Realization of Social Technology through Maximizing the Implementation of the Digital Economy on Gross Domestic Product (GDP) of ASEAN Countries

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Abstract

The objective of this research is to investigate the influence of social technology in fostering digital economic advancements and its consequential effects on the expansion of Gross Domestic Product (GDP) within the membernations of the Association of Southeast Asian Nations (ASEAN). This study focuses on the impact of the use of ICT for export activities (export ICT), the ICT index, and The impact of foreign direct investment (FDI) on the expansion of Gross Domestic Product (GDP) in ASEAN nations from 2014 to 2019.

The employed analytical approach involves the utilization of Ordinary Least Squares (OLS), a technique that computes the data by employing the Chow test and the Hausman Random Effect Model (REM) test.

The research results show that ICT exports do not have a significant effect on GDP, while the ICT index and foreign investment (FDI) have a significant effect on GDP. All independent variables have a significant influence on GDP. The fact that the use of ICT exports will not affect GDP growth. The significant impact of the ICT index on GDP growth is that the lower the ICT index, the more positive GDP growth, and the greater the foreign direct investment (FDI), the more significant GDP growth. The findings of this research can be used by policymakers to develop policies that encourage the implementation of the digital economy towards GDP growth.

Introduction
Background

GDP (Gross domestic product), otherwise called Total national output (Gross domestic product), assumes a critical part in the financial development of a country. As per Rudiawan and Meirinaldi (2019), financial development can be characterized as the genuine expansion in a country's Gross domestic product in a particular year, showed by the ascent in per capita pay of the populace in the nation's economy. Total national output is an imperative pointer in breaking down the financial statesof a country. An expansion in Gross domestic product means a working on monetary state of a nation, while a reduction in Gross domestic product demonstrates financial stagnation[1].

The urgent job of Gross domestic product incorporates demonstrating a country's monetary development, filling in as a sign of prosperity, and helping government navigation. Financial development in a nation doesn't necessarily encounter critical increments at times, it likewise declines. Gross domestic product likewise assumes a critical part in estimating the monetary well-being of a country. Nonetheless, it's essential to take note of that Gross domestic product just measures financial results and doesn't represent different viewpoints like social and ecological elements.

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[1] Hendri Rudiawan and Meirinaldi, *Dampak Faktor-Faktor Makro Ekonomi Terhadap Pertumbuhan Produk Domestik Bruto Indonesia*, *Jurnal Ekonomi*, 2019, XXI <https://doi.org/https://doi.org/10.37721/je.v21i1.535>.

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Table 1. GDP of ASEAN Countries 2014-2019

No	Country	GDP (US$)					
		2014	2015	2016	2017	2018	2019
1.	Brunei	17,103	12,943	11,448	12,136	13,568	13,483
2.	Cambodia	16,764	18,091	19,427	22,042	24,609	27,102
3.	Indonesia	889,385	855.020	930,836	1,014,003	1,039,929	1,121,298
4.	Laos	13,274	14,420	15,893	16,953	18,096	18,844
5.	Malaysia	337,456	299,484	298,681	321,698	358,546	364,403
6.	Myanmar	66,331	59,795	64,632	67,268	76,330	66,500
7.	Philippines	297,832	306.213	318,375	328,782	344,693	372,063
8.	Singapore	314,850	308,002	318,654	341,913	373,134	372,063
9.	Thailand	407.304	401,658	413,454	456,819	506,554	543,958
10.	Vietnamese	186.224	193,628	205,439	223,837	241,039	261,587

Source: ASEANstats, 2022

Table 1 shows that each country in ASEAN experienced an average increase in GDP from 2014to 2019. Countries like "Cambodia, Indonesia, Laos, Malaysia, the Philippines, Thailand, and Vietnam"saw consistent growth in their GDP during this period. On the other hand, countries like Brunei, Myanmar, and Singapore experienced minimal fluctuations in their GDP. Among the ASEAN nations, Indonesia stands out with one of the highest and most consistent GDP growth rates.

Factors influencing GDP growth include export conditions and technological advancements. Exports contribute to increasing a country's income and per capita income. Foreign currency flowing intoa country through exports has a positive impact on GDP growth.
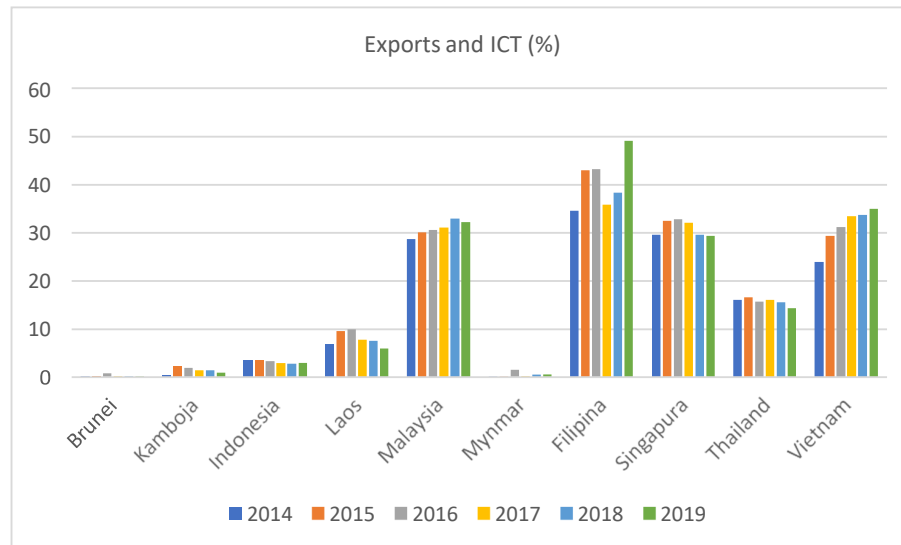

Figure 1. Export ICT ASEAN Countries
Source: ASEANstats, 2022

Graph 1, several countries exhibit a high percentage of exports and significant ICT influence, such as Malaysia, the Philippines, Singapore, and Vietnam. Meanwhile, other ASEAN countries have lower percentages. Research conducted by Dara Resmi et al. (2018) titled "The Influence of Exports on Economic Growth in Indonesia" stated that while exports do not significantly impact economic growth,industrial exports significantly influence the economic expansion over both

immediate and prolonged durations[2].

One more concentrate by Ari Mulianta Ginting (2017) proposed that to drive Indonesia's monetary development, further developing Indonesia's commodity execution is vital. Improvements in Indonesia's product execution can be accomplished through different means, one of which is further developing the commodity organization framework, improving innovative work of Indonesian items, overhauling foundation offices, keeping up with conversion scale steadiness, extending forward thinkingmarkets, and further developing the product ware structure[3].

Technological progress significantly boosts GDP through increased productivity and market expansion. Advances stimulate innovation, enhance product quality, and cut production costs. ImprovedICT indices in ASEAN countries from 2014 to 2019 correlate with GDP growth.
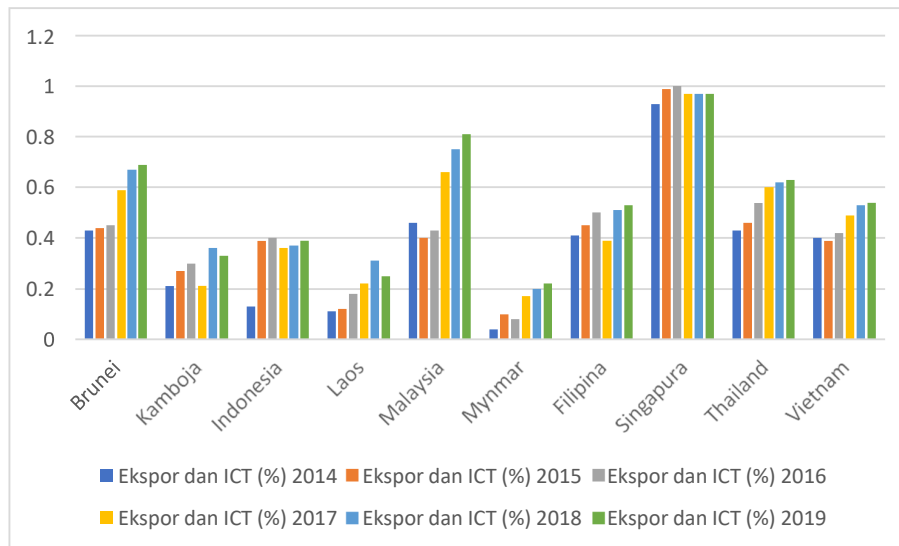

Figure2. ICT Index of ASEAN
CountriesSource: ASEANstats, 2022

Graph 2. The most steady and most noteworthy ICT record exists in Singapore, trailed by Malaysia, Brunei, and Thailand. The ICT file fills in as a standard measure to portray the degree of dataand correspondence innovation improvement inside a district, computerized differences, and the potentialfor ICT advancement. Discoveries from research directed by Albertus Surya Kristiawan et al. (2020) express that the ICT Improvement List and political strength, alongside the shortfall of savagery or psychological warfare, impact the Human Advancement File (HDI)[4].

Another influential factor on GDP is investment. As indicated by the research findings of Novita Nurul Ain (2020), investment significantly affects the economic growth of a country. Moreover, it is stated that investment is just one factor among many driving economic growth and development in Indonesia[5]. This aligns with the savings and investment theory by Harrod-Domar, which states that investment has a positive relationship with a nation's income.

Globalization also affects economic openness, policies, and information. Muhammad Zaenuddin (2009) states that foreign capital significantly aids in reducing issues related to balance of payments and

[2] Dara Resmi Asbiantari, Manuntun Parulian Hutagaol, and Alla Asmara, 'Pengaruh Ekspor Terhadap Pertumbuhan Ekonomi Indonesia', *Jurnal Ekonomi Dan Kebijakan Pembangunan*, 5.2 (2018), 10–31 <https://doi.org/10.29244/jekp.5.2.2016.10-31>.
[3] Ari Mulianta Ginting, 'Analisis Pengaruh Ekspor Terhadap Pertumbuhan Ekonomi Indonesia', *Buletin Ilmiah Litbang Perdagangan*, 11.1 (2017), 1–20 <https://doi.org/10.30908/bilp.v11i1.185>.
[4] Albertus Surya Kristiawan and Deden Dinar Iskandar, 'Analisis Pengaruh Produk Domestik Bruto, ICT Development Index Dan Good Governance Terhadap Indeks Pembangunan Manusia Anggota ASEAN Dan SAARC Kategori Lower-Upper Medium', *Jurnal Dinamika Ekonomi Pembangunan*, 3.2 (2020), 140–56 <https://doi.org/10.14710/jdep.3.2.140-156>.
[5] Novita Nurul Ain', 'Pengaruh Investasi Terhadap Pertumbuhan', 3.1 (2021), 162–69 <https://ejournal.inaifas.ac.id/index.php/Al-tsaman/article/view/504>.

inflation rates, thereby strengthening both the state and domestic private sectors[6].

Following This is the current Genre of investment direct foreign exchange (FDI) in countries in ASEAN in 2014-2019.

Table 2. FDI of ASEAN Countries 2014-2019

No	Country	FDI (US$)					
		2014	2015	2016	2017	2018	2019
1	Brunei	568.2	171.3	-150.4	460.1	517.3	374.6
2	Cambodia	1726.5	1701.0	2475.9	2788.1	3212.6	3663.0
3	Indonesia	21810.4	16642.1	3920.7	20579.2	20563.5	23883.3
4	Laos	913.2	1079.2	1075.7	1695.4	1398.0	755.5
5	Malaysia	10875.3	10180.0	11290.3	9295.8	7611.3	7859.7
6	Myanmar	946.2	2824.5	2989.5	9295.8	1690.8	1729.9
7	Philippines	5814.6	5639.2	8279.5	10256.4	9948.6	8671.4
8	Singapore	73284.5	59702.3	67504.6	82496.0	73917.6	106319.8
9	Thailand	4975.5	8,928	3,486	8,285	73,918	4,790
10	Vietnamese	9200.1	11,800	12,600	14,100	15,500	16,120

Source: ASEANstats, 2022

In **Table 2**, it can be seen that FDI inflows to ASEAN countries experienced a spike from 2014- 2019. Singapore is a country whose high FDI is dispersing other ASEAN countries. Governments in developing countries in Southeast Asia are still trying to improve infrastructure and policies to attract foreign investors. Several countries that have done this include "Indonesia, Malaysia, Myanmar, Thailand, and the Philippines."

At present, there is a substantial surge in the adoption of the digital economy across Southeast Asian nations. Each nation is actively engaged in enhancing its infrastructure and technology, aspiring to elevate its Gross Domestic Product (GDP). However, the GDP in each country is not balanced. Countries that have advanced economic digital technology developments tend to have high GDP, such as Singapore, while other countries still have to catch up. Considering the previously mentioned information, it is crucial to examine the influence of the digital economy on the Gross Domestic Product (GDP) of ASEAN countries from 2014 to 2019. The digital economy in this research is indicated by ICT export factors, ICT index, and FDI.

Utilizing the contextual setting and framing the research issue, this investigation aims to assess the magnitude of influence arising from the digital economy, as evidenced by variables related to the export of Information and Communication Technology (ICT), ICT index, and FDI on the Gross Domestic Product of ASEAN countries in 2014-2019.

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[6] Muhammad Zaenuddin, 'Analisis Faktor-Faktor Yang Mempengaruhi Investasi Pma Di Batam', *Jejak*, 2.2 (2009), 156–66
<https://www.researchgate.net/publication/307754939_ANALISIS_FAKTOR-FAKTOR_YANG_MEMPENGARUHI_INVESTASI_PMA_DI_BATAM>.

LITELATURE
Digital Economy

The concept of the "digital economy" was first coined by Don Tapscott, a renowned IT expert,in his published work. "The Digital Economy: Promise and Peril in the Age of Networked Intelligence"in 1994. Agus Sugiarto (2022) defines the digital economy as all forms of economic activities whose outcomes are measured using digital technology bases such as "the internet, web, artificial intelligence, virtual reality, robotics, and blockchain." It is further explained that the digital economy is the result of millions of online transactions or connectivity that occur daily, involving humans, businesses, data availability, and information processed using digital technology[7].

The Digital Economy, as articulated by Amir Hartman in Dewi Sartika Nasution's work (2019:1), is characterized as the cyberspace where business transactions take place, value is generated and exchanged, and one-on-one relationships evolve through the utilization of various internet initiativesas a means of interaction.' Its presence is characterized by the growing evolution of commercial or tradedealings employing digital platforms as a means for interaction, cooperation, and economic engagementsamong corporations or individuals, exemplified by E-business and E-commerce[8].

According to Agus Sugiarto (2022), the presence of the digital economy has become highly important in supporting global economic growth. Digital technology also become one of the dominant and strategic factors of production in business activities, making the wave of digitalization in the economic field unstoppable.

Role of the Digital Economy in Economic Growth

The role of the "digital economy" is highly significant and strategic in supporting global economic growth. According to Agus Sugiarto (2022), there are several influencing factors. First, the widespread internet penetration that nearly covers the entire world forms the primary foundation for smooth digitalization across nearly all aspects of human life. Second, the sales of mobile devices such ascell phones, tablets, and laptops continue to demonstrate an increasing trend and have evolved into fundamental necessities. Third, an increasing number of businesses are adopting various types of digital technology in their business and production processes. Fourth, the emergence of the pandemic caused by the spread of COVID-19 has acted as a catalyst to rapidly apply digital technology as quickly and maximally as possible to minimize human-physical contact.

A comparable report directed by Teguh Permana and Andriani Puspitaningsih (2021) on the 'Investigation of the Computerized Economy in Indonesia' recommends that the computerized economy proceeds to develop and is anticipated to increment eightfold, extending Indonesia's computerized economy to arrive at a worth of 1796 trillion rupiahs by 2024. The ramifications are that the public authority needs to construct a supporting framework to advance all the more quickly[9].

ICT Exports

As indicated by Regulation Number 11 of 2008, Data Innovation includes everything connected with the cycle, use as an instrument, control, and the board of data. In the interim, correspondence innovation alludes to everything connected with the utilization of apparatuses to process and move information starting with one gadget then onto the next. Subsequently, data innovation and correspondence innovation are two indistinguishable ideas.

Various innovative technologies classified under ICT include the internet, TV, radio, DVD, computers, telephones (landline and mobile), satellite systems, and hardware and software networks. According to Vu et al. (2020), the development of ICT is divided into three major components: communication media (e.g., radio, television), information media (e.g., computers), and communicationtechnology equipment (e.g., satellite, fiber optic cables, telephones). According to Kpodar & Andrianaivo (2011), ICT development has increased productivity and global trade, facilitated business activities, driven industrial growth, and improved education and research collaboration[10].

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[7] Agus Sugiarto, *Mengenal Ekonomi Digital* (Jakarta: PT. Kompas Media Nusantara, 2022).

[8] Dewi Sartika Nasution and others, *Ekonomi Digital* (Mataram: Fakultas Ekonomi dan Bisnis Islam, 2019) <www.uin mataram.co.id%0ASanabil>.

[9] Teguh Permana and Andriani Puspitaningsih, 'Studi Ekonomi Digital Di Indonesia', *Jurnal Simki Economic*, 4.2 (2021), 161–70 <https://doi.org/10.29407/jse.v4i2.111>.

[10] Mihasonirina Andrianaivo and Kangni Kpodar, 'ICT, Financial Inclusion, and Growth Evidence from African Countries', *IMF Working Papers*, 11.73 (2011), 1

As a type of ICT improvement universally, partners included have planned advances together to upgrade the accessibility and nature of ICT information and pointers, particularly in non-industrial nations. At last, this organization in 2004 brought forth The Organization on Estimating ICT for Improvement, settled upon by 14 global associations, turning into a reference for nations overall in making ICT strategies in view of ICT measurements. A few pointers to quantify the limit of access and utilization of ICT include: 1. Web Clients. As characterized by the Unified Countries (Center ICT Marker: Association on Estimating ICT for advancement 2005), a web client is somebody who pays for admittance to the public web (TCP/IP association), no matter what the sort or speed of access, or the gadget used to get to the web (United Nations, 2005).

ICT Index

ICT isn't solely utilized as a communication medium but has also become the primary benchmark for economic players in business and entrepreneurship. With this global trend, Southeast Asian (ASEAN) nations can proactively leverage opportunities arising from the rapid advancement of technology. The importance of telecommunications for a country's economy, particularly as expressed by the International Telecommunication Union (ITU), highlights that a 1% increase in ICT teledensity can lead to a 3% economic growth (Ngatono, 2016)[11].

In their paper titled "Causality Analysis of Information and Communication Technology (ICT) and ASEAN Economic Growth," Sahrina and Ali Anis (2019) stated that technological advancement acts as a driving force for ASEAN countries to achieve exceptional economic performance. Policy makers across ASEAN nations have shown significant interest in enhancing ICT infrastructure. Globally, the state of ICT in several ASEAN countries still lags far behind other developed nations. This might be due to a lack of adequate knowledge in most ASEAN member states about the indicators that need improvement in ICT infrastructure, which would, in turn, contribute to the country's economy[12].

The ICT index referred to in this variable is a standardized measure of ICT development in a region, enabling comparison across time and regions. It's used to measure ICT development growth, assess the digital gap or disparity between regions, and gauge the potential for ICT development. The regions referred to in this research are the countries within ASEAN.

Foreign Direct Investment (FDI)

FDI, known as "Foreign Direct Investment", is an investment or capital injection from foreign or overseas entities. Generally, the purpose behind FDI is to obtain lasting interest, where a long-term relationship between the foreign investor and the company is established, aiming to observe a significant influence of the investor on the company's management. FDI can be executed by individuals or foreign companies from outside the country.

According to Krugman & Obstfeld (2023), FDI is an international flow of capital wherein companies from one country establish their businesses in another. Foreign Direct Investment (FDI) has the potential to bolster export activities through the augmentation of domestic capital, the transfer of technology and novel export-oriented products, facilitation of entry into new or foreign markets, and the provision of training programs aimed at improving the technical expertise and managerial capabilities of domestic workforce.

Temiz and Gokmen (2011) assert that foreign direct investment (FDI) fosters the expansion of exports through the accumulation of capital to support the growth of export activities. Furthermore, it plays a crucial role in facilitating the transfer of technology, fostering the creation of new export-oriented products, streamlining access to untapped markets, and providing opportunities for training domestic workers and enhancing managerial capabilities[13].

Impact of the Digital Economy on Gross Domestic Product

An examination of Indonesia's digital economic landscape conducted by Teguh Permana

<https://doi.org/10.5089/9781455227068.001>.

[11] Ngatono, 'Pengaruh Infrastruktur Telekomunikasi Terhadap Pertumbuhan Ekonomi Di Provinsi Banten Tahun 2004 -2013', *Jurnal PROSISKO*, 3.1 (2016), 33–42 <https://e-jurnal.lppmunsera.org/index.php/PROSISKO/article/view/121/177>.

[12] Sharina and Ali Anis, 'Analisis Kausalitas Teknologi Informasi Dan Komunikasi, Konsumsi Listrik Dan Pertumbuhan Ekonomi Di Indonesia', *Jurnal Kajian Ekonomi Dan Pembangunan*, 4.4 (2022), 11 <https://doi.org/10.24036/jkep.v4i4.14057>.

[13] Dilek Temiz and Aytaç Gökmen, 'Foreign Direct Investment (FDI) and Export Relation in Turkey: 1991–2010', *Journal of Transnational Management*, 16.3 (2011), 157–80 <https://doi.org/10.1080/15475778.2011.596779>.

and colleagues in 2021 reveals a swift expansion in the country's digital economy, potentially becoming the largest market share in Southeast Asia. Research findings indicate that the digital economy is projected to increase eightfold and is estimated to reach a digital economy value of 1796 trillion Indonesian rupiahsby 2024. The implication is that the government must promptly build supportive infrastructure to accelerate this growth.

Empirical evidence demonstrates that the digital economy significantly contributes to economic growth. A study by Huawei and Oxford Economics (2017), cited by Agus Sugiyarto (2022), it was pointed out that the portion of the worldwide Gross Domestic Product (GDP) attributed to the digital economy was merely 15.5% in 2016, with projections anticipating a rise to 24.3% by the year 2025. In 2020, China's advanced economy added to 38.6% of their Gross domestic product, while 7.7% of the UK's economy was ascribed to computerized monetary exercises in 2018.

The job of the advanced economy in the development of a few emerging nations is likewise strikingly critical. For example, in India, it adds to 3.2% of their Gross domestic product and is expectedto make 65 million new positions by 2025. Thailand's computerized economy contributes roughly 20% to its Gross domestic product, while Singapore projected around 60% of its Gross domestic product in 2021 to be gotten from this area. Malaysia's computerized economy contributed around 20% to its Grossdomestic product in 2021, while Vietnam's advanced economy commitment to Gross domestic product came to 8.2% (Sugiyarto, 2022).

Previous Research

Research conducted by Adisti (2021) entitled "Analysis of the Influence of Digital Technologyon Economic Growth (Case Study of Southeast Asia Region in 2010-2018)" found that broadband, as one proxy for technology, had a significant positive impact on economic growth. However, variables like the internet, high-tech exports, working-age population, and elderly population did not have a significanteffect on economic growth. On the other hand, mean years of schooling, Acting as a representative for educational purposes demonstrated a favorable and noteworthy influence on the advancement of economic prosperity[14].

A review the "Examination of the Impact of the Computerized Economy on Financial Development in Indonesia: Board Information Model" by Ahmad Albar Tanjung et al. (2022) planned to decide the degree of the effect of the advanced economy, addressed by the Number of Web Clients (NIU), Internet business Exchange Worth (ETV), and the Quantity of Internet Business Development (NEB), both somewhat and at the same time, on monetary development (EG) in Indonesia.[15].

A study on the "Impact of Information Technology on Gross Domestic Product" conducted by Widias Retiawan et al. (2011) aimed to analyze the influence of ICT indicators on GDP, identify the most influential ICT indicators on GDP, and analyze supportive factors from other sectors toward GDP in both the long and short term in Indonesia. The study revealed that, in the long term, landlines, mobile phones, and the internet significantly and positively affected GDP, with coefficients of 131,808, 24,990,and 547,227, respectively. In the short term, landlines and mobile phones had significant positive effects on GDP with coefficients of 81,907 and 13,891.85, respectively, while the internet did not significantly influence GDP. Government spending on education and the population's education level had a negative and insignificant impact on GDP, while investment had a positive and significant short-term effect but not a significant long-term effect.

Albertus et al. 's (2020) study named "Examination of the Impact of Total National Output, ICTImprovement Record, and Great Administration on the Human Improvement File of ASEAN and SAARC Lower-Upper Medium Classes" demonstrated that GDP, ICT Advancement List, and political dependability without viciousness or psychological warfare had a critical positive relationship. In any case, control of defilement showed a huge negative relationship with the Human Improvement File in ASEAN and lower-medium SAARC classes. Administrative quality had various relationships between the two territorial associations: a positive and huge relationship in lower-medium ASEAN classes yet a negative and critical relationship in lower-medium SAARC classifications.

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[14] Adisti Diva Fahira, 'Analisis Pengaruh Teknologi Digital Terhadap Pertumbuhan Ekonomi (Studi Kasus Wilayah Asia Tenggara 2010-2018)', 2021 <https://jimfeb.ub.ac.id/index.php/jimfeb/article/view/7966/6781#:~:text=Download-,this PDF file,-Fullscreen Fullscreen Off>.

[15] Ahmad Albar Tanjung and others, 'Analisis Pengaruh Ekonomi Digital Terhadap Pertumbuhan Ekonomi Di Indonesia: Model Data Panel', *Ekonomi, Keuangan, Investasi Dan Syariah (EKUITAS)*, 4.2 (2022), 567–75 <https://doi.org/10.47065/ekuitas.v4i2.2223>.

Edi Wahyu Wibowo (2018) in his review named "Examination of Computerized Economy on the Development of ASEAN Nations' Gross Domestic Product" Illustrates the impact of digitization on the economic growth of ASEAN countries has become significant, necessitating enhancements in the management of online users. It is trusted that web clients won't just be buyers but additionally set out business open doors by firing up new undertakings, empowering the monetary development of every country to move along. Regarding the impact of transparency on the economic growth of ASEAN countries, there is a need for enhancement, particularly in the facilitation of exportable goods, reduction of imports, and revision of commodity import duties. This will consequently foster a business-friendly environment in each nation. Normally, expanded transparency will draw in additional ventures, eventually adding to the target of laying out the ASEAN Monetary People group to encourage the thriving of every ASEAN part country[16].

Muhammad Rizal Anggit Putra's research (2021), titled "Analysis of Gross Domestic Product (GDP) Growth of ASEAN Countries in the Years 2015-2019," through t-statistic tests, demonstrates that the money supply, inflation, and trade openness significantly affect GDP growth in ASEAN. Nonetheless, the economic expansion of ASEAN nations remains largely unaffected by foreign direct investment[17].

The findings presented in the 2019 World Bank report entitled "Enhancing the Basis for FutureGrowth: The Advancement of the Digital Economy in Southeast Asia" suggest that, despite challengein accurately gauging the transformative impact of the digital economy on the region's economic terrain, compelling evidence indicates a notable surge in the momentum of the digital economy in Southeast Asia(World Bank, 2019: 39). The manifestation of this phenomenon becomes apparent through the expansionof electronic commerce, the swift integration of financial technology, the heightened prevalence of digitalcontent, and the escalating digitization of both corporate entities and governmental provisions. Nevertheless, for the digital economy to exert a substantial influence on the mitigation of poverty and the promotion of inclusivity, a more comprehensive comprehension of the fundamental supporting factors is imperative[18].

RESEARCH METHODS

Tools and Methods Analysis

Estimate influence digital economy on GDP in ASEAN countries in 2014-2019, researcher use formulated panel data regression in equality as following.

$$GDP_{it} = \beta_0 + \beta_1 \log expict_{it} + \beta_2 ICTindex_{it} + \beta_3 fdi_{it} + e_{it} \dots$$

(3.1) where a:

$GDP\ it$	:	*Gross Domestic Product*
β_0	:	Constant
$\beta_0, \beta_1, \beta_2, \beta_3$	:	Coefficient variable independent
$expict$	:	ICT exports
$ICTindex$	:	ICT Index
fdi	:	Investment foreign
i	:	*Cross section*
t	:	*Time series*
e	:	Residual
log	:	Natural logarithm based e

The phases of estimating a panel data regression model encompass the application of various approaches, namely the "Common Effects Model (CEM), Fixed Effects Model (FEM), and Random Effects Model (REM)." Following this, the Chow Test and the Hausman Test are employed for the purpose of determining the optimal model for estimation.

Panel Data Model Selection

[16] Edi Wahyu Wibowo, 'Analisis Ekonomi Digital Dan Keterbukaan Terhadap Pertumbuhan GDP Negara Asean', *Jurnal Lentera Bisnis*, 7.2 (2018), 66 <https://doi.org/10.34127/jrlab.v7i2.235>.

[17] Muhammad Rizal Anggit Putra, 'Analisis Pertumbuhan Gross Domestic Product (GDP) Negara Asean Tahun 2015-2019', *Industry and Higher Education*, 3.1 (2021), 1689–99 <http://journal.unilak.ac.id/index.php/JIEB/article/view/3845%0Ahttp://dspace.uc.ac.id/handle/123456789/1288>.

[18] World Bank, 'The Digital Economy in Southeast Asia : Strengthening the Foundations for Future Growth', 2019, 128 <http://hdl.handle.net/10986/31803>.

Board information, otherwise called pooled information, is a blend of cross-sectional and time-series information (Widarjono, 2018). There are two benefits to utilizing board information: (1) the blend of cross-sectional and time series information gives a bigger dataset, bringing about more noteworthy levels of opportunity, and (2) the mix of cross-sectional and time series information can resolve that emerge when there are discarded variable issues. To assess a relapse model "using comprehensive data,three approaches can be employed: "the Common Effects Model (CEM), Fixed Effects Model (FEM), and Random Effects Model (REM)."

Common Effect Model (CEM)

The Basic Impact Model represents a straightforward method for analyzing panel data by integrating information from both time series and cross-sectional datasets. With Thus, panel data models only estimated use method *Ordinary Least Squares* (OLS) (Widarjono, 2018). The *Common Effects* model is displayed in Equation (3.2).

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + e_{it} \dots\dots\dots\dots\dots (3.2)$$

Where:
Y	:	variable dependent
X	:	variable independent
i	:	*cross section*
t	:	*time series*

Fixed Effect Model (FEM)

Fixed Effects Model is technique panel data estimation using technique variable *dummy* for see exists difference interceptions, which are also frequent named with *Least Square Dummy Variables* (LSDV) (Widarjono, 2018). The *Fixed Effects* Model is displayed in Equation (3.3).

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 D_{1it} + e_{it} \dots\dots\dots\dots\dots (3.3)$$

Where:
i	: 1, 2, …, n
t	: 1, 2, …, n
D	: *dummy*

Random Effects Model (REM)

The use of dummy variables in the Fixed Effects model aims to represent uncertainty about the true model. However, this also has the consequence of reducing degrees of freedom, which ultimately decreases parameter efficiency. This issue can be addressed by using error term variables, known as theRandom Effects method. In this method, the error term variables may be correlated over time and across individuals (Widarjono, 2018)

Model Estimator Selection

The Chow test serves as an evaluative tool for discerning the optimal model choice between theCommon Effects Model (CEM) and the Fixed Effects Model (FEM) when conducting panel data estimation., with the following steps:

1. Formulation hypothesis:

H_0: CEM selected models

H_A: FEM selected model

2. Determine criteria testing:

"H_0 not rejected if the probability F- statistic > α" "H_0 rejected if probability F- statistic $< \alpha$"

Hausman test

The Hausman test serves "the purpose of determining the optimal model choice between the Fixed Effects Model (FEM) and the Random Effects Model (REM) when conducting panel data estimation.", with the following steps:

1. Hypothesis formula:

H_0: REM selected models

H_A: FEM selected model

2. Determine criteria testing:

"H_0 not rejected if it is a probability $\chi^2 >$ α" "H_0 rejected if probability $\chi^2 < \alpha$"

Significance Test of the Selected Estimator Model

Selected Model Existence Test (F Test)

The utilization of the F-test is employed to demonstrate the collective impact of distinct factors, specifically ICT exports, ICT index, and foreign direct investment (FDI), on the dependent variable, Gross Domestic Product (GDP). The steps in the F-test are as follows:

1. H_0: $\beta_1 = \beta_2 = \beta_3 = 0$, which means all regression coefficients are zero, so together ICT exports, ICT index and investment foreign (FDI) no influential to GDP.
2. H_A: $\beta_1 \neq 0 | \beta_2 \neq 0 | \beta_3 \neq 0$, which means there is at least one regression coefficient that is notzero, so that together, ICT exports, ICT index and investment foreign (FDI) influence to GDP.
3. Determine criteria testing
   H_0 not rejected if the probability value of F - statistics $> \alpha$
   H_0 rejected if the probability value F - statistic $< \alpha$

Coefficient of Determination (R^2)

"The coefficient of determination (R^2) indicates how much variation in the independent variablecan explain the variation in the dependent variable. The value of R^2 ranges between 0 and 1." A model is considered good when the R^2 value approaches one (Widarjono, 2018).

Significance Test of Partial Independent Variable Effects (t-test)

The t-test is directed to inspect whether free factors independently altogether affect the reliantvariable. The hypotheses used in the t-test are as follows:

1. Hypothesis formula
   H_0 : $\beta_i = 0$ (i = 1-3) ; It means ICT exports , ICT index and investment foreign No influential to GDP.

   H_A: $\beta_j > 0$ (j = 1 & 2); It means ICT exports and ICT index each influential positive to GDP.
   H_A: $\beta_3 \neq 0$; It means investment foreign influential to GDP absorption.
2. Determine criteria testing
   a. If probability mark t - statistics $\beta_1 > \alpha$ (i= 1-3), then H_0 not rejected, which means that in a way statistics, ICT exports, ICT index and investment foreign (FDI) no influential toGDP.
   b. If probability mark t - statistics $\beta_j < \alpha$ (j = 1 & 2), then H_0 rejected, which means ICT exports and ICT and investment index foreign (FDI) respectively influential positive to GDP.

DISCUSSION

Panel Data Estimation Results

Study This estimate influence ICT exports, ICTindex, and FDI towards Gross Domestic Product in ASEAN countries in 2014-2019 with panel data regression shown in equation (3.1). Regression results "*Common Effect Model* (CEM), *Fixed Effect Model* (FEM) *and Random Effects Model* (REM)" are shown in Table 4-1.

Table 4-3
Panel Data Regression Results

Variable	CEM		FEM		BRAKE	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	218841.2	0.012	150345.5	0.001	151893.8	0.195
expict	951,660	0.742	439,218	0.846	396.130	0.855
ICTindex	-12471.78	0.958	186412.5	0.002	185004.0	0.002
fdi	3,407	0.142	2,460	0.007	2,445	0.006
R^2	0.082		0.987		0.271	
Adj. R^2	0.0.33		0.984		0.232	
F-stat.	1,673		306,494		6,938	
Prob.(F-stat)	0.183		0,000		0,000	

Selection Test:

1. Chow
   Cross-section $F(9, 47) = 374.614$; Prob. F = 0.000
2. Hausman
   Cross-section rando m χ^2 (3) =0.131; Prob. $\chi2 = 0.988$

Source: Appendices 2 -6

Test Chow

The Chow Test serves as a diagnostic tool for selecting the optimal model, either The CommonEffect Model (CEM) or the Fixed Effect Model (FEM) is discussed within the framework of panel data estimation. It is affirmed that should the probability associated with the F-statistic dip below the predetermined significance level α (set at 0.05), the rejection of the null hypothesis (H0) is warranted, indicating the supremacy of the Fixed Effect Model (FEM). As illustrated in Table 4-3, the Cross-section F probability is recorded as 0.000, surpassing α (0.05). Consequently, the rejection of H0 implies that the more suitable model for estimation is the Fixed Effect Model (FEM).

Hausman Test

The Hausman Test serves as a statistical tool for determining the more suitable model for panel data estimation, comparing the Random Effect Model (REM) and the Fixed Effect Model (FEM). The criterion stipulates that if the χ2 probability is < α (0.05), H0 is embraced, signifying the Random EffectModel (REM) as the fitting choice for estimating panel data. Analysis of Table 4-1 reveals a χ2 probability of 0.988, surpassing α (0.05). Consequently, H0 is accepted, affirming the Random Effect Model (REM) as the apt selection for the panel data estimation model.

Regression Results and Calculations Selected Model Constants

After conducting the Chow Test and the Hausman Test, it can be inferred that the optimal modelfor estimating panel data in this research is the Random Effects Model (REM). Table 4-4 provides a comprehensive display of the outcomes from the REM regression analysis.

Table 4-4
REM Regression Results

GDP_{it}= 151893.8 +396.1298 expict it + 185004.0 ICTindex it + 2.4451 fdi it
         (0.8555)   (0.0017) *   (0.0059)*

$R^2 = 0.270$; DW-stat. = 1,234 ; F-stat = 6.938 ; Prob. F-stat. = 0.000

Source: Appendix 3**. "Note:** *Significant at α = 0.01; **Significant at α = 0.05; ***Significant at α = 0.1; the numbers in parentheses are the probabilities of the t-statistics."

Goodness of Fit Test

Significance Test of the Simultaneous Impact of Independent Variables (F-test)

The F-test is utilized to assess the combined impact of independent variables on the

dependent variable. The null hypothesis (H0) posits that the coefficients for ICT exports, ICT Index, and FDI are all equal to zero ($\beta 1 = \beta 2 = \beta 3 = 0$), implying that these factors do not jointly affect GDP. Rejection of H0 occurs when the F-statistic probability is $< \alpha$, while non-rejection happens when the F-statistic probability is $> \alpha$. According to the findings in Table 4-2, the F-statistic probability is determined to be 0.000, which is $< \alpha$ (0.05). Consequently, H0 is rejected, indicating that ICT exports, ICT Index, and FDI collectively exert an influence on Gross Domestic Product (GDP) in ASEAN countries during the period 2014-2019.

Interpretation of the Coefficient of Determination and the Constant

The R-squared value, denoted as the coefficient of determination (R2), elucidates the extent to which the fluctuations in independent variables elucidate the variances observed in the dependent variable. According to the findings presented in Table 4-4, the R-squared value stands at 0.270. Consequently, 27% of the fluctuations in Gross Domestic Product (GDP) find explanation in the variances observed in ICT exports, ICT Index, and FDI. The remaining 73% of variations are attributed to other factors beyond the scope of the model.

Significance Test of the Partial Effects of Independent Variables (t-test)

The t-test is directed to decide if every free factor exclusively fundamentally affects the reliant variable, it are steady to expect that different factors. The invalid speculation (H0) for the t-test is $\beta 1 = 0$ (I = 1-3), implying that searately, ICT sends out, ICT List, and FDI don't affect GDP (Gross domestic product). Then again, the elective speculation (HA) for the t-test is $\beta 1 > 0$, demonstrating a positive effect of ICT sends out on Gross domestic product, $\beta 2 > 0$, showing a positive effect of ICT File on Gross domestic product, and $\beta 3 \neq 0$, demonstrating an effect of FDI on Gross domestic product. "H0 isn't dismissed if the likelihood of the t-measurement $> \alpha$, and H0 is dismissed if the likelihood of the t- measurement $< \alpha$." The aftereffects of the t-test are introduced in Table 4-4.

Based on Tables 4-3 and 4-5, $\beta 1$ is positively signed with a t-statistic probability of 0.8555, so H0 is not rejected, meaning that ICT exports do not have an impact on Gross Domestic Product (GDP). B2 has a t-statistic probability of 0.0017, so H0 is rejected, indicating that ICT Index has an impact on Gross Domestic Product. Furthermore, $\beta 3$ has a t-statistic probability of 0.000, so H0 is rejected, indicating that FDI has an impact on Gross Domestic Product.

Table 4-5
***t* Test Results**

Variable	Prob t – Stat	Criteria	Conclusion
expict	0.855	> 0.01	β_1 proven No real at α 0.1
ICTindex	0.001	< 0.01	β_2 proven real at α 0.05
fdi	0.005	< 0.01	β_3 proven real at α 0.05

Regression Coefficient Interpretation

In view of Table 4-3, it is realized that ICT trades, ICT files, and FDI decidedly affect the GDP (Gross domestic product). The variable ICT sends out has a relapse coefficient of 396.130, demonstrating a straight relationship. This means that assuming the ICT sends out factor increments by one unit, the Gross domestic product will increment by 396.130 percent. In the meantime, the ICT record has a relapse coefficient of 185,004 with a direct relationship. This suggests that an increment of one unit in the ICT record will expand the Gross domestic product by 185,004 percent. At long last, the FDI coefficient is
2.445 with a straight relationship, showing that a one percent expansion in FDI will prompt a 2.445 percent increment in Gross domestic product.

Economic Interpretation
Impact of ICT Exports on GDP

Based on the results of the t-test, it is known that ICT exports do not have a significant impact on GDP in ASEAN countries during the period 2014-2019. This result aligns with the research hypothesis. The increase in ICT exports does not indicate an increase in a country's GDP. This is consistent with a study conducted by Adisti (2021) titled "Analysis of the Impact of Digital Technology on Economic Growth (Case Study of the Southeast Asia Region, 2010-2018)," which found that broadband, as one of the proxies for technology, Exerts a notable favorable influence on economic expansion. Nevertheless, factors like the internet, exports of advanced technology, the working-age demographic, and the elderly populace demonstrate no substantial impact on economic

growth. Conversely, the average years of schooling, serving as a proxy for education, exhibit a positive and noteworthy influence on economic growth. For high-technology export variables, a study conducted bySantos et al. (2013) showed that the performance of high-technology exports does not significantly increase economic growth due to differences in productivity differentiation between domestic and international competition.

Impact of ICT Index on GDP

The results of the t-test show that the ICT Index has an impact on GDP in ASEAN countries from 2014 to 2019. This result is consistent with the research hypothesis.

Table 4-5. ICT Index of ASEAN Countries

Country	2014	2015	2016	2017	2018	2019
Brunei Darussalam	0.43	0.44	0.45	0.59	0.67	0.69
Philippines	0.41	0.45	0.5	0.39	0.51	0.53
Indonesia	0.13	0.39	0.4	0.36	0.37	0.39
Cambodia	0.21	0.27	0.3	0.21	0.36	0.33
Laos	0.11	0.12	0.18	0.22	0.31	0.25
Malaysia	0.46	0.4	0.43	0.66	0.75	0.81
Myanmar	0.04	0.1	0.08	0.17	0.2	0.22
Singapore	0.93	0.99	1	0.97	0.97	0.97
Thailand	0.43	0.46	0.54	0.6	0.62	0.63
Vietnamese	0.4	0.39	0.42	0.49	0.53	0.54

Source: ASEANstats,2022

The more the ICT index advances, the larger a country's GDP tends to be, as the ICT index develops. This aligns with the findings of Albertus et al.'s research (2020) titled "Analysis of the Impactof Gross Domestic Product, ICT Development Index, and Good Governance on the Human DevelopmentIndex of ASEAN and SAARC Members in Lower-Upper Medium Categories." The research findings suggest a noteworthy correlation between "Gross Domestic Product (GDP), ICT Development Index, and political stability devoid of violence or terrorism, demonstrating a positive and substantial connection. Conversely, the human development index in lower-tier ASEAN and SAARC nations"

displays a significant and adverse relationship with the control of corruption. The quality of regulations shows a varied relationship between the two regional organizations.

Moreover, the examination directed by Yohanes Novi Armunanto et al. (2021) named "Internetbusiness Impact On Monetary Development In ASEAN Nations" shows that online business exchange values, interest in the ICT area, and internet business work by and large affect financial development in ASEAN nations[19].

In accordance with this, Ozcan (2018) explored the repercussions of Information and Communication Technology (ICT) on Turkey's global trade through the application of a gravity model. Ozcan's findings indicated that the ICT Development Index (IDI) exerts a noteworthy influence on the augmentation of both export and import magnitudes in the context of Turkey's bilateral trade. The utilization of Information and Communication Technology (ICT) contributes to the mitigation of trade expenses, encompassing fixed-market entry costs, communication expenditures, and information-relatedoutlays. As the degree of ICT integration advances between two nations, there is a proportional augmentation in bilateral trade endeavors. In essence, the adoption of ICT yields a favorable and noteworthy influence on both the export and import capacities of Turkey, with a more pronounced effecton the latter. This underscores the vital role of accessible internet and dependable ICT utilization in enhancing the magnitude of export transactions.

Effect of FDI on GDP

The t-test results show that FDI affects increasing GDP in ASEAN countries. These results areby the research hypothesis. This is because the greater the FDI in a country, the more development there will be in the sector being invested, resulting in more job opportunities which can increase a country's GDP.

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[19] Yohanes Novi Armunanto, Mar Selina, and I Wayan Suparta, 'E-Commerce Effect On Economic Growth In Asean Countries', *International Journal of Economics and Management Studies*, 8.2 (2021), 100–104 <https://doi.org/10.14445/23939125/IJEMS-V8I2P114>.

In the study conducted by Vafa Zsa Zsa Az Zahran in 2020, titled "Examining the Impact of Foreign Direct Investment and Exports on the Economic Growth of Indonesia," the findings reveal (1) a noteworthy impact of both Foreign Direct Investment and exports on the economic growth of Indonesia,
(2) a collective and substantial influence of Foreign Direct Investment and exports on the overall economic expansion of Indonesia, and (3) an analysis of individual variable impacts underscores that exports emerge as the predominant factor influencing the growth of the Indonesian economy[20].

Research led by Fadhilah (2020) on Unfamiliar Direct Venture (FDI) with the title Dunning Model Methodology for Examining the Determinants of FDI Inflows in 7 ASEAN Nations shows that: Genuine Gross domestic product affects FDI Inflows, Conversion scale affects FDI Inflows, Exchange Transparency affect FDI Inflows, the ICT Improvement File meaningfully affects FDI Inflows, the Defilement Discernment Record significantly affects FDI Inflows, and Street Length meaningfully affects FDI Inflows[21].

Research led by Wulan Rahmawati, (2022) on Elements that Impact Unfamiliar Direct Speculation (FDI) on Financial Development in Indonesia in 2000-2019 plans to break down factors that impact Unfamiliar Direct Venture (FDI), expansion, loan costs and products on monetary development both to some degree and at the same time[22]. Indonesia, ranking as the fourth most populous nation globally, boasts a substantial workforce and abundant natural resources. Consequently, it emerges as a highly promising destination for investment. The influx of foreign investment not only creates numerous employment opportunities but also contributes to the reduction of the unemployment rate. The clearest advantage of approaching unfamiliar speculation is expanding state pay through charges. Aside from that, it makes a more steady relationship in the financial circle of the two nations.

CONCLUSION AND RECOMMENDATIONS

This examination means to appraise the size of the impact of the computerized economy as demonstrated by the ICT trade factors, ICT record, and FDI on the GDP of ASEAN nations in 2014-2019. The after-effects of measurable tests inferred that (1) the halfway ICT send-out factor didn't essentially impact the GDP (Gross domestic product) of ASEAN nations. (2) the ICT list variable essentially affects the Total national output (Gross domestic product) of ASEAN nations, (3) the Unfamiliar Direct Venture (FDI) variable fundamentally affects the GDP (Gross domestic product) of ASEAN nations, (4) Generally speaking along with the factors ICT sends out, ICT File and Unfamiliar Direct Speculation (FDI) altogether affect the GDP (Gross domestic product) of ASEAN nations. From the consequences of measurable tests both somewhat and altogether, it tends to be reasoned that the Computerized Economy impacted the development of the GDP (Gross domestic product) of ASEAN nations in the 2014-2019 period.

The results of this research recommend that the use of ICT is not only for consumers but is used to open up business opportunities so that it will encourage an increase in the Gross Domestic Product (GDP) of ASEAN countries. The large ICT and FDI index opens up opportunities to increase the GDP of ASEAN countries so that openness in terms of bureaucracy is needed to attract foreign investors.

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[21] Silvia Fadhilah, 'Pendekatan Model Dunning Untuk Menganalisis Determinan FDI Inflows Di 7 Negara Asean', 2020, 1–112.
[22] Wulan Rahmawati, 'Analisis Faktor Yang Mempegaruhi Foreign Direct Investment (FDI) Asing Terhadap Pertumbuhan Ekonomi Di Tahun 2000-2019', *Profit: Jurnal Manajemen, Bisnis Dan Akuntansi*, 1.4 (2022), 60–77 <https://doi.org/10.58192/profit.v1i4.193>.

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