The Seybold Report

ISSN 1533-9211

DOI 10.17605/OSF.IO/K75QM

# THE ENABLING CAPABILITIES FOR DIGITAL TRANSFORMATION RESILIENCE AN EMPIRICAL ANALYSIS FOR SELECTED COUNTRIES

**LAKSHMI CHAITANYA DATTI**

Ph.D. Candidate in Faculty of Business and Technology, University of Cyberjaya, Cyberjaya, Malaysia.
Email: 2009-2767@st.cyberjaya.edu.my

**Dr. MUDIARASAN KUPPUSAMY**

Professor, Dean of the Faculty of Business and Technology, University of Cyberjaya, Cyberjaya Malaysia.
Email: drarasan@cyberjaya.edu.my

**Abstract**

Digital transformation resilience is essential for organizations to adapt and respond to changes through digital technologies. A study using data from 61 countries shows that knowledge capability is more critical than technology, future readiness, and data evolution. Understanding and adopting capabilities to maintain resilience is crucial for organizations and countries to counter disruptions caused by crises. This study analyzed data from reliable sources, including IMD, the World Digital Competitiveness Ranking, and WIPO GII. The findings suggest that knowledge capability is more critical for digital transformation resilience than technology, future readiness, and data evolution.

**Keywords:** Digital Transformation, Resilience, Capabilities, Secondary Data, Panel Data

## INTRODUCTION

Businesses must transform digitally to improve customer experiences, optimize operations, and foster growth. Amazon and Netflix are prime examples of companies successfully implementing digital transformation (Banerji, 2022; Van, 2022). Global spending on digital transformation is estimated to reach USD 3.4 trillion by 2026 (IDC, 2023; Statista, 2023). To ensure resilience, organizations must view digital transformation as an ongoing process. Investing in cutting-edge technologies like AI and IoT and continuously building knowledge in this area is essential (Kuppusamy and Datti, 2022; Datti and Kuppusamy, 2023). \

The driving force behind a nation's digital transformation can be pull or push factors. Governments can support digital infrastructure development, skill-building, and public service delivery to mitigate the negative impact of socioeconomic and ICT disruptions. Ongoing investments and resilience are necessary to respond to changes in the business environment. Businesses can fully realize the potential of digital transformation by implementing essential capabilities while harnessing its potential through disruptions (Kuppusamy and Datti, 2022; Datti and Kuppusamy, 2023).

Digital transformation requires research, education, regulations, investment, secure tech, and adaptive attitudes. Resilience is critical to economic stability, job creation, and investment attraction. Business agility, IT integration, and a seamless digital environment can help

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DOI 10.17605/OSF.IO/K75QM

countries stay resilient during disruptions. More research on resilience capabilities and theories using cross-sectional and longitudinal data is needed. Countries with high IMD World Digital Competitiveness rankings are being studied to address this gap.

## LITERATURE REVIEW

### Digital Transformation

For businesses to remain competitive and innovative, they must undergo the process of digital transformation. This involves utilizing digital technologies such as AI, big data analytics, internet technologies, digital platforms, digital ecosystems, information and communication technology, and digital services. New digital technologies drive this process, impacting customer experience, business models, and processes (Pradhan et al., 2020; Saha et al., 2022).

Digital transformation can offer benefits such as mass customization, reduced production costs, and new business models. It also creates new job opportunities while changing how people work. Companies can benefit from digital transformation by expanding their reach internationally, improving their global strategies, and fostering entrepreneurship. Companies can improve individual consumer experiences by utilizing AI, while micro foundations provide resources to use internal and external knowledge efficiently (Bertello et al., 2022).

### Resilience

When managing the environment, it is essential to consider its economic, social, and environmental aspects. The "resilience framework" utilizes an "ecosystem engineering" strategy to enhance stability (Afifi, 2018). Community resilience can be achieved through social support and communication during challenging times (Roberts et al., 2015; Rahman et al., 2017). Access to digital resources can improve the overall quality of life, but it is essential to have good digital literacy and positive attitudes for engagement (Milan, 2018). Developing a digital engagement and resilience framework can improve community resilience in the digital economy.

### Disruption context

Over the past 50 years, economically developed nations have shifted from manufacturing to services as a source of wealth. People now work in banks, software companies, and colleges instead of factories. The information age has increased social freedom and equality (Millenson, 2018). Digital transformation occurs through pull and push factors, including crises that make the change necessary (Datti and Kuppusamy, 2023). Three types of disruptions lead to digital transformation at a country level: socioeconomic policy-driven, information, and communication technology-driven, and crises-driven.

- **Socioeconomic policy driven**

The field of social economics examines how social behavior and economics intersect within a community. This involves analyzing the economic decisions made by individuals and government policies. When a country experiences a debt crisis, it can have a ripple effect on the global economy, as was seen during the 2007-2008 financial crisis (Batool and Sahi, 2019).

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With the increasing digitization of our world, there are new challenges to address, such as issues of inequality and policy. Policymakers need to find ways to balance the benefits of digitalization with the economic challenges faced by countries like Sri Lanka and Pakistan, where there may be a scarcity of necessities and low foreign exchange reserves (Mishara, 2023).

- **Information and communication technology driven**

ICT significantly impacts society, affecting daily life and economic growth. While it offers many opportunities, it also creates issues for businesses and society. Data breaches are a significant threat to data protection, with cybercrime costing businesses trillions annually (Mbuyisa and Leonard, 2017; Bieser and Hilty, 2018). Adopting technology comes with difficulties, such as talent shortages and technological glitches. Developing countries face ICT challenges, but governments can use policies to attract investment. A theoretical foundation is needed for consistency and effectiveness in implementing ICT policies.

- **Crises driven**

Climate change is a primary concern for researchers due to its impact on human and economic society. In the past, natural catastrophes such as earthquakes, tsunamis, and hurricanes have caused significant economic losses (Seddighi et al., 2021). Natural disasters significantly impact a nation's economy, often causing infrastructure damage and hindering a company's ability to produce goods. This can lead to reduced productivity, slower economic development, and increased income inequality and poverty. Covid-19 has also significantly impacted the global economy, leading to de-globalization and an increased focus on digitalization (OECD, 2022). Developing countries have benefited from digitalization efforts, with businesses and educational institutions shifting towards virtual channels. Governments are also exploring emerging digital technologies such as blockchain, 5G infrastructure, and AI.

## Capabilities

The ability of a country to adapt to changes and come up with innovative solutions is known as digital resilience. This quality is crucial for competitiveness and is influenced by national values, culture, history, and institutions. Companies can gain an edge by embracing new technologies and methods to innovate (Kuo et al., 2022; Kamboj et al., 2022). To stay ahead, businesses must be proactive and continuously experiment to anticipate future trends. Digital technology can help improve efficiency and services. For a country to remain resilient, it must prioritize investment in knowledge, technology, and future readiness.

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DOI 10.17605/OSF.IO/K75QM

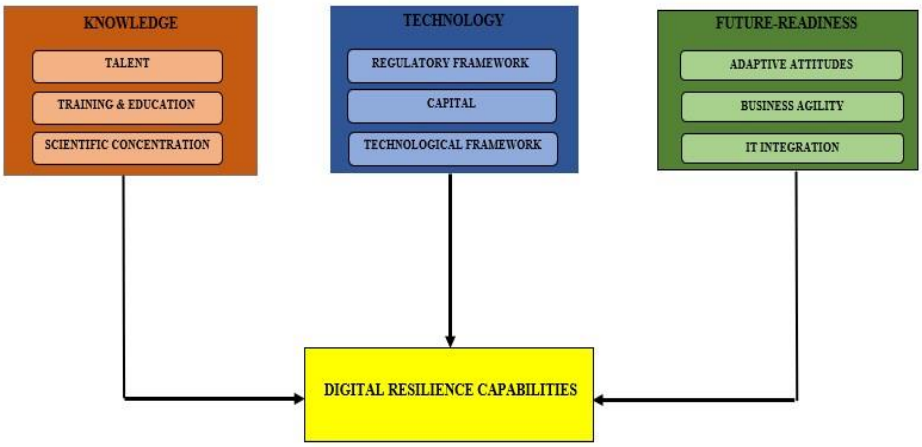


**Figure 1.0 Digital Resilience Capabilities**

## Knowledge

Knowledge is dynamic and involves synthesizing different types of information. Companies can remain competitive by combining explicit and tacit knowledge. Technology is vital in managing knowledge flows, and knowledge sharing drive innovation (Collins, 2019; Balaz et a., 2021). Knowledge infrastructures generate and spread accurate information, challenging false beliefs. Investing in human capital increases productivity, economic growth, and non-economic benefits like health and well-being (Dahiyat et al., 2023). Skilled migration can add to a country's human capital, and digital competencies are crucial for competitiveness in the digital economy. Successful digital transformation requires specific talents, education, and a focus on science.

- **Talent**

Each person has unique skills and talents that can be used to achieve objectives. Talent is vital to businesses and the economy. A talent-driven economy requires investment in education, training, and social assistance (Parilla and Liu, 2021). Postsecondary education and training are essential for the employment market. Talent deployment is crucial and involves setting up rules and practices to use skills effectively (Parilla and Liu, 2021). Strategies can be used to close the talent gap and foster local talent. Nations must provide opportunities for continual learning to attract and maintain talent for economic development.

- **Training and education**

Education and human resource development are essential for economic growth. They build human capital through education, training, and skill development, resulting in increased lifetime earnings and productivity (Sofyan and Abdullah, 2022). Education is a valuable resource for companies, allowing them to produce goods and services that can be sold. Employee training benefits employers and employees, enhancing job satisfaction, profitability, and productivity (Shahzad et al., 2021). Education can also enhance a country's capacity for

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innovation and disseminate knowledge necessary for economic progress – a nation's economy profits from a well-educated workforce, which can perform critical thinking tasks more efficiently.

- **Scientific concentration**

Investments in higher education, research and development, and information and communication technologies are crucial for long-term growth in knowledge economies. Expenditure on tertiary education and R&D, as well as ICT investments, are used to measure spending by governments, businesses, and individuals. R&D intensity is measured by gross domestic R&D expenditure and reflects variations in economic structures (Xu et al., 2021). These indicators are used in growth accounting studies, attributing an economy's growth to increased productivity and factors such as capital and labor. Organizations investing in database integration often need to pay more attention to the importance of knowledge-based capital (Singh et al., 2021). However, research and development, data analytics, and managerial practices can significantly boost productivity and growth. These areas are crucial investments for a company's success.

**Technology**

The digital economy is characterized by cloud computing, distributed computing, the Internet of Things, and big data technology. This technology has revolutionized the marketplaces, with ICT expanding to include social media, mobile apps, cloud platforms, data analytics, search engines, and AI (Wang et al., 2021). These technologies have touched almost every aspect of modern life, from work and entertainment to travel. They have also made remote working more accessible, providing more job opportunities. Digital technology has enabled flexible working arrangements, online access to education and knowledge, and improved communication. It has increased machine intelligence and efficiency, resulting in lower costs for goods and services (Borowski, 2021). Developing technologies like broadband is essential for reducing information asymmetry and promoting innovation. The electronics sector serves as the foundation of the digital economy, and nations are implementing programs to boost their digital sectors. Traditional methods of assessing ICT capital may only partially reflect the impact of digital technologies' spread. Technology integration, including business digitization and e-commerce, can benefit various industries and nations (Anderson et al., 2018). A supportive regulatory framework, capital, and the current technological landscape are crucial to foster technology development.

- **Regulation framework**

Business innovation is crucial for companies as it helps them expand, gain recognition, and create new products. It can also improve working conditions and safety precautions. Poorly implemented regulations can harm a company's viability and the entire industry. Regulations need a framework to assess their action's fairness, effectiveness, and efficiency, which can pinpoint areas for improvement and reduce compliance expenses. The framework also fosters community trust and helps evaluate regulator effectiveness. Regulators are government agencies that manage regulations. They safeguard the economy, society, and people (Hashmi

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and Alam, 2019). A framework for regulations helps businesses carry out their duties safely and effectively, benefiting everyone and reducing resources.

- **Capital**

To achieve high productivity, businesses need to focus on the critical variables of production, which include capital, labor, and entrepreneurship. Capital goods can be boosted through technology, and saving encourages investment to benefit the business. Automation can help increase productivity while freeing up personnel for other tasks. In the current "new normal," effective communication channels are crucial, and technology can also aid in emergency preparedness (Strinati and Barbarossa, 2019; Shin and Kang, 2020). With the help of technology, businesses can operate remotely, manage crises, and increase profits. Therefore, good decision-making and effective use of technology are critical for success.

- **Technological framework**

In the business world, technology infrastructure plays a critical role in facilitating the management and operation of enterprise IT services. Businesses can achieve profitable growth by utilizing the cloud while delivering exceptional user experiences (Sittig and Singh, 2020; Pan et al., 2021). Infrastructure as Code (IaC) opens new possibilities for rapid and adaptable innovation. The unique ability of information technology to adapt, innovate, and respond sets it apart from other workplace cultures. To fuel innovation, businesses require strategic and intelligent infrastructure, though cloud adoption is still in its stages due to technical architecture needs (Piriou et al., 2021). Cloud readiness can be influenced by organizational strategy, IT architecture, and workforce mindset. Companies must have a tailored plan that aligns with their business objectives and modern infrastructure to benefit from technology.

**Future Readiness**

The digitization of business has transformed all aspects of corporate administration. Companies must prioritize organization, culture, employees, and digital environment to stay ahead. Success requires a pioneering mindset and continuous employee training. In Industry 4.0, digitization is critical for competitiveness. Technology is the foundation of business agility, which is essential for success. Leaders must commit to desired business goals and incorporate stakeholder feedback and continuous digital transformation to achieve agile transformation (Gridwichai and Sriviboon, 2020). The Future-readiness factor assesses how well-prepared an economy is for digital change and combines business agility, adaptive attitudes, and IT integration ((IMD, 2023). Adopting digital technologies requires specific attitudes, and companies must prioritize business agility to seize new opportunities.

- **Adaptive attitudes**

Digital adaptability is essential for businesses to stay competitive and achieve success. Digital flexibility allows for the reaction and revision of objectives and methods, making it a valuable indicator of success (Jiang et al., 2019; Almenara et al., 2022). Collaboration between creative and management departments is crucial for creating a successful digital adoption plan that

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DOI 10.17605/OSF.IO/K75QM

aligns with new business models and technological developments (Desveaux et al., 2019; Palad, 2022).

- **Business agility**

Agile development involves short cycles and minimal overhead, allowing for frequent product enhancements and fast iterations. Business agility extends this approach throughout the organization, enabling companies to respond quickly to changing market conditions and customer needs (Dingsoyr et al., 2019; Saqqa and Sawalha, 2020). This leads to increased innovation and higher profits, making it essential for success in today's unpredictable business world.

- **IT integration**

Technology advances productivity and economic growth by allowing for more output with fewer resources and expanding global market reach. Automation and digital advancements shift labor demand towards higher-level skills (Frank et al., 2019; Hossain et al., 2020). Technology also helps businesses run more efficiently and manage production processes, saving time and money.

## RESEARCH METHODOLOGY

To conduct this research, secondary data from reputable sources such as the International Institute for Management Developments (IMD), the World Digital Competitiveness Ranking, and the World Intellectual Property Organization (WIPO) Global Innovation Index (GII) is employed. The data is easily accessible on IMD's website (www.imd.org) and WIPO's website (www.wipo.int). The IMD World Digital Competitiveness (WDC) ranking evaluates how countries utilize digital technology and its effects on government processes, business models, and society. The Global Innovation Index (GII) provides insight into a country's innovation performance and policy responses for improvement. These sources are widely recognized and are essential to economic policymaking.

This research analyzes data from the IMD WDC data set between 2013-2022. The IMD WDC ranking comprises 65 countries, but this research has examined 61 countries. Unfortunately, *Taiwan, Russia, Ukraine, and Venezuela* are not included in this study. Taiwan and Venezuela were not part of the WIPO GII data set between 2013-2022, while Russia and Ukraine's data needed to be more reliable to include in 2022. Additionally, Russia and Ukraine's global economic disruption played a role in their exclusion from the study. To conduct the analysis, panel data regression was employed using E-views software. Figure 1.2 represents the research framework.

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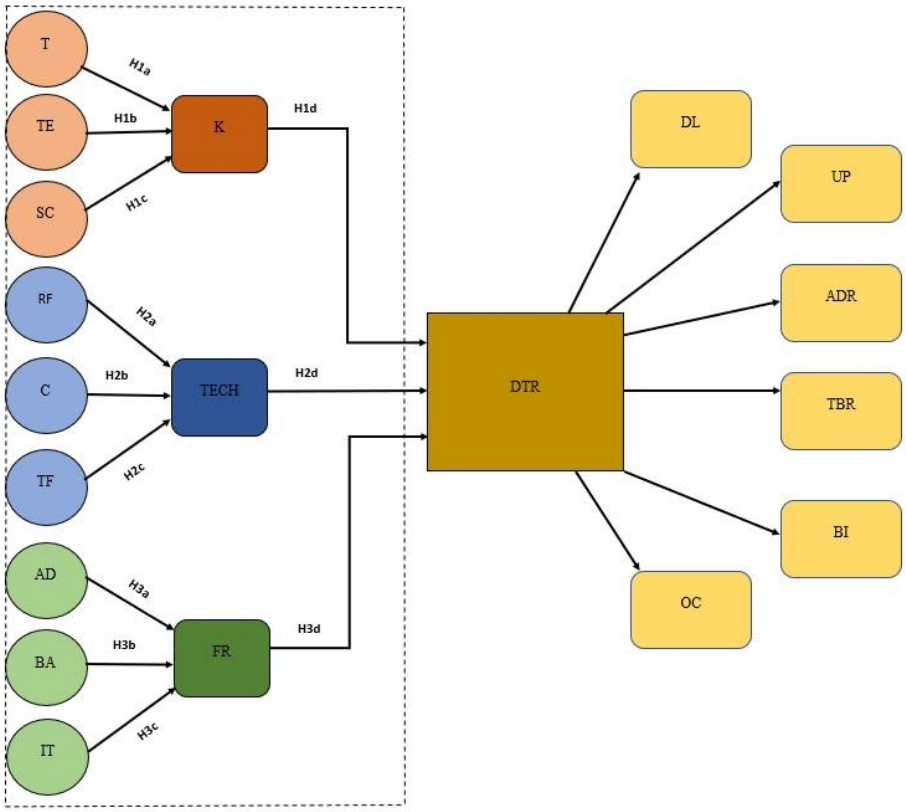
DOI 10.17605/OSF.IO/K75QM

**Figure 1.1: Conceptual Framework**




The Independent variables: *Talent (T), Training & Education (TE), Scientific Concentration (SC), Knowledge (K), Regulatory Framework (RF), Capital (C), Technological Framework (TF), Technology (Tech), Adaptive Attitudes (AD), Business Agility (BA), IT integration (IT), Future-readiness (FR),* and the dependent variables: *Digital transformation resilience (DTR), Digital Literacy/skills (DL), Uptake (UP), Access to Digital Resources (ADR), Technology as a Barrier (TBR), Broadband Infrastructure (BI), Creative Output (OC)*

***Research Hypothesis***

H1a: There is a significant relationship between talent and knowledge.

H1b: There is a significant relationship between training & education, and knowledge

H1c: There is a significant relationship between scientific concentration and knowledge

H1d: There is a significant relationship between knowledge and digital transformation resilience across countries

H2a: There is a significant relationship between regulatory framework and technology

H2b: There is a significant relationship between capital and technology

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H2c: There is a significant relationship between technological framework and technology

H2d: There is a significant relationship between technology and Digital transformation resilience

H3a: There is a significant relationship between adaptive attitudes and future-readiness

H3b: There is a significant relationship between business agility and future-readiness

H3c: There is a significant relationship between IT integration and future readiness

H3d: There is a significant relationship between future-readiness and Digital transformation resilience

## RESULTS

The original data consists of the three subfactors for each factor. Due to high multicollinearity in subfactors, some are rejected, and a new evolution data set is created. In which the knowledge subfactors comprise training & education and scientific concentration, the average of these ranks created new data for knowledge as "Knowledge-New." The technology subfactors comprise the capital and technological framework; the average of these ranks created a new dataset for technology as "Technology-New." The future-readiness subfactors are business agility and adaptive attitudes. The average of these ranks created a new dataset of future-readiness as "Future-readiness new." The dependent variable consists of the average of the ranks of newly evolved data of knowledge, technology, and future readiness. The evolution data has 61 countries as the original dataset and the time series from 2013-2022. The primary focus of the analytical approach in this research is to estimate the effects of the selected independent variables, namely *knowledge, Technology, and Future-readiness.* The effects of the independent variables on the dependent (*Digital Transformation Resilience)* were analyzed using panel data regression. If the obtained p-value is statistically significant at the 5 percent level (p-value < 0.05), then accept the null hypothesis and reject the alternative hypothesis.

**Table 1.1: Panel Data Regression Results**

| Independent variable | Dependent variable | P-value | R-Square | Durbin-Watson |
|---|---|---|---|---|
| Talent | Knowledge | - | - | - |
| Training and Education | Knowledge | 0.000 | 0.928 | 1.6 |
| Scientific concentration | knowledge | 0.000 | 0.928 | 1.6 |
| Regulatory Framework | Technology | - | - | - |
| Capital | Technology | 0.000 | 0.958 | 1.8 |
| Technological Framework | Technology | 0.000 | 0.958 | 1.8 |
| Adaptive attitudes | Future readiness | 0.000 | 0.967 | 1.9 |
| Business agility | Future readiness | 0.000 | 0.967 | 1.9 |
| IT Integration | Future readiness | - | - | - |
| Knowledge | Digital transformation resilience | 0.050 | 0.979 | 2.0 |
| Technology | Digital transformation resilience | 0.303 | 0.979 | 2.0 |
| Future-readiness | Digital transformation resilience | 0.306 | 0.979 | 2.0 |

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**Knowledge**

From Table 1.1, the panel data regression is performed with fixed effects on the evolved knowledge data with the subfactors' training & education and scientific concentration. Each of the subfactors has its hypothesis. The acceptable range for the Durbin-Watson ranges between (1.5 to 2.0). The Durbin-Watson statistics from the above showcase the value (1.6528), so the autocorrelation in the data is acceptable. For the autocorrelation in the data, Durbin-Watson statistics are taken into account. The R- Squared in the above regression is 92% of the variability observed in the regression model. The interpretation of r-squared is how well the regression model explains observed data.

**$H_1$: Talent does not have a significant effect on the knowledge**

The talent is rejected in the evolution data since there is high multicollinearity in the talent.

**$H_0$: Training and education have a significant effect on the knowledge**

The training and education are statistically significant to the knowledge and have a high relationship. The p-value (0.000) is less than the significance value, so accept the null hypothesis and reject the alternative hypothesis.

**$H_0$: Scientific concentration has a significant effect on the knowledge**

The scientific concentration is statistically significant to the knowledge and has a high relationship. The p-value (0.000) is less than the significance value, so accept the null hypothesis and reject the alternative hypothesis.

**$H_0$: Knowledge has significance on Digital transformation resilience**

From Table 1.1 above, the knowledge is statistically significant to digital transformation resilience and has a relationship. The p-value (0.050) is less than the significance value, so accept the null hypothesis and reject the alternative hypothesis.

**Technology**

From Table 1.1 above, the panel data regression with a random effect model is performed on the evolved technology data with the subfactors' capital and technological framework. Each of the subfactors has its hypothesis. The acceptable range for the Durbin-Watson ranges between (1.5 to 2.0). The Durbin-Watson statistics from below showcase the value (1.811), so the autocorrelation in the data is acceptable. For the autocorrelation in the data, Durbin-Watson statistics are taken into account. The R- Squared in the above regression is 95% of the variability observed in the regression model. The interpretation of r-squared is how well the regression model explains observed data.

**$H_1$: Regulatory framework does not have a significant effect on the technology**

The random effects regression outcome shows that the alternative hypothesis is accepted, and the null hypothesis is rejected. Since there is high multicollinearity in the regulatory framework, the regulatory framework is rejected in the evolution data.

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**$H_0$: Capital has significance on technology**

The capital is statistically significant to the technology and has a high relationship. The p-value (0.000) is less than the significance value, so accept the null hypothesis and reject the alternative hypothesis.

**$H_0$: Technological framework has significance on technology**

The technological framework is statistically significant to the technology and has a high relationship. The p-value (0.000) is less than the significance value, so accept the null hypothesis and reject the alternative hypothesis.

**$H_1$: Technology does not have significance on Digital transformation resilience**

The technology is statistically insignificant to the digital transformation resilience and has no relationship. The p-value (0.303) is higher than the significance value, so accept the alternative hypothesis and reject the null hypothesis.

**Future-readiness**

From Table 1.1 above, the panel data regression with a random effect model is performed on the evolved future readiness data with the subfactors' business agility and adaptive attitude. Each of the subfactors has its hypothesis. The acceptable range for the Durbin-Watson ranges between (1.5 to 2.0). The Durbin-Watson statistics from below showcase the value (1.930), so the autocorrelation in the data is acceptable. For the autocorrelation in the data, Durbin-Watson statistics are taken into account. The R- Squared in the above regression is 96% of the variability observed in the regression model. The interpretation of r-squared is how well the regression model explains observed data.

**$H_0$: Adaptive attitudes have significance on future-readiness**

The adaptive attitude is statistically significant to future readiness and has a high relationship. The p-value (0.000) is less than the significance value, so accept the null hypothesis and reject the alternative hypothesis.

**$H_0$: Business agility has significance on future-readiness**

The business agility is statistically significant to the future-readiness and has a high relationship. The p-value (0.000) is less than the significance value, so accept the null hypothesis and reject the alternative hypothesis.

**$H_1$: IT integration does not have significance on future-readiness**

The random effects regression outcome shows that the alternative hypothesis is accepted, and the null hypothesis is rejected. Since there is high multicollinearity in the IT integration, the IT integration is rejected in the evolution data.

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**$H_1$: Future readiness does not have significance on Digital transformation resilience**

The future readiness is statistically insignificant to the digital transformation resilience and has no relationship. The p-value (0.306) is higher than the significance value, so accept the alternative hypothesis and reject the null hypothesis.

## DISCUSSION

To effectively respond to digital transformation, it is crucial to prioritize acquiring knowledge and skills. This promotes innovation and adaptability, improves global competitiveness, and creates new job opportunities while preventing displacement (Kane et al., 2019). Regulatory policies play a vital role in protecting public interests and promoting economic growth. Effective regulations prioritize data security, privacy, and intellectual property rights while promoting social cohesion and transparency (Lv et al., 2021). By building public trust and resilience, regulations can ensure the safety of personal data and encourage investment in technology. It is crucial for countries to continually evaluate and strengthen their policies to withstand disruptions and stay competitive in the global economy. Integrating IT within government operations can result in cost-effectiveness, efficiency, innovation, and improved access to public services and governance (Bulturbayevich, 2021). Digital inclusion through IT can bridge the digital gap and enhance overall security.

Governments worldwide invest in research and development to advance scientific progress. The US has several initiatives, including the 21st Century Cures Act, National Robotics Initiative, CARES Act, and National AI Initiative Act. Other countries like China and Israel are also increasing their R&D investments (National Science Foundation, 2020). Kazakhstan, Israel, and Sweden prioritize education with hybrid learning methods. In the US, policies encourage tech investments, while Luxembourg has PIC and LFF investment funds. Norway has implemented a "Strategy for AI" and a "Digitalization Strategy for the Public Sector." Singapore, South Korea, and Taiwan significantly invest in digital transformation, while Switzerland and Germany prioritize digital education, research, and business development (World Economic Forum, 2022).

Governments are crucial in promoting digital transformation and ensuring it can withstand challenges. To achieve this, they must take proactive measures such as enhancing policies, investing in infrastructure, developing skills, implementing cybersecurity measures, promoting collaboration and inclusivity, and establishing effective planning and response mechanisms. Industries also significantly impact digital transformation resilience and should prioritize resilience capabilities as a strategic imperative to succeed. This can be achieved through training programs focusing on digital skills and cybersecurity measures, prioritizing data protection, and promoting innovation and business agility. Furthermore, academia is essential in examining the academic impacts of resilience capabilities in the context of digital transformation. Academic institutions can enhance digital transformation resilience by integrating resilience capabilities into curricula, conducting research, and investing in infrastructure and resources. By pursuing these endeavors, students can acquire the necessary

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skills and generate valuable insights that inform practical applications and policy decisions, ultimately leading to a robust digital transformation.

## CONCLUSION

Businesses must embrace digital transformation to thrive in today's world. Digital transformation can occur due to organizational needs or unexpected crises. To maintain resilience, businesses need to adapt to changes using digital technologies. Countries must have strategic capabilities to respond to disruptions caused by economic, technological, or health crises. The study found that knowledge capability has a more significant impact on digital transformation resilience than technology or future readiness. Regulatory frameworks and IT integration are also crucial for achieving resilience.

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