



# Rural smartness: Its determinants and impacts on rural economic welfare

Iqbal Yulizar Mukti<sup>1</sup> · Jörg Henseler<sup>2,3</sup> · Adina Aldea<sup>1</sup> · Rajesri Govindaraju<sup>4</sup> · Maria E. Iacob<sup>1</sup>

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## Abstract

Solving urbanization problems, especially in developing countries, solely through the adoption of smartness in urban areas is insufficient as urbanization is mostly driven by the wide urban-rural economic gap. To narrow this gap, the adoption of smartness needs to be extended into rural areas. However, studies in that direction are still lacking. Therefore, we developed a theoretical model that explains the determinants of rural smartness and its subsequent consequences on rural economic welfare. We validated the model with survey data from 179 villages in West Java Province, Indonesia. The results suggest that rural smartness is determined by the interplay of organizational, environmental, and technological readiness, and has a strong positive impact on innovativeness which, in turn, improves the competitiveness of the rural business ecosystem. This model can serve as a reference for further studies of rural smartness and as the foundation for the design of information platforms supporting it.

**Keywords** urbanisation · urban smartness · rural smartness · rural development · economic welfare · partial least square

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✉ Iqbal Yulizar Mukti  
i.y.mukti@utwente.nl

Jörg Henseler  
j.henseler@utwente.nl

Adina Aldea  
a.i.aldea@utwente.nl

Rajesri Govindaraju  
rajesri\_g@mail.ti.itb.ac.id

Maria E. Iacob  
m.e.iacob@utwente.nl

<sup>1</sup> Department of Industrial Engineering and Business Information Systems, University of Twente, Enschede, The Netherlands

<sup>2</sup> Department of Design, Production & Management, University of Twente, Enschede, the Netherlands

<sup>3</sup> NOVA Information Management School (NOVA-IMS), Universidade Nova de Lisboa, Lisbon, Portugal

<sup>4</sup> Department of Industrial Engineering, Insitut Teknologi Bandung, Bandung, Indonesia

## Introduction

According to the United Nations (2019), much of the world's population is migrating towards urban areas rapidly. The current estimation suggests that between 2018 and 2050, the urban population will increase by 58%, from 4.2 to 6.6 billion, accounting for 68% of the world population. While in the past urbanization was often correlated with economic growth, the current increase of urbanization mainly occurs in megacities located in developing countries with low-level income-per-capita (Castells-Quintana & Wenban-Smith, 2019; Jedwab & Vollrath, 2015). *Urbanization without growth* (a term coined by academics to describe the current urbanization phenomenon) has led to serious problems, as the urban infrastructures are overwhelmed by the increasing demand. Urban areas host 50% of the world population, consume 75% of the world's generated energy, but cover only 2% of the planet's surface (Eremia et al., 2017).

Previous studies indicate that the major source of urbanization is rural-urban migration (United Nations, 2019; Zhang, 2016). Data from 89 developing countries analyzed by Castañeda et al. (2018) shows that around 75% of those who live below the poverty line are people in rural areas. In

contrast, urban areas offer much higher income potential and wider economic opportunities. This rural-urban economic gap motivates people to engage in rural-urban migration (Zhang, 2016).

Rapid rural-urban migration often results in numerous negative impacts for the migrants as well as the urban infrastructures. For the migrants, this is because a large proportion of them are lacking the skills necessary for the appropriation of well-paid jobs in the cities. Typically they end up in low-wage jobs or unemployed, which traps them even more in poverty (Zhang, 2016). For the urban infrastructures, because their under-sized capacity has led to various urban problems, to name a few: traffic congestion, energy crisis, and degradation of environmental quality (Chakrabarty & Gupta, 2014; Franco et al., 2017; Zhang, 2016).

On the other hand, there has been a rapid shift towards the intensification of use of the novel information technology (IT) to alleviate and manage the problems faced by urban areas. This trend labelled as “urban smartness” (Albino et al., 2015; Manitiu & Pedrini, 2016), puts forward the idea that IT plays a vital role in optimizing the utilization of urban infrastructures and in empowering urban inhabitants to achieve sustainable economic growth and high quality of life (Caragliu et al., 2011). However, given the current phenomenon of urbanization, solving urban problems to achieve a better living quality for its inhabitants solely through the adoption of smartness in urban areas seems to be insufficient (Kar et al., 2019).

Recent studies suggest that the adoption of the smartness concept should be extended into rural areas as well (Kar et al., 2019). This approach is expected to trigger growth in the rural economy and slow down the rural-urban migration process (Zavratnik et al., 2018). The main argument for this is that fostering innovation driven by IT will lead to the emergence of a better local micro-economic climate (Fennell et al., 2018; Mishbah et al., 2018). This motivates us to address the following research question:

*How can the concept of smartness improve the economic welfare of citizens in rural areas?*

More recently, there is a growing interest among academics for studying smartness adoption as a means to improve the economic situation for people living in rural areas, which resulted in the formulation of strategies, frameworks, and conceptual models (Cunha et al., 2020; Mishbah et al., 2018; Naldi et al., 2015; Zavratnik et al., 2018). However, although these studies already provide some guidance for the adoption of smartness in rural areas, further elaboration of the topic is still needed. More precisely, what is still missing from the current studies are (1) the formulation of a theoretical model that explains the causal mechanism of how smartness adoption leads to economic welfare improvement for rural

citizens, and (2) an empirical assessment of the model based on a real sample. We argue that by filling these gaps, this paper can provide a theoretical foundation that can guide the adoption of rural smartness. To this end, we define the following research objectives for this paper:

1. *To formulate a rural smartness model:* A theoretical model that explains the determinants of rural smartness, and its impact on economic welfare for people living in rural areas. The model we are proposing is grounded upon the following studies: the TOE framework by Tornatzky and Fleischer (1990), the service innovation framework by Lusch and Nambisan (2015), the business competitiveness index and the microeconomic foundation of prosperity by Porter et al. (2007), and on the systematic literature study on rural smartness that has been carried out previously by Mukti et al. (2021).
2. *To empirically validate the rural smartness model:* To validate the model, we use the partial least squares path modelling (PLS-PM) on a sample from rural areas in West Java Province, Indonesia. This region is selected since it represents a relevant context for this study as explained below:
  - a. Representative sampling: in this region, there is a significant average income gap between rural and urban areas. This gap and lack of economic opportunities in rural areas drive people to migrate from rural to urban areas, leading to various problems.
  - b. Timing: The regional government is currently implementing digital initiatives to improve the economic welfare of its rural citizens. The program’s objectives are to provide the villages within the region with access to technology infrastructure and services, and education for digital literacy.

Thus, we argue that this paper’s main theoretical contribution is an empirically validated theoretical model that can also provide practical guidance for the implementation of initiatives towards rural smartness. For example, the measurement of the readiness variables included in the model can help the government to take necessary actions to ensure their achievement. Furthermore, the operationalization of the variables in the model can be translated into a preliminary set of functional requirements of the IT services aiming to accelerate rural economic growth.

The remainder of this paper is organized as follows. The [Theoretical background](#) section describes the theoretical background that supports the theory development process explained in the [Formulation of theoretical model](#) section. The [Method](#) section outlines the sample and data collection method. The [Data analysis](#) section and the [Discussion](#) section present and discuss the results of the PLS-PM

that we employed for data analysis. Finally, [The Conclusion](#) section provides the conclusion of this study and gives pointers to future research.

## Theoretical background

This section is dedicated to a definition of the concept of rural smartness and to the theories and frameworks on which our rural smartness model is grounded. As mentioned earlier, our work rests on earlier research, as follows: the process-oriented framework of IT business value developed by Mooney et al. (1996), the TOE framework by Tornatzky and Fleischer (1990), the service innovation framework by Lusch and Nambisan (2015), the business competitiveness index and the microeconomic foundation of prosperity by Porter et al. (2007), and on the systematic literature study on rural smartness that has been carried out previously by Mukti et al. (2021). In the remainder of this section, these are briefly explained and their relevance for rural smartness is made explicit.

### Rural smartness

In order to properly formulate the theoretical model, we first need to have a reference definition of rural smartness. However, since the concept of rural smartness is still vague, and just starting to gain some attention in the academic literature (Cunha et al., 2020; Zavrtnik et al., 2018), we derived a definition from the definition of urban smartness that is a more established area of research. In this paper, we refer to one of the most cited definitions of urban smartness by Caragliu et al. (2011): “We believe a city to be smart when *investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance*”.

Three main aspects are key in the definition above: the goals (i.e., sustainable economic growth and high quality of life), the resources (i.e., human capital, social capital, and communication infrastructure), and the process (i.e., participatory governance). We include these three aspects in the definition of rural smartness as well.

As far as the goals are concerned, there is a slight scope difference between the adoption of smartness in the urban and the rural contexts. This difference is caused by the different problems they are facing. The problems faced in the urban context are typical for densely populated areas that exhibit a rapid degradation of the overall quality of living, for example, traffic and mobility, waste, pollution, energy scarcity, and social issues (Angelidou, 2017; Neirotti et al., 2014). On the other hand, the problems faced in the rural

context, especially in the developing countries, are strongly related to economic aspects, such as poverty, lack of job opportunities, inefficient business ecosystem, and stagnancy of economic growth (Castañeda et al., 2018; Cunha et al., 2020; Imai et al., 2017; Wiggins & Proctor, 2001). Therefore, given these specificities, the main goal of rural smartness is to improve the rural economic situation, the main argument for this goal being that fostering IT innovation will lead to the emergence of a better local micro-economic climate (Cunha et al., 2020; Zavrtnik et al., 2018).

To identify the resources and the process aspects of rural smartness (i.e., the other two key aspects mentioned in the urban smartness definition), we analyze characteristics of urban smartness that have been mentioned in the extant literature as having an economic contribution and might be also relevant for rural areas. For this, we refer to the results of the systematic literature review (SLR) study by Mukti et al. (2021). We found four main characteristics of smartness that are expected to have positive impacts on the economic welfare of citizens in rural areas. First, the connectivity between the stakeholders throughout the rural business ecosystem (i.e., rural citizens, rural business entities, government, and 3<sup>rd</sup> party) that is enabled by the IT infrastructures and services, defined as *connectedness*. Second, the participation of stakeholders in the governmental programmes to improve the economic welfare of citizens in rural areas that is facilitated by the availability and usage of IT services, defined as *participatory governance*. Third, the creative and innovation capabilities of rural citizens that are empowered by IT, defined as *digitally empowered citizens*. Fourth, the strategic and implementation alignment of IT service provisioning in rural areas, defined as the *coherence of IT service provision*.

To conclude, we note that two main resources are critical for achieving rural smartness: the IT infrastructures and services that enable connectedness between stakeholders in a rural area, and the digitally capable human capital. Furthermore, there are three main processes in rural smartness that we must be in place: the connectedness between stakeholders in rural areas, the active participation of stakeholders to improve living conditions in rural areas, and the coherence of IT service provision.

Therefore, based on the three aspects of rural smartness definition explained previously, we define rural smartness as *the situation in which the combination of investments in IT infrastructure and services, and the human capital is effectively improving the economic welfare of citizens in rural areas through connectedness, participatory governance, and coherence of IT service provisioning*. We use this description as the base definition of rural smartness throughout this paper.

## Process-oriented framework of IT business value

The process-oriented framework of IT business value is a conceptual framework developed by Mooney et al. (1996) that explains how diffusion of IT innovation transforms the value creation process within an enterprise. In essence, this framework suggests that an enterprise is able to derive business value from IT through the transformational effects that IT has on its operation and management processes. Furthermore, this framework suggests that the success of such IT innovation is determined by the support from the internal organization and the external environment.

We use this framework to design the basic structure of the rural smartness theoretical model depicted in Figure 1. The reason for this is that although the framework was initially developed for the context of digital transformation in an enterprise, it can also be used in the context of digital transformation in a community. The suitability of the framework for this purpose is supported by its focus on digital transformation in the context of enterprises and smart cities, as highlighted in Javidroozi et al. (2014), Mamkaitis et al. (2016) and Anthony Jnr (2021). In an enterprise, digital transformation involves the diffusion of IT to re-align the business processes that change the way value is created for its stakeholders. The goals are to increase the enterprise's productivity, decrease production costs, and improve its service for customers. This focus on enterprise digital transformation can also be found in the context of smart cities, where digital transformation involves applying digital technologies to transform the operational processes of cities (e.g., transport systems, energy systems, and economic activities) from a conventional to a digital-based approach with the ultimate goal to improve the quality of life of its citizens.

Aligned with the process-oriented framework of IT business value, the basic structure for model formulation consists of three blocks that are interrelated with rural smartness. First, the *determinants* block is where we include the variables that contribute to the realization of rural smartness. Second, the *process improvement* block is where we consider the variables that represent the influence rural smartness has on the process within the rural business ecosystem. Third, the *desired value* block is where we define the dependent variable, namely the economic welfare improvement.

## The technology-organization-environment framework

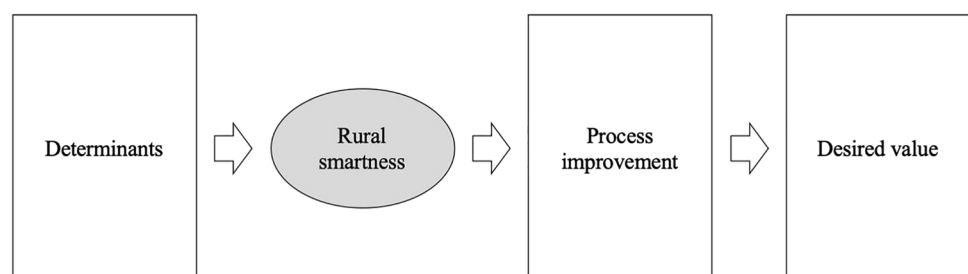
The technology-organization-environment (TOE) framework developed by Tornatzky and Fleischer (1990) explains the elements within the context of an enterprise that influence the adoption and diffusion of technological innovation. These elements are the technological context, the organizational context, and the environmental context. The technological context includes the existing technologies that are currently in use, as well as those that are available in the market and are relevant for the enterprise. The organizational context captures the characteristics and resources of the enterprise, including organizational culture, top-management support, communication process, quality of its human resources, and the amount of slack resources. Finally, the environmental context relates to the facilitating and inhibiting factors in the area where the enterprise operates, for example, socio-cultural issues, regulations, access to 3<sup>rd</sup> party resources, and industry structure (Awa et al., 2015; Baker, 2012; Zhu et al., 2003).

The TOE framework has been widely used as the basis for studying the factors that influence the adoption and diffusion of technology innovation in various contexts. Its wide applicability has been confirmed by different researchers, as this framework has been used to study the influencing factors in the adoption and diffusion of technology infrastructures (e.g., electronic data interchange (Iacovou et al., 1995) and the internet of things (Hsu & Yeh, 2016)), technology services (e.g., e-business (Zhu et al., 2004), ERP (Awa et al., 2016)), and innovation in a community (e.g., smart city (Bremser et al., 2019)). In addition, Trang et al. (2014) show empirically that the TOE framework has a high explanatory power to model the adoption of an IT innovation. Given its wide applicability and relevance, we also utilize it for the identification of variables in the *determinants* block of the rural smartness model.

## The service ecosystem

Service ecosystem is a concept coined by Lusch and Nambrisan (2015) that refers to a set of interacting entities that are connected by a shared institutional logic and mutual

**Fig. 1** Basic structure for model formulation



value creation through service exchange. According to this concept, IT is seen as a means that can help hold together the diverse entities and enable collaboration within the ecosystem.

Lusch and Nambisan (2015) suggest that the creation of a service ecosystem through IT enhances the resource density in the ecosystem and enables entities in the ecosystem to leverage resource liquefaction, thus accelerating the resource integration/absorption process. Resource density is important as it conditions whether resources can be quickly exchanged between the entities in the process of value creation. A high resource density is a prerequisite for entities in the ecosystem to easily integrate various accessible resources, and subsequently trigger collaboration and innovation in the value creation process. On the other hand, resource liquefaction refers to the digitization process that decouples the information from its source. This digitization process enables entities in an ecosystem to improve their capability to absorb, process, and share information.

We argue that Lusch and Nambisan's view can be applied as well to rural areas that have realized rural smartness, as they can be seen as a service ecosystem. This is because the rural areas have the foundational components of a service ecosystem. First, the interacting entities of a service ecosystem can be represented by the stakeholders in a rural business ecosystem that is interconnected through IT infrastructure and services (*connectedness*). Second, the shared institutional logic of a service ecosystem can be represented by the availability of a strategy that aligns well with the IT service provision (*coherence of IT service provision*). Third, the mutual value in a service ecosystem can be represented by the goal of rural smartness, that is, to improve the citizens' economic welfare. Lastly, the service exchange activity of a service ecosystem can be represented by the active participation of stakeholders in the economic welfare improvement initiatives (*participatory governance*). Given this relevance to the context of rural smartness, we incorporate the concept of service ecosystem in the formulation of the theoretical model. This concept helps us to understand the impact of rural smartness on the variables included in the *process improvement* block of the model's basic structure.

### The microeconomic foundation of prosperity

The microeconomic foundation of prosperity is an economic theory from Porter et al. (2007) that emphasizes the importance of microeconomic competitiveness for the prosperity of a nation. According to this theory, the microeconomic entities (at the firm level) are the entities that translate opportunities created by the macro context (e.g., macroeconomic, political, legal, and social context) into prosperity. As a result, the improvement of competitiveness at the

microeconomic level is crucial, since it forms the foundation of prosperity.

In order to have resilient and sustainable competitiveness at the microeconomic level, Porter et al. (2007) suggest that firms must adopt the innovation-driven economy, and argues that, the ability to produce innovative products and services using the most advanced methods available is the very source of a firm's competitiveness. This approach is considered to be more beneficial than the factor-driven economy (i.e., relying on low-cost labor and unprocessed natural resources) or the investment-driven economy (i.e., relying on infrastructure investment), as it leads to a stronger resilience when facing external disruptions. Therefore, the capacity to innovate can be seen as a key factor to improve competitiveness.

Furthermore, to operationalize competitiveness, Porter et al. (2007) developed the business competitiveness index (BCI). The measurement of BCI covers 58 indicators that represent competitiveness at the firm and at the national business environment levels (Porter et al., 2007). The BCI seeks to explore the relationship between business competitiveness and prosperity measured by GDP per capita. To have a better understanding of the relationship, Porter et al. (2007) plotted the BCI against GDP per capita of 127 countries in a regression model. The coefficient of determination ( $R^2$ ) of the regression model showed that 82% of the variance in the GDP per capita is explained by the BCI. This result suggests that competitiveness in the business environment is a very strong predictor for economic welfare.

We include the concepts of microeconomic foundation of prosperity in the theoretical model formulation to help us understand the predictors of economic welfare improvement enabled by rural smartness. To this end, based on Porter's we decided to include innovativeness and competitiveness as main variables in the *process improvement* block of the rural smartness model, and we hypothesize that they have a significant relationship with the dependent variable representing economic welfare improvement in the *desired value* block.

### Formulation of theoretical model

In formulating the theoretical model, we refer to the basic structure presented in Figure 1 that we explained in the previous section. We used the TOE framework to identify the variables that act as the determinants for rural smartness. On the other hand, we used the concept of service ecosystem and the microeconomic foundation of prosperity to identify the variables that mediate the impact of rural smartness on economic welfare improvement. Next to these foundational theories, we also use relevant articles based on a systematic literature study by Mukti et al. (2021) to define indicators of the variables included in the model.

Figure 2 shows the proposed theoretical model of rural smartness. In summary, this model hypothesizes that: (1) there are three interrelated variables that act as the determinants for rural smartness: *technological readiness*, *organizational readiness*, and *environmental readiness*, and (2) there are two variables that mediate the impact of rural smartness on the perceived economic welfare improvement: *innovativeness* and *competitiveness*.

The theoretical model includes two types of variables, namely, latent variables and emergent variables. Latent variables are the variables that cannot be measured directly but instead inferred through their indicators. Latent variables typically represent abstract concepts, such as attitude, traits, or behavior (Benitez et al., 2020; Henseler et al., 2016). Variables in the model operationalized as latent variables were innovativeness, competitiveness, and perceived economic welfare improvement. These variables are represented in an oval shape. On the other hand, emergent variables refer to the variables that emerge from a combination of their indicators. Emergent variables fit best to model man/firm-made artefacts, such as technologies, systems, processes, strategies, or management instruments (Benitez et al., 2020; Henseler et al., 2016). Variables in the model operationalized as emergent variables were organizational readiness, technological readiness, environmental readiness, and rural smartness. These variables are depicted using a hexagon shape. In the next sub-sections, we explain each of these variables, define their measurement indicators, and provide theoretical argumentation for the hypotheses in the model.

### Determinants of rural smartness

As explained in the [Theoretical background](#) section, we used the TOE framework as the basis to define the independent variables that can be seen as the determinants of rural smartness. Consistent with the TOE, the variables

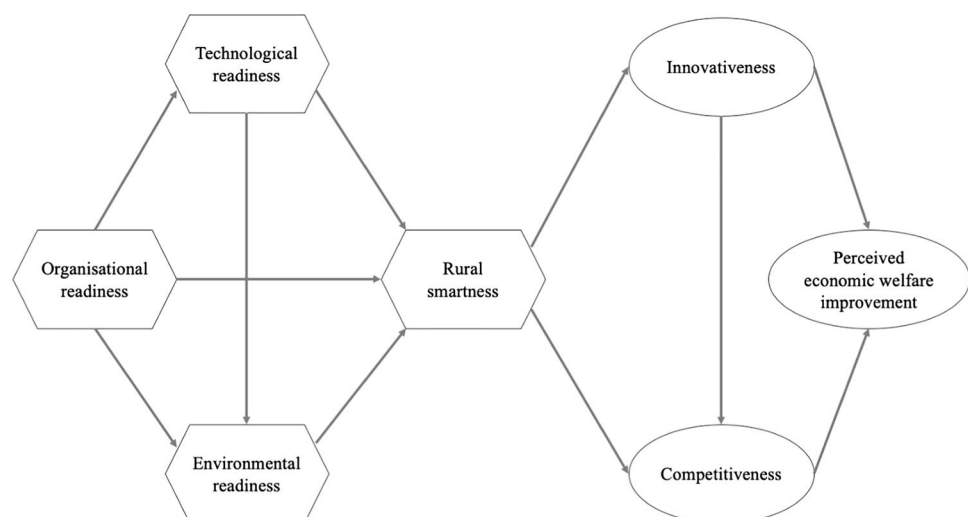
are *technological readiness* (technology context), *organizational readiness* (organization context), and *environmental readiness* (environment context). Table 1 presents their formal definition and their indicators. The indicators (and the instrument development process) are the result of the SLR included in Mukti et al. (2021), which identified the challenges occurring during the adoption and diffusion of smartness in rural areas from the perspective of the TOE. We argue that by being ready to overcome these challenges, we can increase the likelihood of realizing rural smartness. In the following sub-sections, we explain the formulation of the research hypotheses that interrelate these variables.

### Role of organizational readiness

Previous studies found that the organizational entity that plays an important role in the initiatives toward rural smartness is the government (Jung et al., 2014; Mishbah et al., 2018; Zavrtnik et al., 2018). This finding implies that organizational readiness in the context of rural smartness is actually synonymous with the readiness of the government. To understand the role of the government, we need to look at the characteristics of rural areas, at least from three perspectives: geographic, economic, and human resources.

First, geographically, rural areas are typically remote locations with limited connectivity to economic centers that concentrate in urban areas. Given this geographical situation, the logistics and transportation costs to and from urban areas are high and lead to stagnation of economic growth in rural areas (Cunha et al., 2020; Wiggins & Proctor, 2001). Second, the rural economy dependencies are very much dependent on the agricultural sector. However, agricultural activities are less profitable compared to non-agricultural activities. This situation causes workers in rural areas to migrate and seek employment in the non-agricultural sector in urban areas, which deprives rural areas of the

Fig. 2 Theoretical model



**Table 1** Antecedent of rural smartness: variables, definitions, and indicators

| Variable                 | Definition   | Indicators   |
|--------------------------|--|--|
| Organisational readiness | The degree to which the government considered as being ready to realise rural smartness  | <ol style="list-style-type: none"> <li>1. Certainty of sustainable funding</li> <li>2. IT capability</li> <li>3. Commitment to support</li> <li>4. Collaboration</li> </ol>  |
| Technological readiness  | The degree to which the required technological elements are considered as being ready to realise rural smartness                             | <ol style="list-style-type: none"> <li>1. Internet access</li> <li>2. Information technology services suitability</li> <li>3. IT device ownership</li> <li>4. Electric reliability</li> <li>5. Adequacy of IT strategic guidelines</li> </ol>  |
| Environmental readiness  | The degree to which the citizens, the third parties, and the regulatory environment are considered as being ready to realise rural smartness | <ol style="list-style-type: none"> <li>1. Digital knowledge of rural citizens</li> <li>2. The willingness of rural citizens to utilise technology in their economic activities</li> <li>3. The purchasing power of rural citizens for IT services</li> <li>4. The entrepreneurial capability of rural citizens</li> <li>5. Supportive regulations and policies</li> <li>6. Citizens involvement</li> <li>7. Third-parties involvement</li> </ol> |

young population and workplaces (Cunha et al., 2020; Imai et al., 2017). Third, from a human resource perspective, an empirical study found that 80% of the extremely poor and 75% of the moderately poor are people living in rural areas (Castañeda et al., 2018), implying that rural citizens have a much lower purchasing power when compared to urban citizens. Furthermore, rural citizens typically have a low educational level. Although most rural citizens finished the high-school education level, only a small fraction of them continue with higher education (Imai & Malaeb, 2018). This situation makes human resources in rural areas less competitive, low-skilled and cheap (Zhang, 2016).

Given the current conditions of rural areas described above, it is difficult to rely on the private sector to realize rural smartness. The low purchasing power, the low education level of human resources, and the high logistics and transportation costs make the investment in rural areas not economically attractive for the private sector. Therefore, the initiation of programs for rural smartness must be the responsibility of the government (Jung et al., 2014; Mishbah et al., 2018; Wiggins & Proctor, 2001; Zavrtnik et al., 2018), as explained below.

As a public entity, the government has the obligation to improve the economic situation of people living in rural areas. One of the regional governments' primary tasks is to allocate the necessary budget to develop the infrastructures in the respective rural areas, either logistics infrastructures (e.g., roads and bridges) or IT infrastructure (e.g., internet access and reliable electricity), in such a way that it improves the connectedness between the different stakeholders of the rural business ecosystem (Rodríguez-Pose & Hardy, 2015; Zavrtnik et al., 2018). Furthermore, the government can

initiate a collaboration with the private sector, for example through a public-private partnership scheme, to provide IT infrastructure and service for rural areas. In this way, the private sector can be encouraged to get involved actively in rural development (Gulati, 2007; Zavrtnik et al., 2018). The government also has the authority to initiate educational policies and programs with the goal of accelerating the diffusion of productive utilization of IT by rural citizens. These educational policies and programs encompass not only technical digital literacy but also creative literacy and entrepreneurship skills, in such a way that they can empower rural citizens to have a better livelihood (Nedungadi et al., 2018). Finally, the government as the policy maker has the capability to ensure the coherence of IT services provisioning in rural areas, in line with the strategic directions and necessary regulations for rural development (Naldi et al., 2015; Talbot, 2016).

The explanation of the roles of the government described above suggests that organizational readiness not only has a direct positive effect on the realization of rural smartness, but also contributes to the realization of technological, and environmental readiness.

**H1:** *Organizational readiness contributes positively to technological readiness.*

**H2:** *Organizational readiness contributes positively to environmental readiness.*

**H3:** *Organizational readiness contributes positively to the realization of rural smartness.*

## Role of technological readiness

In the context of the theoretical model (see Table 1), we refer to technological readiness as the technological elements required for rural smartness. These elements are especially concerned with the readiness of internet access, including its services and associated supporting infrastructures (online services, stable electricity, and IT devices). In particular, these technological elements are provided, either independently by the government (therefore, IT strategic guideline is included in the technological readiness), or independently by the third party. Support from the third party to the government, as the responsible organization, in realizing rural smartness is part of the environmental readiness (Bhattacharya & Wamba, 2018; Dewi et al., 2018; Ramdani et al., 2009) that will further be explained in the next section.

As explained earlier, important geographic characteristics of rural areas, are remoteness and poor organization of transportation and logistics. The immediate consequence of this is low accessibility to the resources and markets which force business ecosystems in rural areas to operate mostly locally and in silos (Cunha et al., 2020; Philip & Williams, 2019). This situation implies that rural areas do not have much potential of their own to accelerate their economic growth (Naldi et al., 2015).

On the other hand, studies found that internet access enables businesses in rural areas to mitigate the issue with geographic isolation (Freeman et al., 2016; Philip & Williams, 2019). Having access to online services such as websites, social media, and e-commerce, enables them to connect to a broader market, and pool of suppliers and resources, regardless of their location. This helps businesses in rural areas to improve their efficiency in production and marketing activities and triggers the growth of their business (Philip & Williams, 2019; Prieger, 2013). Therefore, access to the internet and online services is instrumental for achieving connectedness between stakeholders in a rural business ecosystem, which is the foundation for rural smartness.

Furthermore, internet access also has particular benefits for rural communities. First, it enables rural citizens to have access to online learning opportunities and learning communities, ranging from informal information portals and community networking to formal online education and training courses (Mason & Rennie, 2004). Second, access to the internet encourages rural citizens to participate actively in rural development initiatives. Citizens in rural areas can use the internet to find information and to discuss important issues in their community. This awareness can motivate them to initiate voluntarily activities to improve the situation in their village (Stern et al., 2011).

Based on the above arguments, we expect the technological readiness contributes positively to the realization of rural smartness, as well as, to environmental readiness.

**H4:** *Technological readiness contributes positively to environmental readiness.*

**H5:** *Technological readiness contributes positively to the realization of rural smartness.*

## Role of environmental readiness

Environmental readiness (see Table 1) mainly covers three aspects related to rural smartness: the citizens, the third parties, and the regulatory environment. Next, we explain the importance of these three aspects for the realization of rural smartness.

The goal of IT implementation in the context of rural smartness is to improve the quality of living and the economic welfare of rural citizens. However, the benefits of IT implementation are lost when the IT is not actually used as intended (Davis, 1993). A systematic literature study found there are several factors that hinder the actual use of IT by rural citizens (Mukti et al., 2021). First, rural citizens have low digital literacy, namely a lack of knowledge to properly use the IT devices and services (Dowell, 2019; Nedungadi et al., 2018). Second, rural citizens have a low purchasing power. The average wage in rural areas is much lower compared to the wage in urban areas, and a significant percentage of rural citizens are living below the poverty line (Castañeda et al., 2018; Imai & Malaeb, 2018), which makes the affordability of IT devices/services extremely low. Third, from a cultural perspective, citizens in rural areas tend to be traditionalists and exhibit rather strong resistance to change and innovation. For them, a computer, a smartphone and the internet represent the products of and a threat to their community (Correa & Pavez, 2016; Ray, 2018). These challenges make citizens in rural areas have a low motivation to embrace IT as a part of their economic activities and way of working and living. Therefore, to increase the likelihood of rural smartness, readiness in the citizens' aspect is needed.

However, readiness in the aspect of citizens per se is not sufficient to realize rural smartness. This is because, from a higher perspective, rural area is being viewed as an ecosystem that comprised of different interrelated stakeholders. According to the quadruple helix model, besides the citizens' aspects, involvement of the third parties (e.g., university and industry) and the supportive regulatory environment are also considered as the crucial elements that enable regional connectedness and participatory ecosystem, which are the important characteristics of rural smartness (Carayannis et al., 2018; Van Waart et al., 2016). The R&D third parties (e.g., universities) play a significant role in knowledge creation and diffusion that triggers innovation in the ecosystem, whereas the non-R&D third parties (e.g., industries) play an important role to provide necessary services for the ecosystem (Borghys et al., 2020; Carayannis et al., 2018). On the other hand, the supportive regulatory environment plays



an essential role to push forward the adoption of IT innovation in the ecosystem. For example, a regulation on data interoperability can increase the confidence of IT service providers to interchange the data with the other stakeholders in the ecosystem, in such a way, can accelerate the value creation process and at the same time protect the rights of the involved stakeholders (Weber & Podnar Zarko, 2019).

The importance of the citizens, the third party and the regulatory environment for the realization of rural smartness described above, motivates us to posit that environmental readiness can be a strong determinant of rural smartness.

**H6:** *Environmental readiness contributes positively to the realization of rural smartness.*

### Impact of rural smartness

Based on the model's basic structure explained in the [Theoretical background](#) section, rural smartness is hypothesized to have an impact on the variable in the *desired value* block through its positive influences on the variables within the *process improvement* block. The variable in the *desired value* block should be a dependent variable that measures the economic welfare improvement. However, it is extremely difficult to isolate and measure the improvement as a result of rural smartness of economic welfare, since many other variables beyond the context of this research model may influence its value (Wu & Wang, 2006). This difficulty has been acknowledged in several other studies that measured the impact of IT innovations. To address this difficulty, previous studies in the literature measured the impact based on perceptions of those who are affected by the IT innovations, for example, perceived usefulness (Davis, 1989), perceived benefits (Karlinsky-Shichor & Zviran, 2015), and perceived economic wellbeing (Sinha & Verma, 2020). We follow the same line of thinking and define the dependent variable in our theoretical model as *perceived economic welfare*

*improvement*, which reflects the degree to which rural citizens believe the realization of rural smartness will result in economic welfare improvement.

On the other hand, based on the concepts of BCI and the microeconomic foundation of prosperity explained in the [Theoretical background](#) section, we identified that there are two variables in the *process improvement* block of the model's basic structure, namely innovativeness and competitiveness. These variables act as the variables that mediate the effect of rural smartness on the perceived economic welfare improvement.

Table 2 presents the definition and indicators of the variables related to the impact of rural smartness. These indicators are derived from our previous SLR regarding the economic impacts of smartness adoption (Mukti et al., 2021). The formulation of research hypotheses that interrelate these variables are explained in the following sub-sections.

### Immediate impacts of rural smartness

As explained in the [Theoretical background](#) section, according to the concept of service ecosystem by Lusch and Nambisan (2015), rural areas that have realized rural smartness can leverage resource liquefaction and enhance the resource density within their ecosystem. In the rural context, liquefaction of resources means that the information about resources owned by businesses in rural areas, either tangible resources (e.g., goods and natural resources) or intangible resources (e.g., skills and culture) are converted into a digital form. This digital transformation process empowers businesses in rural areas to be able to exchange information about their resources without needing to have physical interactions. Therefore, rural businesses are no longer isolated. Instead, they operate within a collaboration network that constitutes a fertile ground for them to innovate by combining the available resources (e.g., new product or new service) (Lusch & Nambisan, 2015; Talbot, 2016). Consequently, the development of the innovations inspires rural citizens to become

**Table 2** Impact of rural smartness: variables, definitions, and indicators

| Variable                               | Definition  | Indicators   |
|--|---|--|
| Rural smartness                        | The degree to which rural smartness is realised   | 1. Connectedness<br>2. Participatory governance<br>3. Digitally empowered citizens<br>4. Coherence of IT service provision |
| Innovativeness                         | The degree to which businesses in rural areas considered as being innovative  | 1. Business collaboration improvement<br>2. Value creation improvement<br>3. Increase in entrepreneurship                  |
| Competitiveness                        | The degree to which businesses in rural areas considered as being competitive   | 1. Market access improvement<br>2. Business productivity improvement<br>3. Business efficiency improvement                 |
| Perceived economic welfare improvement | The degree to which rural citizens believe the realisation of rural smartness will result in economic welfare improvement | 1. Perceived income increase<br>2. Perceived increase in the employment rate   |

entrepreneurs, which in time can stimulate growth in rural economic activities (Yadav & Goyal, 2015).

From another point of view, the liquefaction and the high density of resources can help rural businesses to strengthen their competitiveness. Within the collaboration network, the rural businesses can establish, for example, cooperative arrangements for sales or promotion, in such a way that they are able to reach the customers, not as independent entities, but based on a cooperative approach such that they have access to a broader market (Cunha et al., 2020). Furthermore, with the help of the digitization of resources and the easiness to exchange their resources within the collaboration network, rural businesses can operate efficiently and be more productive with their available resources (Oluwatayo, 2014; Talbot, 2016).

Based on the above arguments, that explained how businesses in rural areas can benefit from the liquefaction and the high density of resources, we hypothesize that rural smartness contributes positively to the innovativeness and the competitiveness of rural businesses.

*H7: Rural smartness contributes positively to innovativeness.*

*H8: Rural smartness contributes positively to competitiveness.*

### Role of innovativeness and competitiveness

In the rural context, small and medium enterprises (SMEs) are the main actors that drive the economy (Arifin et al., 2020; Talbot, 2016). However, due to their geographical nature, these rural SMEs typically operate in isolation: having limited access to market, resources, and funding; thus their numbers is limited and stagnant (Eniola & Entebang, 2015; Muñoz & Kimmitt, 2019). This is why the business environment in rural areas need to become more interconnected, in order to trigger innovation (i.e., creation of new products, new services, and new businesses). These innovations, in turn, can contribute directly to the economic welfare improvement (e.g., through the creation of job opportunities) or indirectly through the competitiveness improvement (e.g., access to a wider market, higher productivity, and a more resource-efficient production) (Cunha et al., 2020; Naldi et al., 2015; Talbot, 2016). The above argument is aligned with the microeconomic foundation of prosperity by Porter et al. (2007) that is explained in the [Theoretical background](#) section, where the ability to innovate through a collaborative environment is the dominant source of competitiveness that leads to prosperity.

Based on these arguments we posit that innovativeness contributes positively to competitiveness, and both variables (innovativeness and competitiveness) are predictors of the perceived economic welfare improvement.

*H9: Innovativeness contributes positively to competitiveness.*

*H10: Innovativeness contributes positively to the perceived economic welfare improvement.*

*H11: Competitiveness contributes positively to the perceived economic welfare improvement.*

## Method

### Sample

To validate the proposed theoretical model, we have chosen a sample from the villages in West Java Province, Indonesia. We selected this region because it is confronted with serious urbanization problems caused by rural-urban migration, and because currently, the regional government has been implementing initiatives towards the realization of rural smartness.

West Java is the most populated province in Indonesia, with more than 48 million people inhabiting 27 cities and more than 5000 villages (BPS, 2018). Although rural areas in this region are much larger compared to the urban areas, in recent years most of its rural inhabitants have been migrating in a high tempo to urban areas. Currently, more than 70% of the region's population is living in urban areas (Statista, 2019). This urbanization has a positive and a negative side. On the positive side, the economic growth rate of this region is higher than the national average (5.58% compared to 5.17% national economic growth (BPS, 2018)). On the negative side, urban areas in this region are extremely densely populated and confronted with a variety of problems, including, traffic congestion, unemployment, scarcity of housing, and pollution. The urbanization that takes place in the region is mainly triggered by the wide economic gap between urban and rural areas. This can be seen by the higher poverty rate in rural areas with 10.25% compared to 6.47% in urban areas (West Java Provincial Government, 2018). To narrow the economic gap between urban and rural areas, the provincial government has been initiating the diffusion of rural smartness by introducing the West Java Digital Village program.

In more detail, as provided by the report from the West Java Digital Service (2020), there are three layers representing the key initiatives in the West Java Digital Village Program: basic internet infrastructure (layer 1), digital literacy (layer 2), and digital services (layer 3). For layer 1, the government has been implementing basic internet infrastructure in rural areas and providing IT devices for the rural community. As of March 2020, 4,541 out of 5,342 villages (85%) have been equipped with internet access. For layer 2, the government has been conducting initiatives to improve the digital literacy of people living in rural areas. For example, by collaborating with several technology companies,

universities and volunteers to provide training on digital-related subjects in various villages across the region. For layer 3, in collaboration with the third-party service providers, the government has been implementing several digital village themes to improve the economic climate in rural areas. The digital village themes were the following:

1. *Digital commerce*: through collaboration with online marketplace providers, rural businesses are facilitated to sell their products online. As of March 2020, this digital village theme has been implemented in 25 villages.
2. *Digital fishery*: through collaboration with an IoT-based fishery service provider, rural fishery farming businesses are facilitated with automatic feeding machines to improve their productivity. As of March 2020, this digital village theme has been implemented in one village and planned to be replicated to another six villages across the province.
3. *Digital agriculture*: through collaboration with an IoT-based agriculture service provider, rural agriculture businesses are facilitated with IoT devices to optimize their yields. As of March 2020, this digital village theme has been implemented in three villages.
4. *Multimedia*: through collaboration with a digital multimedia service provider, rural citizens are trained in digital-content-making skills, enabling them to have the necessary ability for the creative economy. As of March 2020, this digital village theme has been initiated in the form of training to representatives from 20 villages.

## Data collection

### Respondents

The data is collected by distributing a survey to a sample of respondents that have an understanding of the IT utilization by citizens in the rural areas of the West Java Province, in Indonesia. For this purpose, two groups of respondents were selected to participate in this study: the village neighborhood heads and the village agents. The village neighborhood heads refer to the local citizens elected by the local communities as the leaders of particular neighborhoods within rural areas of the West Java Province. Their primary duty is to work with the local government to deliver public services for the local community. On the other hand, the village agents consist of individuals employed by the government to live and work in the villages across the West Java Province. Their main duty is to work with the local community to improve the rural economic situation by facilitating rural development activities, such as providing training in business development and assisting the community to establish proper rural businesses.

Both sample groups understand the situation concerning the utilization of IT in their rural areas since they were closely involved in the West Java Digital Village Program. The village neighborhood heads were the key users of the Sapawarga application, a mobile application provided by the provincial government which aims to help citizens channel their aspiration, improve government's information delivery, and facilitate citizens' access to public services through digital means (Nurhuda et al., 2021; West Java Digital Service, 2020). As the key users, they received training on the use of the app and IT literacy in general, thus having adequate knowledge of IT to play the role of the mediator between the local citizens and the provincial government through the use of the app (Kompas, 2019; West Java Digital Service, 2020). On the other hand, the initiatives to improve the rural economy carried out by the village agents were aligned with the digital village themes explained in the previous section. For that purpose, the village agents have been properly trained by the local government with the necessary IT skills, such as e-commerce, digital marketing, and e-governance (West Java Digital Service, 2020).

The main purpose of the trainings received by respondents in both groups is mainly acquisition of skills. The effectiveness of the training was expressed in terms of the extent to which the trained skills can be applied by the participants in their actual jobs (Hunt, 2003). Therefore, to facilitate the skills transfer in the context of the job performed by the participants, it is important for them to have the opportunity to perform the skills in a supportive post-training environment (Arthur Jr. et al., 2003). In that regard, the village neighborhood heads were granted access to using the Sapawarga application to facilitate the interaction of local citizens with the government. On the other hand, the village agents were given the opportunity to apply their knowledge by being involved in the West Java Digital Village Program. In addition, the ICT agency of the provincial government provided a technical contact center to ensure any issues raised in this post-training environment could be addressed.

### Data collection procedure

We prepared a self-administered online questionnaire using a five-point Likert scale (1 = "strongly disagree"; 5 = "strongly agree") to measure the perception of the respondents on the indicators of each variable in the theoretical model. However, before we distributed the questionnaire to the actual respondents, as suggested by Reynolds et al. (1993), we conducted a pilot test by means of personal interviews. The aims of this pilot test are 1) to detect errors in the questionnaire (i.e., double questions, ambiguous questions, and missing questions), and 2) to ensure the intended respondents understand correctly the formulation of statements in the questionnaire.

Seven participants took part in the pilot test. Five participants were village agents, working in the villages, and understanding the real state of affairs concerning IT diffusion among citizens in rural areas of West Java. One participant was the head of the Communication and Information Office of the West Java provincial government, who understands the rural smartness program that is being implemented in the province. Lastly, one participant was a research scholar, who gave the academic perspective on the research instrument. We administered the questionnaire by asking these pilot participants to fill it in and provide their feedback. Based on this pilot test, the statements in the questionnaire were reviewed and modified appropriately. 36 lists all the statements of the final version of the questionnaire, whereas 37 presents the statements of the initial version of the questionnaire and its revisions based on the pilot test.

We distributed the final version of the self-administered questionnaire to the intended respondents by online means. First, to get responses from the village's agents, we sent them a direct link to the online questionnaire. Second, to get responses from the village neighborhood heads, we embedded the link of the questionnaire in the Sapawarga mobile application that was exclusively authorized for them.

We received 231 total responses from the village agents and the village's neighborhood heads that we considered as valid responses. The invalid responses either had missing values or the completion time was less than 7 minutes. This minimum completion time was based on our internal test with representatives of village agents, the head of the ICT agency of West Java, and a few researchers. The fastest completion time from the test was just above 7 minutes and the longest completion time was about 10 minutes. Therefore, we concluded that the completion time of 7 minutes was the minimum amount of time needed for properly reading the questions and filling in the answers without any interruptions. We were aware that the respondents who manage to filled in the questionnaire within this 7 minutes threshold only have about 14 seconds for reading, understanding, and answering each question. Nevertheless, some of the respondents were able to complete within the time frame due to their familiarity with the context of the questions since, as explained in the earlier part of this section, the respondents were part of the West Java Digital Village Program. We were not using outlier detection that is generally used for inclusion and exclusion of test results (Zijlstra et al., 2007) because the respondents can "pause and continue later" the questionnaire filling process. We recorded these "pause" times and found that these additional times led to a large variation of the completion times (*standard deviation: 420*), which makes the outlier method impossible to use.

There were several approaches discussed in the literature to detect the insufficient effort responding (IER) that threaten the data quality (Huang et al., 2011). These

approaches are including: infrequency (e.g., evaluating items that would have the same responses from all individuals who understand the statement correctly), inconsistency (e.g., comparing the response on one item to the response on the other item), pattern (e.g., evaluating consecutive identical responses), and response time (e.g., evaluating responses that have short completion time). Among these methods, we preferred to use the response time as the exclusion criterion because, particularly for an online survey, this method effectively detects the IER (Malhotra, 2008). The empirical study by Malhotra (2008) has shown that the quick completion time is mainly motivated to satisficing the survey, without paying sufficient attention to properly answering the question, therefore leading to the low data quality.

Furthermore, since our unit of analysis is a village, we aggregated multiple responses coming from the same village, resulting in 179 distinct villages. We used the unweighted group mean technique for this aggregation, where the aggregated value is the unweighted average of the responses' value. This approach is commonly used in behavioral research when it is difficult to reach a consensus among the multiple responses, and when there are only minor differences among the responses (Van Bruggen et al., 2002).

## Data analysis

To empirically analyze the theoretical model, we employed the PLS-PM method on the collected data. There are several reasons why we consider the use of PLS-PM is relevant to validate our proposed theoretical model. First, PLS-PM has been used as the predominant method to evaluate structural equation models in the field of information systems (Benitez et al., 2020). Second, it has the ability to model both latent and emergent variables (Benitez et al., 2020; Henseler et al., 2016). Third, in the case of a small sample size, PLS-PM has better accuracy in the estimation of path coefficients compared to other variance-based methods (Benitez et al., 2020). Finally, PLS-PM has the capability to evaluate the overall fit of the model (Benitez et al., 2020). We follow the guidelines provided by Benitez et al. (2020) in performing and reporting the PLS-PM analysis.

## Evaluation of the sample size

To estimate the minimum sample size of the target population, we applied power analysis using Cohen's power table. The following are the parameters that we used in the estimation: predetermined effect size of 0.30 (medium), the statistical power of 0.8, and the significance level of 0.05. Based on these parameters, Cohen's power table suggests a minimum sample size of 85. Considering the outcomes of this power analysis, our collected sample size of 179 is considered to

be adequate for detecting the desired effects, and therefore sufficient to perform a correct statistical analysis.

**Estimation**

We used ADANCO 2.1.1 professional for Windows to run the statistical analysis of the PLS-PM (Henseler & Dijkstra, 2015), with the following settings:

- we used *Mode A consistent* for the reflective measurement model since it ensures a consistent estimation for inter-construct correlations, path coefficients, and loadings (Dijkstra & Henseler, 2015).
- we used *Mode A* for the composite measurement model to ensure that the weight of indicators contributes proportionally according to the correlations between the construct scores and the indicators (Rigdon, 2012). Moreover, the statistical inference in the model was based on the bootstrap procedure, relying on 4999 bootstrap runs with a maximum number of 400 iterations.

Prior to running the statistical analysis of the PLS-PM, we defined a set of dominant indicators to ensure that the sign of the weights and the factor loading estimates reflect a positive correlation between the indicators and their respective variables (Benitez et al., 2020; Henseler & Schuberth, 2020). Based on theoretical relevance, we chose *internet access*, the *certainty of sustainable funding*, the *willingness of rural citizens to utilize technology in their economic activities*, *connectedness*, *improved business collaboration*, *increase market access*, and *perceived income increase* as the dominant indicators in the model.

**Evaluation of the measurement model**

The measurement model specifies the relations between a variable and its observed indicators (Henseler et al., 2016). There are two different forms of measurement models that are included in our theoretical model. First, the reflective measurement model, which assumes a causal relationship between indicators and their construct, which is referred to as the latent variable. Second, the composite measurement model, in which the indicators, do not cause, but are combined to compose the construct, is referred to as the emergent variable (Benitez et al., 2020). In our theoretical model,

the reflective measurement model is applied to innovativeness, competitiveness, and perceived economic welfare, and the composite measurement model is applied to organizational readiness, environmental readiness, technological readiness and rural smartness.

**Evaluation of overall fit of the saturated model**

Prior to the assessment of the measurement model, we first evaluate the overall model fit of the saturated model. The saturated model refers to a model in which all constructs are allowed to be freely correlated. The purpose of this evaluation is to assess the validity of the reflective and composite measurement models, thus help us avoid a model misfit caused by the misspecification of the measurement model (Benitez et al., 2020).

Table 3 presents three discrepancy metrics that measure the overall model fit, namely the standardized root mean squared residual (SRMR), the unweighted least squares discrepancy ( $d_{ULS}$ ), and the geodesic discrepancy ( $d_G$ ). Although based on the individual discrepancy metrics mixed conclusions can be drawn, we still conclude that the saturated model has an acceptable overall model fit. There are two reasons for this conclusion. First, these discrepancy metrics were addressing the same subject (the difference between the empirical correlation matrix and the model-implied correlation matrix), where two of the three metrics indicated a good model fit. Second, although according to  $d_{ULS}$  the model did not meet the good fit criteria, the difference with the 99% quantile of their reference distribution ( $HI_{99}$ ) is very small (below 0.01), which we consider sufficient for accepting the model. In the following steps, each variable in the reflective measurement model and in the composite model will be examined separately.

**Assessment of the reflective measurement model**

The purpose of assessing the reflective measurement model is to evaluate the relationship between latent variables and their observed indicators. In this assessment, we evaluated four measurements, namely, composite reliability, convergent validity, indicator reliability, and discriminant validity.

Composite reliability, measured by  $\rho_A$  (Dijkstra & Henseler, 2015), is the measurement that evaluates the correlation between a latent variable and its indicators. The value of

**Table 3** The overall fit of the saturated model

| Discrepancy | Overall saturated model fit evaluation |  |                                      |
|-------------|--|--|--------------------------------------|
|             | Value                                  | Threshold                              | Conclusion                           |
| SRMR        | 0.0605                                 | 0.0800                                 | Supported: SRMR < 0.0800             |
| $d_{ULS}$   | 1.4858                                 | $HI_{95}$ : 1.2115; $HI_{99}$ : 1.4773 | Not supported: $d_{ULS}$ > $HI_{99}$ |
| $d_G$       | 0.6375                                 | $HI_{95}$ : 0.7087; $HI_{99}$ : 0.7906 | Supported: $d_G$ < $HI_{95}$         |

**Table 4** Reflective measurement model evaluation

| Code   | Indicator                             | $\rho_A$ | AVE    | Loading |
|--|---------------------------------------|----------|--------|---------|
| <i>Innovativeness (IN)</i>                       |                                       | 0.8416   | 0.6323 |         |
| IN1  | Improved business collaboration       |          |        | 0.7232  |
| IN2  | New value creation                    |          |        | 0.8500  |
| IN3  | Increase in entrepreneurship          |          |        | 0.8071  |
| <i>Competitiveness (CO)</i>                      |                                       | 0.9000   | 0.7497 |         |
| CO1  | Increased market access               |          |        | 0.8778  |
| CO2  | Improved business productivity        |          |        | 0.8676  |
| CO3  | Improved business efficiency          |          |        | 0.8520  |
| <i>Perceived economic welfare benefits (PEW)</i> |                                       | 0.8181   | 0.6911 |         |
| PEW1   | Perceived income increase             |          |        | 0.8511  |
| PEW2   | Perceived increase in employment rate |          |        | 0.8111  |

$\rho_A$  of all latent variables shown in Table 4 were all above the threshold value of 0.707, implying more than 50% of the variance in the construct scores can be explained by the underlying latent variable (Benitez et al., 2020). These results lead to the conclusion that the latent variables in the model have adequate composite reliability.

Convergent validity, measured by the average variance extracted (AVE), refers to the degree to which the indicators that belong to a particular latent variable actually measure the same construct. The AVE of all latent variables shown in Table 4 were all above the threshold value of 0.5, indicating more than 50% of indicators' variance is explained by the underlying latent variable (Benitez et al., 2020). Thus, the results show that the latent variables in the model have adequate convergent validity.

Indicator reliability, measured by the factor loading estimate, evaluates whether indicators that measure a particular latent variable are reliable. Table 4 shows that the factor loading estimates of the indicators range from 0.7232 to 0.8676, which is above the threshold of 0.707 (Benitez et al., 2020). These results demonstrate that indicators of all latent variables in the model are reliable.

Discriminant validity evaluates whether two latent variables are statistically different. We used the heterotrait-to-monotrait ratio of correlations (HTMT) (Henseler et al., 2015) as the criteria to assess the discriminant validity. Table 5 shows the results of the HTMT criteria. As can be seen in the table, all HTMT values, except between *competitiveness* and *innovativeness*, were below the recommended threshold of 0.85. However, although the HTMT between *competitiveness* and *innovativeness* is slightly higher than 0.85, the HTMT<sub>inference</sub> between the variables is smaller than one, implying that all correlations between the latent variables in the model have sufficient discriminant validity. Furthermore, results of the sufficient discriminant validity based on HTMT is supported by the assessment of cross-loadings. The Cross-loading matrix provided in 38 shows the

**Table 5** HTMT criteria

| Construct                                 | Innovativeness                                     | Competitiveness                                    | PEW |
|---|--|--|-----|
| Innovativeness                            |  |  |     |
| Competitiveness                           | HTMT: 0.8632<br>HTMT <sub>inference</sub> : 0.9362 |  |     |
| Perceived economic welfare benefits (PEW) | HTMT: 0.6827<br>HTMT <sub>inference</sub> : 0.7973 | HTMT: 0.7623<br>HTMT <sub>inference</sub> : 0.8576 |     |

correlations of all indicators were strongest on their respective latent variable.

### Assessment of the composite measurement model

The objective of assessing the composite measurement model is to evaluate the relationship between the emergent variables and their indicators. There are two evaluations that we conducted to evaluate the relationship between the emergent variable and its indicators. First, as presented in Table 6, we assessed the weight and the loading of the indicator to evaluate its relative and absolute contribution to the variable. It can be seen from the table that all of the weights and loadings are statistically significant, and thus provide empirical evidence that each indicator contributes significantly to the respective emergent variable. Second, we assessed the cross-loadings for the indicators of the emergent variables. Provided in 38, the cross-loading matrix shows that the correlations of all indicators were strongest on their respective emergent variable.

### Evaluation of the structural model

The purpose of evaluating the structural model is to assess the relationship between all variables included in the

**Table 6** Composite measurement model evaluation

| Code                                 | Indicator  | Weight    | Loading   |
|--------------------------------------|--|-----------|-----------|
| <i>Technological readiness (TR)</i>  |  |           |           |
| TR1                                  | Internet access  | 0.2212*** | 0.7931*** |
| TR2                                  | Information technology services suitability                                      | 0.2618*** | 0.8585*** |
| TR3                                  | Digital devices ownership penetration  | 0.2205*** | 0.7852*** |
| TR4                                  | Electric reliability   | 0.2347*** | 0.7481*** |
| TR5                                  | Adequacy of IT strategic guidelines  | 0.3034*** | 0.8274*** |
| <i>Organizational readiness (OR)</i> |  |           |           |
| OR1                                  | Certainty of sustainable funding   | 0.2544*** | 0.8540*** |
| OR2                                  | Organization capability  | 0.2589*** | 0.8569*** |
| OR3                                  | Commitment from the government   | 0.3170*** | 0.8629*** |
| OR4                                  | Collaboration  | 0.3324*** | 0.8643*** |
| <i>Environmental readiness (ER)</i>  |  |           |           |
| ER1                                  | Digital knowledge of rural citizens  | 0.1697*** | 0.7018*** |
| ER2                                  | Willingness of rural citizens to utilize technology in their economic activities | 0.1428*** | 0.6269*** |
| ER3                                  | Purchasing power of rural citizens for IT services                               | 0.1915*** | 0.7389*** |
| ER4                                  | Entrepreneurial capability of rural citizens                                     | 0.1777*** | 0.7288*** |
| ER5                                  | Supportive regulations and policies  | 0.2327*** | 0.7618*** |
| ER6                                  | Citizens involvement   | 0.2243*** | 0.8022*** |
| ER7                                  | Third-parties involvement  | 0.2192*** | 0.7441*** |
| <i>Rural smartness (RS)</i>          |  |           |           |
| RS1                                  | Connectedness  | 0.2817*** | 0.8026*** |
| RS2                                  | Participatory governance   | 0.3254*** | 0.8818*** |
| RS3                                  | Digitally empowered citizens   | 0.3054*** | 0.8344*** |
| RS4                                  | Coherence of IT services provision   | 0.3120*** | 0.7442*** |

\*\*\*  $p < 0.001$ , one-tailed test

theoretical model (Henseler et al., 2016). Measurements of the structural model consist of the overall fit of the estimated model, the path coefficients between variables and their effect sizes, and the coefficient of determination  $R^2$  (Benitez et al., 2020).

**Evaluation of the overall fit of the estimated model**

The main goal of measuring the overall fit of the estimated model is to obtain empirical evidence for the proposed hypotheses depicted in the theoretical model. The adequate overall model fit suggests that there is a high chance that the proposed hypotheses (Benitez et al., 2020) accurately describe real phenomena.

As can be seen from Table 7, the results show a consensus among the discrepancy metrics. The SRMR was below the suggested threshold of 0.08, the  $d_G$  was below the  $HI_{95}$ , and the  $d_{ULS}$  was below the  $HI_{99}$ , indicating that the estimated model was not rejected (Benitez et al., 2020). These values provide empirical evidence that the proposed model is well suited for explaining the determinants and impacts of rural smartness.

**Evaluation of path coefficients and their effect sizes**

The path coefficients between variables in the model indicate the change in the dependent variable if the independent variable is increased by one standard deviation while keeping all the other independent variables constant (Benitez et al.,

**Table 7** The overall fit of the estimated model

| Discrepancy | Overall saturated model fit evaluation |  |                                  |
|-------------|--|--|----------------------------------|
|             | Value                                  | Threshold                              | Conclusion                       |
| SRMR        | 0.0678                                 | 0.0800                                 | Supported: SRMR < 0.0800         |
| $d_{ULS}$   | 1.8687                                 | $HI_{95}$ : 1.7578; $HI_{99}$ : 2.3108 | Supported: $d_{ULS}$ < $HI_{99}$ |
| $d_G$       | 0.6563                                 | $HI_{95}$ : 0.7318; $HI_{99}$ : 0.8135 | Supported: $d_G$ < $HI_{95}$     |

2020). A path coefficient is considered significant when the *p*-value is below the pre-defined  $\alpha$  level (Henseler et al., 2016).

On the other hand, the effect sizes, measured by Cohen's  $f^2$ , quantify the magnitude of an effect of the independent variable to the dependent variable (Henseler et al., 2016). It compares the endogenous construct's coefficient of determination if the effect is included in the model ( $R^2_{included}$ ) and the coefficient of determination if the effect is discarded from the model ( $R^2_{excluded}$ ) with the following formula  $f^2 = (R^2_{included} - R^2_{excluded}) / (1 - R^2_{included})$  (Henseler, 2020). The values of  $f^2$  from 0.02 to 0.150, 0.150 to 0.350, and above 0.350 can be regarded as weak, moderate, and strong effect sizes, respectively (Cohen, 1988). In practice, the change in the  $R^2$  values is calculated by estimating the path model twice. The first calculation includes the independent variable (the effect), whereas the second calculation excludes the effect (Hair Jr et al., 2017).

Table 8 presents the results for path coefficients and effect sizes between variables in the model. As it can be seen from the results, there are mixed conclusions that can be drawn with respect to the proposed hypotheses. We found support for the following hypotheses: *H1*, *H2*, *H3*, *H4*, *H6*, *H7*, *H9*, and *H11*, while *H5*, *H8*, and *H10* are not supported. Further interpretations of these findings will be discussed in The Discussion section.

### Evaluation of $R^2$

Table 9 presents the  $R^2$  values that indicate the share of variance in the dependent variable explained by this model. The conclusion that can be drawn from the  $R^2$  value is relative to the theoretical maturity of the phenomena that is being investigated. For the phenomena that are already quite well understood, relatively high  $R^2$  values are expected. However, for the phenomena that are less well understood or still

in the emergence stadium, lower  $R^2$  values are still acceptable (Benitez et al., 2020). To our knowledge, the empirical research addressing the causal relationship of the determinants and impact of rural smartness is still in its infancy. Therefore, the  $R^2$  values in the model that are ranging from 0.3021 to 0.7427 are considered to be satisfactory results.

## Discussion

### Major findings and interpretations

**Finding 1:** *Organizational readiness has a strong positive effect on the other readiness factors (technological readiness and environmental readiness) and has a direct contribution to the realization of rural smartness.*

Since organizational readiness refers to the readiness of the government, this finding provides solid empirical evidence that the government holds a critical role in the achievement of rural smartness. The government has to be the one that triggers the initiatives toward rural smartness because the investments (e.g., internet connection, IT devices, and IT services) in rural areas are not economically attractive, or even affordable for the private sector (Jung

**Table 9**  $R^2$  values

| Variable                               | $R^2$  |
|--|--------|
| Technological readiness                | 0.3021 |
| Environmental readiness                | 0.4758 |
| Rural smartness                        | 0.5555 |
| Innovativeness                         | 0.6315 |
| Competitiveness                        | 0.7427 |
| Perceived economic welfare improvement | 0.5838 |

**Table 8** Results of path coefficients and effect sizes

| Hypothesis   |     | Path Coefficient | Hypothesis results | Effect size ( $f^2$ )       |
|--|-----|------------------|--------------------|-----------------------------|
| Organizational readiness → Technological smartness       | H1  | 0.5496***        | Supported          | 0.4329 ( <i>strong</i> )    |
| Organizational readiness → Environmental readiness       | H2  | 0.5654***        | Supported          | 0.4276 ( <i>strong</i> )    |
| Organizational readiness → Rural smartness               | H3  | 0.2479**         | Supported          | 0.0677 ( <i>weak</i> )      |
| Technological readiness → Environmental readiness        | H4  | 0.1920*          | Supported          | 0.0491 ( <i>weak</i> )      |
| Technological readiness → Rural smartness                | H5  | -0.0118          | Not supported      | 0.0002 ( <i>no effect</i> ) |
| Environmental readiness → Rural smartness                | H6  | 0.5627***        | Supported          | 0.3734 ( <i>strong</i> )    |
| Rural smartness → Innovativeness                         | H7  | 0.7950***        | Supported          | 1.7135 ( <i>strong</i> )    |
| Rural smartness → Competitiveness                        | H8  | 0.0496           | Not supported      | 0.0035 ( <i>no effect</i> ) |
| Innovativeness → Competitiveness                         | H9  | 0.8219***        | Supported          | 0.9673 ( <i>strong</i> )    |
| Innovativeness → Perceived economic welfare improvement  | H10 | 0.0872           | Not supported      | 0.0047 ( <i>no effect</i> ) |
| Competitiveness → Perceived economic welfare improvement | H11 | 0.6877***        | Supported          | 0.2934 ( <i>moderate</i> )  |

\*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$



et al., 2014; Mishbah et al., 2018; Wiggins & Proctor, 2001; Zavratinik et al., 2018).

In the West Java province Indonesia, where we conducted our survey, the regional government has been implementing the Digital Village program. The main objective of the program is to improve the economic welfare of people living in rural areas through IT utilization. This program addresses technological and environmental readiness. As far as technological readiness is concerned, the regional government provides IT infrastructure and necessary IT devices to facilitate rural citizens access to the internet. On the other hand, to ensure environmental readiness, the government organizes digital literacy education programs for rural citizens and collaborates with the private sector to provide IT services in rural areas. However, although the effect sizes of the organizational readiness to the technological readiness and environmental readiness were strong, its direct effect size on rural smartness is considered to be weak. One of the possible reasons for this result is that because rural smartness primarily relies on the connectedness among the rural business ecosystem stakeholders (environmental aspect) that are empowered by IT (technological aspect). Therefore, the primary role of the government is not per se to achieve rural smartness but to ensure the technological and environmental readiness that, in turn, will eventually lead to rural smartness. This suggests, that the effect of organizational readiness on rural smartness is rather indirect, and mediated by the other two readiness types.

**Finding 2:** *Technological readiness contributes positively to environmental readiness but has no direct contribution to the realization of rural smartness.*

This finding suggests that having all required technological elements in place does not necessarily guarantee the realization of rural smartness, or in other words, “a fool with a tool is still a fool”. In order for rural smartness to be realized, the environmental elements need to embrace the provided technological elements effectively.

Furthermore, although the positive correlation between technological readiness and environmental readiness has been found to be statistically significant, the effect size of the relationship is weak. There are two things that can be concluded from these findings. First, it seems that in our sample, the usage of the provided technologies is not as expected. This argument is supported by the fact that from our survey results that the dominant usages of the provided IT services are social communications (e.g., social media and chat) and information access (i.e., internet browsing), mostly for entertainment purposes, not for the online activities that have economic benefits. Second, it is possible that there is another technology element not covered in the current model that can give positive contributions to environmental

readiness. This technological element might concern specific IT services that facilitate cohesive collaboration between stakeholders involved in the rural business ecosystem. For example, an IT service platform that facilitates collaboration between local government and private companies to serve rural businesses with broader access to market and funding.

**Finding 3:** *Environmental readiness mediates the effect of organizational readiness and technological readiness on rural smartness and has been found to be the strongest determinant of rural smartness.*

This finding provides empirical support for the argument that the readiness of rural citizens, the involvement of the third parties, and the supportive regulatory environment in embracing IT innovation in the rural business ecosystem are the most important elements needed for success in realizing rural smartness. This finding is also aligned with the quadruple helix model (Van Waart et al., 2016), in which has been theorized that the success of innovation in a region can only be achieved when there is a good synergy between the citizens, the third parties (i.e., industries and universities), and the government.

In the West Java province, the provincial government has been implementing several initiatives to ensure the readiness of the environmental elements. The provincial government has been running the “Patriot Desa” program, in which they employed individuals that work in the villages as the agent of change to increase the capability of rural citizens in embracing IT innovation. Furthermore, the government acts as a catalysator and has been collaborating with the private sectors to provide IT services for rural citizens under cooperation schemes that are beneficial for both parties. For example, both parties have collaborated for providing online commerce platforms to sell the local produce and IoT systems that help farmers optimize the use of their farming lands. Lastly, with respect to the regulatory aspect, the provincial government incorporates the Digital Village program as part of its strategic development plan to ensure continuous support for rural smartness initiatives.

**Finding 4:** *Rural smartness has a strong positive effect on innovativeness but has no direct effect on competitiveness. Its impact on competitiveness is mediated by innovativeness. Improvement in the competitiveness of the rural business ecosystem is expected to eventually improve the economic welfare of citizens in rural areas.*

This finding is very relevant to the business environment in rural areas where small-medium enterprises (SMEs) are the main economic drivers (Arifin et al., 2020; Talbot, 2016). Without the diffusion of technological innovation, these SMEs have limited access to markets, resources, and

funding sources that limit their numbers and the creation of economic values (Eniola & Entebang, 2015; Muñoz & Kimmitt, 2019). As evidenced by this finding, rural areas that meet the characteristics of rural smartness are becoming fertile grounds for innovations, thus accelerating the creation of economic values and new rural businesses. Furthermore, this finding provides empirical evidence that improvement on the competitiveness in the rural business environment can only be achieved once there are sufficient numbers of rural business entities and economic offerings.

In West Java, the provincial government has been initiating the diffusion of rural smartness by introducing the Digital Village program. The Digital Village program, as indicated by the strong effect size from rural smartness to innovativeness, has been enabling rural communities to create new economic offerings and triggering them to start their business. Once the rural areas have sufficient economic offerings and rural businesses are established, as further indicated by the strong effect size from innovativeness to competitiveness, the Digital Village program enables the rural businesses to access a broader market, increase their productivity, and enable a resource-efficient production. However, although the correlation between competitiveness and the perceived economic welfare was statistically significant, the effect size was moderate. One of the possible reasons for this result is that the Digital Village program is still at an early stage, thus the significant economic impact is not yet visible. Another reason, as indicated by the  $R^2$  value of the perceived economic welfare improvement ( $R^2 = 0.584$ ), is that not all shares of variance in the variable were explained by the model. This result suggests that other factors could determine the economic welfare improvement of rural citizens, such as consumer demand, market competition, and macro-economic conditions (Porter, 2003).

## Implications

Empirical validation of the proposed theoretical model has some clear practical and theoretical implications. From a practical perspective, the results suggest that the government needs to ensure that the organizational readiness requirements implied by the model are being fulfilled. These requirements cover the certainty of funding for initiatives focusing on rural smartness, the capability to manage the provisioning and operation of IT services in rural areas, the commitment to support, and the ability to collaborate with the related stakeholders. Fulfilment of these elements turns out to be the key enabler for technological and environmental readiness, which in turn will lead to the realization of rural smartness. Furthermore, the results also suggest that having the required technology infrastructure in place does not guarantee success in realizing rural smartness. The most critical factor is the synergy among the environmental

elements of rural smartness, namely, the citizens, the third parties (e.g., private companies), and the regulatory environment. In addition, the characteristics that have been found to be significant to achieve rural smartness (i.e., connectedness, participatory governance, digitally empowered citizens, and coherence of IT service provision), can be translated into the functional requirements for specific IT services aimed at accelerating the economic growth in rural areas.

On the other hand, from a theoretical perspective, the achievement of a good overall model fit suggests that the validated theoretical model can be used as a reference to study rural smartness. Academics can experiment with and refine the provided operationalization of the theoretical model with samples coming from other rural areas involved in similar initiatives, such as the villages from the Information Network Village (INVIL) project in South Korea (Jung et al., 2014) or the Taobao villages in China (Lulu, 2019). Such experiments can enrich the understanding of the underlying mechanisms leading to rural smartness. Moreover, since the operationalization of rural smartness as an emergent variable can be translated into a set of functional requirements for the design of an IT artefact, this paper can support future research that exploration of the link between empirical research and design science research in this field.

## Conclusion

The current urbanization trend that causes serious stress and overload of the extant urban infrastructure has led to various urbanization problems, such as poverty, traffic congestion, energy crisis, and pollution. However, although urban smartness initiatives have been implemented to mitigate these various urban problems, it is difficult to improve the quality of living in urban areas without, addressing the causes of this accelerated urbanization process. Since one of the major sources of urbanization is the rural-urban migration, mainly triggered by the wide economic gap between rural and urban areas, the smartness initiatives need to be extended to rural areas, in particular with the aim to narrow the economic gap and slow down the migration.

This paper proposes and validates empirically a theoretical model that explains the determinants and impacts of rural smartness on the economic welfare of rural citizens. The sample to validate the model originates from the West Java province, Indonesia. Our analysis of the collected data using PLS-PM led to the following findings and recommendations:

1. The government, as the organisational entity responsible for the initiatives toward rural smartness, is found to be a strong determinant for the other readiness factors (technological readiness and environmental readiness) and has a direct positive contribution toward the reali-

sation of rural smartness. This finding suggests that in order to realise rural smartness, the government needs to ensure the certainty of funding for initiatives toward rural smartness, the capability to manage the provision and operation of IT services in rural areas, the commitment to support, and the ability to collaborate with the related stakeholders.

2. Technological readiness is found to have no direct correlation with rural smartness. However, but has a positive effect on environmental readiness which is the strongest determinant of rural smartness. This finding implies that having the required technological elements in place is not a guarantee for the realisation of rural smartness. In order for rural smartness to be realised, the adoption, diffusion and use of the provided technological elements throughout the rural ecosystem have to be effective. Therefore, as the strong determinant of environmental readiness, the government needs to ensure the business rural ecosystem is ready to embrace the initiatives toward rural smartness. This assumes the abilities of rural citizens (digital knowledge, willingness to use, purchasing power, and active involvement), the involvement of the third parties, and the supported regulatory environment.
3. Rural smartness is found to have a strong positive effect on innovativeness which in turn improves the competitiveness of the rural business ecosystem. Improvement of the competitiveness of the rural business ecosystem, in the end, is expected to improve the economic welfare of citizens in rural areas. Accordingly, to accelerate the realisation of rural smartness, its characteristics can be translated into the functional requirements for IT services to be developed, implemented and offered for consumption to the rural business ecosystem.

Finally, our work has several limitations that suggest some avenues for future research. First, our data is cross-sectional, implying that we cannot analyze the longitudinal process, such as analyzing the impact of rural smartness on the actual improvement of rural citizens' economic welfare over a certain period. Accordingly, it is advisable for future research to conduct longitudinal measurements to test the theoretical model.

Second, our validation of the theoretical model only used the sample from one region. Although the empirical results of the model validation are very likely to hold for other rural areas that have similar settings, having just one sample might be a threat to the generalizability claim of our findings. Therefore, to strengthen the generalizability, future research is recommended to test the theoretical model with a sample chosen from a combination of different regions or countries, especially the ones involve in similar initiatives, such as the villages from the Information Network Village

(INVIL) project in South Korea (Jung et al., 2014) or the Taobao villages in China (Lulu, 2019).

Third, the empirical results found that the effect size of technological readiness on environmental readiness is weak. However, theoretically, technological readiness has an important role in empowering stakeholders of the rural business ecosystem to realize rural smartness. This finding thus leaves room for future research to explore other technological elements that could have a significant positive contribution to environmental readiness.

Fourth, we only evaluated unidirectional relationships among the variables in the theoretical model. This is due to the following reasons:

1. The validity of the test on bidirectional relations with the cross-sectional data is questionable due to the time factor. The basic argument is that the bidirectional relationships, if they exist, should not be observed at the same time, especially when the time-lag between the cause and effect is significantly different (Wong & Law, 1999). Since the nature of the cause and effect of the hypotheses in our model is not simultaneous, testing bidirectional relations with the cross-sectional data that we have is not preferable.
2. To evaluate bi-directional relationships within the structural model, the exogenous variables that predict the endogenous variables, referred to as instrumental variables, are required (Finch & French, 2015; Wong & Law, 1999). However, we did not collect data on the potential instrumental variables, thus testing the bi-directional relationships is not possible.

However, on the one hand between technological readiness and environmental readiness, and on the other hand between innovativeness and competitiveness, bidirectional relationships might occur. For the former, over time, the improvement of environmental readiness (for example, an improvement on the digital readiness and the purchasing power of rural citizens) would attract third parties to provide specialized IT services for rural areas. In this way, environmental readiness could also have a positive effect on technological readiness. For the latter, over time, the improvement in business efficiency (as an indicator of competitiveness) could lead to a better ability in creating new economic values (as an indicator of innovativeness); thus, the competitiveness could also have a positive effect on the innovativeness. Therefore, future research may investigate such possible bi-directional relationships by means of a longitudinal study and collect data for the required instrumental variables.

## Appendix 1

Table 10

Table 10 Final questionnaire statements

| Code                                 | Indicator  | Definition  | Statement   |
|--------------------------------------|--|---|---|
| <b>Technological readiness (TR)</b>  |  |   |   |
| TR1                                  | Internet access  | Level of internet access in the rural area.   | Proper internet access already established in the rural areas   |
| TR2                                  | Information technology services suitability                                      | Level of IT service suitability with the situation and needs in the rural area.                                 | The provided IT services is suitable for the needs and situation in the rural areas   |
| TR3                                  | Digital devices ownership penetration  | Penetration level of devices owned by rural citizens to access the IT service.                                  | The citizens in rural areas already have digital devices to access the provided IT services   |
| TR4                                  | Electric reliability   | Level of electric reliability in the rural area.  | Electricity in the rural areas is reliable to access the provided IT services   |
| TR5                                  | Adequacy of IT strategic guidelines  | The level of adequacy of strategic guidelines for the provision of IT services in the rural area.               | <ol style="list-style-type: none"> <li>1. Programs from the provincial government in the provision of IT services in rural areas have been defined.</li> <li>2. Programs from the provincial government to inform citizens about the utilization of IT services in rural areas have been defined.</li> </ol>  |
| <b>Organizational readiness (OR)</b> |  |   |   |
| OR1                                  | Certainty of sustainable funding   | Level of certainty of sustainable funding for the provision of IT infrastructure and services in rural areas    | The provincial government has a strong funding commitment for the provision of IT infrastructure and service in rural areas   |
| OR2                                  | IT capability  | Level of capability of the government in managing IT services provision in rural areas                          | The provincial government is competent in managing the IT services provision in rural areas.  |
| OR3                                  | Commitment to support  | Level of commitment of the government in supporting the utilisation of IT services in rural areas               | <ol style="list-style-type: none"> <li>1. The provincial government has a strong commitment to supporting the utilization of IT services in rural areas.</li> <li>2. The village government has a strong commitment to supporting the utilization of IT services in rural areas.</li> </ol>   |
| OR4                                  | Collaboration  | Level of collaboration of the government in the initiatives toward rural smartness                              | <ol style="list-style-type: none"> <li>1. The provincial government is able to collaborate with the citizens to facilitate the usage of IT services</li> <li>2. The provincial government is able to collaborate with the other government institutions to facilitate the provisioning of IT services in rural areas</li> <li>3. The provincial government is able to collaborate with third parties (e.g., companies, startups, educational institutions, financial institutions, and media) to facilitate the provisioning of IT services in rural areas</li> </ol> |
| <b>Environmental readiness (ER)</b>  |  |   |   |
| ER1                                  | Digital knowledge of rural citizens  | Level of digital knowledge of rural citizens  | Citizens in rural areas are capable of using the provided IT services   |
| ER2                                  | Willingness of rural citizens to utilise technology in their economic activities | Willingness level of rural citizens to utilize IT services in their economic activities                         | Rural citizens are willing to utilise IT services for their economic activities   |
| ER3                                  | Purchasing power of rural citizens for IT services                               | Level of purchasing power of rural citizens for IT services   | Rural citizens have sufficient financial means to utilise the provided IT services.   |
| ER4                                  | Entrepreneurial capability of rural citizens                                     | Level of the entrepreneurial capability of rural citizens   | The rural citizens have good entrepreneurial capabilities   |
| ER5                                  | Supportive regulations and policies  | Level of supported regulations and policies for the utilization of IT services in the rural economic activities | The existing regulatory framework and policies encourage the utilization of IT services for business activities of citizens in rural areas  |

**Table 10** (continued)

| Code                                      | Indicator                                 | Definition  | Statement  |
|---|---|---|--|
| ER6                                       | Citizens involvement                      | Level of involvement of rural citizens in the provision of IT services and related policy   | The rural citizens are involved in the development of the IT services that are intended to be used for their activities  |
| ER7                                       | Third-parties involvement                 | Level of third-parties involvement for the IT services provision in rural areas   | The third parties (e.g., companies, start-ups, educational institutions, financial institutions, and media) are involved to a large extent in the provisioning of IT services in rural areas   |
| Rural smartness (RS)                      |   |   |  |
| RS1                                       | Connectedness                             | Level of connectedness between stakeholders in rural areas that enabled by IT infrastructures and services  | Stakeholders in the rural areas are able to exchange information effectively through the usage of IT services  |
| RS2                                       | Participatory Governance                  | Level of stakeholders' participation in the initiatives to improve the welfare of citizens in rural areas, that is enabled by availability and usage of IT services | Rural citizens are able to participate effectively in the initiatives to improve their welfare due to the availability and usage of IT services<br>Third parties are able to participate effectively in the initiatives to improve the welfare of citizens in rural areas due to the availability and usage of IT services |
| RS3                                       | Digitally empowered citizens              | Level of citizens creative and innovation ability empowered by IT services  | 1. Citizens in rural areas able to access broader positive information through IT services<br>2. Citizens in rural areas have better abilities in creating products/services that bring economic benefit by using IT services  |
| RS4                                       | Coherence of IT services provision        | Level of strategy and implementation alignment of the provision of IT services in rural areas   | There is a clear strategy from the provincial government in the provision of IT services in rural areas  |
| Innovativeness (IN)                       |   |   |  |
| IN1                                       | Improved business collaboration           | Level of increase in innovation through collaboration between stakeholders in the rural business ecosystem that is empowered by IT services                         | The provided IT services effectively facilitate innovation through collaboration between stakeholders in the rural business ecosystem  |
| IN2                                       | New value creation                        | Level of increase in the creation of new products or services empowered by IT services  | The provided IT services make possible the creation of new products or services  |
| IN3                                       | Increase in entrepreneurship              | Level of increase in the creation of the new business entity empowered by IT services   | The provided IT services contribute to the growth of the number and variety of new business entities.  |
| Competitiveness (CO)                      |   |   |  |
| CO1                                       | Increased market access                   | Level of increase in access by business entities in rural areas to a broader market through the utilization of IT services  | The provided IT services effectively increase the access for business entities to a broader market   |
| CO2                                       | Improved business productivity            | Level of increase in products/services that are produced/delivered by business entities in rural areas through the utilization of IT services                       | The provided IT services contribute to the growth of the volume of the products/services delivered by business entities in rural areas   |
| CO3                                       | Improved business efficiency              | Level of improvement in the efficiency of resources utilized by business entities in rural areas in providing their products/services                               | The provided IT services improve the utilization, sharing, and distribution of resources by business entities in rural areas   |
| Perceived economic welfare benefits (PEW) |   |   |  |
| PEW1                                      | Perceived income increase                 | Level of increase in the income of citizens in rural areas through the utilization of IT services   | IT services enable citizens in rural areas to increase their income  |
| PEW2                                      | Perceived increase in the employment rate | Level of increase in the number of people being employed by business entities in rural areas  | IT services lead to an increase of employment in rural areas   |

## Appendix 2

Table 11

**Table 11** Initial questionnaire statements and its revision based on pilot test

| Code | Indicator  | Statement  | Statement's revision   |
|------|--|--|--|
| TR1  | Internet access  | Proper internet access already established in the rural areas  | N/A  |
| TR2  | Information technology services suitability                                      | The provided IT services is suitable for the needs and situation in the rural areas  | N/A  |
| TR3  | Digital devices ownership penetration  | The citizens in rural areas already have digital devices to access the provided IT services  | N/A  |
| TR4  | Electric reliability   | Electricity in the rural areas is reliable to access the provided IT services  | N/A  |
| TR5  | Adequacy of IT strategic guidelines  | <ul style="list-style-type: none"> <li>• IT provisioning strategies in rural areas have been defined.</li> <li>• Programs to inform citizens about the utilization of IT services in rural areas have been defined</li> </ul>  | <ul style="list-style-type: none"> <li>• Programs from the provincial government in the provision of IT services in rural areas have been defined.</li> <li>• Programs from the provincial government to inform citizens about the utilization of IT services in rural areas have been defined.</li> </ul>   |
| OR1  | Certainty of sustainable funding   | Funding for the provision of IT infrastructure and service in rural areas has been secured   | The provincial government has a strong funding commitment for the provision of IT infrastructure and service in rural areas  |
| OR2  | IT capability  | The provincial government is competent in managing the IT services provision in rural areas.   | N/A  |
| OR3  | Commitment to support  | <ul style="list-style-type: none"> <li>• The provincial government has a strong commitment to supporting the utilization of IT services in rural areas.</li> </ul>   | <ul style="list-style-type: none"> <li>• The provincial government has a strong commitment to supporting the utilization of IT services in rural areas.</li> <li>• The village government has a strong commitment to supporting the utilization of IT services in rural areas.</li> </ul>  |
| OR4  | Collaboration  | <ul style="list-style-type: none"> <li>• The provincial government is able to collaborate with the citizens to facilitate the usage of IT services</li> <li>• The provincial government is able to collaborate with third parties (e.g., companies, startups, educational institutions, financial institutions, and media) to facilitate the provisioning of IT services in rural areas</li> </ul> | <ul style="list-style-type: none"> <li>• The provincial government is able to collaborate with the citizens to facilitate the usage of IT services</li> <li>• The provincial government is able to collaborate with the other government institutions to facilitate the provisioning of IT services in rural areas</li> <li>• The provincial government is able to collaborate with third parties (e.g., companies, startups, educational institutions, financial institutions, and media) to facilitate the provisioning of IT services in rural areas</li> </ul> |
| ER1  | Digital knowledge of rural citizens  | Citizens in rural areas are capable of using the provided IT services  | N/A  |
| ER2  | Willingness of rural citizens to utilise technology in their economic activities | Rural citizens are willing to utilise IT services for their economic activities  | N/A  |
| ER3  | Purchasing power of rural citizens for IT services                               | Rural citizens have sufficient financial means to utilise the provided IT services.  | N/A  |
| ER4  | Entrepreneurial capability of rural citizens                                     | The rural citizens have good entrepreneurial capabilities  | N/A  |
| ER5  | Supportive regulations and policies  | The existing regulatory framework and policies encourage the utilisation of IT services for business activities of citizens in rural areas   | N/A  |
| ER6  | Citizens involvement   | The rural citizens are involved in the development of the IT services that are intended to be used for their activities  | N/A  |

**Table 11** (continued)

| Code | Indicator                                 | Statement  | Statement's revision  |
|------|---|--|---|
| ER7  | Third-parties involvement                 | The third parties (e.g., companies, start-ups, educational institutions, financial institutions, and media) are involved to a large extent in the provisioning of IT services in rural areas   | N/A   |
| RS1  | Connectedness                             | Stakeholders in the rural areas are able to exchange information effectively through the usage of IT services  | N/A   |
| RS2  | Participatory governance                  | <ul style="list-style-type: none"> <li>• Rural citizens are able to participate effectively in the initiatives to improve their welfare due to the availability and usage of IT services</li> <li>• Third parties are able to participate effectively in the initiatives to improve the welfare of citizens in rural areas due to the availability and usage of IT services</li> </ul> | N/A   |
| RS3  | Digitally empowered citizens              | <ul style="list-style-type: none"> <li>• Citizens in rural areas are empowered through IT services</li> <li>• Through the use of IT services, citizens in rural areas have better abilities in creating products/services that bring economic benefit</li> </ul>   | <ul style="list-style-type: none"> <li>• Citizens in rural areas able to access broader positive information through IT services</li> <li>• Citizens in rural areas have better abilities in creating products/services that bring economic benefit by using IT services</li> </ul> |
| RS4  | Coherence of IT services provision        | There is clear management of the IT services provisioning in rural areas   | There is a clear strategy from the provincial government in the provision of IT services in rural areas   |
| IN1  | Improved business collaboration           | The provided IT services effectively facilitate innovation through collaboration between stakeholders in the rural business ecosystem  | N/A   |
| IN2  | New value creation                        | The provided IT services make possible the creation of new products or services  | N/A   |
| IN3  | Increase in entrepreneurship              | The provided IT services contribute to the growth of the number and variety of new business entities.  | N/A   |
| CO1  | Increased market access                   | The provided IT services effectively increase the access for business entities to a broader market   | N/A   |
| CO2  | Improved business productivity            | The provided IT services contribute to the growth of the volume of the products/services delivered by business entities in rural areas   | N/A   |
| CO3  | Improved business efficiency              | The provided IT services improve the utilization, sharing, and distribution of resources by business entities in rural areas   | N/A   |
| PEW1 | Perceived income increase                 | IT services enable citizens in rural areas to increase their income  | N/A   |
| PEW2 | Perceived increase in the employment rate | IT services lead to an increase in employment in rural areas   | N/A   |

## Appendix 3

Table 12

Table 12 Cross-loadings matrix

| Indicator | TR            | OR            | ER            | RS            | IN            | CO            | PEW           |
|-----------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| TR1       | <b>0.7931</b> | 0.4167        | 0.3333        | 0.2758        | 0.2351        | 0.1804        | 0.1115        |
| TR2       | <b>0.8585</b> | 0.4338        | 0.4154        | 0.3807        | 0.3200        | 0.2392        | 0.2564        |
| TR3       | <b>0.7852</b> | 0.3767        | 0.3832        | 0.2643        | 0.3164        | 0.2694        | 0.2180        |
| TR4       | <b>0.7481</b> | 0.4366        | 0.3937        | 0.2508        | 0.2930        | 0.2984        | 0.1808        |
| TR5       | <b>0.8274</b> | 0.5219        | 0.4724        | 0.4267        | 0.3655        | 0.2369        | 0.1624        |
| OR1       | 0.4394        | <b>0.8540</b> | 0.4952        | 0.4347        | 0.4223        | 0.4137        | 0.2599        |
| OR2       | 0.4303        | <b>0.8569</b> | 0.4919        | 0.4699        | 0.4310        | 0.4268        | 0.3156        |
| OR3       | 0.5089        | <b>0.8629</b> | 0.5953        | 0.5993        | 0.4836        | 0.4614        | 0.3473        |
| OR4       | 0.4967        | <b>0.8643</b> | 0.6884        | 0.5918        | 0.5713        | 0.5142        | 0.4350        |
| ER1       | 0.3974        | 0.4357        | <b>0.7018</b> | 0.3851        | 0.4019        | 0.4567        | 0.3423        |
| ER2       | 0.2191        | 0.3760        | <b>0.6269</b> | 0.3957        | 0.4440        | 0.4509        | 0.2433        |
| ER3       | 0.4148        | 0.4287        | <b>0.7389</b> | 0.5161        | 0.4182        | 0.3731        | 0.3436        |
| ER4       | 0.2701        | 0.3962        | <b>0.7288</b> | 0.5602        | 0.5341        | 0.5229        | 0.5064        |
| ER5       | 0.4878        | 0.5565        | <b>0.7618</b> | 0.6057        | 0.5352        | 0.4997        | 0.3896        |
| ER6       | 0.3941        | 0.5863        | <b>0.8022</b> | 0.5904        | 0.5329        | 0.4588        | 0.3706        |
| ER7       | 0.3406        | 0.5919        | <b>0.7441</b> | 0.5905        | 0.5401        | 0.4756        | 0.4196        |
| RS1       | 0.3255        | 0.4538        | 0.5467        | <b>0.8026</b> | 0.5766        | 0.5385        | 0.4542        |
| RS2       | 0.3537        | 0.5230        | 0.6675        | <b>0.8818</b> | 0.6668        | 0.5955        | 0.4804        |
| RS3       | 0.2820        | 0.4735        | 0.5821        | <b>0.8344</b> | 0.6611        | 0.6212        | 0.5439        |
| RS4       | 0.3668        | 0.5652        | 0.5583        | <b>0.7442</b> | 0.6839        | 0.5370        | 0.5150        |
| IN1       | 0.4261        | 0.5180        | 0.6019        | 0.6114        | <b>0.7232</b> | 0.5926        | 0.4810        |
| IN2       | 0.2568        | 0.4545        | 0.5004        | 0.6709        | <b>0.8500</b> | 0.7457        | 0.5653        |
| IN3       | 0.2531        | 0.3787        | 0.5063        | 0.6133        | <b>0.8071</b> | 0.7079        | 0.5707        |
| CO1       | 0.2195        | 0.4674        | 0.5370        | 0.5996        | 0.7315        | <b>0.8778</b> | 0.7174        |
| CO2       | 0.2786        | 0.4938        | 0.5611        | 0.6380        | 0.7567        | <b>0.8676</b> | 0.6189        |
| CO3       | 0.2923        | 0.4225        | 0.5378        | 0.5875        | 0.7493        | <b>0.8520</b> | 0.6444        |
| PEW1      | 0.1749        | 0.3292        | 0.4183        | 0.5287        | 0.5584        | 0.6658        | <b>0.8511</b> |
| PEW2      | 0.2111        | 0.3405        | 0.4377        | 0.4866        | 0.5720        | 0.6013        | <b>0.8111</b> |



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## References

- Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology*, 22(1), 3–21. <https://doi.org/10.1080/10630732.2014.942092>
- Angelidou, M. (2017). The role of smart city characteristics in the plans of fifteen cities. *Journal of Urban Technology*, 24(4), 3–28. <https://doi.org/10.1080/10630732.2017.1348880>
- Anthony Jnr, B. (2021). Managing digital transformation of smart cities through enterprise architecture – a review and research agenda. *Enterprise Information Systems*, 15(3), 299–331. <https://doi.org/10.1080/17517575.2020.1812006>
- Arifin, B., Wicaksono, E., Tenrini, R. H., Wardhana, I. W., Setiawan, H., Damayanty, S. A., Solikin, A., Suhendra, M., Saputra, A. H., Ariutama, G. A., Djunedji, P., Rahman, A. B., & Handoko, R. (2020). Village fund, village-owned-enterprises, and employment: Evidence from Indonesia. *Journal of Rural Studies*, 79, 382–394. <https://doi.org/10.1016/j.jrurstud.2020.08.052>
- Arthur Jr., W., Bennett Jr., W., Edens, P. S., & Bell, S. T. (2003). Effectiveness of training in organizations: A meta-analysis of design and evaluation features. *Journal of Applied Psychology*, 88(2), 234–245. <https://doi.org/10.1037/0021-9010.88.2.234>
- Awa, H. O., Ojiabo, O. U., & Emecheta, B. C. (2015). Integrating tam, tpb and toe frameworks and expanding their characteristic constructs for e-commerce adoption by smes. *Journal of Science & Technology Policy Management*, 6(1). <https://doi.org/10.1108/JSTPM-04-2014-0012>
- Awa, H. O., Ukoha, O., & Emecheta, B. C. (2016). Using toe theoretical framework to study the adoption of erp solution. *Cogent Business & Management*, 3(1), 1196571. <https://doi.org/10.1080/23311975.2016.1196571>
- Baker, J. (2012). The technology–organization–environment framework. *Information Systems Theory. Integrated Series in Information Systems*, 28, 231–245. [https://doi.org/10.1007/978-1-4419-6108-2\\_12](https://doi.org/10.1007/978-1-4419-6108-2_12)
- Benítez, J., Henseler, J., Castillo, A., & Schuberth, F. (2020). How to perform and report an impactful analysis using partial least squares: Guidelines for confirmatory and explanatory research. *Information & Management*, 57(2). <https://doi.org/10.1016/j.im.2019.05.003>
- Bhattacharya, M., & Wamba, S. F. (2018). A conceptual framework of rfid adoption in retail using toe framework. In *Technology adoption and social issues: Concepts, methodologies, tools, and applications* (pp. 69–102). IGI Global. <https://doi.org/10.4018/978-1-5225-5201-7.ch005>
- Borghys, K., Van Der Graaf, S., Walravens, N., & Van Compernelle, M. (2020). Multi-stakeholder innovation in smart city discourse: Quadruple helix thinking in the age of “platforms”. *Frontiers in Sustainable Cities*, 2, 5. <https://doi.org/10.3389/frsc.2020.00005>
- BPS. (2018). *Indonesian statistical database*. <https://www.bps.go.id/>. Accessed 25 June 2019
- Bremser, C., Piller, G., & Rothlauf, F. (2019). How smart cities explore new technologies. *International Conference on Business Informatics Research*. [https://doi.org/10.1007/978-3-030-31143-8\\_1](https://doi.org/10.1007/978-3-030-31143-8_1)
- Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, 18(2), 65–82. <https://doi.org/10.1080/10630732.2011.601117>
- Carayannis, E. G., Grigoroudis, E., Campbell, D. F., Meissner, D., & Stamati, D. (2018). The ecosystem as helix: An exploratory theory-building study of regional co-competitive entrepreneurial ecosystems as quadruple/quintuple helix innovation models. *R & D Management*, 48(1), 148–162. <https://doi.org/10.1111/radm.12300>
- Castañeda, A., Doan, D., Newhouse, D., Nguyen, M. C., Uematsu, H., & Azevedo, J. P. (2018). A new profile of the global poor. *World Development*, 101, 250–267. <https://doi.org/10.1016/j.worlddev.2017.08.002>
- Castells-Quintana, D., & Wenban-Smith, H. (2019). Population dynamics, urbanisation without growth, and the rise of megacities. *The Journal of Development Studies*, 1–20. <https://doi.org/10.1080/00220388.2019.1702160>
- Chakrabarty, A., & Gupta, S. (2014). Traffic congestion in the metropolitan city of kolkata. *Journal of Infrastructure Development*, 6(1), 43–59. <https://doi.org/10.1177/0974930614543046>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Erlbaum Press. <https://doi.org/10.4324/9780203771587>
- Correa, T., & Pavez, I. (2016). Digital inclusion in rural areas: A qualitative exploration of challenges faced by people from isolated communities. *Journal of Computer-Mediated Communication*, 21(3), 247–263. <https://doi.org/10.1111/jcc4.12154>
- Cunha, C. R., Gomes, J. P., Fernandes, J., & Morais, E. P. (2020). Building smart rural regions: Challenges and opportunities. In *Trends and innovations in information systems and technologies* (pp. 579–589). [https://doi.org/10.1007/978-3-030-45697-9\\_56](https://doi.org/10.1007/978-3-030-45697-9_56)
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319. <https://doi.org/10.2307/249008>
- Davis, F. D. (1993). User acceptance of information technology: System characteristics, user perceptions and behavioral impacts. *International journal of man-machine studies*, 38(3), 475–487. <https://doi.org/10.1006/imms.1993.1022>
- Dewi, M. A. A., Hidayanto, A. N., Betty, P., Kosandi, M., & Budi, N. F. A. (2018). Smart city readiness model using technology-organization-environment (toe) framework and its effect on adoption decision. *The Pacific Asia Conference on Information Systems (PACIS)*. <https://aisel.aisnet.org/pacis2018/268/>. Accessed 26 June 2019
- Dijkstra, T. K., & Henseler, J. (2015). Consistent and asymptotically normal pls estimators for linear structural equations. *Computational Statistics & Data Analysis*, 81, 10–23. <https://doi.org/10.1016/j.csda.2014.07.008>
- Dowell, M.-M. S. (2019). Toward a working definition of digital literacy. In *Advanced methodologies and technologies in library science, information management, and scholarly inquiry* (pp. 118–129). IGI Global. <https://doi.org/10.4018/978-1-5225-7659-4.ch010>

- Eniola, A. A., & Entebang, H. (2015). Sme firm performance-financial innovation and challenges. *Procedia - Social and Behavioral Sciences*, 195, 334–342. <https://doi.org/10.1016/j.sbspro.2015.06.361>
- Eremia, M., Toma, L., & Sanduleac, M. (2017). The smart city concept in the 21st century. *Procedia Engineering*, 181, 12–19. <https://doi.org/10.1016/j.proeng.2017.02.357>
- Fennell, S., Kaur, P., Jhunjunwala, A., Narayanan, D., Loyola, C., Bedi, J., & Singh, Y. (2018). Examining linkages between smart villages and smart cities: Learning from rural youth accessing the internet in india. *Telecommunications Policy*, 42(10), 810–823. <https://doi.org/10.1016/j.telpol.2018.06.002>
- Finch, W. H., & French, B. F. (2015). Modeling of nonrecursive structural equation models with categorical indicators. *Structural Equation Modeling: A Multidisciplinary Journal*, 22(3), 416–428. <https://doi.org/10.1080/10705511.2014.937380>
- Franco, S., Mandla, V. R., & Rao, R. M. K. (2017). Urbanization, energy consumption and emissions in the indian context a review. *Renewable and Sustainable Energy Reviews*, 71, 898–907. <https://doi.org/10.1016/j.rser.2016.12.117>
- Freeman, J., Park, S., Middleton, C., & Allen, M. (2016). The importance of broadband for socio-economic development: A perspective from rural Australia. *Australasian Journal of Information Systems*, 20. <https://doi.org/10.3127/ajis.v20i0.1192>
- Gulati, A. G. (2007). Public-private partnership for rural ict services. *Management in Government*. <https://ssrn.com/abstract=1415563>. Accessed 7 Sept 2020
- Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (pls-sem)* (Second ed.). Sage publications. <https://us.sagepub.com/en-us/nam/a-primer-on-partial-least-squares-structural-equation-modeling-pls-sem/book244583>. Accessed 29 Apr 2020
- Henseler, J. (2020). *Composite-based structural equation modeling: Analyzing latent and emergent variables*. Guilford Publications. <https://www.guilford.com/books/Composite-Based-Structural-Equation-Modeling/Jorg-Henseler/9781462545605>. Accessed 20 Oct 2021
- Henseler, J., & Dijkstra, T. K. (2015). *Adanco 2.1.1*. In Composite Modelling. <https://www.composite-modeling.com/>
- Henseler, J., Hubona, G., & Ray, P. A. (2016). Using pls path modeling in new technology research: Updated guidelines. *Industrial Management & Data Systems*, 116(1), 2–20. <https://doi.org/10.1108/imds-09-2015-0382>
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135. <https://doi.org/10.1007/s11747-014-0403-8>
- Henseler, J., & Schubert, F. (2020). Using confirmatory composite analysis to assess emergent variables in business research. *Journal of Business Research*, 120, 147–156. <https://doi.org/10.1016/j.jbusres.2020.07.026>
- Hsu, C.-W., & Yeh, C.-C. (2016). Understanding the factors affecting the adoption of the internet of things. *Technology Analysis & Strategic Management*, 29(9), 1089–1102. <https://doi.org/10.1080/09537325.2016.1269160>
- Huang, J. L., Curran, P. G., Keeney, J., Poposki, E. M., & DeShon, R. P. (2011). Detecting and deterring insufficient effort responding to surveys. *Journal of Business and Psychology*, 27(1), 99–114. <https://doi.org/10.1007/s10869-011-9231-8>
- Hunt, D. P. (2003). The concept of knowledge and how to measure it. *Journal of Intellectual Capital*, 4(1), 100–113. <https://doi.org/10.1108/14691930310455414>
- Iacovou, C. L., Benbasat, I., & Dexter, A. S. (1995). Electronic data interchange and small organizations: Adoption and impact of technology. *MIS Quarterly*, 19(4), 465–485. <https://doi.org/10.2307/249629>
- Imai, K. S., Gaiha, R., & Garbero, A. (2017). Poverty reduction during the rural–urban transformation: Rural development is still more important than urbanisation. *Journal of Policy Modeling*, 39(6), 963–982. <https://doi.org/10.1016/j.jpolmod.2017.10.002>
- Imai, K. S., & Malaeb, B. (2018). *Asia's rural-urban disparity in the context of growing inequality* (IFAD, Ed.). IFAD. [https://www.ifad.org/documents/38714170/40704142/27\\_research.pdf/86ff7619-8814-48d0-a232-fc694fcc55ce?eloutlink=imf2ifad](https://www.ifad.org/documents/38714170/40704142/27_research.pdf/86ff7619-8814-48d0-a232-fc694fcc55ce?eloutlink=imf2ifad). Accessed 19 Jan 2020
- Javidroozi, V., Shah, H., Amini, A., & Cole, A. (2014). Smart city as an integrated enterprise: A business process centric framework addressing challenges in systems integration. *3rd International Conference on Smart Systems, Devices and Technologies, Paris*. [http://www.open-access.bcu.ac.uk/6254/1/Vahid\\_Javidroozi\\_contribution\\_40017\\_SMART\\_2014.pdf](http://www.open-access.bcu.ac.uk/6254/1/Vahid_Javidroozi_contribution_40017_SMART_2014.pdf). Accessed 26 June 2019
- Jedwab, R., & Vollrath, D. (2015). Urbanization without growth in historical perspective. *Explorations in Economic History*, 58, 1–21. <https://doi.org/10.1016/j.eeh.2015.09.002>
- Jung, M. C., Park, S., & Lee, J. Y. (2014). Information network villages: A community-focused digital divide reduction policy in rural korea. *Journal of Telecommunications the Digital Economy*, 2(1), 21. <https://doi.org/10.18080/jtde.v2n1.322>
- Kar, A. K., Ilavarasan, V., Gupta, M. P., Janssen, M., & Kothari, R. (2019). Moving beyond smart cities: Digital nations for social innovation & sustainability. *Information Systems Frontiers*, 21(3), 495–501. <https://doi.org/10.1007/s10796-019-09930-0>
- Karlinsky-Shichor, Y., & Zviran, M. (2015). Factors influencing perceived benefits and user satisfaction in knowledge management systems. *Information Systems Management*, 33(1), 55–73. <https://doi.org/10.1080/10580530.2016.1117873>
- Kompas. (2019). *Diskominfo jabar berikan pelatihan "aplikasi sapa warga" kepada masyarakat*. Retrieved 19 October 2021 from <https://regional.kompas.com/read/2019/08/08/18574061/diskominfo-jabar-berikan-pelatihan-aplikasi-sapa-warga-kepada-masyarakat?page=all>
- Lulu, F. (2019). *Taobao villages - the emergence of a new pattern of rural ecommerce in china and its social implications*. <https://indonesia.fes.de/e/en-taobao-villages-the-emergence-of-a-new-pattern-of-rural-ecommerce-in-china-and-its-social-implications>. Accessed 11 May 2020
- Lusch, R. F., & Nambisan, S. (2015). Service innovation: A service-dominant logic perspective. *MIS Quarterly*, 39(1). <https://www.jstor.org/stable/26628345>. Accessed 22 Nov 2019
- Malhotra, N. (2008). Completion time and response order effects in web surveys. *Public Opinion Quarterly*, 72(5), 914–934. <https://doi.org/10.1093/poq/nfn050>
- Mamkaitis, A., Bezbradica, M., & Helfert, M. (2016, 12-15 Sept. 2016). Urban enterprise: A review of smart city frameworks from an enterprise architecture perspective. *2016 IEEE International Smart Cities Conference (ISC2), Trento, Italy*. <https://doi.org/10.1109/ISC2.2016.7580810>
- Manitui, D. N., & Pedrini, G. (2016). Urban smartness and sustainability in europe. An ex ante assessment of environmental, social and cultural domains. *European Planning Studies*, 24(10), 1766–1787. <https://doi.org/10.1080/09654313.2016.1193127>
- Mason, R., & Rennie, F. (2004). Broadband: A solution for rural e-learning? *The international review of Research in Open Distributed Learning*, 5(1). <https://doi.org/10.19173/irrodl.v5i1.173>
- Mishbah, M., Purwandari, B., & Sensuse, D. I. (2018). Systematic review and meta-analysis of proposed smart village conceptual model: Objectives, strategies, dimensions, and foundations. *Proceedings of the International Conference on Information Technology Systems and Innovation (ICITSI 2018)*. <https://doi.org/10.1109/ICITSI.2018.8696029>

- Mooney, J. G., Gurbaxani, V., & Kraemer, K. L. (1996). A process oriented framework for assessing the business value of information technology. *The DATA BASE for Advances in Information System*, 27(2), 68–81. <https://doi.org/10.1145/243350.243363>
- Mukti, I. Y., Jacob, M. E., Aldea, A., Govindaraju, R., & van Hillegersberg, J. (2021). Defining rural smartness and its impact: A systematic literature review. *Journal of the Knowledge Economy*. <https://doi.org/10.1007/s13132-021-00736-7>
- Muñoz, P., & Kimmitt, J. (2019). Rural entrepreneurship in place: An integrated framework. *Entrepreneurship & Regional Development*, 31(9–10), 842–873. <https://doi.org/10.1080/08985626.2019.1609593>
- Naldi, L., Nilsson, P., Westlund, H., & Wixe, S. (2015). What is smart rural development? *Journal of Rural Studies*, 40, 90–101. <https://doi.org/10.1016/j.jrurstud.2015.06.006>
- Nedungadi, P. P., Menon, R., Gutjahr, G., Erickson, L., & Raman, R. (2018). Towards an inclusive digital literacy framework for digital india. *Education and Training*, 60(6), 516–528. <https://doi.org/10.1108/ET-03-2018-0061>
- Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., & Scorrano, F. (2014). Current trends in smart city initiatives: Some stylised facts. *Cities*, 38, 25–36. <https://doi.org/10.1016/j.cities.2013.12.010>
- Nurhuda, N., Darwiyanto, E., & Widowati, S. (2021). Implementation of analytical hierarchy process (ahp) for determining priority of software assessment in west java provincial government based on iso/iec 25010 (case study: Sapawarga application). *Indonesian Journal on Computing (Indo-JC)*, 6(1), 23–40. <https://doi.org/10.34818/indojc.2021.6.1.525>
- Oluwatayo, I. B. (2014). Information and communication technologies as drivers of growth: Experience from selected small-scale businesses in rural southwest nigeria. *Spanish Journal of Rural Development*, 5(2), 65–76.
- Philip, L., & Williams, F. (2019). Remote rural home based businesses and digital inequalities: Understanding needs and expectations in a digitally underserved community [Article]. *Journal of Rural Studies*, 68, 306–318. <https://doi.org/10.1016/j.jrurstud.2018.09.011>
- Porter, M. E. (2003). Building the microeconomic foundations of prosperity: Findings from the business competitiveness index. In *The global competitiveness report* (Vol. 2004, pp. 29–56). <https://cites.eerx.ist.psu.edu/viewdoc/download?doi=10.1.1.372.2547&rep=rep1&type=pdf>
- Porter, M. E., Ketels, C., & Delgado, M. (2007). The microeconomic foundations of prosperity: Findings from the business competitiveness index. In *The global competitiveness report* (pp. 51–81). <https://cites.eerx.ist.psu.edu/viewdoc/download?doi=10.1.1.372.2547&rep=rep1&type=pdf>
- Prieger, J. E. (2013). The broadband digital divide and the economic benefits of mobile broadband for rural areas. *Telecommunications Policy*, 37(6–7), 483–502. <https://doi.org/10.1016/j.telpol.2012.11.003>
- Ramdani, B., Kawalek, P., & Lorenzo, O. (2009). Predicting smes' adoption of enterprise systems. *Journal of Enterprise Information Management*, 22(1/2), 10–24. <https://doi.org/10.1108/17410390910922796>
- Ray, P. P. (2018). Digital india: Perspective, challenges and future direction. *International Conference on Power, Signals, Control and Computation (EPSCICON)*, 6–10. <https://doi.org/10.1109/EPSCICON.2018.8379594>
- Reynolds, N., Diamantopoulos, A., & Schlegelmilch, B. (1993). Pre-testing in questionnaire design: A review of the literature and suggestions for further research. *Market Research Society. Journal.*, 35(2), 1–11. <https://doi.org/10.1177/147078539303500202>
- Rigdon, E. E. (2012). Rethinking partial least squares path modeling: In praise of simple methods. *Long Range Planning*, 45(5), 341–358. <https://doi.org/10.1016/j.lrp.2012.09.010>
- Rodríguez-Pose, A., & Hardy, D. (2015). Addressing poverty and inequality in the rural economy from a global perspective. *Applied Geography*, 61, 11–23. <https://doi.org/10.1016/j.apgeog.2015.02.005>
- Sinha, N., & Verma, P. (2020). Adoption of ict enabled agricultural extension services through perceived economic wellbeing: Ict and pewb. *International Journal of Information Communication Technology Education*, 16(3), 30–41. <https://doi.org/10.4018/IJICTE.2020070103>
- Statista. (2019). *Share of the urban population in west java, indonesia in 2010 with estimates up to 2030*. Retrieved June 22, 2019, from <https://www.statista.com/statistics/915485/indonesia-urbanizati-on-rate-prediction-of-west-java/>
- Stern, M. J., Adams, A. E., & Boase, J. (2011). Rural community participation, social networks, and broadband use: Examples from localized and national survey data. *Agricultural Resource Economics Review*, 40(2), 158–171. <https://doi.org/10.1017/S106828050000798X>
- Talbot, S. (2016). Creating a smart rural economy through smart specialisation: The microsphere model. *Local Economy*, 31(8), 892–919. <https://doi.org/10.1177/0269094216678601>
- Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation*. Lexington books.
- Trang, S., Zander, S., & Kolbe, L. (2014). E-business adoption at the firm level: Comparing the predictive power of competing adoption models. *35th International Conference on Information Systems, Auckland*. <https://aisel.aisnet.org/icis2014/proceedings/EBusiness/34/>. Accessed 19 Oct 2021
- United Nations. (2019). *Orld urbanization prospects: The 2018 revision (st/esa/ser. A/420)*. United Nations New York. <https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf>. Accessed 21 July 2020
- Van Bruggen, G. H., Lilien, G. L., & Kacker, M. (2002). Informants in organizational marketing research: Why use multiple informants and how to aggregate responses. *Journal of marketing research*, 39(4), 469–478. <https://doi.org/10.1509/jmkr.39.4.469.19117>
- Van Waart, P., Mulder, I., & de Bont, C. (2016). A participatory approach for envisioning a smart city. *Social Science Computer Review*, 34(6), 708–723. <https://doi.org/10.1177/0894439315611099>
- Weber, M., & Podnar Zarko, I. (2019). A regulatory view on smart city services. *Sensors (Basel)*, 19(2). <https://doi.org/10.3390/s19020415>
- West Java Digital Service. (2020). *Desa digital: Menuju desa jabar juara dengan inovasi digital*. <https://www.coursehero.com/file/86139488/Pitch-Deck-Desa-Digital-3pdf/>. Accessed 13 July 2021
- West Java Provincial Government. (2018). *Rancangan akhir: Rencana pembangunan jangka menengah daerah, provinsi jawa barat, 2018 - 2023*. <https://jabarprov.go.id/index.php/pages/id/795>. Accessed 13 Oct 2020
- Wiggins, S., & Proctor, S. (2001). How special are rural areas? The economic implications of location for rural development. *Development policy review*, 19(4), 427–436. <https://doi.org/10.1111/1467-7679.00142>
- Wong, C.-S., & Law, K. S. (1999). Testing reciprocal relations by non-recursive structural equation models using cross-sectional data. *Organizational Research Methods*, 2(1), 69–87. <https://doi.org/10.1177/109442819921005>
- Wu, J.-H., & Wang, Y.-M. (2006). Measuring kms success: A respecification of the delone and mclean's model. *Information & Management*, 43(6), 728–739. <https://doi.org/10.1016/j.im.2006.05.002>
- Yadav, V., & Goyal, P. (2015). User innovation and entrepreneurship: Case studies from rural india. *Journal of*

- Innovation and Entrepreneurship*, 4(1). <https://doi.org/10.1186/s13731-015-0018-4>
- Zavratnik, V., Kos, A., & Duh, E. S. (2018). Smart villages: Comprehensive review of initiatives and practices. *Sustainability*, 10(7). <https://doi.org/10.3390/su10072559>
- Zhang, X. Q. (2016). The trends, promises and challenges of urbanisation in the world. *Habitat International*, 54, 241–252. <https://doi.org/10.1016/j.habitatint.2015.11.018>
- Zhu, K., Kraemer, K., & Xu, S. (2003). Electronic business adoption by european firms: A cross-country assessment of the facilitators and inhibitors. *European Journal of Information Systems*, 12(4), 251–268. <https://doi.org/10.1057/palgrave.ejis.3000475>
- Zhu, K., Kraemer, K. L., & Dedrick, J. (2004). Information technology payoff in e-business environments: An international perspective on value creation of e-business in the financial services industry. *Journal of Management Information Systems*, 21(1), 17–54. <https://doi.org/10.1080/07421222.2004.11045797>
- Zijlstra, W. P., Van Der Ark, L. A., & Sijtsma, K. (2007). Outlier detection in test and questionnaire data. *Multivariate Behavioral Research*, 42(3), 531–555. <https://doi.org/10.1080/00273170701384340>

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