Determinants of Smart-Circular Economy Integration in the Creation of Quality of Life and SDGs Empowerment in Indonesia: PLS-SEM Modeling Study

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Abstract
The country's economy is evolving, driven by activities that enhance income and welfare, encompassing financial aspects, technological advances, and ecosystem preservation. The circular and intelligent economies support sustainable development through resource efficiency and technology. This study examines the role of government support, Industry 4.0 resource capability, and netizen character in driving Smart Economy and Circular Economy development and their implications for quality of life and SDGs empowerment in Indonesia. The research was conducted in five leading Smart Cities—Jakarta, Bandung, Surabaya, Semarang, and Makassar—which represent regional innovation hubs in digital governance and smart development initiatives. Using a quantitative approach, data were collected from 300 respondents through structured questionnaires and analyzed using structural equation modeling (SEM-PLS). The findings reveal that Industry 4.0 resource capability and netizen character significantly contribute to Smart Economy and Circular Economy development. However, government support does not show a significant direct effect on Smart Economy development. This finding suggests that policy ineffectiveness may stem from limited inter-institutional coordination, bureaucratic fragmentation, and inconsistent implementation across regions. In contrast, Smart Economy and Circular Economy development positively influence quality of life and SDGs empowerment. The study highlights the need to prioritize policy coordination, strengthen digital infrastructure, and enhance collaborative governance to ensure more effective Smart Economy implementation. Rather than providing broad recommendations, the results emphasize improving institutional synergy and harmonizing regional policies as key strategies to address the rejected hypotheses. These findings contribute to the growing discourse on sustainable digital transformation and offer practical implications for advancing integrated Smart-Circular development at the national level.
Keywords*: Circular Economy, Quality of Life, Smart Economy, SDGs*
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A. INTRODUCTION

A country's economy constantly changes yearly due to economic activities that continue to occur and are sought to increase from the previous period. The success of a country in managing its resources is reflected in the level of income earned, which is illustrated by the rate of economic growth that increases yearly (Steidle et al., 2024). More significant income reflects better welfare conditions for the community (Shynkaruk et al., 2020). A country's income level also reflects its economy's condition and growth rate (Tayibnapis et al., 2018).

Welfare is a measure to determine whether an individual or group of people is in a state of prosperity (Li et al., 2023). Welfare is indicated by good health conditions, an improved economy, a

high level of education, and a decent quality of life (Song et al., 2022). Community welfare is one of the sustainable development goals (SDGs), which describes the government's success in building a country's economy.

At this time, people's welfare is not only measured financially but also includes technological advances and the preservation of natural ecosystems (Vučeković et al., 2023). Technology is crucial in improving the quality of life and providing better access to education, healthcare, and economic opportunities (Wu et al., 2015). Meanwhile, a well-maintained natural ecosystem ensures the sustainable availability of natural resources, supports environmental health and improves air and water quality (Pretty et al., 2016). The combination of technological advancement and environmental protection creates an essential balance to achieve comprehensive and sustainable well-being for the entire community.

Concerns about environmental issues are increasingly widespread globally. Environmental protection is now a priority for many organizations. Therefore, they increasingly focus on implementing sustainable practices to support the transition to a circular economy. The circular economy is an economic system that shifts the concept of "end of life" by emphasizing the use of renewable energy and the reduction, reuse, recycling, and recovering of materials in the production, distribution, and consumption processes (D'Amato et al., 2017).

The system aims to achieve sustainable development that includes environmental quality, economic well-being, and social justice for current and future generations (Latif et al., 2023). The circular economy provides added value by utilizing waste in production and consumption. The main focus of this system is to eliminate waste, ensure the sustainable use of goods, and restore natural ecosystems (Subekti, 2023). Previous research has shown that the primary goal of the circular economy is to achieve economic well-being and environmental quality (Trigkas et al., 2020). In addition, Stumpf et al. (2021) state that the circular economy seeks to maintain the turnover of resources while reducing the impact of extraction, emissions, and disposal of natural resources (Stumpf et al., 2021). The implementation of the circular economy system is carried out at three levels: micro (product), meso (industry), and macro (national or regional) (Arista et al., 2023).

On the other hand, policymakers consider science, technology, and innovation essential in achieving national sustainable development goals through startups based on these three aspects (Hecht et al., 2019). The leading global trends today include Industrialization and Globalization 4.0, with modern technology as one of the elements (Ngo & Le, 2021). In the Indonesian context, the transition toward Industry 4.0 is formally outlined in the national roadmap Making Indonesia 4.0, initiated by the Ministry of Industry. This roadmap aims to revitalize the manufacturing sector through the adoption of advanced technologies such as AI, IoT, robotics, and big data, focusing on five priority sectors and ten cross-sector national initiatives, including digital infrastructure, innovation ecosystems, sustainability standards, and human resource development (Susilo, 2020). Through this strategy, Indonesia seeks to enhance productivity, strengthen global competitiveness, and support sustainable industrial transformation, thereby providing a concrete policy foundation for Smart and sustainability-oriented economic development.

Over time, the complexity of development has also increased. The benefits of progress are real, but so are the weaknesses and negative impacts of such growth. Local governments must have strategies to overcome this development's economic, environmental, and employment challenges (Gurjanov et al., 2020). The intelligent economy has recently emerged as a boost to national economic growth. Innovative Economy

integrates advanced technology and data analytics to improve efficiency, productivity, and financial sustainability (Popova & Popovs, 2022.The intelligent economy drives inclusive and adaptive growth through digital innovation, automation, and connectivity, delivering intelligent solutions to economic, environmental, and social challenges (Magdy et al., 2020)

Conceptually, the intersection between the Smart Economy and the Circular Economy lies in the role of digital technologies as enablers of circular practices. While the Circular Economy focuses on closing material loops, extending product life cycles, and minimizing waste, its effective implementation requires real-time monitoring, data transparency, and intelligent optimization of resource flows (Bashynska et al., 2024).

The Smart Economy, through digital technologies such as IoT, artificial intelligence, and big data analytics, provides the technological infrastructure necessary to track material lifecycles, improve reverse logistics systems, and enhance resource efficiency (Siddiqui & Pandit, 2021). Therefore, the Smart-Circular Economy represents an integrated development paradigm in which digital intelligence accelerates circular transition while circular principles guide technological innovation toward sustainability.

Integrating the Circular Economy and Smart Economy is very important to achieve the nation's welfare. The Circular Economy promotes efficient and sustainable use of resources, reduces waste, and extends product life cycles (Lewandowski, 2016). When combined with the Smart Economy, which leverages advanced technology and data analytics, the efficiency and productivity of the economy increase significantly (Truant et al., 2024). This integration enables real-time resource use monitoring and optimization, supporting inclusive and sustainable economic growth. By reducing environmental impact and fostering innovation, this integration improves economic well-being and the community's overall quality of life.

Both the concepts of circular economy and smart economy receive a lot of attention in many areas of business and management study, such as strategic management (Mendoza et al., 2022), Sustainability (Akberdina et al., 2023), Supply Chain Management (Khan et al., 2022) and economy (M. Kim et al., 2023). Implementing a circular economy in Europe could reduce CO2 emissions by up to 48% by 2030 (Försterling et al., 2023). In addition, the circular economy improves economic efficiency by extending product life cycles and creating innovative new business models (Aranda-Usón et al., 2020). The circular economy supports sustainable development by creating a more robust local economy, especially MSMEs, and improving the community's quality of life through pollution reduction and creating a cleaner environment (Sohal et al., 2022).

On the other hand, a lot of literature reveals that the application of advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and big data can improve operational efficiency and business productivity (Arvindhan, 2021). In the economic context, the Smart Economy drives growth through digital innovation and automation, which reduces costs and increases competitiveness (Tamvada et al., 2022). Galperina et al. (2016) mentioned the Smart Economy's contribution to providing more efficient and responsive public services, such as smart transportation and better energy management (Galperina et al., 2016).

Although the contribution of the Circular Economy and Smart Economy has been found in many studies, gaps still arise in the lack of integration of the two to achieve maximum public welfare impact. In addition, with a lot of literature, both of them are only independent factories. In fact, both the circular and smart economies must be supported by multi-stakeholder capabilities and support.

Indonesia continues to face significant environmental and structural economic challenges despite recent progress in several development indicators. In 2023, Indonesia's carbon emissions reached approximately 692 million tons of CO_2, positioning the country among the largest global emitters. National waste generation remains substantial, exceeding 56 million tons annually, with less than half managed properly. Although the Environmental Quality Index (IKLH) improved to 75.53 in 2024 and Indonesia's SDGs achievement reached 70.22% in 2025, only a limited number of SDG targets have been fully achieved (GoodStats, 2025). Similarly, while the Human Development Index (HDI) increased to 75.90 in 2024-2025, structural issues such as manufacturing concentration, export dependency on commodities, and productivity gaps persist (Maulana et al., 2025). These conditions highlight the urgency of identifying integrative development models capable of simultaneously enhancing environmental sustainability, economic resilience, and quality of life. However, empirical evidence examining how Smart-Circular Economy integration contributes to improving Quality of Life (QoL) and accelerating SDGs achievement in Indonesia remains limited.

From the background and urgency of the gap above, this study aims to analyze the determinants of strengthening Smart-Circular Economy integration in the drive to create a Quality of Life for the Indonesian people and the SDGs empowerment in Indonesia. This study is built with three research questions, namely:

RQ1. How do Government Support, Industry 4.0 Resource Capability, and Netizen Character contribute to strengthening the integration of Smart-Circular Economy Development?

RQ2. How does Smart-Circular economy development impact the quality of life?

RQ3. How does Smart-Circular economy development impact SDGs Empowerment?

This study contributes theoretically by analyzing the factors that strengthen the integration between the Smart-Circular Economy in the context of creating the Quality of Life of the Indonesian people and the empowerment of the SDGs in Indonesia. By asking three research questions, this study builds an in-depth understanding of the multi-stakeholder support factors in the development of Smart-Circular Economy (RQ1) integration, the impact of the Smart-Circular Economy on quality of life (RQ2), and its impact on the empowerment of the SDGs (RQ3). Its practical contribution lies in providing insights that stakeholders, policymakers, and practitioners can use to develop more effective strategies and policies to drive the integration of the Smart-Circular Economy, improve people's quality of life, and achieve sustainable development goals.

B. LITERATURE REVIEW

2.1. Circular Economy

The Circular Economy is a concept that aims to address environmental and economic challenges by transforming the traditional model of a linear economy based on take-use-throw-away into a more sustainable system (Milios, 2021). According to Tiwari & Goel (2023), a circular economy is an economic model that seeks to create economic growth by keeping the value of products, materials, and resources in circulation for as long as possible, thereby reducing the negative social and environmental impacts caused by linear economic approaches (Tiwari & Goel, 2023). The concept focuses on reusing existing products and materials to reduce waste and minimize the use of new natural resources (Schwanholz & Leipold, 2020). In practice, this means designing more durable, repairable, and easily recyclable products. The production process is also optimized to reduce waste and emissions.

The circular economy benefits the environment and offers new economic

opportunities. Companies can save on production costs by reducing reliance on new raw materials and extending product life cycles (seyyedi et al., 2023). In addition, service-based businesses, such as product rental and maintenance, can thrive in this economic model (Hill, 2015).

The implementation of the circular economy requires cooperation between various stakeholders, including the government, industry, and society. Governments can play an important role by creating policies that support circular practices, such as tax incentives for recycled products and strict regulations on waste disposal (García-Sánchez et al., 2021). Meanwhile, the industry must adopt product design and manufacturing innovations (Lahcen et al., 2022). Public awareness and participation are also very important to ensure the success of the circular economy, for example through active participation in recycling programs and the selection of environmentally friendly products (Hailemariam & Erdiaw-Kwasie, 2023). The circular economy offers a path to a more sustainable future, where economic well-being and environmental sustainability can go hand in hand. This model has the potential to create a more efficient and equitable system in the use of resources, as well as provide long-term benefits for future generations.

2.2. Smart Economy

Smart Economy is a concept that integrates digital technology with the economy to create a more efficient, inclusive, and sustainable system (Anttiroiko et al., 2014). By leveraging technologies such as the Internet of Things (IoT), artificial intelligence (AI), blockchain, and big data, the Smart Economy seeks to increase productivity, drive innovation, and optimize the use of resources (Azkalhaq & Amani, 2018). The Smart Economy aims to improve the arrangement of primary, secondary, and tertiary industries to improve people's welfare and build a financial ecosystem (Naiki, 2023). Smart Economy is the development of economic governance that is able to face challenges and adapt to changes so that an ecosystem that supports community economic activities is in line with the region's leading economic sectors.

The smart economy consists of 3 (three) sub-pillars, namely (1) building a competitive industrial ecosystem, (2) improving community welfare, and (3) building an economic transaction ecosystem. The dimensions of the smart economy include (1) a competitive industrial ecosystem, (2) people's welfare, and (3) a Financial Transaction Ecosystem (Vinod Kumar & Dahiya, 2017). One of the key aspects of the Smart Economy is the digitization of business processes (Pajilani et al., 2022a). Companies can use technology to automate routine tasks, reduce operational costs, and improve efficiency. For example, with AI and machine learning, companies can analyze data in real-time to make faster and more accurate decisions. This improves competitiveness and allows for a faster response to market changes (De Giovanni, 2023).

The Smart Economy also focuses on economic inclusion by providing access to financial services for previously unreachable communities (Lobo et al., 2022). With digital technologies like mobile payments and fintech platforms, individuals and small businesses can access credit, save, and invest, which drives more equitable economic growth (Sinitsyn et al., 2022). Smart Economy is about applying the latest technologies and creating a smarter, fairer, and more sustainable economic system for the future (Svobodová & Bednarska-Olejniczak, 2020).

2.3. Quality of Life Concept

Quality of Life according to the World Health Organization Quality of Life (WHOQOL) Group, is defined as an individual's perception of an individual's position in life in the context of the culture and value system in which the individual lives and its relationship to one's goals, expectations, set standards and concerns

(Adeyeye et al., 2014). Quality of life is defined as an individual's perception of their position in life in the context of the culture and value system in which they live and concerning their goals, expectations, standards, and concerns (Pukeliene & Starkauskiene, 2011). QoL is measured not only through material wealth but also through other factors that affect daily life. Key indicators of QoL include health, education, environment, work, work-life balance, and access to basic services (Vo et al., 2016).

Good health allows active participation in social and economic life, supported by health services, nutritious food, and a clean environment. Education increases awareness of healthy living and opens up job opportunities. A clean environment reduces the risk of disease. Decent work and fair wages provide a sense of purpose and a source of income. Still, work-life balance is important for mental and physical health—access to clean water, sanitation, electricity, and essential transportation for a healthy and productive life.

2.4. SDGs Concept

The Sustainable Development Goals (SDGs) are a global agenda adopted by the United Nations (UN) in 2015 to end poverty, protect the planet, and ensure prosperity for all by 2030 (Burton & Salama, 2023). The SDGs consist of 17 goals and 169 interrelated targets that cover various aspects of development, including economic, social, and environmental.

The seventeen SDGS goals are (1) No Poverty; (2) No hunger; (3) Healthy and Prosperous Life; (4) Quality Education; (5) Gender Equality; (6) Clean Water and Proper Sanitation; (7) Clean and Affordable Energy; (8) Decent Work and Economic Growth; (9) Industry, Innovation, and Infrastructure; (10) Reducing the gap; (11) Sustainable Cities and Settlements; (12) Responsible Consumption and Production; (13) Climate Change Management; (14) Ocean Ecosystems; (15) Terrestrial Ecosystems; (16) Peace, Justice and Resilient Institutions; and (17) Partnerships to Achieve Goals (Kushnir & Nunes, 2022). To facilitate implementation, the 17 SDGS Goals are grouped into four pillars, namely 1) Social development pillars including Goals 1, 2, 3, 4, and 5; 2) The pillars of economic development include Goals 7, 8, 9, 10, and 17; 3) Pillars of environmental development, including Goals 6, 11, 12, 13, 14, and 15, and 4) Pillars of legal and governance development including Goal 16 (Nawn, 2015).

The implementation of the SDGs in Indonesia is regulated by Presidential Regulation of the Republic of Indonesia Number 111 of 2022 concerning the Implementation of the Achievement of Sustainable Development Goals. This regulation sets the goals of the SDGs, namely: 1) ensuring sustainable improvement of people's economic welfare; 2) maintaining the sustainability of the community's social life; 3) maintaining the quality of the environment and inclusive development; and 4) implementing governance that is able to improve the quality of life from one generation to the next (Aminullah, 2020).

The principles of the SDGs are integrated into every stage of implementation in Indonesia. The first principle is universality, which means that the SDGs must be implemented throughout Indonesia (Lhutfi et al., 2024). The second principle is integration, which indicates that the social, economic, environmental, legal, and governance dimensions must be interrelated and integrated (Salim & Palullungan, 2021). The third principle is "No One Left Behind," ensuring that all stakeholders are involved and that everyone benefits from the implementation of the SDGs (Safitri et al., 2021). Involvement in achieving the SDGs involves various parties, including the government and non-governmental actors at the national and local levels. Efforts at the national level are carried out through the National Action Plan, SDGs Indicator Metadata, SDGs Roadmap 2030, as well as annual reports and Voluntary

National Review (VNR) (R. F. Putri et al., 2019). At the regional level, implementation through Regional Action Plans in provinces, districts/cities SDGs Center/Network/Hub supports non-governmental participation in higher education institutions and companies/associations. SDG funding must be diverse, not only from the government budget but also from business actors, philanthropy, and global financial potential for the sustainability of the implementation of the SDGs (Shintasiwi, 2021).

2.5. Hypothesis Development

Government support refers to government interventions and contributions in various forms to facilitate and strengthen certain sectors of society (Kequan, 2024). This includes the provision of funds, regulations, fiscal policies, tax incentives, and public services aimed at supporting economic development, social welfare, and environmental sustainability (Phung, 2023). This support aims to create conditions conducive to growth and stability, address market imbalances, and ensure that all citizens have access to the resources and opportunities necessary to improve their quality of life (Skica & Rodzinka, 2021). Government support for important sectors of society is a crucial aspect of development and welfare (Debus et al., 2017).

The theoretical study of government support includes a variety of economic, social, and political theories that explain how and why governments are involved in various sectors. Zulu-Chisanga et al (2021) stated that government intervention is needed to overcome economic imbalances and achieve sustainable growth (Zulu-Chisanga et al., 2021). Governments can use various fiscal and monetary policy tools to stimulate aggregate demand, create jobs, and reduce unemployment (Moslehpour et al., 2023).

Government support is essential in sustainable practices and technological advancements. Governments have a central role in creating policies and regulations that encourage the use of environmentally friendly technologies and sustainable practices (Purnomo et al., 2022). For example, Li et al. (2022) stated that tax incentives for companies that adopt green technologies or support research and development (R&D) in renewable energy can accelerate innovation and the adoption of sustainable technologies (Li et al.2022). In a global context, the sustainable development theory highlights the importance of government support in addressing environmental challenges and ensuring that economic development does not damage natural resources (Röth & Schwander, 2021). Governments must adopt policies that encourage the efficient and environmentally friendly use of resources. In the context of technological advancements, Chen et al (2023) and Haryono (2024) found the impact of education policies that focus on STEM (science, technology, engineering, and mathematics) in the success of digitalization practices in the education sector (Chen et al., 2023; Haryono, 2024).

Thus, this study assumes that policy support can encourage the practice of a smart circular economy in Indonesia.

H1. Government support has a significant positive effect on smart economy development
H2. Government support has a significant positive effect on circular economy development

Industry 4.0, or the Fourth Industrial Revolution, is an industrial transformation that utilizes digital technology to increase efficiency and innovation in the production process (Arvindhan, 2021). One of the key concepts in Industry 4.0 is "Resource Capability," which refers to the ability of resources (including humans, machines, and systems) to adapt and collaborate dynamically in a connected and intelligent production environment (Ramzan et al., 2020). Industry 4.0 technologies are integrated with the Internet of Things (IoT), big data, artificial

intelligence (AI), and cloud computing (Haseeb et al., 2019)

Industry 4.0 Resource Capability is essential in a country's sustainable economic practices and information technology adaptation because it provides a foundation for greater efficiency, innovation, and responsiveness to market changes (Arifiani et al., 2019). Advanced technologies such as IoT, AI, and big data enable industries to optimize resource use, reduce waste, and significantly increase productivity (Soomro et al., 2021). This is in line with the principles of a sustainable economy that prioritizes environmental and long-term economic sustainability. Several related studies have examined the role of technology adaptation 4.0 in circular practices both as a business model and a strategic model of the country (Ericsson et al., 2022; Lakmali et al., 2020; Müller et al., 2021; Shamim et al., 2019). In their study, Maisiri & Van (2019) found the role of Industry 4.0 technology adoption in the sustainable production of food companies and strengthening the circular economy capabilities of South African countries (Maisiri & van Dyk, 2019).

In addition, this ability encourages the country to be more adaptive to the development of global information technology (Tripathi & Gupta, 2021). With a strong technological infrastructure and skilled workforce, the country can improve its international competitiveness, attract foreign investment, and accelerate digital transformation (Suchek et al., 2023). This is important to ensure that the economy remains relevant and thriving in a dynamic digital age, supporting inclusive economic growth. Allam & Newman (2018) and Kim et al (2016) found direct development between industry 4.0 technology and socio-economic progress integrated with Smart City technology policies (Allam & Newman, 2018; K. Kim et al., 2016).

Thus, this study requires an empirical examination of the role of Industry 4.0 technology capabilities in the practice of Smart-Circular Economy in Indonesia.

H3. Industry 4.0 resource capability has a significant positive effect on smart economy development

H4. Industry 4.0 resource capability has a significant positive effect on circular economy development.

Netizen character refers to internet users' behavior, attitude, and ethics in cyberspace. These characters reflect how individuals interact on digital platforms, including social media, forums, and other websites (Kuo et al., 2021). Netizens with positive characters usually show a polite attitude, respect differences of opinion, and share accurate and useful information. They also tend to support digital ethics such as respecting the privacy of others and not spreading negative content or hoaxes. Conversely, netizens with negative characters may engage in cyberbullying, spreading fake news, or trolling.

Netizen character does not only reflect individual digital ethics but also influences collective economic transformation mechanisms. Positive netizen behavior, such as responsible information sharing and constructive engagement, facilitates the dissemination of sustainability knowledge and strengthens public awareness regarding circular practices (Poon & Tse, 2024). Through digital advocacy, product reviews, and social media campaigns, netizens create market pressure that encourages companies to adopt environmentally responsible and circular production systems. Furthermore, active participation in digital communities enhances collaboration, knowledge exchange, and technological feedback loops, which are essential components of smart economy development (Ghosh et al., 2022). Therefore, positive netizen character can indirectly and

directly accelerate both smart and circular economic transformation.

The character and quality of human resources, including netizens, have a crucial role in the success of a country's vision (Wastutiningsih, 2020). By disseminating information, building online communities, and rallying support for state-sponsored initiatives, Netizen Characters influence public opinion, encourage governments and companies to take action, and spark their active participation (Zhang et al., 2023). In the context of sustainability initiatives, they can be agents of change in the digital world that promote awareness of environmental, social, and economic issues (Lei, 2011). The study of green lifestyle shows the role of social media followers in building awareness of the importance of maintaining sustainability (Chaudhury & Albinsson, 2015; Norman-Burgdolf & Rieske, 2021; N. K. Putri et al., 2019).

Netizen Character also has a crucial role in accelerating the technological growth of a country (Amoah & Jibril, 2021). Communities play a role for change agents who use the internet to disseminate information, inspire, and build innovation-focused communities (Oh & Seo, 2021). By sharing knowledge and experience, they encourage collaboration between individuals and companies, accelerating the pace of technological innovation. The public, in this case, netizens also provide valuable feedback to technology developers, helping them improve products and services according to user needs (Hecht et al., 2019).

The above study estimates that netizen characters play a role in the practice of the Smart-Circular Economy in Indonesia.

H5. Netizen character has a significant positive effect on smart economy development
H6. Netizen character has a significant positive effect on circular economy development

Smart Economy Development is one of the crucial pillars of smart city development that focuses on the integration of technology and innovation to improve economic efficiency, productivity, and community welfare (Qian et al., 2021). Wei & Onder (2023) stated that the involvement of information and communication technology in improving economic efficiency can significantly improve welfare (Wei & Onder, 2023). Studies reveal that the implementation of the Smart Economy can create new jobs, increase productivity, and accelerate economic growth through innovation (Anthony, 2023; Romagnoli et al., 2022). In addition, the Smart Economy also enables more efficient resource management and better decision-making through data analysis (Rochdane & Hamdani, 2018). Other literature reviews show that the implementation of industrial digitalization practices and economic movements can contribute significantly to achieving the Sustainable Development Goals (SDGs) (Carayannis & Rakhmatullin, 2014; Founoun & Hayar, 2018). Its implementation improves economic efficiency through digitalization and smart technology and supports SDG 8 (Decent Work and Economic Growth) by creating new jobs and accelerating economic growth. In addition, Papadopoulou (2021) stated that the integrated economic practice of technological advancement contributes to SDG 9 (Industry, Innovation, and Infrastructure) by encouraging innovation and development of digital infrastructure. In addition, SED supports SDG 11 (Sustainable Cities and Communities) through better resource management and carbon emission reduction and SDG 12 (Responsible Consumption and Production) with production efficiency and waste reduction.

This study assumes that Smart Economy Development can affect the community's quality of life and the achievement of Indonesia's SDGs.

H7. Smart economy development has a significant positive effect on the quality of life of the Indonesian people

H8. Smart economy development has a significant positive effect on the empowerment of SDGs.

The Circular Economy plays an important role in addressing modern society's environmental and economic challenges. This concept focuses on redesigning production and consumption systems to minimize waste and maximize the use of resources through the principles of reduction, reuse, recycling, and recovery (Milios, 2021). Research shows that the implementation of the circular economy can reduce dependence on limited natural resources, reduce greenhouse gas emissions, and create new economic opportunities through innovation and increased resource efficiency (Tiwari & Goel, 2023). In addition, the circular economy also contributes to the practice of SDGs by encouraging production and consumption patterns that are more environmentally and socially friendly (Bekmurzaev & Dadaev, 2021; Tunn et al., 2019). Sengupta et al (2023) stated that circular practices in the household manufacturing sector positively impact public health by reducing the risk of exposure to harmful chemicals and pollution (Sengupta et al., 2023). The existence of the circular economy is considered to encourage the creation of new jobs in sectors such as recycling, repair, and environmentally friendly technological innovation. The development of new skills in the workforce improves competitiveness and economic well-being.

On the other hand, circular economy development plays a crucial role in achieving a country's SDGs (Awan & Sroufe, 2022). By adopting the principles of reduce, reuse, recycle, and recovery, circular practices help reduce waste and emissions, supporting SDG 12 (Responsible Consumption and Production). Circular implementation for resource efficiency and green innovation, the circular economy also contributes to SDG 9 (Industry, Innovation, and Infrastructure) and SDG 13 (Climate Action) by reducing the carbon footprint and promoting green technologies. From the perspective of economic inclusivity, these practices increase economic resilience and create jobs, contributing to SDG 8 (Decent Work and Economic Growth) and SDG 11 (Sustainable Cities and Communities). This study assumes that circular economy development can affect the community's quality of life and the achievement of Indonesia's SDGs.

H9. Circular economic development has a significant positive effect on the quality of life of the Indonesian people

H10. Circular economic development has a significant positive effect on the empowerment of SDGs.

C. RESEARCH METHODS

This study chooses an empirical quantitative approach based on surveys. The five Best Smart Cities in Indonesia in 2024 by the Ministry of Communication and Information Technology, namely DKI Jakarta, Yogyakarta City, Denpasar City, Surabaya City, Semarang City and Makassar City were selected as the analysis unit. This study seeks to test the proposed hypothesis path with 10 hypotheses and research models, as shown in Figure 1.

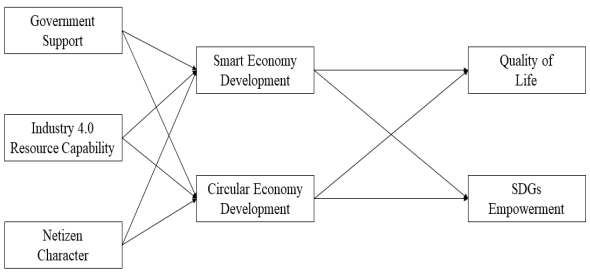

Figure 1. Research Model

The questionnaire instrument was developed with three parts of the questionnaire. The first part of the questionnaire explains the purpose of the study, expresses gratitude to the

respondents for their participation, and ensures that the data obtained from this survey will only be used for research purposes. The next section aims to collect demographic information from the respondents. Meanwhile, the last part of the questionnaire is designed to collect data relevant to the research (See Appendix 1 for more detail).

Each item on the scale is drawn from the appropriate literature and graded using a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). The government support variable has 6 items (Ganlin et al., 2021; Phung, 2023; Purnomo et al., 2022; Skica & Rodzinka, 2021), Industry 4.0 resource capability has 10 items (Alam & Dhamija, 2022; Lakmali et al., 2020; ul zia et al., 2023), netizen character has 7 items (Lu et al., 2020; Wang & Lin, 2016; Wen et al., 2022), smart economy development has 10 items (Anttiroiko et al., 2014; Azkalhaq & Amani, 2018; Naiki, 2023; Pajilani et al., 2022b; Qian et al., 2021), circular economy development has 10 item (D'Amato et al., 2017; Latif et al., 2023; Subekti, 2023), quality of life has 6 item (Arsovski, 2019; Pukeliene & Starkauskiene, 2011; Vo et al., 2016) and SDGs empowerment has 8 item (Burton & Salama, 2023; Leavesley et al., 2022; Perry et al., 2021).

The research questionnaire was distributed online through Google Form on the basis of hybrid dissemination through social media and meeting respondents in the field. Of the total responses collected, approximately 65% were obtained through online dissemination via social media platforms, while 35% were collected through direct, face-to-face engagement in the field. This hybrid approach was intended to reduce coverage bias by reaching respondents with varying levels of digital accessibility and engagement, thereby minimizing the risk of overrepresentation from digitally active participants. The questionnaire was distributed for 2 months from April to May 2024. Respondents in this case were drawn by purposive sampling. The criteria were selected with screening questions on the active use of technology in economic activities and understanding of the Smart-Circular Economy concept. Based on Hair et al. (2019) statement, the minimum sample must be achieved by five times the number of indicators (Hair et al., 2019). With a total of 57 items, the minimum number of respondents that must be achieved is 285. However, the use of purposive sampling with screening criteria requiring respondents to actively use technology and understand the Smart-Circular Economy concept may have resulted in a sample that is relatively more technologically literate and conceptually informed than the average Indonesian population. Consequently, the findings may not fully represent the broader population, particularly individuals with lower levels of digital engagement or limited familiarity with the concept. This potential selection bias should be considered as a limitation of the study.

This study chose the Partial Least Square-Structural Equation Modelling (PLS-SEM) analysis technique with SmartPLS Version 3 software. PLS-SEM is able to handle a variety of complex modeling questions that often arise in the social sciences. We chose to use PLS-SEM in this study for the following reasons. First, this study explores the linear relationship between latent and dependent variables (Becker et al., 2023). Second, PLS-SEM does not require a strong theoretical foundation and can be used as a method to develop theories (Sarstedt et al., 2022). Most importantly, PLS requires a minimal sample size, making it ideal for testing relatively small samples in the context of multiset structural equation models (Russo & Stol, 2021). In addition, PLS analysis can provide accurate data estimates even if the data distribution is very abnormal (Sarstedt et al., 2020).

D. RESULTS AND DISCUSSION

The respondents of this study consisted of 300 people, with the majority of women (73%)

and the rest (27%). Based on age, the most respondents were in the range of 25-34 years (35%), followed by the age of 18-24 years (33%), 35-44 years (22%), and 46-55 years (10%). In terms of education, the majority of respondents are university graduates (55%), followed by postgraduate (24%) and school graduates (21%). Respondents' employment varied with most working in the business sector (28%), followed by employees of private companies (23%), students (22%), government employees (9%), freelancers (7%), and others (11%). More detailed characteristics are presented in Table 1.

Table 1. Characteristics of Respondents

Characteristic	Frequency	Percentage
Gender		
Male	82	27%
Female	218	73%
Age (in years)		
18-24	99	33%
25-34	105	35%
35-44	65	22%
46-55	31	10%
Education		
School	63	21%
College Graduate	164	55%
Postgraduate	73	24%
Occupation		
Government Employee	26	9%
Private Company Job	70	23%
Business	85	28%
Student	67	22%
Freelance	19	7%
Other	33	11%

The Measurement Outer Model test is the first stage of analysis that aims to assess the validity and reliability of measurement instruments in the PLS-SEM-based research model. The validity test considers the value of the loading factor and the Average Variance Extracted (AVE). The loading factor must be greater than 0.7, while the AVE must be greater than 0.5 (Hair et al., 2018). The reliability value is measured from the expected Composite Reliability and Cronbach Alpha values of more than 0.7 (Hair et al., 2018). This test ensures that the measurement model has sufficient validity and reliability before proceeding to the structural model testing.

The measurement outer model test results in show that all variables meet the validity and reliability criteria. The loading factor values for all indicators are above 0.7, indicating good convergence validity. The AVE (Average Variance Extracted) value ranges from 0.509 to 0.681, with most above the 0.5 threshold, indicating that these variables are able to explain most of the variance of the indicators. Cronbach's Alpha (CA) and Composite Reliability (CR) for all variables are also above 0.7, indicating high internal reliability. Thus, this measurement model can be considered valid and reliable to proceed to structural analysis (See Appendix 2 for more detail).

The full collinearity VIF values range from 1.876 to 2.764, which are below the recommended threshold of 3.3 (Kock, 2015). This indicates that the model is free from critical multicollinearity and common method bias issues. Therefore, the constructs in this study do not exhibit high collinearity, and the structural model can be considered statistically reliable for hypothesis testing.

Table 2. Full Collinearity VIF Results

Construct	VIF
Government Support	2.134
Industry 4.0 Resource Capability	2.587
Netizen Character	1.943
Smart Economy Development	2.764
Circular Economy Development	2.451
Quality of Life	1.876
SDGs Empowerment	2.318

The Inner Structural Model test in structural path analysis aims to evaluate the relationship between latent variables in the research model. This process involves several key steps, including testing the direct relationships between constructs and assessing the strength and significance of those relationships (Streukens & Leroi-Werelds, 2016). Figure 2 is the structural

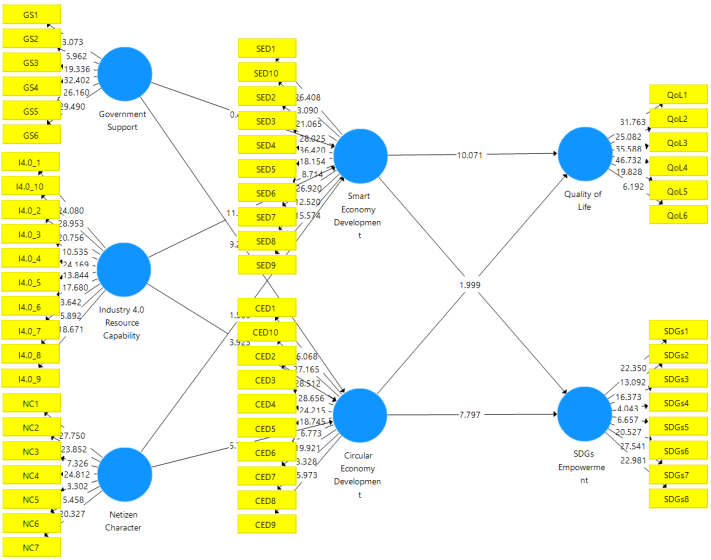

Figure 2. Output Bootstrapping

inner model test output through the SmartPLS Version 3 Bootstrapping procedure.

The determination coefficient test is crucial to show the proportion of variance described by the independent variable to the dependent variable (Hair et al., 2019). The higher the R^2 value, the better the model will explain the variability of the data. The results of the R-Square test in Table 3 show a very high level of explanation of the variability of the research model.

The R-Square value for the development of the intelligent economy by government support, Industry 4.0 resource capability, and netizen character is 0.966, indicating that these factors can explain 96.6% of the variance in the development of the smart economy. For circular economy development, the R-squared value is 0.989, indicating an explanation of variability of 98.9%. The development of the smart economy and circular economy has a significant influence on the quality of life and empowerment of the SDGs, with R-Square values of 0.942 and 0.959, respectively, showing a robust and reliable model in explaining variability in the quality of life and empowerment of the SDGs.

A hypothesis proposal is acceptable if the Path Coefficient value is positively charged, the t-statistic value is greater than the critical value of 1.96, and the p-value is less than 0.05 (Hair et al., 2019). The results of hypothesis testing in Table 3 show some essential findings. Government support is not significant to the development of the smart economy but is critical for the development of the circular economy. The resource capability of Industry 4.0 is substantial to the development of the smart economy and circular economy. The character of netizens is not significant to the development of the smart economy but significant to the circular economy. The development of the intelligent economy significantly improves the quality of life and empowerment of the SDGs.

The results of the first hypothesis test are surprising because they show that government support does not significantly impact the development of the Smart Economy. These results starkly contrast with previous studies that highlighted the crucial role of governments in the success of digital transformation (Chen et al., 2023; Haryono, 2024). Existing government policies and programs may not be effective enough in encouraging the development of the Smart Economy. This can be caused by factors such as a lack of coordination between government agencies, complicated bureaucracy,

Table 3. Hypothesis and R-Square Test Results

Hypothesis	Path Coefficient	t-test	p-value	Decision	R-Square
Government Support → Smart Economy Development	0.035	0.420	0.675	Rejected	0.966
Government Support → Circular Economy Development	0.449	9.297	0.000	Accepted	0.989
Industry 4.0 Resource Capability → Smart Economy Development	0.764	11.259	0.000	Accepted	0.966
Industry 4.0 Resource Capability → Circular Economy Development	0.154	3.923	0.000	Accepted	0.989
Netizen Character → Smart Economy Development	0.195	1.569	0.117	Rejected	0.966
Netizen Character → Circular Economy Development	0.408	5.709	0.000	Accepted	0.989
Smart Economy Development → Quality of Life	0.809	10.071	0.000	Accepted	0.942
Smart Economy Development → SDGs Empowerment	0.474	7.206	0.000	Accepted	0.959
Circular Economy Development → Quality of Life	0.171	1.999	0.046	Accepted	0.942
Circular Economy Development → SDGs Empowerment	0.522	7.797	0.000	Accepted	0.959

or a lack of incentives for the private sector to participate. In addition, each region has policy autonomy that makes a difference in the seriousness of the Smart Economy.

Considering that it will hinder Indonesia's digital transformation with the constraints of Smart Economy policy disparities between regions, this condition must be watched out for. Other factors besides government support may be more critical in driving the development of the Smart Economy—for example, skilled human resources, adequate infrastructure, and a strong culture of innovation.

However, contrasting results appear in the second hypothesis, which shows the positive impact of government support on the development of the Circular Economy. These results support previous literature that mentions the crucial role of governments in multisectoral sustainability practices (Purnomo et al., 2022; Röth & Schwander, 2021). This indicates that government policies and initiatives are crucial in encouraging sustainable and environmentally friendly business practices. Government support can include fiscal incentives, supportive regulations, and green infrastructure development initiatives. These results show that the government has the power to steer the economy in a more sustainable direction by providing incentives and policies that support the transformation to a Circular Economy.

The government serves as a leader in promoting environmentally friendly business practices and helping to address today's environmental challenges. The success of circular economy development depends on the government's commitment to encouraging sustainable business practices and creating an environment that supports innovation and economic growth balanced with environmental sustainability.

Next, the results of hypothesis testing show that Industry 4.0 Resource Capability has a significant favorable influence on the development of the smart economy and the development of the circular economy. Thus, the third and fourth hypotheses are accepted; this supports the previous literature that shows the importance of the existence of advanced technologies in digital transformation and sustainable industrial modeling innovations (Allam & Newman, 2018; Ericsson et al., 2022; Maisiri & van Dyk, 2019; Soomro et al., 2021; Suchek et al., 2023). The positive influence on smart economy development shows that adopting the latest technology, process

automation, and better integration of information systems in the context of Industry 4.0 can accelerate economic growth focused on increasing productivity, innovation, and efficiency. This can lead to better and faster development of intelligent products and services, improving the competitiveness of the industry and the economy as a whole. Industry 4.0 opens new possibilities for innovation and business models, driving economic growth and creating new opportunities. On the other hand, the positive influence on the development of the circular economy highlights the role of Industry 4.0 in creating a more sustainable and environmentally friendly economy. Companies can optimize resource use, reduce waste, and extend product lifecycles by using connected and environmentally friendly technologies, such as the Internet of Things (IoT) and big data analytics.

This is following the principles of circular economy, which prioritizes reuse, recycling, and waste reduction as a solution to Indonesia's current environmental and economic challenges. Netizen characters were found to have no significant effect on innovative economic development. This result rejects the fifth hypothesis and contradicts previous literature that finds netizens' role in technological developments (Amoah & Jibril, 2021). However, this condition is possible because the main center of the development of the Smart Economy lies in technological infrastructure. The character of the netizen may not have a strong enough influence to override these broader determinants. Their existence is more of a comprehensive societal change that indirectly affects economic growth. For example, increased online engagement and awareness of digital technologies can foster a more tech-savvy population, potentially driving demand for digitized products and services and impacting people's economic movements.

Next, netizen characters have a significant favorable influence on circular economy development. Thus, the sixth hypothesis is accepted and supports the previous literature (Chaudhury & Albinsson, 2015; Norman-Burgdolf & Rieske, 2021; N. K. Putri et al., 2019)—the behavior and characteristics of individuals in cyberspace impact efforts towards a sustainable and environmentally friendly economy. Netizens can effectively disseminate information about the principles and practices of the circular economy, foster public understanding, and encourage individuals to implement ecologically friendly behaviors. Social media platforms, online communities, and educational content can be powerful tools to raise awareness. In addition, they play a role in the practice of sustainable consumption patterns by purchasing durable, reusable, and recycled products, reducing waste generation, and supporting businesses that prioritize sustainability. The current function of Indonesian netizens as public policy controllers is to advocate for policies that support circular economy practices through social media or online petitions. By harnessing the power of netizens, we can accelerate the transition to a circular economy, minimize environmental impact, and drive a more resource-efficient future

The results of the hypothesis test show that Smart Economy Development has a significant favorable influence on the quality of life of the Indonesian people. This indicates that initiatives and policies that promote the smart economy—such as the application of information and communication technology, business innovation, and digital infrastructure—contribute directly to improving people's quality of life. The smart economy can increase efficiency and productivity, create new creativity-based jobs, increase incomes, and reduce economic inequality. For example, with better internet access, people can more easily get information, education, and new economic opportunities in Indonesia that were previously unreachable. In addition, the smart economy can also support more effective management of resources, such as energy and transportation, which positively impact the

environment and public health. Initiatives such as smart cities that utilize technology to improve public services, reduce congestion, and optimize energy use also contribute to a better quality of life for Indonesians.

Smart Economy Development has a significant positive effect on SDGs Empowerment in Indonesia. This can be interpreted as the role of the Smart Economy in increasing efficiency, productivity, and economic inclusivity. This aligns with several SDG goals, such as poverty alleviation, improving the quality of education, and gender equality. Initiatives and strategies in developing the smart economy, such as using digital technology, innovation, and smart infrastructure, can directly support achieving the sustainable development goals (SDGs) in Indonesia. This positive impact indicates that investments in technologies and policies that support the smart economy can improve people's well-being, energy efficiency, and access to essential services such as education and health.

The integration of technology in economic processes can be a catalyst for the empowerment of local communities and the reduction of social disparities. Thus, developing an intelligent economy encourages economic growth and ensures that all levels of society can feel the benefits of such growth.
The results of the hypothesis test show a significant favorable influence of the development of the Circular Economy on the quality of life of the Indonesian people. This can be interpreted as the importance of a sustainable economic approach in improving human welfare. In Indonesia, where environmental problems and social inequality are still significant challenges, implementing the Circular Economy can be a sustainable solution. By promoting environmentally friendly practices and encouraging waste reduction, we can improve the well-being of society as a whole.

The significant positive influence of the development of the Circular Economy on the quality of life of the Indonesian people also shows that awareness of the importance of the environment and social welfare is increasing. This can encourage the government, companies, and communities to invest more in initiatives and policies that support sustainable development, bringing long-term positive impacts to the Indonesian people.

Circular Economy Development has also found its impact on SDGs Empowerment in Indonesia. Circular economy practices can protect vulnerable natural ecosystems and reduce the harmful effects of climate change. By extending the life of resources and reducing waste production, Circular Economy Development can help maintain an ecological balance crucial for environmental sustainability. In addition, creating new circular products can encourage the development of sustainable businesses that protect vulnerable natural ecosystems and reduce the negative impacts of climate change. By extending the life of resources and reducing waste production, Circular Economy Development can help maintain an ecological balance crucial for environmental sustainability.

The analysis of the implications of these findings also highlights the importance of public policies that support and encourage sustainable economic practices. Governments, the private sector, and civil society must work together to create an environment promoting innovation and infrastructure investment that supports Circular Economy Development. Education and public awareness are essential to encourage behavior change towards more sustainable consumption patterns.

E. CONCLUSION

This study evaluates the influence of government support, industry 4.0 resource capabilities, and the character of netizens on the development of the Smart Economy and Circular Economy in Indonesia. The results of the hypothesis test show that the government's

support for developing the Smart Economy is not significant, perhaps due to ineffective policies, complicated bureaucracy, and policy differences between regions. On the contrary, government support positively affects the Circular Economy, demonstrating the importance of fiscal policies and incentives in encouraging sustainable business practices. The capability of Industry 4.0 resources has been found to significantly influence the development of the Smart Economy and Circular Economy. Adopting advanced technologies and process automation in the context of Industry 4.0 accelerates economic growth focused on productivity, innovation, and efficiency. Netizen characters do not have a significant effect on the Smart Economy but positively impact the Circular Economy, demonstrating their role in disseminating information and encouraging environmentally friendly practices. The development of the Smart Economy has a significant positive effect on the quality of life and the empowerment of the SDGs in Indonesia. Smart technology initiatives can increase economic efficiency, productivity, and inclusivity, supporting the achievement of the SDGs. Circular Economy also positively affects the quality of life and empowerment of the SDGs, indicating the importance of sustainable practices in improving people's welfare and protecting the environment. This research highlights the need for public policies that support innovation and investment in developing a circular and smart economy.

The government needs to optimize coordination between related institutions to increase the development of the Smart Economy and Circular Economy in Indonesia. Establishing a dedicated working team tasked with harmonizing policies and reducing bureaucracy will ensure effective regional program implementation. In addition, investment in digital infrastructure is urgently needed. Developing 5G networks, data centers, and AI-IoT innovations will support adopting Industry 4.0 technologies and drive innovation in the smart economy sector. Governments should also incentivize the private sector to invest in smart technologies and sustainable business practices. These incentives can be tax reductions, subsidies, or easy access to financing for high-tech and environmentally friendly projects. With the right incentives, the private sector will be more motivated to actively participate in developing the Smart Economy and Circular Economy. In addition, strengthening human resources through training and certification programs is very important. The government must launch programs that upskill digital technology and sustainability workforce. Cooperation with education and training institutions to provide relevant curricula will also ensure that the workforce is prepared for the challenges and opportunities in the smart economy. Governments should promote a culture of innovation by rewarding and recognizing companies and individuals who contribute significantly to developing sustainable technologies and practices. In addition, green infrastructure development initiatives need to be expanded, including recycling facilities and more effective waste management. With this approach, the government can steer the economy towards sustainability and efficiency, ensuring that all levels of society feel the benefits. Collaboration can be carried out with academics in interdisciplinary research to support Smart-Circular Economy innovation. The role of education is also critical through the development of curriculum or teaching materials for the Smart-Circular Economy concept, Industry 4.0 technology, and sustainable practices to produce graduates who are ready to face this challenge.

This research has several limitations. First, the ineffectiveness of government policies in developing the Smart Economy shows the need for a more in-depth evaluation of coordination between institutions and bureaucracy. Second, policy variations between regions contribute to inconsistent implementation outcomes. These

disparities suggest the importance of developing a more standardized national framework to ensure policy alignment across regions. In this regard, future research may consider proposing and operationalizing a standardized National Smart-Circular Index as a benchmarking tool to measure regional performance, improve comparability, and enhance policy harmonization at the national level. Future research needs to explore the role of other factors, such as human resources and infrastructure, in the Smart Economy. In addition, further research should consider the impact of netizens more broadly and examine the contribution of Industry 4.0 technology to the circular economy. An in-depth study of public policies that promote a sustainable economy is also needed to reinforce these findings.

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Appendix 1 : Mapping of Questionnaire Items to Original Sources

Table a. Mapping of Questionnaire Items to Original Sources

Variable	Item Code	Adapted / Derived From	Original Construct
Government Support	GS1–GS2	Ganlin et al. (2021)	Institutional policy support
	GS3	Phung (2023)	Regulatory facilitation
	GS4	Purnomo et al. (2022)	Financial incentives
	GS5–GS6	Skica & Rodzinka (2021)	Public funding effectiveness
Industry 4.0 Resource Capability	I4RC1–I4RC3	Alam & Dhamija (2022)	Digital infrastructure capability
	I4RC4–I4RC6	Lakmali et al. (2020)	Technological readiness
	I4RC7–I4RC10	ul Zia et al. (2023)	Smart technology integration
Netizen Character	NC1–NC3	Wang & Lin (2016)	Online engagement behavior
	NC4–NC5	Lu et al. (2020)	Digital participation attitude
	NC6–NC7	Wen et al. (2022)	Responsible online conduct
Smart Economy Development	SED1–SED3	Anttiroiko et al. (2014)	Smart governance
	SED4–SED6	Qian et al. (2021)	Innovation ecosystem
	SED7–SED10	Pajilani et al. (2022b); Naiki (2023)	Digital economic integration
Circular Economy Development	CED1–CED4	D'Amato et al. (2017)	Resource efficiency
	CED5–CED7	Latif et al. (2023)	Sustainable production
	CED8–CED10	Subekti (2023)	Waste reduction practices
Quality of Life	QoL1–QoL2	Pukeliene & Starkauskiene (2011)	Social welfare
	QoL3–QoL4	Arsovski (2019)	Economic well-being
	QoL5–QoL6	Vo et al. (2016)	Environmental satisfaction
SDGs Empowerment	SDG1–SDG3	Burton & Salama (2023)	Sustainable engagement
	SDG4–SDG6	Perry et al. (2021)	Community empowerment
	SDG7–SDG8	Leavesley et al. (2022)	Policy alignment with SDGs

Appendix 2 : Measurement Outer Model Results

Table 2. Measurement Outer Model Results

Variable	Loading Factor	AVE	CA	CR
Government Support				
I feel that the government provides enough counseling and training on the importance of the circular economy and how to implement it in the community.	0.759	0.536	0.810	0.865
I feel that the government provides adequate financial support for circular economy initiatives and projects in my neighborhood.	0.794			
I feel that the government has implemented regulations and policies that support the effective implementation of the circular economy.	0.812			
I feel that the government provides adequate infrastructure and facilities to support circular economy activities in my community.	0.865			
I feel that the government is active in establishing collaboration and partnerships with various parties to promote and support the circular economy.	0.839			
I feel that the government is actively conducting socialization and public campaigns about the importance of the circular economy and its impact on the quality of life and the achievement of the SDGs.	0.854			
Industry 4.0 Resource Capability				
I feel that Industry 4.0 technologies (such as IoT, AI, and automation) are ready to be adopted in the industrial sector in Indonesia.	0.823	0.531	0.895	0.916
Digital infrastructure in Indonesia is adequate to support the implementation of the Industry 4.0 concept.	0.803			
Human resources in Indonesia have sufficient capabilities to operate Industry 4.0 technology.	0.802			
The government and the private sector have invested enough in Industry 4.0 technology.	0.711			
Government policies and regulations support the development and application of Industry 4.0 technology.	0.824			
There is good collaboration between the government, industry, and academia in supporting Industry 4.0.	0.757			
The general public in Indonesia is already aware of the importance of Industry 4.0 technology.	0.810			
The data security system in Indonesia is strong enough to support the use of Industry 4.0 technology.	0.784			

Variable	Loading Factor	AVE	CA	CR
Industry 4.0 technology can improve sustainability and energy efficiency in the industrial sector.	0.767			
Industries in Indonesia are able to adapt and be flexible in implementing Industry 4.0 technology.	0.752			
Netizen Character				
I actively participate in online discussions on environmental issues and the circular economy.	0.812	0.509	0.820	0.867
I often share information about the importance of protecting the environment on social media.	0.837			
I have a good understanding of the concept of circular economy and its application in Indonesia.	0.789			
Social media influences my actions in supporting circular economy practices.	0.812			
I often join online communities that focus on improving the quality of life through the circular economy.	0.778			
I feel that my contributions on social media can help achieve the Sustainable Development Goals (SDGs).	0.772			
I support the use of smart technology to support the circular economy in Indonesia.	0.793			
Smart Economy Development				
The use of innovative technologies has improved economic efficiency in my environment.	0.800	0.585	0.915	0.931
The digitization of public services has made it easier for me to access my daily needs.	0.727			
Improving digital infrastructure connectivity helps local economic development	0.782			
Implementation of energy-efficient technology supports sustainable economic growth	0.858			
Smart and integrated waste management programs help reduce environmental impact and improve quality of life	0.867			
Smart economic development creates more inclusive economic opportunities for all levels of society	0.792			
The adoption of sustainable product innovation has increased the competitiveness of local products	0.785			
Data security in the digital economy system provides confidence to the public in conducting online transactions	0.834			
Community participation in decision-making related to the smart and circular economy increases a sense of ownership and responsibility	0.749			
Education and training programs related to the smart economy help improve people's skills and knowledge	0.804			

Variable	Loading Factor	AVE	CA	CR
Circular Economy Development				
I feel that waste management in my area has been done well and sustainably	0.714	0.509	0.886	0.907
I have been involved in circular economic-related activities, such as recycling or the use of environmentally friendly products	0.847			
People in my area have a high awareness of the importance of the circular economy	0.855			
Local governments have provided sufficient support in implementing circular economy principles	0.831			
I got enough information and training on circular economy practices	0.800			
I feel that community participation in circular economy programs is very high	0.797			
Eco-friendly products are easy to find and buy in my area	0.949			
The implementation of the circular economy has helped in conserving natural resources in my area	0.773			
I believe that smart technology can help realize an effective circular economy	0.957			
I am optimistic that Indonesia can achieve the Sustainable Development Goals (SDGs) by implementing a circular economy	0.809			
Quality of Life				
I feel that the environment where I live is clean and healthy	0.848	0.681	0.904	0.927
I am satisfied with the access and quality of public services such as health, education, and transportation in my area	0.824			
I feel that my economic condition is good enough to meet my daily needs	0.881			
I feel like I have a good balance between work and personal life	0.889			
I feel safe and comfortable living in my neighborhood	0.818			
I feel engaged and have a good connection with the community around me	0.971			
SDGs Empowerment				
I feel that the community around me is actively participating in sustainable development initiatives	0.816	0.526	0.865	0.895
I feel that I have adequate access to information about the Sustainable Development Goals (SDGs)	0.761			
I feel involved in the decision-making process related to sustainable development in my neighborhood	0.804			

Variable	Loading Factor	AVE	CA	CR
I am aware of the importance of protecting the environment to support sustainable development goals	0.724			
I feel that sustainable development initiatives in my neighborhood have improved my quality of life	0.714			
I feel that I have received enough education and training on the importance of the SDGs and how to achieve them	0.770			
I feel that there is good collaboration between the government, the private sector, and the community in realizing the sustainable development goals	0.808			
I see efforts to create a sustainable economy in my neighborhood that is in line with the goals of the SDGs	0.790			