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Investigating the effect of technology-based village development towards smart economy: An application of variance-based structural equation modeling

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ABSTRACT

Indonesia is a country dominated by rural areas. Addressing rural poverty is a priority of the Indonesian government work program and an effort to achieve the Sustainable Development Goals (SDGs). One of the actual programs dealing with poverty is a digital village which is implemented in a smart village ecosystem. Since 2018, Indonesia has initiated various pilots of smart village projects. The success of a smart village is closely related to citizen science. The purpose of this research was to build a citizen science prospect model for a smart economy in a smart village ecosystem using Structural Equation Model – Partial Least Square (SEM-PLS) approach. This study proposes a novelty of measuring villagers' readiness to build a smart economy in a smart village ecosystem based on the strength of community support. We propose an assessment of the prospect of developing a smart economy in a smart village through the citizen science level that integrates exogenous variables of community support for the environment, citizen character, empowerment, entrepreneurship, innovation, and the smart economy. The citizen science model towards a smart economy showed a high level of predictive relevance, which was 87,2%. The citizen science model towards a smart economy can also explain empirical data with a GoF value of 0,488. This research showed that the indicators of Information Communication Technology (ICT), ICT literacy, access to education and research and development (R & D) facilitation, motivation for smart villages, and innovation in villages were driven by family participation. The collaboration with the private sector, local government, and communities drive the village's smart economy. The SEM PLS approach has not been widely used in research on the smart village component, especially the relationship between citizen science and the smart economy. Therefore, this research can fill the gap in smart village research, which is still dominated by a descriptive approach.

1. Introduction

The Indonesian Ministry of Villages for the Development of Disadvantaged Regions and Transmigration of Indonesia strives to accelerate village development systematically and consistently. One of the strategies carried out by the Ministry is to publish the Sustainable Development Goals (SDGs) of the village in 2020. These goals are expected to accelerate the achievement of Indonesia's SDGs by 2030. Indonesia has a more dominant rural area (91%), so the acceleration of village development is expected to be a stimulus for achieving Indonesia's SDGs. The acceleration of development in the village has shown significant results, including an increase in the quantity and quality of infrastructure, physical and non-physical facilities such as health, human resources (HR), and social welfare. Indonesia already has elementary school infrastructure spread over 86.19%

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of villages/districts. Junior high school infrastructure is spread over 96.06% of sub-districts, and high school is spread over 90.40% of sub-districts in Indonesia. Indonesia already has health infrastructure spread over 95% of regencies/cities. Village Owned Enterprises has strengthened the economic infrastructure of villages in Indonesia five years ago, whose number continues to increase. In 2020, villages that already have Village Owned Enterprises reached 71.07% of villages, and reservoirs spread over 16.31% of villages (BPS, 2020a).

The acceleration of village development is conducted by accelerating access to information in villages and remote areas of the archipelago. The Indonesian Ministry of Communication and Information has set a target for 12,548 villages to have 4G internet access by 2023, supported by the construction of 9,113 base transceiver stations (BTS) in villages 3,435 BTS in disadvantaged, frontier, and outermost (3T) areas. The expansion of internet access to villages and even remote areas of the archipelago is the main program of the Communications and Information Technology Accessibility Agency of the Indonesian Ministry of Communication and Information to support the achievement of SDGs 2030.

The expansion of internet access is the main force in accelerating village development which is carried out through the digital village and smart village approaches. Smart village development is the ninth SDGs related to achieving village infrastructure and innovation needs (Iskandar, 2020). In 2017, Indonesia pioneered the development of a digital village by constructing an android-based command center in Lamahu Village, Gorontalo. The success of the digital village was followed by the initiation of the digital village program in the concept of a smart village in Yogyakarta, which built four smart villages in 2017-2018. The four smart villages in Yogyakarta carry out four variations of smart villages, namely smart economy (Kulonprogo Regency), smart governance (Dlingo Village), smart living (Patehan Village), and smart tourism (Pulepayung Village) (Somwanshi et al., 2016; Santoso et al., 2019). As a result, the enthusiasm of local governments in implementing smart villages is increasing. It is supported by the increase in Indonesia's ICT development index in 2020, which reached the level of 5.59 compared to 2019 and reached the level of 5.32 (BPS, 2020b). Increasing the ICT development index in Indonesia is expected to encourage the success of the smart village program in Indonesia. The development of digital village pilots and smart villages in Indonesia is increasing along with smart village research in Indonesia. Smart village research in Indonesia began with proposed models and basic concepts (Mishbah et al., 2018; Ella & Andari, 2018; Andari & Ella, 2018), socio-economic and political analysis (Santoso et al., 2019; Sutriadi, 2018), implementation of village geographic information systems (Afnarius et al., 2020; Adi & Suhartono, 2017; Marlintha et al., 2017), even proposed intelligent village based on artificial intelligence and big data (Tosida et al., 2020a; Tosida et al., 2020b). However, there is still little research that discusses the readiness of villagers in carrying out sustainable smart village programs.

The readiness of villagers is very important in developing a smart village ecosystem because villagers in the concept of a smart village need to be positioned as subjects of development, not only as objects of development. Smart villages that can be sustainable are generally built and initiated by villagers who innovate and are supported by synergistic collaboration with the government, private sector, academics, and even with the media as partners for program socialization. Multi actors who collaborate in creating, connecting, and maintaining the sustainability of science development are citizen science (Bonney et al., 2016). The readiness of villagers in developing smart villages is closely related to citizen science. Citizen science is the main foundation in measuring the penetration of knowledge and citizen participation to maintain the sustainability of regional development (Alan, 2002). One of the challenges of smart village development in Indonesia is the readiness of citizens to accept, learn, participate and carry out ICT-based innovations and maintain the rhythm of program dynamics and sustainability. This study proposes an analysis of the readiness of villagers in the development of a smart economy in a smart village environment using a quantitative approach to the Structural Equation Model – Partial Least Square (SEM-PLS).

Currently, there is a lack of quantitative research related to the development of smart villages. In contrast to quantitative research on rural development, which has made many significant contributions, including those related to strengthening entrepreneurship (Purusottama et al., 2018; Muda & Erlina, 2020; Riana, 2015), microfinance (Hussaini & Chibuzo, 2018; Galluzzo, 2020a), women empowerment (Kumari et al., 2020), renewable energy sustainability (Rachmawatie et al., 2019; Rachmawatie et al., 2021a, 2021b), agri-food innovation (Martínez-Filgueira et al., 2022), village revitalization for the industrial revolution 4.0 (Lin, 2021), village sustainability and resilience (Galluzzo, 2018, 2019, 2020b; Hayat et al., 2020). This study uses technology-based village development variables (Rachmawatie et al., 2021a) related to community support, villager character, environment, and empowerment. The variable in (Rachmawatie et al., 2021a) is integrated with the smart economy variable in a smart village (Santoso et al., 2019) and the smart economy variable - smart village based on the industrial revolution 4.0 (Maja et al., 2020), which is related to innovation, entrepreneurship or start-up. This research was conducted in Kabandungan Sub-district, Sukabumi District, West Java Province.

In December 2019, the community of Tugubandung Village, Kabandungan Sub-district called the Kabandungan Youth Community (Kompak), together with IPB University academics and village government officials, agreed to initiate a smart economy in a smart village. This initiative was strengthened by Kompak, which has provided and managed village internet networks independently through public cooperation. The cooperation also plays a role in helping farmers and micro and small business actors (SMEs) for capital and selling commodities and products in their environment. In May 2020, Kompak developed its cooperative into a manufacturer of handmade uninterrupted power supply (UPS). It is made from waste cell phone batteries and further strengthened by Kompak in expanding internet access to five other villages in Kabandungan Sub-District.

Kompak, together with other communities such as the farming community and the arts community and academic components, and the village government strive to socialize, educate, and maintain the rhythm of the empowerment program towards a smart economy-smart village to be sustainable. As a result, the benefits felt by residents, especially in improving the residents' economy, are increasingly widespread.

The main objective of this study was to identify and analyze the prospect of citizen science as a driving factor for the development of a smart economy – smart village from the perception of villagers using the SEM-PLS quantitative approach. The contribution of this research is (1) providing input for local governments, especially the Sukabumi District Government, in formulating community-based smart village development policies that innovate through ICT, (2) sharing information with other researchers who are interested in developing smart villages, especially through the optimization of ICT innovations for the economic development of villagers in Indonesia, and (3) proposing the measurement of readiness level of villagers towards the smart economy.

2. Literature Review

2.1 Citizen Science in Smart Village Ecosystem Terminology

Smart village is one of the keys to the successful implementation and sustainability of a smart village is the participation of citizens and stakeholders who work together to achieve the goal of a smart village (Santoso et al., 2019; Holmes, 2017; Ramachandra et al., 2015; Anderson et al., 2017; Anderson, 2019). Citizen science broadly refers to the active involvement of the general public in scientific research assignments. Citizen science is a growing practice in which scientists and citizens collaborate to generate new knowledge for science and society (Vohland et al., 2021). Therefore, implementing a smart village is closely related to citizen science. Citizen science is a cyclical process that connects three main components, namely creation, connection, and collaboration (https://learningisopen.org/toolkit/citizen-science/). The activities in each component can be broken down into cyclical activities that include planning investigations, observations, data analysis, and interpretation, making problem questions, and the last stage is the construction and explanation of the construction and communication process (Dickinson et al., 2012).

Citizen science, especially in ecology and the environment, is carried out through various approaches that continue to develop. Before the 1990s, it was dominated by a simple approach but led to scientific sampling and an elaboration approach. In the 1990s, citizen science developed rapidly through the integration of simple approaches, scientific sampling, and an increasingly massive elaboration approach, while in the 2000s, citizen participation began to develop, until 2014 (Roy et al., 2012). The keys to successful citizen science are clear goals, data reliability, citizen empowerment, optimal communication, contribution to science, and becoming a reference and development along with research (Beza et al., 2017). The level of citizen science related to the role of its citizens can be divided into four levels, namely: 1) Crowdsourcing, citizens act as sensors, 2) Distributed Intelligence, citizens as interpreter bases, 3) Participatory Science, citizens participate in the problem definition process and data collection, 4) Extreme / Collaborative Science, citizens play a role in the problem definition process, data collection and even data analysis. Therefore, the parties involved in a citizen science project may include professional scientists, credentialed scientists, academic scientists, residents, amateurs (hobbyists), community members, volunteers, indigenous villagers, and human sensors.

Citizen science is very closely related to public policy, and the impact of citizen science on the policy includes three main components, namely knowledge (equipped and open), citizens (contribution and care), policy (according to objectives and developed based on facts). The three components have a cyclical relationship and are carried out through problem definition, formation, adoption, implementation, and evaluation of policies. For example, the stages of implementing a citizen science project (Newman et al., 2012; Ferrara et al., 2018) are: 1) planning for stakeholder assistance; 2) evaluation of stakeholder expectations, needs and objectives; 3) defining outcomes and balancing stakeholder interests; 4) project design and developing strategies related to outcomes (potential stakeholder engagement), 5) selection of data governance models, measuring privacy levels, agreement on recognition, and authorship (stakeholder involvement in the evaluation or decision-making process), 6) drafting agreements to the public/citizens, including the outcomes to be achieved, the role of participants and stakeholders in the project, data governance, privacy, recognition and others, 7) dissemination of project plans, 8) dissemination of agreements/agreements to the public to maintain transparency, 9) evaluation of ongoing planning and establishing feedback mechanisms to adapt the participation strategy to the development of stakeholder interests during project execution, 10) communication process on how input from stakeholders affects outcomes and decisions, 11) evaluation of commitment to accountability agreements/agreements that have been made.

2.2 Implementation of Citizen Science Scheme in Smart Village

One of the keys to a successful citizen science project, including its implementation in a smart village, is capacity building (Holmes, 2017; Anderson, 2019; Anderson et al., 2017). An example of successful capacity building by LUMAMA (a local Non-Government Organization (NGO) in Mawengi, Tanzania) funds micro-hydropower. Initially, only the ordinary electricity system was used by 260 users (including 30 commercial entrepreneurs and 6 enterprises). In 2014, the electrical system increased to 1200 users, and the maximum output was 260 kW. The electricity system is combined with capacity building initiatives for villagers and carrying out developments in agriculture, business, education, land use, land-use plans, and water conservation. Pre-pay tariff structure scheme and balanced budget to increase the productivity of electricity use, including for rice milling machines. The capacity building carried out by LUMAMA takes place in a sustainable and integrated manner so that villagers can participate in maintaining infrastructure, collaborating between resources, and building trust between the community, LUMAMA, and the local government. The capacity-building model related to clean cooking is carried out in stages which include: 1) responding to the basic needs and cultural norms of citizens, 2) raising awareness, 3) gender issues, 4) financing the cookstove value chain, 5) supporting the business operation value chain, 6) quality, product standards and trials, 7) health issues and 8) biogas.

The use of ICT in rural areas is increasing in the use of smartphones for entertainment and is widely used for online transactions and more complex utilities. One of the uses is to build smart villages by optimizing citizen science (Zavratnik et al., 2018). The development of citizen science in supporting the development of smart villages is closely related to the optimization of citizen participation through an online environment to provide multidimensional services. This multidimensional service refers to the 6 pillars of the foundation (Santoso et al., 2019). The experiences of several countries that have succeeded in building the concept and implementation of smart villages can be a reference for the development of smart village concepts, models, and frameworks in Indonesia.

Smart village development in West and East Africa, North and Northeast Asia, North and Central America, the Caribbean, and Mexico carry the concept of sustainable energy services, catalysts for ICT-integrated independent village development. The integration process aims to achieve the SDGs parameters (Holmes, 2017). The main activity of this project was a holistic mentoring process through a tiered approach at certain village levels. These activities were integrated with appropriate activities and directly influenced the achievement of the SDGs through energy accessibility. Smart village activities will be successful if carried out on the initiative of villagers, accompanied, and supported by various relevant stakeholders, through coordination, collaboration, and consistency of ongoing activities towards achieving the agreed SDGs parameters (Maja et al., 2020; Holmes, 2017; Ramachandra et al., 2015; Anderson, 2019).

Political policies are urgently needed to maintain the stability of the smart village framework that has been agreed upon; therefore, access to the relevant ministries is the main key to the success of the smart village. In addition, definite legal instruments and clarity of resource support are important factors so that the smart village framework can be implemented sustainably, especially for achieving SDGs in 2030. The resources in question include holistic and comprehensive funding, not only for energy accessibility programs but also for further activities and programs (Santoso et al., 2019; Holmes, 2017; Ramachandra et al., 2015; Anderson et al., 2017).

Access to funding from the private sector and financial assistance from other parties is urgently needed, especially subsidies for the procurement of the main components of off-grid energy. The subsidy in question is very good if targeted and given a definite and clear time limit. In addition, local governments need to contribute to physical and non-physical investments to increase citizen awareness of creating an integrated environment with a technology-based energy supply. It is expected to create and even improve the quality of the micro and small business climate in a sustainable and independent village environment (Santoso et al., 2019; Holmes, 2017; Anderson, 2019).

Implementation of citizen science in smart villages connectivity issues through ICT will affect other aspects such as health, education, clean cooking (pollution reduction), agricultural productivity, and SMEs. The health issue related to the availability of environmentally friendly energy that can provide low-emission cooking equipment, compared to the culture of cooking using previous appliances, is still in the form of a research and development program. The education and empowerment of mothers to make the smart village program successful can be studied. Educational issues related to the availability of environmentally friendly energy by providing ICT tools and improving the skills and competencies of teachers are also on the agenda of future smart village research. Increasing agricultural productivity related to the availability of environmentally friendly energy and ICT through education and empowerment of farmers, thereby increasing the added value of the people's economy, is a busy research agenda. Finally, the citizen science research agenda in smart villages is the issue of community resilience through mitigation of disaster-prone areas by utilizing ICT that is the direct influence of energy accessibility (Maja et al., 2020; Holmes, 2017; Ristianti, 2016; ENRD, 2018).

One of the ICT implementations that has succeeded in the smart village program is in Chhotkei. This smart village concept also manages customer information systems, technical support, ongoing technical training, and value-added services for customers. The data on the local server is synchronized with the remote server in the cloud via a VSAT internet connection. Local consumers can get usage information, payments made/due, and register complaints through a simple mobile application and energy cards accessed from the intranet via wifi hot spots spread throughout the village. The infrastructure created by Smart NanogridTM also supports telemedicine, tele-education, tele-panchayat, smart agriculture, and smart water management, and they were created by Holmes (2017). Reflections on the design parameters for suitable technologies for adoption by villagers and SMEs are low initial costs, can be built and repaired locally and easy to use, and have short payback periods.

Community empowerment schemes are the key to the success of smart village development; even the ratio of social aspects reaches 70% compared to technical aspects (30%). The empowerment process generally takes 6-18 months per project. The village community empowerment scheme is optimal if the village head and village elders are involved intensively. All elements of the village community, including women and youth, can be the strength and key to the success of a smart village project. Still, an approach that focuses on alleviating community poverty is needed, not just the technical success of the project. The smart village project mechanism is built to become social capital for the community, and the project continuity initiative must come from its residents. The sense of belonging to the social capital that has been formed will be stronger because the initiatives and projects are run from, by, and for the villagers (Ramachandra et al., 2015; Anderson et al., 2017; Anderson, 2019).

Government initiatives are also important to build village community empowerment schemes that will grow on a bottom-up basis. For example, in Indonesia, the government recruited and deployed 80 engineers to find and build various schemes to empower rural communities and carry out gradual and continuous monitoring. Empowerment projects can also involve villagers as project employees/stakeholders according to the needs of each stage. Another way is to involve villagers in the initial investment of the project. So, the sense of ownership, commitment, and responsibility for the project's sustainability is strengthened. An example is the Aga Khan Rural Support Program (Holmes, 2017).

The successful micro-hydro schemes in Pakistan and Borneo and mini-grids in India involve local communities strengthened by strong community-based management and ownership structures. Therefore, it is very important to improve the competence and skills of villagers in business management. Many project failures also occur because there are no definite sources of funds to finance projects. Therefore, government support through binding regulations from both the village level (through village funds) and the sub-district, district, provincial, and even national levels need to work together to provide financial support for projects like this (Santoso et al., 2019; Holmes, 2017).

ICT schemes to increase citizen participation and literacy in politics (Banerjee, 2015; Callen et al., 2016). An example is a program conducted in Tanzania. Government-led initiatives to use ICTs to increase transparency, accountability, and participation include web-based references, consultations, debates, and petitions. However, effective regulation and use of e-participation require an effective bureaucracy. The required level of resources may not yet be available in some developing countries.

The quantitative approach using SEM-PLS for citizen science cases in a smart village environment is rarely made. However, the SEM-PLS approach has been widely used to analyze village development and citizen science. Research related to citizen science is done using Principal Component Analysis (PCA) to group the motivational factors into smaller sets of groups and assess the correlation between the motivational factors. To determine how different types of motivation can be explained with farmer characteristics (gender, age, education level, household head (Y/N), and country) using Generalized Linear Models (GLM) (Beza et al., 2017), Quantitative risk analysis (Alan, 2002), Quantitative Web Research for the Social (Omar, 2019) were also done to analyze citizen science. Both qualitative and quantitative methods in the study of online communities, the quantitative studies producing results that can be generalized and qualitative studies, uncover the richness of individual experiences or discrete cases. Holistic case-study research, a common approach in strategic communication scholarship, would also be appropriate. A neuro-fuzzy approach is developed to identify suitable crowdsourcing tasks. In addition, a set of measures/principles is formulated to integrate anti-cheating concerns at the HIT design stage. Evaluation of innovation was conceived by AHP (Chang et al., 2014).

On the other hand, community-based monitoring (CBM) review and its descriptions have already been done (Conrad & Hilchey, 2011). The conversion of the Community System to a data collection tool for Community Science proved successful. The system's multimedia capabilities allow the data collection to mix recording of scientific measurements with qualitative information that helps in interpreting and making sense of the quantitative measurements. This platform is database-centric and thus allows the capture and storage of data from multiple devices (currently Web and mobile) in one central location. All map-based data is captured and held in native spatial data format inside the database. To support Citizen Science activity, the system has been designed to allow new projects to be added without the requirement for additional development (programming), and an administration tool was developed to support this task (Ellul et al., 2011). Crowdsourcing-based QoS adaptor (CQA) and its key components and QoS control structures. It can be applied to mobile cloud computing environments to provide QoS management for cloud service. Its shows the presentation of the system design, together with its implementation. The context parameters associated with the concept are also discussed. We explained how CQA intelligently provides QoS control using context-awareness method results (Yao et al., 2015).

3. Materials and Methods

The citizen data analysis phase toward the smart economy model was broadly carried out in two stages: (1) describing the data to obtain an overview of the potential level of citizen science for the smart economy (2) conducting SEM-PLS modeling. First, the basis for developing a citizen science toward smart economy model was carried out through a theoretical framework, as shown in Fig. 1.

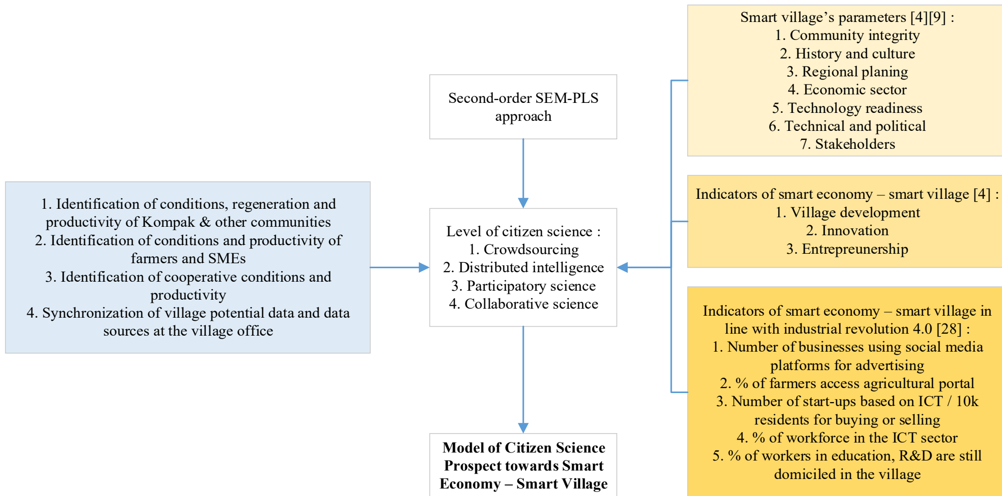

Fig. 1. The theoretical framework of the citizen science model for a smart economy

3.1 Operationalization of measures

The SEM-PLS modeling stage consisted of four stages, namely:

1. Conceptualization of the model - designing structural and reflective measurement models. The design of the structural model was based on the research hypothesis. The construction of the path diagram through the framework is shown in Figure 2. This study proposes a modification of the relationship of community support (CS), environment (Ev), citizen character (CC), and empowerment (Em) (Rachmawatie et al., 2021a), with entrepreneurship (En), innovation (In), and the development of the smart economy – smart village (SE) (Santoso et al., 2019; Maja et al., 2020).
2. The conversion of the path diagram into a system of equations for the relationship between variables is shown in Figure 3.
3. Estimating the weights, averages, and constants was carried out by estimating the weights' value to create a score for the latent variable. Latent variables as linear aggregates and indicators whose weight values are obtained from the PLS method
4. Evaluation of the model is assessed from the value of Goodness of Fit. This stage was carried out to see whether the model compiled met the sufficient and necessary requirements. The parameters of the goodness of the model were evaluated based on the level of goodness of the measurement model and the built structural model.

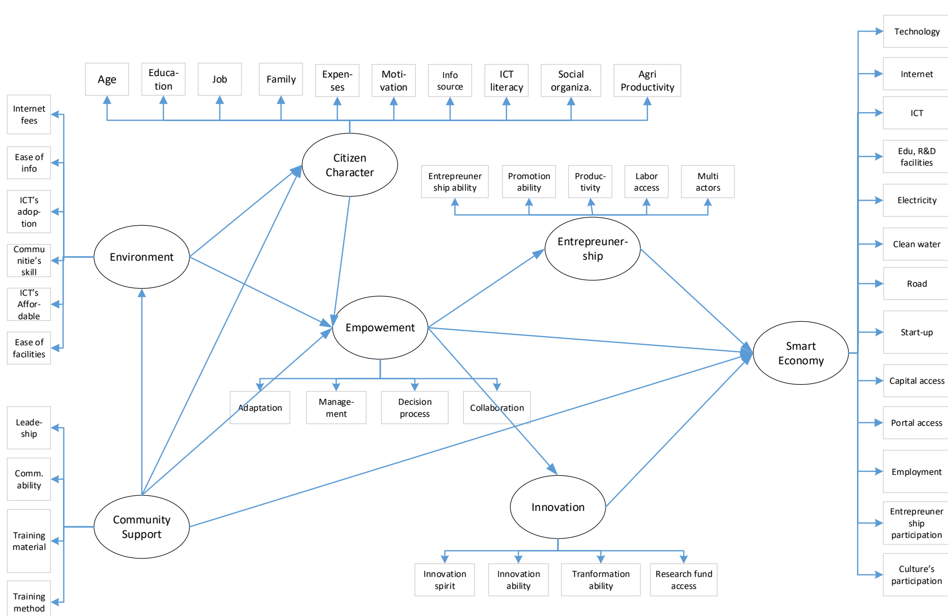

Fig. 2. Conceptual model

3.2 Instrumentation and data collection

This study used four initial variables (Rachmawatie et al., 2021a). The variable was then integrated with the smart economy - basic smart village variable (Santoso et al., 2019) and modified with the smart economy - smart village indicator based on the industrial revolution 4.0 (Maja et al., 2020). The questionnaire consisted of 35 questions related to family conditions and productivity which were converted into five-point categorizations and 83 questions related to citizen perceptions of the prospects of citizen science for the development of a smart economy – smart village, which used a five-point Likert Scale. The instrument was then distributed to 370 respondents—the number of respondents was 5% of the number of farming families and SMEs in the sub-district. The number of samples per village is determined proportionally based on the number of farmers and SMEs in each village. A number of 350 valid questionnaires were collected out of 370 distributed. Data collection techniques were carried out through observation, interviews, and distributing questionnaires. Data collection was carried out by a crowdsourcing process (Assumpcao et al., 2019; Haklay, 2013), which involved the community. This technique was provided in previous training to community leaders. As a result, community leaders became peer tutors and taught community members how to collect data. This data collection strategy was used because community members knew more about the respondent's character, condition, and situation so that the data collection process was more effective and efficient. This sample number met the minimum requirements, which must be equal to or greater than ten times the largest number of reflective indicators used to measure a construct (variable). Figure 2 shows that the largest number of reflective indicators was in the "Smart Economic Development" variable, 13 indicators, so the total minimum sample was 130 samples. A large sample size (more than 250) could improve the accuracy and consistency of the model estimation results (Hair et al., 2021; Sholihin & Ratmono, 2021). Based on Fig. 2, a research hypothesis was proposed, which included:

H1: *Community support has a positive effect on the environment.*

H2: *Community support has a positive effect on the citizen's character.*

H3: *Community support has a positive effect on empowerment.*

H4: *Community support has a positive effect on smart-economy development.*

H5: *The environment has a positive effect on the citizen's character.*

H6: *Environment has a positive effect on empowerment.*

H7: *The citizen character has a positive effect on empowerment.*

H8: *Empowerment has a positive effect on entrepreneurship.*

H9: *Empowerment has a positive effect on innovation.*

H10: *Empowerment has a positive effect on the development of smart-economy.*

H11: *Entrepreneurship has a positive effect on the development of smart-economy.*

H12: *Innovation has a positive effect on the development of smart-economy.*

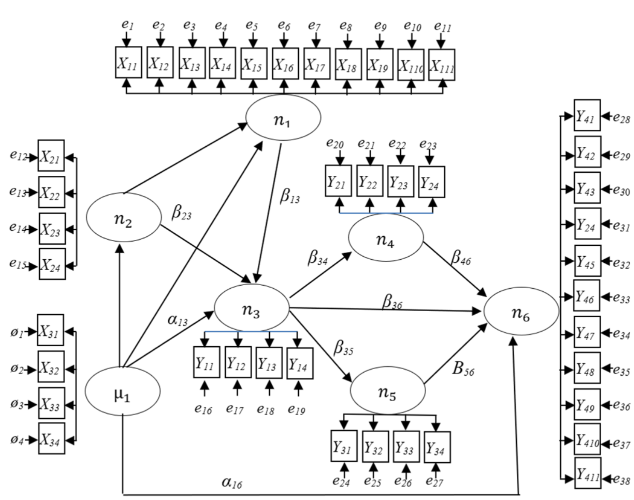

Fig. 3. Path diagram of citizen science for smart economy model

Based on the path diagram in Figure 3, the measurement model was described as follows:

$X_{11} = £x_{11}\, n_1 + e_1$	$X_{24} = £x_{24}\, n_2 + e_{15}$	$Y_{32} = £y_{32}\, n_5 + e_{25}$
$X_{12} = £x_{12}\, n_1 + e_2$	$X_{31} = £x_{31}\, \mu_1 + ø_1$	$Y_{33} = £y_{33}\, n_5 + e_{26}$
$X_{13} = £x_{13}\, n_1 + e_3$	$X_{32} = £x_{32}\, \mu_1 + ø_2$	$Y_{34} = £y_{34}\, n_5 + e_{27}$
$X_{14} = £x_{14}\, n_1 + e_4$	$X_{33} = £x_{33}\, \mu_1 + ø_3$	$Y_{41} = £y_{41}\, n4_6 + e_{28}$
$X_{15} = £x_{15}\, n_1 + e_5$	$X_{34} = £x_{34}\, \mu_1 + ø_4$	$Y_{42} = £y_{42}\, n_6 + e_{29}$
$X_{16} = £x_{16}\, n_1 + e_6$	$Y_{11} = £y_{11}\, n_3 + e_{16}$	$Y_{43} = £y_{43}\, n_6 + e_{30}$
$X_{17} = £x_{17}\, n_1 + e_7$	$Y_{12} = £y_{12}\, n_3 + e_{17}$	$Y_{44} = £y_{44}\, n_6 + e_{31}$
$X_{18} = £x_{18}\, n_1 + e_8$	$Y_{13} = £y_{13}\, n_3 + e_{18}$	$Y_{45} = £y_{45}\, n_6 + e_{32}$
$X_{19} = £x_{19}\, n_1 + e_9$	$Y_{14} = £y_{14}\, n_3 + e_{19}$	$Y_{46} = £y_{46}\, n_6 + e_{33}$
$X_{110} = £x_{110}\, n_1 + e_{10}$	$Y_{21} = £y_{21}\, n_4 + e_{20}$	$Y_{47} = £y_{47}\, n_6 + e_{34}$
$X_{111} = £x_{111}\, n_1 + e_{11}$	$Y_{22} = £y_{22}\, n_4 + e_{21}$	$Y_{48} = £y_{48}\, n_6 + e_{35}$
$X_{21} = £x_{21}\, n_2 + e_{12}$	$Y_{23} = £y_{23}\, n_4 + e_{22}$	$Y_{49} = £y_{49}\, n_6 + e_{36}$
$X_{22} = £x_{22}\, n_2 + e_{13}$	$Y_{24} = £y_{24}\, n_4 + e_{23}$	$Y_{410} = £y_{410} n_6 + e_{37}$
$X_{23} = £x_{23}\, n_2 + e_{14}$	$Y_{31} = £y_{31}\, n_5 + e_{24}$	$Y_{411} = £y_{411}\, n_6 + e_{38}$

and we will get:

$n_3 = \mu_1\alpha_{13} + n_2\beta_{23} + n_1\beta_{13} + €_3$ $\quad n_4 = n_3\beta_{34} + €_4$ $\quad n_5 = n_3\beta_{35} + €_5$ $\quad n_6 = \mu_1\alpha_{16} + n_3\beta_{36} + n_4\beta_{46} + n_5\beta_{56} + €_6$

3.3 Data screening methods

This research was equipped with a screening stage, which included identification and filling in the blank data, a bias response test, and a different test (one-way ANOVA) between two respondents (SMEs and farmers). The results showed that all blank data could be identified and replaced using mean and mode values. Furthermore, the response bias test was carried out based on a previous study that showed no difference between the beginning and the end of the response. Finally, the results of the one-way ANOVA indicated that there was no significant difference between the respondents, villagers who are SMEs and farmers.

3.4 Analytical procedures

The measurement model is processed by looking for the estimated values of weights, loadings, averages, and constants to determine the latent variable scores, which was the core process of PLS-SEM (refer to Figure 3). The final stage of citizen science modeling for the smart economy was to evaluate the model (goodness of fit) (Hair et al., 2021). Model evaluation was carried out on the measurement model and the structural model. The measurement model is an indicator representation of the latent variables, while the structural model represents between variables. The evaluation of the model was carried out in 4 stages, namely: 1) convergent validity, to measure the level of correlation between indicators and latent variables, which was expressed by the value of loading factor and average variance extracted (AVE); 2) discriminant validity, to measure the diversity of latent variables. A high discriminant validity value indicated that a latent variable is unique. Discriminant validity was measured by comparing the square root of the AVE of each latent variable with the correlation between the latent variables in the model; 3) reliability, to measure the consistency of measurement, and expressed in the value of composite reliability (pc); 4) hypothesis testing was carried out through 3 statistical hypothesis processes, namely: a) statistical hypothesis for the measurement model (H0 : £ = 0 versus H1 : £ = 0); b) statistical hypothesis for the structural model, the effect of exogenous variables on endogenous variables (H0 : = 0 versus H1: = 0); c) statistical hypothesis for the structural model of the effect of endogenous variables with other endogenous variables (H0: = 0 versus H1: = 0).

4. Results and Discussion

Citizen science for smart village development is dominated by social science, so it was analyzed using the SEM-PLS approach. In the case of village development, SEM-PLS has been used by involving various indicators (Rachmawatie et al., 2019; Galluzzo, 2019; Ellul et al., 2011). In this research, a citizen science model is proposed to develop a smart economy – a smart village. This proposed model modifies a model of technology-based village development (Rachmawatie et al., 2021a) with the smart economy variable (Santoso et al., 2019; Maja et al., 2020). The citizen science model for the smart economy is expected to measure the potential level of citizen science through the strength of community support for smart economic development, especially in Kabandungan Sub-district, Sukabumi District, West Java Province. As a result, this model can also be implemented in other areas. The validity and reliability of the citizen science model for smart economic development were evaluated using Smart-PLS version 3.3.3. By using the second-order fitting type I (Reflective-Reflective) model, we were able to understand the effect of each indicator on the dimensions, as well as the effect of each dimension on the latent variables. The second-order citizen science model for the smart economy and the value of the indicator path coefficients, dimensions, and latent variables are shown in Fig. 4.

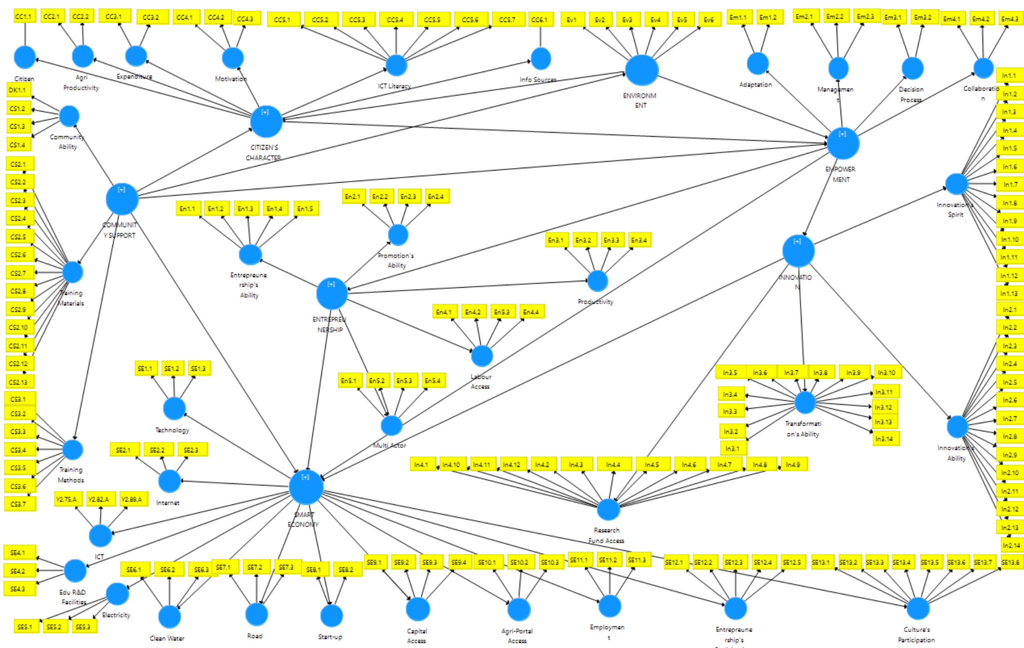

Fig. 4. Model of second-order citizen science for a smart economy

4.1 Validity and reliability of second-order citizen science for a smart economy

Confirmation of the potential citizen science model for a smart economy was carried out through validity and reliability. The validity of variables and dimensions were evaluated using convergent validity (Cronbach's alpha, Rho-A, and AVE) and discriminant validity (Fornell-Larcker criteria). Reliability was evaluated using composite reliability (CR). The results are shown in Table 1. According to Table 1, the AVE root of all latent variables was higher than the highest correlation value of the other latent variables, so the resulting discriminant validity is a previous study (Hair et al., 2021). The AVE value of all latent variables of this model was more than 0,5. Following a previous study (Chang et al., 2014), the AVE value was allowed to be more than 0,5 for a relatively new theory developed. The model of potential citizen science for a smart economy in a smart village environment is a relatively new theory. Then, the internal consistency measured using CR was good because it had a value of more than 0,7.

Table 1
Validity and reliability of second-order citizen science models for a smart economy

Variable	Discriminant Validity (Cornell-Larcker Criteria)							Convergent Validity			Reliability
	CS	Ev	CC	Em	En	In	SE	Cronbach's Alpha	Rho-A	AVE	CR
CS	0.716							0.900	0.918	0.529	0.918
Ev	0.413	0.792						0.881	0.909	0.627	0.909
CC	0.020	0.105	0.716					0.855	0.890	0.542	0.890
Em	0.452	0.585	0.066	0.728				0.900	0.904	0.529	0.918
En	0.517	0.558	0.159	0.700	0.767			0.965	0.966	0.588	0.968
In	0.570	0.609	0.071	0.618	0.705	0.712		0.965	0.965	0.506	0.967
SE	0.314	0.174	0.236	0.235	0.189	0.386	0.774	0.985	0.985	0.600	0.986

4.2 Evaluation of second-order citizen science model for a smart economy

The next evaluation stage evaluated the significance and relevance of the latent variable weights, as shown in Fig. 4. Evaluation of the significance and relevance of the model was carried out at a critical value of 2,57 and a significance level of 0,05. The level of contribution of dimensions and variables in the second-order citizen science model for the smart economy was evaluated using z-test as shown in Fig. 5. The standard regression coefficients in Fig. 5 show that innovation, entrepreneurship, and community support significantly affected the prospects of citizen science for a smart economy. Empowerment had a significant effect on entrepreneurship and innovation but did not significantly affect the prospect of citizen science for a smart economy. The environment had a significant effect on the character of citizens and empowerment, but on the other hand, the character of citizens did not significantly affect empowerment. Community support had a significant effect on the environment, but community support did not significantly affect the character of the residents. We also evaluated the significance and relevance of the model for each dimension. This evaluation was to find out dimensions that had no direct significance and relevance to developing a smart economy through strengthening citizen science. The evaluation results of the significance and relevance of the dimensions show that all dimensions had a significant contribution, except expenditures and sources of information.

We evaluated the collinearity of the second-order citizen science model latent variables for the smart economy using the Variance Inflation Factor (VIF). Collinearity (a relationship that is too strong between independent variables) was avoided, and the maximum value of VIF was 5 (Hair et al., 2021). Referring to the collinearity limit rule, the citizen science model for the smart economy was valid because all variables had a VIF value of less than 5, as is shown in Table 2. The final stage evaluation was evaluating the structural model using the R^2, F^2, Good of Fitness (GoF), and Q^2 tests. In the inner model, we measured the structural model related to the endogenous latent variables through the R2 test. Table 2 shows that the model of empowerment, entrepreneurship, and innovation structure was moderate, while the variables of citizen character, environment, and smart economy had a weak structure. Q^2 shows the diversity of endogenous variables explained by exogenous variables. Based on Table 2, GOF evaluation showed a value of 87.2%. It shows that the diversity of endogenous variables (Ev, CC, Em, En, In, and SE) was explained by exogenous CS variables around 87,2%. The rest was explained by other variables not included in the model.

Based on a previous study (Hair et al., 2021), the value of Q^2 shows the strength of predictive relevance at a high level if it has a value of more than 35%. It can be interpreted that the community support in the Kabandungan Sub-district was able to show the diversity of other variables in the citizen science prospect model for a smart economy in a smart village environment at a high level. The average value of F^2 was 0.19. This value indicated that the strength and significance of the community support variable at the structural level of smart economy development was sufficient. We propose a four-level citizen science assessment (Beza et al., 2017) referring to the average value of evaluating the strength and significance of exogenous variables at the structural level. Citizen science level with a value of more than 0,02 is crowdsourcing, more than 0.15 is distributed intelligence, more than 0,25 is participatory science, and more than 0,35 is extreme or collaborative science. The evaluation of GoF in the second-order SEM PLS model and the prospect of citizen science towards a smart economy can explain empirical data well with a GoF value of more than 0,35.

Table 2
Evaluation of Collinearity, R^2, GoF and F^2

Variable	VIF	R^2	F^2						Q^2	GoF
			Ev	CC	Em	En	In	SE		
CS	2.888		0.205	0.005	0.089			0.023		
Ev	2.113	0.170		0.016	0.309					
CC	1.687	0.002			0.001					
Em	2.173	0.396				0.959	0.617	0.004	**0.872**	**0.488**
En	2.884	0.490						0.036		
In	3.960	0.381						0.099		
SE	3.660	0.191								

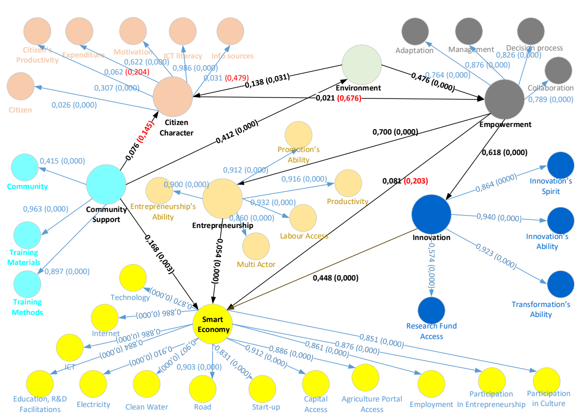

Fig. 5. The value of the contribution of the dimensions and latent variables of the citizen science model for the smart economy (corresponding significances $p < 0.05$)

4.3 Discussion

The second-order Type, a Reflective-Reflective model of citizen science potential for developing a smart economy, was carried out specifically using the by name by address (BNBA) principle of the directions (Iskandar, 2020) for 370 samples. This study uses the VB-SEM approach to handle many variables, even when multicollinearity occurs. It is robust and not based on many assumptions or conditions (data do not need to be normally distributed and can handle various types of data). The sample size does not have to be large) and is applicable for the purposive sampling technique (Hair et al., 2021). The purpose of PLS , in addition to confirming the theory is also able to explain the relationship between variables. SEM-PLS can analyze variables formed by reflective indicators (changes in latent variables cause changes in dimensions and indicators) (Sholihin & Ratmono, 2021). Based on the level of contribution of variables and dimensions, we analyzed the level of contribution of variables and dimensions as it is shown in Table 3-6. The order of contribution levels of citizen science potential variables for the smart economy is innovation, community support, entrepreneurship and empowerment. In Table 3-6, we also analyzed the contribution dimensions based on the order of strength of their contribution to the potential of citizen science for the smart economy in Kabandungan Sub-district, Sukabumi District, West Java Province.

Table 3
Analysis of the contribution level of citizen science driving innovation to smart economy

1. Innovations ability	2. Transformations ability	3. Innovations spirit	4. Research funds access
The community innovated to build an internet network and was managed independently in the Kabandungan Sub-district (before smart village 35% coverage, after smart village initiation coverage 72%)	Community managed internet access is increasing because it is cheaper and good quality	Farmer communities, some of whom also worked as elementary school teachers, conducted simple research on digital insecticide spray tools	Obtained through a community managed cooperative
The community innovated to produce handmade uninterruptable power supply (UPS) and marketed it online (social media), so that it was able to empower young vocational school graduates as employees as many as 5 people (average production/month 50 units)	The community was able to encourage mothers to become resellers of community-run internet services		Community members' personal funds
Community support, village government, other family members	Community support, husband/wife, children and family members	Community, child and employee support	Community support, non-ICT innovation group members, ICT and wife/husband

Table 4
Analysis of the contribution level of citizen science community supported for smart economy

Order of community support dimensions and indicators		
1. Training materials	**2. Training methods**	**3. Community ability**
The community actively provided training, both formally and informally, to residents, both in collaboration with academics, local governments and ministries	Community training activities, both independently and in collaboration with academics/local governments/ministerial that mostly contributed to the development of a smart economy were through demonstrations, exhibitions and field visits.	The capabilities of the community that mostly contributed to the development of a smart economy were related to: 1) managing the level of member participation in training and coaching; 2) suitability of training modules with training needs and intensity
Training materials and methods contributed significantly to ICT and internet training for businesses, formation and development of cooperatives/village owned enterprises and tourist villages		

Table 5
Analysis of the contribution level of entrepreneurship driving citizen science to smart economy

Order of entrepreneurship dimensions and indicators				
1. Labor access	**2. Productivity**	**3. Promotions ability**	**4. Entrepreneurships ability**	**5. Multi actor**
UPS micro-enterprises and internet services managed by the community through cooperatives were able to increase the access of workers to computer vocational school graduates	The provision of internet networks and independent governance by the community was able to increase the productivity of citizens, especially during the pandemic, cheap internet for education and business promotion. The product has not had the Indonesian National Standard (SNI) yet.	The community-based internet promotion strategy was also able to empower mothers through the reseller model so that they became family income generators and were more trusted	Women micro-enterprises coordinated by the community through whatsapp groups and the SABA WARGA program to regulate the distribution of the types of products sold. Products used raw materials in collaboration with the farming community.	The role of the community was more dominant, more trusted by the residents, especially after the success of providing cheap internet and managed with cooperatives by involving women as resellers.

Table 6
Analysis of the contribution level of citizen science driving empowerment for smart economy

Order of empowerment dimensions and indicators			
1. Manage business	**2. Decision process**	**3. Collaboration**	**4. Adaptation**
Community support had not been able to strengthen community business governance in general in the Kabandungan Sub-district because optimal community activities ran in one village (Tugubandung). Empowerment encouraged a smart economy if it was able to contribute to help capital returns, business financial management and access to capital	Community support had not been able to strengthen resident' confidence to make decisions after learning ICT – the Internet and after socializing smart villages. The expansion of internet access in five other villages had only been running for three months since May 2021, so the mechanism for the involvement of mothers and residents in internet governance had not worked well.	Community support that was still centered in one village had resulted in empowerment not yet contributed to build the strength of cooperation, both between micro-business groups (especially during difficult times such as a pandemic), or with other communities.	Community support had not been able to encourage community empowerment related to ICT adaptation because the existing innovation and entrepreneurship mechanisms had not been adapted by the other five villages. In addition, the distance to the sub-district center, infrastructure, education, and village government support were needed.
Need cooperation	Need socialization, coaching and assistance in collaboration with stakeholders		

The driver of citizen science for smart economy was also influenced by variables that indirectly had a significant effect, namely through environment, which connected through empowerment, as it is shown in Table 7.

Table 7
Analysis of the contribution level of environment by empowerment variables to the smart economy

Order of environmental indicators					
1. Citizen ICT adoption through communities	**2. Ease of business information through the community**	**3. Community service for ICT/internet disruption**	**4. The affordability of ICT costs**	**5. Community technician skills**	**6. Internet fees managed by community**
The initiation of smart village development (late 2019 until now) by the community & academics gradually provided socialization and strengthening of ICT adoption through the expansion of the internet by the community	Citizen businesses were promoted through the SABA WARGA program and promotions through social media. Such as UPS handmade businesses, farming businesses, culinary businesses, t-shirts and souvenir businesses, grocery stalls and others.	Residents at the same time become educated regarding ICT literacy by the community when the community provides services for internet or other ICT devices.	The cost of ICT in question was the use of the internet through smart phones and computers for education, business, program socialization, and disruption services	Community technicians were dominated by young computer vocational school graduates. Socialization of internet disturbance services and optimization of internet usage is more effective through SABA WARGA	Citizens rated the internet fees managed by the community as cheap & satisfying. Internet users increased by 50% due to the support of internet resellers.

Based on Fig. 5 community support did not contribute significantly to citizen character and empowerment. Therefore, we propose the need for increased community support to increase the motivation of smart villages, and farmer productivity, by optimizing the ICT literacy of already strong citizens. Community support can also be optimized by being more active in providing entrepreneurship training (especially for mothers who have micro-independent businesses), and agricultural management (vegetable commodities, chicken commodities) and strengthen cooperation with academia, the private sector (investors and potential buyers of commodities). The dimensions of the training materials that had been carried out by the community so far had made a strong contribution to the character of the residents. Another suggestion is that it was necessary to increase community support to strengthen the character of citizens in the formation of empowerment, through optimization of business management, decision making, collaboration and adaptation of already strong ICT. Citizen perceptions of the smart economy showed a good level of understanding on the indicators of smart economy development. This can be seen from the dimensions that can be influenced by the smart economy having a loading factor value above 0,8. The highest dimension that was closely related to the smart economy indicator was access to capital, electricity, internet, ICT, access to agricultural portals, and educational and R & D facilities in the village, in this condition related to a previous study (Maja et al., 2020). In the second place, the strength of the smart economy also contributed to the dimensions of employment, entrepreneurial participation, cultural participation, and the formation of technology-based start-ups in the village, and it's related to Vohland et al. (2021).

4.4 Initiation and strengthening of citizen science for smart economy development

The citizen science model was also expected to be able to show the willingness of the residents towards smart village development, because the theoretical framework was equipped with "motivation" indicators on the "citizen character" variable. Citizen of the Kabandungan Sub-district is dominated by farmers and SMEs; therefore, the indicators were related to the "productivity" of farmers also strengthened the character of the residents (Yao et al., 2015). The development of a smart village in the Kabandungan Sub-district, Sukabumi District, West Java Province, began with Kompak activities. The guidance and empowerment of the information public community (KIM) also occured in the Kabandungan Sub-district, Sukabumi District, West Java Province, Indonesia. KIM had developed into a Kompak. The existence of the community can be used as a generator for community empowerment in rural areas, especially related to the development of smart villages. The research results of Mishbah et al. (2018) showed that the focus area for the development of agricultural commodities was a focus area that was widely researched up to 30%. This shows that the chances of successful smart village development with agricultural focus areas were relatively higher than other areas. The concept of a smart village was also based on various participatory dimensions, and one of them is supported by the existence of a community that was a generator of smart village development activities. In the Kabandungan Sub-district already had Kompak which had pioneered a variety of activities. The pioneering activities of Kompak had even initiated the formation of cooperatives. This cooperative was expected to help raise capital for farmers and became partners in marketing.

The Syariah Baitul Maal wa Tamwil (BMT) cooperative has been operating for two years. Baitul Maal wa Tamwil (BMT) is a non-governmental organization established and developed by the community, usually at the beginning of its establishment using resources, funds or capital, from the local community (Galluzzo, 2020a). Cooperative members consisted of farmers (50%), traders and SMEs (30%) and the rest were civil servants or other private companies. The condition of cooperatives was also less than optimal due to lack of capital, high debt/arrears of members and the low competence of cooperative managers related to cooperative management. Until this second year, the cooperative was only able to provide capital of six million rupiah per year per member. This of course had not been able to help farmers in capital. Even the condition of the cooperative was getting worse due to the high arrears of members.

One of the solutions for this condition was circumvented by Kompak by building several SMEs that became cooperative partners, including micro cellphones and accessories, hand made UPS, airbrush and design, dress and t-shirts, as well as other micro businesses as start-ups. However, these micro-enterprises had not run optimally, and were still incidental in nature, so they had not been able to strengthen cooperatives as capital and market institutions. Several studies related to the development of smart villages that optimized community empowerment had been carried out (Santoso et al., 2019; Anderson et al., 2017; ENRD, 2018; Holmes et al., 2017). One of the main factors for the success of the smart village program was the use of ICT as the main gateway for communication both internally and with external parties (Maja et al., 2020). The communication in question could be accommodated in the concept of agricultural e-commerce and integrated with other widely available data sources such as social media, news portals or official agency websites. The ease of access to data from these various data sources could be a high potential to be explored into information, knowledge and policies so that they met the concept of data analytics. Kompak had been able to innovate and manage cooperatives and ANUNET, although it was not yet optimal. The potential of communities that were able to take the initiative through economic and ICT institutions and economic institutions to improve the citizen economy which had the potential to build a smart community in a smart economy environment (Vohland et al., 2021). The citizen science ecosystem to drive the smart economy in Kabandungan Sub-district was built through a four-party collaboration with stakeholders as it is shown in Fig. 6.

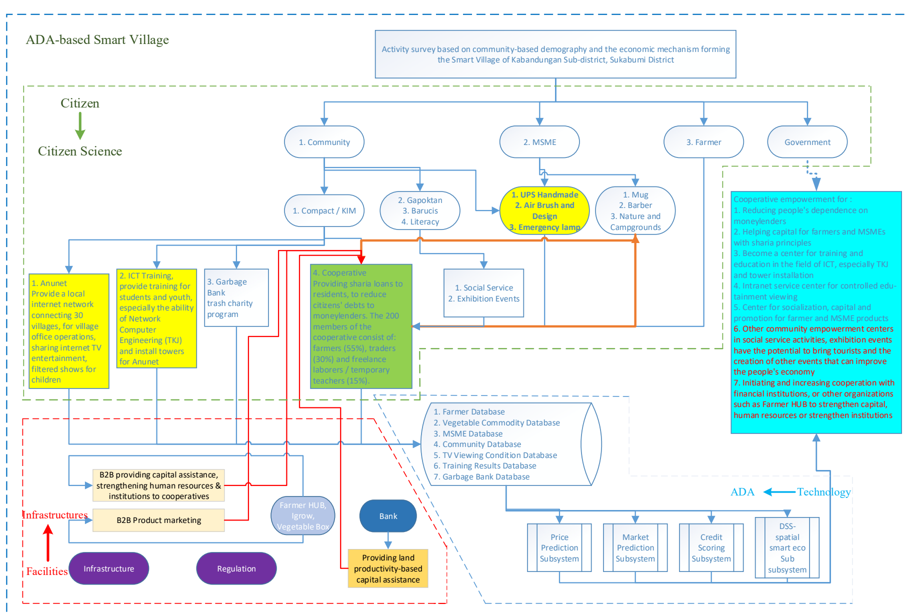

Fig. 6. Strengthening citizen science for smart economy in smart village ecosystem in Kabandungan Sub-district

At the end of 2020, Kompak collaborated with the ANUNET Cooperative and supported by the Ministry of Communication and Informatics program to continue to penetrate the internet network through the installation of towers and internet networks in the Kabandungan Sub-district (an example of internet network installation activities in the Kabandungan Sub-district area which was carried out independently by Kompak in collaboration with the ANUNET Cooperative, it is shown in Figure 7). To date, 72% of the Kabandungan Sub-district area has been connected to the internet, with the installation of the internet empowering Kompak members and the youth of Kabandungan Sub-district. In early June 2021, Kompak and the ANUNET Cooperative were able to optimize the SABA WARGA, application which had been launched by the West Java local government. Initially, the SAPA WARGA application was in the form of giving mobile phones to representatives of residents to convey complaints or problems that occurred in the community. However, this application did not work well, because the mobile phone facility was no longer used for reporting citizen problems, but it was more dominantly used for personal interests. Therefore, Kompak took the initiative to re-form the SABA WARGA program to become a village command post facilitated by free internet, thus enabling residents to gather according to the character of the natives to discuss problems that occured in the community, and through this post directly reported the results of discussions to Secretary and Head of Village. Currently, eight SABA WARGA's Command Posts had been formed in Tugubandung Village, and four Command Posts for the Village Secretary, Secretary General of Indonesian Youth National Committee (KNPI) and the community associations in the Tugubandung Village area.

Fig. 7. Internet network installation activities by Kompak in the Kabandungan Sub-district

Based on the evaluation of the inner model through the F^2 value at the moderate level and elaborated with the citizen science level (Beza et al., 2017), the potential of citizen science in Kabandungan Sub-district was point in the level of crowdsourcing. Villagers in the Tugubandung village had been able to become the interpreter base, through Kompak support, but this situation wasn't covered in Kabandungan Sub-district as general. The smart economy will be optimal if citizen science had reached the level of participatory science, where most of the citizens, especially farmers and SMEs were able to participate in the problem definition process and data collection. Therefore, we propose the first activities to strengthen citizen science through expanding the reach of the community self-management internet (before smart village 35%, currently it reached 72%, it is hoped that after the implementation of smart economy-smart village it reached 100%). We propose the second program that was increasing the quantity of empowerment of women became a community self-managed internet reseller, which is related to (Kumari et al., 2020). One of the activities of women empowerment activities to become internet resellers in Kabandungan Sub-district showed in Fig. 8.

Fig. 8. One of the activities of women empowerment to become internet resellers in Kabandungan Sub-district

The third proposal was increasing the quantity of the SABA DESA program (making "Points/Consultation Centers" in each village related to independent healthy internet-based education) accompanied by the community along with the Ministry of Communication and Informatics and academics. One of the activities of enhancement of SABA WARGA program showed in Fig. 9.

Fig. 9. One of the activities of enhancement of SABA WARGA program

The fourth program was proposing by Research and Development (R&D) plan for the development of IoT-based UPS monitoring system technology, collaboration between academics and communities. The fifth proposal was developing technology-based start-ups in villages and developing independent messaging applications for agricultural commodities and SMEs products in collaboration with academics and communities (Fig. 10).

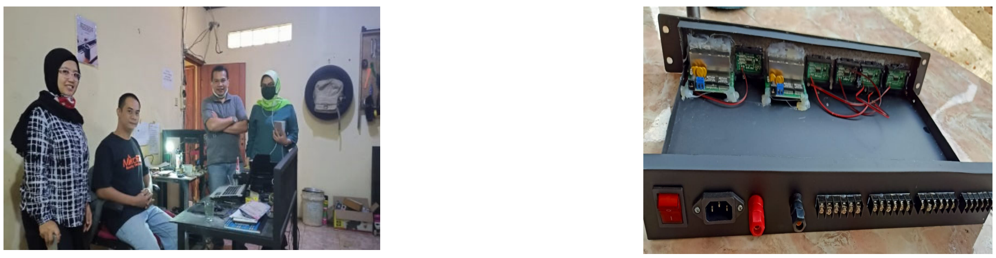

Fig. 10. The activity of monitoring IoT-based UPS's R&D

5. Conclusion

This study proposes a novelty of measuring the level of readiness of villagers to build a smart economy – smart village based on the strength of community support. We propose an assessment of the prospect of developing a smart economy – smart village through the citizen science level that integrates exogenous variables of community support for the environment, citizen character, empowerment, entrepreneurship and innovation and the smart economy. The citizen science model towards a smart economy showed a high level of predictive relevance, which was 87.2%. The citizen science model towards a smart economy was also able to explain empirical data well with a GoF value of 0.488. We elaborated four levels of citizen science based on the average value of the evaluation of the strength and significance of the community support variable at the structural level of the smart economy – smart village. Citizen science level with a value of more than 0.02 was crowdsourcing, more than 0.15 was distributed intelligence, more than 0.25 was participatory science and more than 0.35 was extreme or collaborative science. In the case of village resident readiness towards a smart economy - smart village in Kabandungan Sub-district, Sukabumi District, West Java, Indonesia, they occupied the crowdsourcing level. Even though the community had a high level of innovation, community activities are still focused on one village, so it had not had a significant impact on improving the global economy in the sub-districts. The order of variables that directly contributed to the development of a smart economy – smart village in Kabandungan District was innovation, entrepreneurship and community support. The strength of the community was able to encourage the growth of village resident innovation through environmental variables and empowerment. The order of the dimensions of innovation that contributed to the development of a smart economy – smart village was the ability to innovate, the ability to transform, the spirit of innovation and access to research funds in the village. Innovation in Kabandungan District has increased after KOMPAK installed the internet in villages independently. Internet management by KOMPAK in collaboration with the public cooperation was able to empower mothers to become internet voucher resellers, so as to grow family income. This was an optimism for the community to increase the participation of villagers in developing citizen science towards a smart economy. Four-party support for strengthening citizen perceptions of the smart economy in Kabandungan District had increased, as evidenced by the increase in internet coverage in Kabandungan District from 30% to 72%. This increase was the result of support from the Ministry of Communication and Informatics and academics who provided training and strengthening KOMPAK so that they were able to install and manage the internet independently in villages. KOMPAK support did not significantly contribute to the character and empowerment of the people in Kabandungan District. Therefore, we recommend the following: a) it is necessary to increase community support to increase the motivation of smart villages, and farmer productivity, by optimizing the ICT literacy of citizens who are already strong, b) community support can also be optimized by being more active in providing entrepreneurship training (especially for mothers who have independent micro-enterprises) and agricultural management (vegetable commodities, chicken commodities) and strengthening cooperation with academics, the private sector (investors and potential buyers of commodities). The dimensions of the training materials that have been carried out by the community so far have made a strong contribution to the character of the citizens, c) it is necessary to increase community support to strengthen the character of the citizens in the formation of empowerment, through optimization of business management, decision making, cooperation and adaptation of already strong ICT. We propose activities to increase the level of citizen science from the crowdsourcing level to the distributed science level through several activities including: a) expanding the reach of the self-managed internet community in Kabandungan District (from

72% to 100%), b) optimizing the empowerment of mothers to become self-managed internet resellers community, c) optimization of the SABA DESA program, d) compiling R&D technology for IoT-based UPS monitoring systems, collaboration between academics and the community, and e) developing technology-based start-ups in villages and developing independent delivery messaging applications for agricultural commodities and MSME products in collaboration with academia and community.

6. Research implications

We imitated the citizen science measurement model for the smart economy in a smart village environment through the stages as shown in Fig. 11. The questionnaire was distributed to respondents (village residents) through community assistance in the village each. The existence of the community played an important role in the formation of this model, because the community in the village understood the character of the residents better, and the community was also more easily involved in peer tutoring programs related to distributing questionnaires to residents. If data from respondents had been obtained, then the next process was data cleaning and followed by a modeling process using second-order SEM-PLS to form the value of the contribution of variables, dimensions and citizen science indicators for the smart economy. The contribution value was converted into citizen science level. Based on this model, it could be seen the strengths and weaknesses of the citizen science variables, dimensions and indicators for the development of a smart economy. So it could be proposed recommendations for strengthening or optimizing the variables, dimensions and indicators of the smart economy in accordance with the character of the citizens.

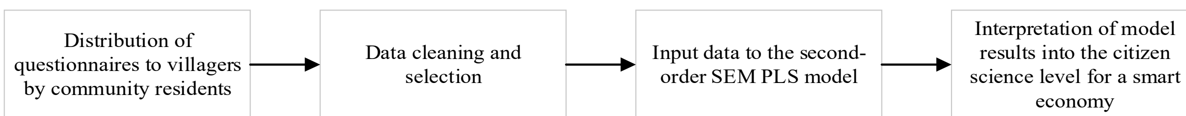

Fig. 11. Stages of research imitation

The level of citizen science for the development of a smart economy had managerial implications for the sub-district government in measuring the readiness of citizens towards a smart economy. Based on the value of the contribution of the variables, dimensions and indicators that made up the smart economy, the sub-district government could find out the strengths and weaknesses of its citizens related to the potential for smart economy development. Thus, the sub-district government could synergize with the community, village government, central government (relevant ministries), academia, and the private sector, to develop short-term, medium-term and long-term strategic plans in accordance with the results of citizen science level. Community support is the center of strength for the formation of a smart economy. Community collaboration with synergistic four-parties is needed to strengthen the variables, dimensions and indicators of smart economy development which includes aspects of technological literacy, internet, ICT, educational facilities and research and development, availability of electricity, clean water, roads, willingness to start-up, access to capital, access to agricultural portals, access to labor, participation in entrepreneurship and participation in culture.

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