the critical role of human resources in promoting development and digital transformation in the context of the Fourth Industrial Revolution, most of these studies only focus on the importance of human resources in the technological transformation and process improvement aspects. There has been a lack of specific research measuring the impact of human resources on state effectiveness in the context of digital transformation and innovation. In developing countries like Vietnam, the shortage of skilled labor in high-tech and digital governance sectors is a major challenge, which has not been thoroughly examined in terms of its influence on state effectiveness. Therefore, a major hypothesis of this article is that human resources have a positive impact on state effectiveness in the context of the Fourth Industrial Revolution and innovation. This is hypothesis 1 (H1).

Businesses are significantly impacted by the Fourth Industrial Revolution, making digital transformation a mandatory requirement for optimizing production processes and minimizing costs. The integration of smart technologies like AI, IoT, and automation helps companies reduce errors, improve product quality, and respond quickly to production issues (Arnold et al., 2016). Additionally, the adoption of advanced technologies such as cyber-physical systems, IoT, cloud computing, and big data analytics not only enhances operational efficiency but also demands new skills from the workforce, enabling businesses to improve productivity and flexibility while reducing costs (Awan et al., 2021a; Awan et al., 2022). Bogers et al. (2019) suggest that the shift from traditional business models to open business models leads to significant changes in market structure. According to Brasseur et al. (2017), thanks to information and communication technologies, companies can customize production to meet customer demands while maintaining low costs and high efficiency. This creates fierce competition, forcing businesses to innovate continuously to survive and grow (Santos et al., 2017). Bašić (2023) further explains that in the era of Industry 4.0, the relationship between businesses and customers becomes more important than ever. Open business models require companies to optimize their value relationships with customers to enhance competitiveness, which is especially necessary during crises such as pandemics or wars (Grabowska & Saniuk, 2022). However, digital skill shortages in businesses (Bikse et al., 2022), combined with high initial investment costs and business risks, particularly in emerging markets, make many companies hesitant to invest in technology due to the high costs and unclear returns. The lack of strong support from government policies adds to the uncertainty, increasing risks for businesses, especially in an increasingly competitive global environment (Alshahrani, 2023). Therefore, state intervention through financial support policies, incentives for technological investment, and the creation of a favorable legal environment is key to helping businesses successfully undergo digital transformation and ensure sustainable development. Despoudi et al. (2023) emphasize that high investment costs and inadequate infrastructure are significant barriers for SMEs in India when adopting Industry 4.0 for a circular economy model. From another perspective, Ivaldi et al. (2022) suggest that organizations must promote continuous learning to develop new skills and flexible work cultures, enabling employees to face the challenges of Industry 4.0. A flexible approach is considered the most effective method for placing people at the center of technological progress while combining the development of soft skills such as problem-solving, project management, and teamwork. Additionally,

it highlights that technological development must align with social sustainability, ensuring that the economic benefits of technology are not concentrated in the hands of a few but spread throughout society. Shet & Pereira (2021) assert that business managers need to develop 14 core competencies to successfully take advantage of the opportunities in Industry 4.0, including innovative leadership, change management, digital literacy, and systems thinking. Moreover, their research emphasizes that social sustainability in Industry 4.0 requires managers not only to have technological skills but also to develop the ability to manage the social impact of new technologies.

In the context of the Fourth Industrial Revolution, the role of the state in supporting technological innovation and the digital transformation of businesses is crucial. According to the research of Ye et al. (2022), excessive government intervention in business operations not only reduces the ability of businesses to invest in research and development but also encourages them to seek political advantages rather than focusing on long-term innovation strategies. They point out that stringent internal controls may hinder business creativity and innovation due to complex processes and the fear of risk associated with innovation failure. Furthermore, when internal control quality is high, it can exacerbate the negative impact of government intervention on technological innovation, leaving businesses constrained by both factors and, consequently, reducing the level of innovation. To promote innovation and digital transformation, the state needs to reduce intervention and create a more market-oriented environment, allowing businesses to develop long-term strategies and invest in new technologies. At the same time, according to the research of Aregawi & Patnaik (2023), government intervention through support and development programs has had positive effects in enhancing innovation capacity. However, the study also indicates that businesses still face limitations in skills, knowledge, and financial support from the state, leading to low levels of innovation. Many businesses only achieve “occasional innovation,” highlighting the need for more in-depth policies to effectively foster innovation. The shortage of skills and knowledge in managing and developing technology is one of the main factors hindering business innovation. To improve innovation effectiveness, the government should increase technical support, training, and financial assistance, helping businesses achieve higher levels of innovation.

Businesses play a crucial role in enhancing state effectiveness by adopting technologies such as AI, IoT, and automation to optimize production processes, reduce costs, and increase productivity. These advancements not only help businesses minimize errors and improve product quality but also contribute to sustainable development and enhance national competitiveness. The development of businesses heavily relies on state support through financial policies, infrastructure development, and human resource training. Effective management, decision-making, and resource allocation by the state create favorable conditions for businesses to engage in digital transformation and innovation. However, excessive state intervention, such as the implementation of strict control measures, can reduce business innovation motivation. This increases risks and limits creativity, ultimately affecting the level of technological innovation. Therefore, state intervention must be carefully adjusted to strike a balance between supporting businesses and maintaining a free market environment for sustainable development. Thus, state effectiveness is not only based on management and policy formulation capabilities but also on creating a favorable

environment for businesses to thrive, contributing to social prosperity and sustainable development.

While research has addressed the role of businesses in innovation and digital transformation, most studies focus on identifying the importance of businesses in adopting new technologies and improving production efficiency. There is still a lack of detailed studies on the relationship between business and state effectiveness, particularly in measuring how businesses impact state governance and policy implementation in the context of the Fourth Industrial Revolution. Additionally, research should delve deeper into the role of SMEs in contributing to state effectiveness, rather than just focusing on large-scale enterprises. Moreover, existing studies have not yet clarified the reciprocal relationship between businesses and the state, especially how government support policies affect business innovation and, conversely, how business development impacts state governance effectiveness. Because of this, I propose that businesses have a positive impact on state effectiveness in the context of the Fourth Industrial Revolution and innovation, as my second hypothesis (H2).

Digital transformation is a crucial factor in improving how organizations and businesses operate. Alvarenga et al. (2020) argue that digital transformation is not just about integrating technology but also about enhancing how businesses interact with customers and partners. This leads to a comprehensive change in business operations. In the public sector, Mergel et al. (2019) point out that digital transformation is synonymous with e-government, where administrative processes are digitized to provide services to citizens and businesses more quickly and efficiently. Collaboration between the state and businesses is key to ensuring a smooth digital transformation process that benefits the entire society (Schallmo & Williams, 2018). Industry clusters play a significant role in promoting innovation and digital transformation in the context of the Fourth Industrial Revolution. These clusters are not just economic hubs but also key drivers of innovation, creating a collaborative environment where businesses can share knowledge and improve access to new technologies. By building strong networks between businesses and the scientific community, industry clusters can support the digital transformation process, helping companies effectively implement advanced technological solutions (Tsakalerou & Akhmadi, 2021). Moreover, state policies supporting digital transformation are a crucial factor in fostering business development and facilitating the transition to Industry 4.0. Mackiewicz & Götz (2024) emphasize that government policy plays a vital role in creating favorable conditions for businesses within industry clusters to adopt Industry 4.0 technologies. Specifically, through financial support mechanisms, tax incentives, and investment in technology infrastructure, the state can help businesses more easily access advanced technologies. De Propriis & Bailey (2021) expand on this by stating that state support policies for Industry 4.0 should be extended at the local level.

State effectiveness in the context of the Fourth Industrial Revolution increasingly depends on the ability to apply and promote digital transformation. Digital transformation is not merely about adopting technology but involves a comprehensive shift in how the state manages, provides services, and fosters development for businesses and society. The success of this transformation is determined by the state's ability to formulate policies, implement technological projects, and manage resources effectively. As highlighted in previous studies, digital

transformation improves governance capacity, reduces corruption, and enhances the transparency and efficiency of public services. It also drives business development through supportive policies, creating opportunities for developing digital skills, particularly in advanced technologies like AI and IoT. Another crucial aspect is that the combination of digital transformation and transparent governance can help address challenges related to environmental protection and social welfare. Effective digital policies not only bring economic benefits but also improve citizens' lives by providing fast public services, reducing administrative burdens, and enhancing interactions between the government and society. Clearly, the effectiveness of the state in the digital age will depend on its ability to adapt flexibly, the professionalism of the administrative apparatus, and the level of cooperation between stakeholders. This ensures that digital transformation policies are not merely technological solutions but also contribute to sustainable development and social equity.

In research on digital transformation, most studies focus on the impact of digital transformation on the business sector, public administrative systems, or technology-promoting policies. There is little analysis of how digital transformation directly affects state effectiveness, especially in the context of the Fourth Industrial Revolution and innovation, or how it helps improve state effectiveness from the perspective of policy formulation, public governance, and public service delivery. Additionally, the interaction between the state and society in the process of digital transformation has not been explored in depth. Existing research often emphasizes the role of technology in public governance but does not fully consider how digital transformation can strengthen the relationship between the state and the public, as well as how it impacts public trust and support for state policies. Therefore, I aim to test the hypothesis that digital transformation has a positive impact on state effectiveness in the context of the Fourth Industrial Revolution and innovation, hypothesis 3 (H3).

New technologies also play a crucial role in mitigating negative environmental impacts and promoting sustainable development by optimizing supply chain and production management processes while encouraging recycling and waste reduction through the circular economy (Awan et al., 2022). AI can assist in risk management and make greener production decisions (Cioffi et al., 2020). Mao et al. (2019) suggest that AI can synthesize data to optimize resource usage, while cloud computing not only reduces costs but also helps businesses use energy efficiently (Chang et al., 2010). Robots and automation contribute to reducing energy consumption and CO₂ emissions in production processes (Gadaleta et al., 2019; Ogbemhe et al., 2017). Ajwani-Ramchandani et al. (2021), Yamamoto et al. (2020) and Bikse et al. (2022) emphasize that adopting these technologies not only minimizes waste but also fosters flexible production, allowing companies to customize products according to customer needs while maintaining production efficiency and environmental protection. Another breakthrough technology is blockchain, regarded as a key tool in the Fourth Industrial Revolution thanks to advances in computing. Blockchain technology is increasingly used in areas such as supply chain management, energy, and climate change. Blockchain supports sustainable production models by processing, monitoring, and storing data related to pollution and environmental degradation, as well as providing real-time data on green activities, which aids environmental management decision-making (Parmentola et al., 2022). Additionally, blockchain

helps deploy green supply chains, enabling businesses to track the entire process from production to consumption transparently and efficiently (Mora et al., 2021). However, traditional blockchain systems consume significant amounts of energy, produce large amounts of CO₂ emissions, and require substantial infrastructure for server storage, leading to issues such as deforestation and the waste of natural resources (Parmentola et al., 2022). This indicates that although blockchain has great potential to support sustainable models, technical improvements are needed to minimize its negative environmental impacts.

In the context of the Fourth Industrial Revolution, the role of the state in supporting technological innovation through tax policies and subsidies is crucial. According to Li & Rao (2023), environmental taxes have a threshold effect on the development of green technology, but the current tax levels are not sufficient to optimally encourage development. At the same time, government subsidies can help mitigate the negative effects of the environmental tax burden on green technology innovation, particularly when tax levels have not reached the necessary threshold to stimulate innovation. The combination of environmental taxes and government subsidies not only supports the development of green technology but also helps optimize state policies in encouraging businesses to undertake innovation projects. The authors further recommend enhancing oversight of subsidy implementation and expanding the scope and level of environmental taxes to maximize the effectiveness of green technology while promoting sustainable development.

It is evident that state effectiveness in the context of the Fourth Industrial Revolution is closely tied to environmental factors, particularly the state's ability to manage and adjust policies to promote sustainable development. The application of new technologies such as AI, blockchain, and robotics can optimize resource usage, reduce energy consumption, and decrease CO₂ emissions during production. Blockchain, despite its significant potential in supporting sustainable models and managing green supply chains, faces challenges related to high energy consumption and CO₂ emissions. This highlights the need for technical improvements to mitigate the negative environmental impacts of these technologies. This emphasizes the role of the state in establishing supportive policies, such as environmental taxes and subsidies, to encourage the development of green and sustainable technologies. However, the current environmental tax levels are insufficient to effectively stimulate technological innovation, necessitating stronger government oversight and expanded policy measures. Thus, state effectiveness in managing environmental factors is not solely based on policy formulation and execution but also depends on flexible coordination among stakeholders to ensure sustainable development. The combination of governance capacity and new technologies allows the state to not only improve public service efficiency but also contribute to environmental protection and social welfare development.

While existing research highlights the important role of new technologies such as AI, blockchain, and supply chain management solutions in supporting sustainable development and reducing environmental impacts, there is still a lack of in-depth studies focusing on the relationship between environmental factors and state effectiveness in the context of the Fourth Industrial Revolution. Specifically, further research is needed to clarify how environmental policies, green technologies, and state-led environmental protection measures can impact state management capacity

and policy implementation effectiveness. Additionally, research is lacking on the relationship between state governance and businesses in the field of environmental protection, especially how the state can support businesses in adopting environmentally friendly technologies to drive innovation and digital transformation. The potential of the environment in promoting sustainable development has not been fully evaluated, especially in a context where other factors such as human resources and businesses also impact state effectiveness. In line with this, I propose the hypothesis that the environment positively impacts state effectiveness in the context of the Fourth Industrial Revolution and innovation, which I will call H4.

Finally, social welfare in the context of the Fourth Industrial Revolution is significantly impacted by the development of new technologies. AI can improve working conditions, reduce working hours, and increase labor productivity (Khakurel et al., 2018). Additionally, Joung et al. (2013) argue that the concept of welfare in the Fourth Industrial Revolution not only involves protecting workers' rights but also ensuring safety and health in the workplace through regulations and monitoring technologies, thereby improving labor conditions and enhancing workers' quality of life. However, the replacement of human labor with robots and automation can lead to increased unemployment, raising social welfare concerns (Frey & Osborne, 2017; Lloyd & Payne, 2019), as well as worker stress and job displacement due to automation (Ammirato et al., 2023). There are challenges regarding inequality in the labor market, where many low-skill jobs may be replaced by automation, while the demand for digital and analytical skills continues to rise (Bikse et al., 2022; Gonese & Ngepah, 2024). Although technology brings benefits such as increased productivity and reduced production costs, it also raises concerns about job loss and shifts in labor structures. This is especially important for emerging countries, where the unskilled workforce constitutes a significant portion of the labor market. The state needs to implement measures such as retraining programs and appropriate social welfare policies to ensure that these changes do not exacerbate social inequality and to protect workers' rights during the digital transformation era (Alshahrani, 2023).

Thus, social welfare plays a crucial role in evaluating state effectiveness in the context of the Fourth Industrial Revolution. Technological advancements, particularly in AI, automation, and the IoT, have the potential to improve working conditions, increase labor productivity, and enhance quality of life. However, the accompanying challenges, such as job loss due to automation and rising inequality in the labor market, require the state to implement appropriate social welfare policies. An effective state is one that balances the promotion of innovation with the protection of social welfare. This includes providing retraining programs to equip workers with new skills, especially those affected by job displacement due to technological advancements. Additionally, the state must build support systems that protect workers' rights, ensure safety and health in the workplace, and create fair regulations and policies to prevent increasing social inequality. Collaboration between stakeholders such as the government, businesses, and society is key to ensuring that social welfare is maintained and developed in the digital age. In this context, state effectiveness is not only measured by the ability to govern and implement policies but also by the state's capacity to protect citizens' rights and ensure equal access to the benefits brought by digital transformation and technology.

Research on the impact of social welfare in the context of the Fourth Industrial Revolution primarily focuses on labor market issues, automation, and the replacement of workers by robots and AI. There is a lack of in-depth studies that clearly analyze the impact of social welfare policies on state effectiveness. In particular, few studies have examined the relationship between welfare policies, workplace safety, and technological development in protecting workers' rights and how these factors influence the state's governance capacity and social support during the digital transformation process. There is little evaluation of the role of social welfare in maintaining social stability and mitigating the negative effects of automation, such as unemployment and inequality, from the perspective of state policy. The lack of analyses on how the state can optimize welfare policies to ensure social equity during the digital transformation should be fixed. I pose the hypothesis that welfare positively impacts state effectiveness in the context of the Fourth Industrial Revolution and innovation, and refer to this as H5.

In the context of the Fourth Industrial Revolution and innovation, although many studies have addressed the role of factors such as human resources, businesses, digital transformation, the environment, and social welfare in enhancing state effectiveness, several gaps remain. In particular, current research mostly focuses on the individual impacts of each factor without clarifying their overall interaction and influence on state governance. Moreover, there is a lack of studies measuring the impact of human resources and businesses, especially SMEs, on improving governance, as well as the role of digital transformation in enhancing state-society interaction. While new technologies have contributed significantly to sustainable development and environmental protection, the relationship between environmental policy and state effectiveness remains underexplored. Similarly, social welfare policies in the context of automation have not been sufficiently studied to fully assess their impact on social stability and governance effectiveness. Based on these gaps, the study proposes the five hypotheses outlined above: that human resources (H1), businesses (H2), digital transformation (H3), the environment (H4), and welfare (H5) all positively impact state effectiveness in the context of the Fourth Industrial Revolution and innovation.

RESEARCH METHODS

This study combines both qualitative and quantitative research methods to answer its research question. Qualitative research was conducted by synthesizing previous theories and research findings related to state effectiveness in the context of science, technology, and innovation in Vietnam, based on factors such as human resources, businesses, digital transformation, environment, and welfare. This approach helps to establish a solid theoretical foundation and guide the development of research hypotheses and models, which are critical for understanding state effectiveness in the Fourth Industrial Revolution. From this, my hypotheses (H1-H5) and models were developed with adjustments and supplements to ensure alignment with the current context of the Fourth Industrial Revolution and international economic integration. Additionally, I conducted discussions with 10 managers and researchers from universities and research institutes to refine and enhance the scales

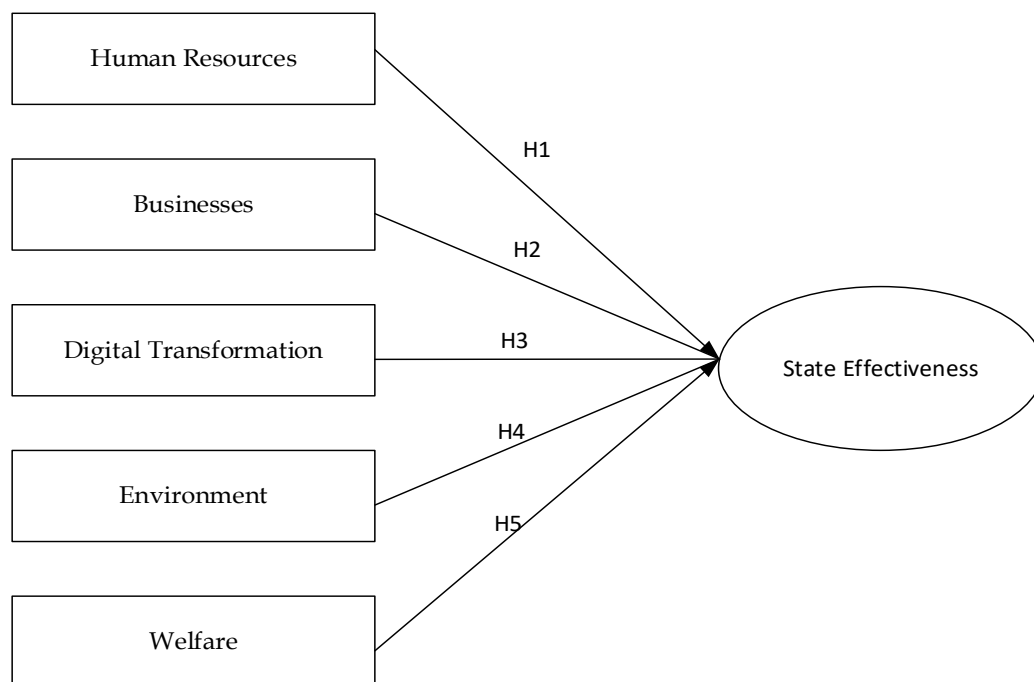
and research models, making them more practical (Creswell, 2007; Merriam & Tisdell, 2009; Miles et al., 2014; Patton, 2002).

Quantitative research was carried out through basic analyses of survey data, such as descriptive statistics, Cronbach's alpha reliability assessment, exploratory factor analysis (EFA), and linear regression models using SPSS software (Hair et al., 2010). Survey data were collected from 481 civil servants whose work is related to state effectiveness, including officials from central and local levels. The quantitative phase was designed to test the hypotheses developed in the qualitative stage, ensuring that the findings are grounded in real-world data and can be generalized to broader contexts. The data collection period spanned from May 2024 to September 2024.

The rationale for choosing this mixed-method approach lies in the complexity of the research issue. By combining qualitative insights and quantitative validation, the study provides a robust framework for understanding the multi-faceted nature of state effectiveness, especially in a rapidly evolving environment shaped by technological advancements and global integration. Figure 2 below illustrates the diagram of the main elements in the research model and their relationship to state effectiveness in the context of the Fourth Industrial Revolution and innovation.

Figure 2

Research model.



USE OF LIKERT SCALE

A 5-point Likert scale was used to measure the agreement level of survey participants with relevant statements. The Likert scale, developed to assess attitudes and opinions, is a commonly used tool in social science research (Joshi et al., 2015; Robinson, 2023; Yamashita & Millar, 2021). The specific levels of this research's Likert scale included: (1) Strongly disagree; (2) Disagree; (3) Neutral; (4) Agree; (5) Strongly

agree. In so using the Likert scale, this study applies recent advances in Likert scale development (Jebb et al., 2021) and incorporates contemporary measurement techniques to assess consensus and stability in the data (Claveria, 2021). Additionally, the Likert model has been adapted to meet criteria for organizational resilience and risk management in various contexts (Pescaroli et al., 2020). Table 1 below presents the results of the scale of factors in the research model.

Table 1

Scales of factors in the research model.

Factor	Encode	Scale	Sources
Human Resources	HR1	Training of human resources is emphasized and carried out regularly and continuously.	Alshahrani (2023); Ammirato et al. (2023); Bikse et al. (2022); Kumi et al. (2024); Piwowar-Sulej, (2020); Sivathanu, (2018); Trompisch, (2017); Zhou & Zheng (2023)
	HR2	Training is specific, clear and appropriate to the context.	
	HR3	The state creates conditions and promulgates appropriate policies and regulations in human resource development.	
	HR4	The state's support mechanism for unemployment insurance, job position change and social security is timely.	
	HR5	The state has a clear plan in case of industries becoming obsolete from Industrial Revolution 4.0.	
Businesses	BN1	Businesses adapt well to the context.	Alshahrani (2023); Aregawi & Patnaik (2023); Arnold et al. (2016); Awan et al., (2021a); Awan et al. (2022); Bašić (2023); Bikse et al. (2022); Bogers et al. (2019); Brasseur et al. (2017); Despoudi et al. (2023); Grabowska & Saniuk (2022); Ivaldi et al. (2022); Moradi et al. (2021); Santos et al. (2017); Shet & Pereira (2021); Ye et al. (2022).
	BN2	Businesses are proactive, flexible and dynamic in building business processes.	
	BN3	Businesses are well prepared in the context of global competition.	
	BN4	The state creates conditions and issues clear regulations and policies to support businesses.	
	BN5	The State ensures cyber security elements for production and business activities in the digital environment.	
Digital Transformation	DT1	Businesses apply digital conversion to the process of handling work in daily production and business.	Alvarenga et al. (2020); De Propriis & Bailey (2021); Mackiewicz & Götz (2024); Mergel et al. (2019); Schallmo
	DT2	Businesses increase the investment of capital in the system of machinery,	

		equipment and facilities for production and business. The state has a policy to support businesses investing in digital conversion and the application of scientific and technological advances in production and business. The state has a digital transformation strategy. There are procedures for applying science and technology innovation, ensuring convenient, simple and sustainable development for businesses.	& Williams (2018); Tsakalerou & Akhmadi (2021).
	DT3		
	DT4		
	DT5		
Environment	EM1	Businesses have capital invested in AI to solve environmental issues.	Ajwani-Ramchandani et al.
	EM2	Businesses have capital invested in robotics to solve environmental issues.	(2021); Awan et al. (2022); Bikse et al. (2022); Chang et al.
	EM3	Businesses have capital invested in blockchain and waste treatment systems.	(2010); Cioffi et al. (2020); Gadaleta et al. (2019); Li &
	EM4	Businesses have clear and specific sustainable development strategies.	Rao (2023); Mao et al. (2019); Mora et al. (2021); Ogbemhe et
	EM5	The state creates favorable conditions and appropriate sanctions for businesses regarding the environment.	al. (2017); Parmentola et al. (2022); Yamamoto et al. (2020).
Welfare	WF1	Businesses have clear and specific social security policies ensuring the rights of workers.	
	WF2	Businesses have provisions to support workers made redundant by Industrial Revolution 4.0.	Alshahrani (2023); Ammirato et al. (2023); Bikse et al. (2022); Frey & Osborne (2017);
	WF3	The state has policies to support jobs and social insurance for the unemployed.	Gonese & Ngepah (2024); Khakurel et al. (2018); Lloyd &
	WF4	The state has a policy for retraining workers displaced by Industrial Revolution 4.0.	Payne (2019); Pereira & Romero (2017); Tjahjono et al. (2017); Venkatesh et al. (2020).
	WF5	The state has strategies to replace industries that have been affected by Industrial Revolution 4.0.	
State Effectiveness	ES1	The state has a development strategy for navigating Industrial Revolution 4.0 and innovation.	
	ES2	The state promulgates specific and clear laws regarding innovation in Industrial Revolution 4.0.	
	ES3	The management entities are satisfied with the performance of the state in the context of Industrial Revolution 4.0 and innovation.	Compiled by author.
	ES4	The state is transparent with businesses and promotes opportunities presented by Industrial Revolution 4.0 and innovation.	

SAMPLE SIZE AND SAMPLING METHOD

According to Bollen (1989), Hair et al. (2010), Trong & Ngoc (2008), Tabachnick & Fidell (2019), and Field (2017), the minimum sample size for EFA is at least five times the number of observed variables. With 25 observed variables, the minimum required sample size is 125. A survey sample was randomly conducted, targeting civil servants whose job positions are related to the research criteria on state effectiveness in the context of the Fourth Industrial Revolution and innovation in Vietnam. These civil servants are from both central and local governments across 12 major cities and provinces in the country.

To ensure higher reliability and a valid sample rate greater than 50 percent, I selected a sample size of 500. This decision is justifiable, as a larger sample size helps to enhance the stability and reliability of results. According to Goretzko et al. (2021), increasing sample size can minimize bias and improve the accuracy of estimates, particularly in cases with low factor loadings or when the data is highly complex. Furthermore, choosing a sample size of 500 ensures a higher valid sample rate, which is crucial for generalizing the research findings to similar populations. Given that the study involves civil servants from various administrative levels in different regions of Vietnam, a larger sample size enhances the representativeness of the research findings on state effectiveness in the context of the Fourth Industrial Revolution and innovation.

I distributed 500 surveys, 400 of which were digital and sent online. I vetted returned surveys by removing invalid responses, such as surveys with no answers, surveys answered by the wrong target group, or surveys where most of the questions were answered with the same option. After filtering, 481 valid responses remained and were encoded for analysis using SPSS 20 software.

A total of 150 surveys were issued in north Vietnam, with 142 valid returns; 100 questionnaires were distributed in central Vietnam, with 93 valid returns; and in the south, 250 questionnaires were issued, yielding 246 valid returns. See table 2. A high response rate is crucial for representativeness and reliability of survey data (Memon et al., 2020). A response rate above 70 percent is considered ideal in social research, as it helps minimize nonresponse bias (Fowler, 2014). The 96.2 percent response rate in this survey far exceeds the typical standard, suggesting that the survey was well-managed and that the participants were highly engaged.

Table 2

Summary of survey samples.

No	Area	Number of survey form issued	Number of valid survey forms
1	North	150	142
2	Center	100	93
3	South	250	246
	Total	500	481

RESULTS AND DISCUSSION

Respondents were 43.2 percent female and 56.8 percent male, with most having a postgraduate degree (53.6 percent). Most were experienced mid-career civil servants, with 27.9 percent aged 25-35 years old and 29.7 percent aged 35-45 years old. Respondents worked at central, provincial, district, or commune-level government departments, and fairly evenly spread between them. See table 3.

Table 3

Demographics of survey respondents.

Variable	Content	Frequency (people)	Rate (%)
Gender	Female	208	43.2
	Male	273	56.8
Education	College Degree	25	5.2
	Bachelor Degree	198	41.2
	Postgraduate Degree	258	53.6
Age	Under 25	101	21.0
	From 25 to 35	134	27.9
	From 35 to 45	143	29.7
	Over 45	103	21.4
Workplace	Central government (Ministry)	120	24.9
	Provincial-level Local government (Department)	123	25.6
	District-level Local government (Division)	117	24.3
	Commune-level local government (People's Committee)	121	25.2

Assessing the reliability of Cronbach's alpha is the first step in implementing a linear regression model, with 29 variables of six factor groups included in the analysis, including: HR (Human Resources), BN (Businesses), DT (Digital Transformation), EM (Environment), WF (Welfare) and ES (State Effectiveness), all variables meet the requirement of a total variable correlation coefficients greater than 0.3 (Field, 2017; Hair et al. 2010; Tabachnick & Fidell, 2019). Along with that, all Cronbach's alpha coefficients are 0.6 or higher. More detail is in table 4.

Table 4

Summary of Cronbach's alpha coefficient based on SPSS 20 analysis results.

Factor	Number of initial variables	Cronbach's alpha coefficient	Number of valid variables
Human Resources	5	0.805	5
Businesses	5	0.854	5
Digital Transformation	5	0.841	5
Environment	5	0.824	5
Welfare	5	0.890	5
State Effectiveness	4	0.637	4

After evaluating the reliability of Cronbach's alpha, the study had 29 suitable variables belonging to six factors to include in the EFA factor analysis to explore the scale structure of five independent factor groups, namely HR, BN, DT, EM, WF, and with one dependent factor ES (State Effectiveness). The results of an EFA factor analysis of variables belonging to independent factors with a Kaiser–Meyer–Olkin coefficient reaching 0.780, greater than 0.5; this confirms that the EFA results of the variables belonging to independent factors are completely suitable for exploring the structure of the scales. Along with that, Bartlett's test has a Sig. coefficient less than 5 percent, showing that the results of EFA factor analysis of variables belonging to independent factors are statistically significant (Watkins, 2018).

Additionally, the results of EFA factor analysis of variables belonging to independent factors show that the breakpoint is at the 5th line with an eigenvalue of 2.503, greater than one. This confirms that the variables included in the analysis are arranged into five groups of factors, and the cumulative in the 5th line is 62.705 percent, greater than 50 percent, showing that the variability of the data is explained up to 62.705 percent (Goretzko et al., 2021). Moreover, the factor rotation results show that 25 variables belonging to independent factors are specifically arranged into five factor groups: HR, BN, DT, EM, and WF, seen in table 5.

Table 5

Results of EFA analysis of variables belonging to independent factors based on SPSS 20 analysis results.

	Component				
	1	2	3	4	5
WF1	0.877				
WF5	0.867				
WF2	0.826				
WF4	0.819				
WF3	0.766				
BN2		0.836			
BN3		0.805			
BN5		0.781			
BN4		0.767			
BN1		0.760			
DT2			0.858		
DT1			0.787		
DT3			0.774		
DT5			0.759		
DT4			0.718		
EM2				0.832	
EM5				0.787	
EM3				0.749	
EM4				0.745	
EM1				0.692	
HR1					0.820
HR4					0.806
HR2					0.771
HR3					0.722
HR5					0.614

KMO = 0.78; Bartlett's Test of Sphericity = 5455.661; Sig. = 0					
Eigenvalues	4.136	3.462	2.854	2.721	2.503
Variance (%)	16.544	13.850	11.417	10.883	10.012
Cumulative (%)	16.544	30.394	41.811	52.693	62.705

After performing the EFA analysis of the independent variables, I conducted an EFA analysis for the dependent variable ES. This showed that the results of the three variables ES1, ES2, and ES3 were all greater than 0.5 and met the requirements. However, in one case, the ES4 variable had a result less than 0.5. This shows that the ES4 variable does not have a strong correlation with other factors and does not contribute significantly to explaining the variation in the data. Therefore, I removed the ES4 variable to ensure the accuracy and reasonableness of the analysis model (Watkins, 2018). After removing the ES4 variable, the EFA analysis results met the criteria for statistical significance.

The results of EFA factor analysis of ES variables in table 6 show that the KMO value is 0.684, greater than 0.5; this confirms the KMO value, ensuring the appropriateness of EFA and the meaningfulness of the data included in the factor analysis. The Chi-Square statistic of Bartlett's test has a value of 312.794 with a significance level of Sig. = 0, which is less than 0.05, showing that the KMO test results are entirely statistically significant at the five percent significance level (Goretzko et al., 2021).

The cumulative analysis for the dependent variables shows that the cumulative value reaches 65.643 percent. This value is nearly average (a reference value, not a conclusion). Therefore, 65.643 percent of the variation in the data is explained by one factor, and the measurement scales were derived and accepted (Watkins, 2018). The stopping point when extracting factors at the first factor is an eigenvalue of 1.969. The factor loading coefficients of the component variables ES1, ES2, and ES3 are 0.810, 0.791, and 0.829, respectively, all greater than 0.5, showing that the component variables of the ES factor warrant inclusion in data analysis (Goretzko et al., 2021).

Table 6

Results of EFA analysis of variables belonging to the dependent factor based on SPSS 20 analysis results.

Component	
ES3	0.829
ES1	0.810
ES2	0.791
KMO = 0.684; Bartlett's Test of Sphericity = 312.794; Sig. = 0.000	
Eigenvalues	1.969
Cumulative (%)	65.643

Based on the results of correlation analysis in table 7, we see that the dependent factor of entrepreneurial intention has a positive same direction correlation with the independent factors, specifically, the Pearson correlation value of the factors HR, BN, DT, and EM, with the ES, are 0.322; 0.305; 0.377; 0.320; 0.305 – greater than zero, and the coefficients Sig. of the factors are all less than 0.05. According to Field (2017), Hair

et al. (2010), and Tabachnick & Fidell (2019), this means the correlation between factors is statistically significant for the author to conduct linear regression model analysis.

However, the WF variable has a very low correlation coefficient with all other factors in the model and does not reach statistical significance. Specifically, the correlation of WF with factors such as HR (-0.013), BN (0.076), DT (0.016), EM (0.022), and especially ES (0.065) are all insignificant, with Sig. values all greater than 0.05. This shows that WF does not contribute significantly to explaining the variation of factors in the model, especially ES, the main factor in the study. Retaining WF may reduce the efficiency and accuracy of the model, so removing WF is necessary to focus on variables with greater impact such as HR, DT, EM, and BN. The hypothesis related to WF was removed, because WF has no meaningful correlation with other factors in the model. Removing WF helps streamline the model and improve the explanatory power of factors related to ES.

Table 7

Results of Pearson correlation analysis based on SPSS 20 analysis results.

		HR	BN	DT	EM	WF	ES
HR	Pearson Correlation	1					
	Sig. (2-tailed)						
BN	Pearson Correlation	0.065	1				
	Sig. (2-tailed)	0.156					
DT	Pearson Correlation	0.039	0.118**	1			
	Sig. (2-tailed)	0.397	0.010				
EM	Pearson Correlation	0.087	0.136**	0.148**	1		
	Sig. (2-tailed)	0.057	0.003	0.001			
WF	Pearson Correlation	-0.013	0.076	0.016	0.022	1	
	Sig. (2-tailed)	0.778	0.096	0.724	0.624		
ES	Pearson Correlation	0.322**	.305**	0.377**	0.320**	0.065	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.155	

** Correlation is significant at the 0.01 level (2-tailed).

The results of the regression model analysis in table 8 show that factors affecting the role of ES include: HR, BN, DT and EM; that is, these variables affect ES in the same direction. R square is 0.343; this result shows that the model's suitability is 34.3 percent, or in other words, 34.3 percent of ES variation is explained by the factors HR, BN, DT and EM. Using the F test in ANOVA analysis of variance shows that the F value is 62.118 with a significance level of Sig. less than 0.05. This shows that the combination of five independent factors in the model can explain the change in ES (Hair et al., 2010; Field, 2017; Tabachnick & Fidell, 2019).

Table 8

Results of linear regression analysis.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	0.253	0.197		1.287	0.199		
Human Resources	0.231	0.031	0.277	7.403	0.000	0.989	1.011
Businesses	0.170	0.029	0.220	5.841	0.000	0.969	1.032
Digital Transformation	0.238	0.029	0.308	8.162	0.000	0.968	1.033
Environment	0.172	0.030	0.220	5.807	0.000	0.958	1.043

Note: R square = 0.343; adjusted R square = 0.337; F = 62.118 (Sig. = 0.000); Durbin Watson = 1.758
Dependent Variable: ES.

Therefore, the regression analysis model to be implemented was as follows:

$$ES = \beta_0 + \beta_1HR + \beta_2BN + \beta_3DT + \beta_4EM + \varepsilon$$

The unstandardized regression equation shows the relationship between factors affecting ES as follows:

$$ES = 0.253 + 0.231*HR + 0.170*BN + 0.238*DT + 0.172*EM + \varepsilon$$

The regression equation according to the standardized coefficient Beta shows the relationship between factors affecting ES as follows:

$$ES = 0.277*HR + 0.220*BN + 0.308*DT + 0.220*EM + \varepsilon$$

Based on the standardized Beta coefficient, we can see that the factor with the highest level of influence on ES is DT with a Beta coefficient of 0.308; this means that when the DT factor increases by one unit, ES increases by 0.308 units. HR has a Beta of 0.277, indicating that when HR increases by one unit, ES increases by 0.277 units. The BN and EM factors both have a Beta coefficient of 0.220, meaning that improvements in these factors will positively affect ES, with each factor increasing 0.220 units when ES increases by one unit.

The results also show that the VIF coefficients for the factors HR, BN, DT, and EM are 1.011, 1.032, 1.033, and 1.043, respectively, which are within the allowable level (less than 2), indicating that the model does not suffer from multicollinearity. Additionally, the Durbin Watson value = 1.758 is within the acceptable range (from 1.5 to 2.5), meaning the model does not have autocorrelation at lag 1 (Hair et al., 2010; Field, 2017; Tabachnick & Fidell, 2019; Trong & Ngoc, 2008).

CONCLUSION

This study has clarified the main factors affecting ES in Vietnam. Regression analysis shows that WF did not have a significant impact, while the other factors all had a positive influence on ES. This reflects the differences in the impact of these factors and provides clear empirical evidence to guide policy development in alignment with Vietnam's current context. Specifically, HR plays an important role, with a standardized Beta coefficient of 0.277, confirming that investment in HR development will directly improve ES. This finding aligns with the initial hypothesis

that, although technology is rapidly advancing, humans remain irreplaceable in many fields. Furthermore, DT has the strongest impact on effectiveness, with a standardized Beta coefficient of 0.308, highlighting the importance of developing e-government and applying new technologies. This fully aligns with the research objective established from the beginning, considering DT as a key factor in enhancing public management efficiency. Additionally, factors such as BN and EM also have significant impacts, with standardized Beta coefficients of 0.220, indicating that business support and environmental protection are indispensable in promoting the effectiveness of state management and sustainable development.

Although WF did not show a significant impact in this model, further research is needed to thoroughly evaluate its role in other contexts. Previous studies have indicated that social welfare plays an important role in protecting workers' rights and ensuring social stability in the context of digital transformation and automation (Sivathanu & Pillai, 2018; Tjahjono et al., 2017). However, the indirect impacts of social welfare on state effectiveness have not been fully explored. Therefore, future research should focus on improving measurement methods and better identifying the indirect impacts that social welfare may have. Furthermore, future studies should delve deeper into the role of SMEs in the digital transformation process. Research has shown that SMEs are a crucial part of the economy, especially in developing countries, but they are facing many challenges in adopting advanced technologies (Despoudi et al., 2023; Ye et al., 2022). This gap opens up opportunities for further research on how SMEs can leverage new technologies to improve state effectiveness. Additionally, the interaction between the government and citizens during the digital transformation process is also an area worth investigating. E-government is considered a key factor in improving transparency and public management efficiency (Mergel et al., 2019; Schallmo & Williams, 2018), but further studies are needed to assess the impact of e-government on citizens' satisfaction and trust.

The results of this study not only reinforce the initial hypotheses but also closely link to the research objectives set forth in the introduction. The main objective of the research was to clarify the impact of human resources, businesses, digital transformation, environment, and social welfare on state effectiveness in the Fourth Industrial Revolution. Overall, the hypotheses regarding (to desist from the acronyms) human resources, businesses, digital transformation, and environment have been tested and confirmed, while social welfare requires further in-depth study in other conditions. This concludes the narrative of the study while opening up directions for future research.

These important findings not only help shape development strategies but also provide policy recommendations to promote digital transformation, human resource development, business support, and environmental protection. Although social welfare did not show a clear impact in this study, it remains an important factor that should be carefully considered in the future. The combination of humans and technology, along with state support in promoting innovation and environmental protection, will continue to play a vital role in ensuring sustainable development and enhancing the effectiveness of the state in this new era.

RECOMMENDATIONS

Human resources are a key factor in evaluating the performance of the state. The strong development of AI and robotic automation has created fundamental changes in the structure of work and the workforce. Although human capacity can hardly keep up with the development of technology, people are still irreplaceable in many fields. The combination of technology and people creates new opportunities to improve labor efficiency. The promotion of the use of Industrial Revolution 4.0 technologies will not lead to complete automation, but raises the question of the best possible cooperation between humans and machines. Emerging technologies such as the IoT and AI will automate most human resources processes, changing human resources services to the concept of “smart human resources.” This requires governments to invest heavily in education and training, to equip the workforce with the skills needed to work in a high-tech environment.

To facilitate the growth of businesses, governments must introduce advanced information technology solutions in all aspects of production. This not only allows specific products to be ordered by customers, but also allows the entire value chain involved to more precisely tailor production to customer expectations while keeping costs low, high quality and efficient. Companies collaborating under an open business model are constantly looking for innovative forms of cooperation with all business partners throughout the value creation chain. The government needs to create a favorable legal and business environment to promote the development of businesses, including minimizing administrative barriers, providing financial support and encouraging innovation.

Digital transformation is a key factor in improving state performance. Strengthening and developing e-government is an indispensable part of the administrative reform process. E-government not only helps improve state management efficiency, but also facilitates transparency and positive interaction between the government and the people. New technologies such as AI, cloud computing, robotics applications and blockchain need to be deployed to optimize public services, improve management efficiency and reduce corruption. The application of these technologies can improve service quality, reduce processing time and increase citizen satisfaction.

Assessing the impact of new technologies on the environment is very important. New technologies not only improve production and management efficiency, but also contribute to environmental protection by minimizing emissions and saving energy. The government needs to introduce policies that encourage the use of green and sustainable technologies, and strengthen environmental monitoring and management measures. This not only helps protect the environment but also creates a sustainable business environment, contributing to long-term economic development.

The government should continue to invest in social welfare programs to ensure that, although social welfare does not have a direct impact in this research model, its indirect benefits remain crucial. This includes protecting workers’ rights in industries at risk of automation, as well as providing retraining and upskilling support to help the workforce transition to high-tech sectors. Social welfare should be carefully considered in future studies to evaluate its indirect impact on state effectiveness,

particularly in different contexts and conditions. These indirect impacts may include improvements in the physical and mental health of citizens, which, in the long term, could positively influence national stability and sustainable development.

State performance is an important indicator reflecting the government's capacity in national management and development. In the context of globalization and the Industrial Revolution 4.0, requirements for state performance are increasingly high. To meet these challenges, governments need to be flexible and adapt quickly to economic, political and technological changes. Evaluation of state performance needs to be based on specific criteria such as human resources, businesses, digital transformation, environment and social welfare. Only then can a government ensure sustainable and comprehensive development.

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