Formulating and Validating Sustainable Residential Area Indicators in Suburban Metropolitan Jakarta

Pitri Yandri^{1*} Dominicus Savio Priyarsono² Akhmad Fauzi³ Arya Hadi Dharmawan⁴

1 Ahmad Dahlan Institute of Technology & Bisnis

2 Department of Economics, IPB University

3 Rural and Regional Development Planning Sciences Study Program, IPB University

4 Department of Human Ecology, IPB University

** Corresponding Author, Email: p.yandri@gmail.com*

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Abstract: In today's empirical studies on sustainability, researchers still rely on the concept of "triple bottom lines" (economic, social, and environmental), which are influential in covering development issues. However, this concept has limitations for specific cases, such as regional, local, and sectoral levels. One sector that should adopt sustainability principles is the residential area in the suburban area. The academic discourse on sustainable residential area (SRA) is still requiring extensive research, especially on generating reliable and valid indicators. In the policy arena, particularly in Indonesia, an accurate indicator of measuring SRA is not available. Thus, this study intends to develop and validate the SRA indicators. The "citizen-led" approach was used in this study to observe 332 households spread in the cities of South Tangerang, Tangerang, Depok, and Bekasi. These cities are spatially located in the hinterland of Greater Jakarta. Households are divided into residential and non-residential area households. By extending into a literature review, this study develops 51 SRA indicators grouped into economic, social, environmental, infrastructure, technology, and governance parameters. Moreover, using structural equation modelling with a confirmatory factor analysis approach, this study generates 36 valid and reliable SRA indicators. This study provides that the model could be considered a structure and system that enhances the SRA.

1. INTRODUCTION

In many economic development textbooks, the concept of sustainable development still refers to the definition of the World Commission on Environment and Development (WCED). It defines sustainability as the "patterns of development that meet the needs of the present generation without jeopardizing the ability of future generations to meet their own needs" (WCED, 1987). After ten years, Elkington (1997) introduced the concept of "triple bottom lines" (social, economic, and environmental) as the basic concepts of interrelation in interpreting the concept of sustainability. Although the concept is used as a primary reference in empirical research, it has not been considered yet, and debate among academics, particularly for the local context and specific cases, continues (Seghezzeo, 2009). Therefore,

the opportunity to bridge the gaps is still wide open. Moreover, much research shows that sustainability has shifted from a global perspective to a meso perspective: local, regional, and sectoral ([Finco and Nijkamp, 2001](#)).

For example, in the context of urban sustainability, Talen ([2014](#)) states that the issues at this level revolve around housing, transportation, the environment, and the interconnection of administrative governance. Especially for housing, the academic discourse on sustainable housing areas has prompted the attention of researchers and the government. For instance, Yigitcanlar et al. ([2015](#)) conducted empirical research on sustainable housing in Malaysia. Meanwhile, Pakzad and Salari ([2018](#)) examined sustainable housing in Iran by observing a small-size neighbourhood. In Indonesia, Sudarwanto et al. ([2014](#)) conducted a study on the formulation of indicators of sustainable housing areas. In the policy arena, such as in Germany, a certification system is implemented to assess whether a housing area is sustainable or not ([Rid et al., 2017](#)).

A brief description of some empirical studies and their implementation for the policymaker raises a fundamental question of why housing areas must comply with sustainable principles. Winston and Eastaway ([2008](#)) provide four arguments. First, housing is a critical public policy domain that can affect urban development and potentially contribute to sustainable development. Second, housing construction, including its design, has a significant impact on the environment. Third, housing construction and its facilities affect how we manage waste. Fourth, housing development impacts the use of electricity, wood, and so on, and it directly affects sustainability.

In Indonesia, the idea of implementing a sustainable housing area has not received serious attention. Although the National Development Planning Agency of the Republic of Indonesia has issued regulation No. 7/2018 concerning Coordination, Planning, Monitoring, Evaluation, and Reporting on the Implementation of Sustainable Development Goals, the regulation focuses on how residents obtain accessibility to basic needs for decent and affordable housing. In other words, the regulation has not paid attention to how a housing area meets the principles of sustainability. Achievement of sustainable housing areas is relevant when it is related to the reality and phenomena faced in known suburban areas today, such as South Tangerang, Tangerang, Depok, and Bekasi.

Their spatial characteristics face various spill-over effects, such as economic, social, spatial, and environmental impacts. One example of spill-over effects is the continuing increase in population due to migration from rural to urban areas and migration from the city centre to the suburbs. The Regional Statistics Agency shows that the population is continuously increasing. In the last eight years (2010–2018), the average population growth rate increased by 2.16% in Tangerang City, 3.56% in South Tangerang City, 3.53% in Depok City, and 2.50% in Bekasi City.

In turn, increased population growth will reduce the demand for land, especially for housing and settlements. Housing developers then followed up the process to build a residential area to respond to the increased demand. Empirical evidence shows that residential land area increased from 60.07% in 2011 to 61.79% in 2016, equivalent to a 1.72% increase or 2.53 km² of the total area of 147.19 km². In Depok City, in 2005, the residential land area reached 44.31% of the total land area, which increased to 53.24% in 2012. Meanwhile, in Bekasi City during 2005–2014, land changes for settlements reached 250.32 ha or 58.48%. Although residential land in Tangerang City in 2010 was only 22.13% of the total area, the number

increased to 26.54% in 2013. The growth of the residential land area in Tangerang City reaches an average of 6% per year.

In addition to these facts and phenomena, Indonesia does not have official indicators to measure the sustainability of housing areas. Although the Minister for Public Works and Human Settlements tried designing sustainable urban settlements in 2014, the concept has not yet been manifested as a concrete public policy. Alternatively, the National Standardization Agency (BSN) of the Republic of Indonesia also released the Procedures for Urban Environmental Planning in the City with Indonesian National Standard (SNI) 03-1733-2004 (BSN, 2004). The SNI is indeed oriented toward sustainability, but several indicators still have not adapted other dimensions of sustainability, such as social and economic. Based on this description, this study aims (1) to develop variables and indicators of sustainable housing areas (from now on referred to as sustainable residential area/SRA) in suburban areas and (2) to validate the constructs and indicators that have been devised.

2. LITERATURE REVIEW

In scientific articles, the terms pointing to settlements and housing, for example "housing", "settlements", "residential area", and "neighbourhood", vary greatly. In the Oxford English Dictionary, "housing, or more generally living spaces, refers to the construction and assigned usage of houses or buildings collectively, for sheltering people—the planning or provision delivered by an authority—with related meanings." Meanwhile, "settlement" is defined as "a place where people live together".

Furthermore, the "residential area" used in which housing predominates, as opposed to industrial and commercial areas, includes single-family housing, multi-family residential, or mobile homes. In some literature, a residential area is also called a housing cluster (Hapsariniaty et al., 2013) or a housing complex (Kerr, 2008). In 2002, Leisch referred to the residential area as a gated community.

Figure 1. Distinction between residential area and settlement in Suburban Metropolitan Jakarta, Indonesia

In legal-formal terms in Indonesia, housing is part of the settlement. The characteristic differentiator between settlements and housing is that apart

from having the boundaries of ownership and authority, settlements are built by communities individually. In contrast, housing is built by the private or government sector. Thus, the knot line that the housing is a residential area can be quickly drawn. In Indonesia, a residential area built in the private sector is sold back to the community. An example of a residential building by the private sector is BSD City, a large housing company in Indonesia. Another example of housing built by the government, is that such as police housing or state university lecturers housing. From the perspective of their spread pattern, the housing is more organized than the settlement. Figure 1 shows actual illustrations in spatial maps of housing and settlements.

From the perspective of regional economics, the emergence of residential areas positively impacts generating additional resources in human capital. It has a function as an engine of growth ([World Bank, 2009](#)). This viewpoint resonates with Robert Lucas (1967–1981) through his economic growth theory ([Andrada, 2017](#)). For Lucas, the process will eventually approach convergent economic growth. Moreover, because of Lucas, labour mobility and capital would help economic concentration, and this flow mitigates differences in well-being that can accompany the economic concentration. In the policy arena, this perspective will result in facilitation and making efforts, especially by middle-class residents who have the skills and education ([World Bank, 2009](#)).

However, several studies related to residential areas inform us that residential areas changed the livelihood strategy of people working in the agriculture sector ([Elhadary et al., 2013](#); [Liu and Liu, 2016](#)) because construction transforms agricultural land. Besides this, residential areas suppress social capital ([Clark, 2007](#)), put pressure on minority community groups ([Raguset, 2014](#)), and cause the emergence of economic inequality and revenues ([Huang and Jiang, 2009](#); [Neckerman et al., 2009](#); [Yandri, 2014](#); [Zhao, 2016](#)), social segregation ([Yandri, 2015](#)), and settlement segregation ([Hwang, 2015](#)). The emergence of residential areas precisely resulted in the low political participation of its citizens ([Schram, 1991](#)). The study of the situation was verified by Newman et al. ([2013](#)) in the United States and ([Yandri, 2017](#)) in South Tangerang Municipality, Indonesia. All such information implies that residential areas should apply sustainability principles.

As stated in the introduction section, the study of sustainability has covered the specific arena of development with a varied context. In a spatial context, many studies focus on rural and urban sustainability. In rural areas, the focus is on household livelihood issues, as mentioned in Deng et al. ([2020](#)), or the sustainability of spatial interactions between the two regions ([Ji et al., 2019](#)). For example, Buchori and Sugiri ([2016](#)) use the terminology "sustainable metropolitan" to encourage applicable policies while maintaining the concept of triple bottom lines. The progress made by various studies related to sustainability is attractive regarding the idea, methodology, and approach. Unfortunately, the study still places three fundamental pillars as the basis for analysis and development. Therefore, our study implemented a new concept by adding two advanced pillars to complement the previous three pillars (Figure 2).

Figure 2. The theoretical framework of sustainable residential area

The formulation of the pillar is undoubtedly opposed by the mainstream, which generally understands the academic discourse on sustainability. In classic sustainability, its pillar comprises economic, social, and environmental (triple bottom lines), as mentioned by Elkington (1997). However, this article examines new parameters, especially in residential areas, namely infrastructure, technology, and governance as the foundation (Figure 2). The consideration to include infrastructure parameters relies on the argument that the situation of the residential area in urban/suburban areas is undoubtedly different compared with that in rural areas. The social, economic, and spatial conditions in urban/suburban are characterised by the middle-class population (Ningrum et al., 2014), which has a higher demand for sophisticated and accessible infrastructure facilities than people in rural areas.

Related to the technology parameter, (Bugliarello, 2004) states the critical role of technology in achieving sustainable development. A focus on urban sustainability must involve the necessity of technology in answering the question "what can we do?". Technology is needed to translate our understandings into designs and functions that enhance urban and global sustainability. Cities with complex structures from the social and economic aspects require an integrated response to overcome their problems and challenges. Technology enables urban governance to be more participatory and contributes to social inclusion by increasing the availability of facilities for planners to respond to service needs. Therefore, the application of technology contributes to urban sustainability (United Nations, 2015).

Why does governance need to be the foundation? Citing Jha and Murthy (2000), we found that the current concept of sustainability is incomplete because it excludes the spatial aspects and behaviour and property rights in the model. They stated that human behaviour changes and endogenously confirmed property rights would eventually change sustainability. Therefore, one of their five important proposals is nonmarket intervention, implying that government elements have become a new sustainability issue through governance. Governments are considered because they involve the question of "do their policies contribute to the achievement of sustainable development?" (Evans et al., 2006)

3. STUDY AREA

We observed Tangerang, South Tangerang, Depok, and Bekasi (Figure 3), small towns with autonomy and self-government. In these cities, massive residential areas are large, medium, and small in various land sizes. In South Tangerang, for example, BSD City and Bintaro Jaya developers are under the management of Sinar Mas Land and Jaya Property Corporation, respectively. In Bekasi and Tangerang, Sumarecon Agung Corporation developed Sumarecon Residential Area. These residential development companies are the largest in Indonesia.

Figure 3. Suburban Metropolitan Jakarta, Indonesia

The private sector's contribution to the construction of large residential areas impacts the economies of those cities. For instance, South Tangerang is an area dominated by tertiary sectors: trade, hotels, restaurants, transport and communication, banking and financial institutions, and services and real estate (Table 1).

Table 1. GDRP by industry in South Tangerang, Tangerang, Bekasi, and Depok City (%)

GDRP by industry	South Tangerang	Tangerang	Bekasi	Depok
Agriculture, forestry, and fishing	0.25	6.96	0.96	1.40
Mining and quarrying	0.00	0.00	0.00	0.00
Manufacturing	9.64	3.72	34.34	31.13
Electricity and gas	0.14	6.80	1.94	0.31
Water supply, sewerage, waste management, and remediation activities	0.04	8.04	0.09	0.07
Construction	15.81	6.70	11.00	19.31
Wholesale and retail trade; repair of motor vehicles and motorcycles	16.80	4.94	22.60	21.75
Transportation and storage	3.32	8.67	10.18	4.54
Accommodation and food service activities	3.12	8.90	3.88	3.75
Information and communication	11.03	9.24	2.06	1.86
Financial and insurance activities	1.28	2.91	3.09	4.05
Real estate activities	17.32	8.11	1.57	1.57
Business activities	3.83	7.17	0.45	0.20
Public administration and defence, compulsory	1.35	5.18	1.98	2.63

social security				
Education	8.77	7.46	2.30	2.73
Human health and social work activities	4.16	8.04	1.08	1.08
Other services/ activities	3.14	8.03	2.81	3.61

Source: [Local Statistical Bureau, 2019](#)

4. METHOD

Several studies related to efforts to develop sustainability indicators were adopted based on regional (local) values through a combination of expert-led and citizen-led approaches ([Turcu, 2013](#)), based either on literature studies such as those conducted by Aulia ([2016](#)) and Xu et al. ([2018](#)), or based on secondary data such as the study of Shiau et al. ([2015](#)). Then they used the rough sets theory method and two-stage principal component analysis. Following Turcu ([2013](#)), Aulia ([2016](#)), and Xu et al. ([2018](#)), we use the SRA indicator formulation in this study from the literature. We use ([Olsson et al., 2004](#)) framework in determining the relevance indicator, which are: (1) relevant to decision-making, (2) clear in value, (3) adequate in scope, (4) feasible, parsimonious, and adequately communicated, (5) democratic/participatory, (6) integrated/ multidimensional, and distributional, (7) forward-looking, physical, and comparable. Furthermore, the selected indicator should meet suburban characteristics in Indonesia. Starting now, we validate it with a citizen-led approach by household perceptions. The observed households live in residential and non-residential areas in Suburban Metropolitan Jakarta.

The criteria for determining suburban areas are that these areas spatially intersect with Metropolitan Jakarta Province, namely, South Tangerang, Tangerang, Depok, and Bekasi City. We use the purposive sampling technique to collect data from 82 respondents in South Tangerang, 88 respondents in Tangerang, 82 respondents in Depok, and 80 respondents in Bekasi. The total number of respondents is 332. We use a questionnaire with an ordinal scale, which were ordered from critical (weight 7) to unimportant (weight 1).

In addition to the approach used by Shiau et al. ([2015](#)) and Magee and Scerri ([2012](#)), we used a combination of qualitative and quantitative approaches. We examined them with the analytic hierarchy process (AHP) method. Another approach used by Asmelash and Kumar ([2019](#)) is the structural equation model (SEM) analysis technique, which develops and examines the validity of tourism sustainability indicators. Following Asmelash and Kumar ([2019](#)), we also used SEM techniques with the confirmatory factor analysis (CFA) approach through Amos 22.0 software. CFA is a multivariate analysis method that can be used to confirm whether the measurement model is built according to the one hypothesized. In CFA analysis, the hypothesized model must be valid. Validity refers to the ability of an indicator to measure the desired measurement. The validity of indicators in measuring latent variables is assessed by testing whether all values of the loading factor (λ_i) are valid by using t-tests for a certain level of confidence. The validity of the indicators was examined using construct reliability (CR) and the average variance extracted (AVE). AVE shows the total variance of the variable that the measurement model can explain. The general model of CFA is as follows.

$$x = \Lambda x\xi + \delta$$

Where x is a vector for $q \times 1$ indicator variables, Λx is a loading factor matrix (λ) or a coefficient that shows the relationship of x with $q \times$ of size $q \times n$ (between indicators are assumed to be correlated; must have common factors) (Solimun et al., 2017), ξ is (ksi) is a vector for latent variables of size $n \times 1$, and δ is a vector for measurement errors of size $q \times 1$. Evaluation of the CFA model is assessed through the following criteria: (1) large test χ^2 values relative to the degree of freedom indicate that the model does not fit the empirical data; (2) root of mean square error of approximation (RMSEA) value smaller than or around 0.10 is an indication of the acceptance of a model; (3) goodness of fit index (GFI) value of > 0.90 is said to have been supported by empirical data; (4) minimum sample discrepancy function/degree of freedom (CMIN/DF) value of ≥ 5 indicates a good model (Wheaton et al., 1977); (5) Tucker–Lewis index value of > 0.90 ; and (6) comparative fit index (CFI) value of > 0.90 .

Figure 4. Development of the SRA indicator measurement/validation model

4.1 Respondent's demographic profile

In terms of age, the youngest and oldest respondents are 17 and 63 years old, respectively. However, between these age ranges, the age variations of respondents vary greatly. For a more readable frequency distribution, age is presented in the form of certain classes. The most commonly used statistical procedure is first: specify the range (r) of the data as formula (1); second, set the interval class (k) used by Sturges formula (2); and third, specify the interval length of type (c) as shown in formula (3).

$$r = \text{maximum value} - \text{minimum value} \quad (1)$$

$$k = 1 + 3,3 \log (n) \quad (2)$$

$$c = r/k \quad (3)$$

Using formula (1), the following information is obtained: the data range (r) is 46, the interval class (k) as shown in formula (2) is 6.8, which is rounded into seven categories, and the interval length of the categories (c) is 7, as obtained by formula (3). From such information, Table 2 presents the frequency distribution in the age classes of respondents. As shown in Figure

4, respondents in residential areas are dominated by individuals aged 17–23 years old (40%), and the remaining are 24–30 years old (21%), 31–37 years old (13%), 38–44 years old (10%), 45–51 years old (9%), and 52–58 years old (4%). Respondents who are 17–44 years old indicate that residential areas are dominated by the middle-class age range, whom are physically productive.

Table 2. Demographic profile; n = 332

Respondent profile	Residential area (%)	Non-residential area (%)
Age (years)		
17–23	40	49
24–30	21	26
31–37	13	13
38–44	10	6
45–51	9	7
52–58	4	1
59–65	2	0
No answer	2	0
Education attainment		
Junior high school	0	2
Senior high school	44	51
Diploma/bachelor	40	39
Master's degree	14	4
Doctoral degree	2	0
No answer	0	4
Gender		
Male (%)	37	
Female (%)	61	
No answer (%)	2	

Identically, respondents in non-residential areas are the same. A total of 45% of respondents were dominated by ages 17–23 years, followed by 24–30 years (26%) and 31–37 years (12%), and the remaining 45–51 years (7%) and 52–58 years (1%). However, 3% of respondents did not indicate their age (Table 2). In aggregate, 42% of respondents were in the age range of 17–23 years; 26%, 24–30 years; 13%, 31–37 years; 8%, 34–44 years; and 8%, 45–51 years (Table 2). These data confirm that the dominating residents in South Tangerang, Depok, Tangerang, and Bekasi are those within the age range of 20–49 years (Table 3).

Table 3. Young population in Suburban Metropolitan Jakarta

Age (years)	Suburban Metropolitan Jakarta			
	South Tangerang	Tangerang	Depok	Bekasi
15–19	127.892	163.726	121,180	242.879
20–24	140.117	201.482	136,140	266.528
25–29	154.212	226.498	133,636	295.052
30–34	159.648	221.788	113,630	269.446
35–39	156.648	196.986	91,459	237.452
40–44	144.909	173.269	71,502	205.672
Total	883.426	1.183.749	667.547	1.517.029
% of total population	52,07	54,16	58,38	55,50

Source: [Local Statistical Bureau, 2019](#)

In aggregate, the respondents' gender was dominated by women (61% of the total respondents), and 37% were men. Table 2 presents information on

the distribution of respondents' gender frequency. In terms of education level, in residential and non-residential areas in South Tangerang, Depok, Tangerang, and Bekasi City, 47% of respondents are high school/vocational degree holders, and 40% have received higher education, either diploma or bachelor degree. Moreover, as many as 9% of respondents are master's degree holders (Table 2).

The data showed no significant variability between the two regions regarding the education levels in residential and non-residential areas. The distribution of respondents in both areas is dominated by high school/vocational education level, with a 44% distribution in the region and 51% in non-residential areas. Significant differences only occur at the level of education in the master's and doctoral degrees. In residential areas, respondents with a master's degree reached 14% of the total respondents, whereas, in non-residential areas, respondents with the same level of education only comprise 4% of the total. Some respondents tiered doctoral degrees in the residential area as much as 1%, whereas, in non-residential areas, no respondents have a doctoral degree. The results imply that residential areas seem to be better than those in non-residential areas regarding educational attainment.

5. RESULTS AND DISCUSSION

Based on literature studies, we developed the following six parameters of SRA: (1) economy, (2) social, (3) environment, (4) infrastructure, (5) technology, and (6) governance. We argue that infrastructure should be included as one of the SRA's variables because of the spatial conditions of suburban areas, which are different from the situation in rural areas. The needs of suburban communities are commanding ([Ningrum et al., 2014](#)), and fast-paced middle-class workers need good-quality infrastructure in supporting all their activities. Although the technology variable deals with "what can we do?", it must translate our understanding into designs and functions that can expand urban and global sustainability. Cities with complex structures, both in terms of social and economic aspects, require integrated responses to overcome problems and challenges that arise ([Bugliarello, 2004](#)). According to the United Nations ([2015](#)), technology enables more participatory urban governance. It contributes to social inclusion by increasing the availability of means for planners to respond to the need for services. Therefore, technology applications contribute to urban sustainability.

In the context of governance, Jha and Murthy ([2000](#)) state that the concept of sustainability has not addressed challenges because it excludes spatial and behavioural aspects and ownership rights in the model. They stated that human behaviour changes in the long run, and they endogenously confirmed ownership rights would change sustainability. Therefore, their valuable suggestions include the need for nonmarket interventions to achieve sustainability, implying that elements of government through governance have become a new issue in sustainability. The government element is vital because it involves whether their policies contribute to sustainable development or not ([Evans et al., 2006](#)).

Hence, adding the governance variables is relevant to be developed. In many studies, the nine indicators of good governance are as follows: (1) the participation of all people in the development process; (2) compliance to the rule of law; (3) transparency by the local government; (4) government

having high responsiveness to the needs (both primary and secondary) of the community; (5) consensus-oriented; (6) fairness; (7) governance being carried out effectively and efficiently; (8) accountability; and (9) strategic vision of regional leaders in bringing their regions to become more prosperous. We use these characteristics as a basis to develop governance indicators.

Furthermore, those six parameters are reflected by 51 indicators (Table 4). After the indicators of each parameter are compiled, the following procedure is to validate those parameters and indicators. In this procedure, the development of path diagrams for each parameter is also included (Figure 4). Furthermore, the 51 indicators are examined by checking the value of the loading factor. A high indicator loading factor value will produce high CR and AVE values. Conversely, a low load factor value will result in a low CR and AVE value, resulting in an invalid parameter. Table 5 results from indicator validation, informing that the indicator has a low loading factor value, and constructed reliability resulted of indicator eliminated are shown in Table 6.

Table 4. Formulation of sustainable residential area indicators

Parameter	Indicators	Description	Annotation and Citation
Economic	1	Economic network connectivity	Interrelation and combination of variations in economic activity. The basic idea is mixtures of activities and mutually inseparable. Talen (2014)
	2	Adoption of local labour	The residential area employs local people as household assistants, security guards, etc. Novelty
	3	Suburban farming	Residents can conduct small-scale agricultural activities in the residential area. It can be formed by using the front yard and back yard of farming activities, using pots as a planting medium. (Holler and Serra, 2012), (Hoornweg and Freire, 2013)
	4	Price	Affordable price of housing unit in residential area. (Hapsariniaty et al., 2013), (Handayani, 2009)
	5	Value of investment location of residential area	Strategic location of residential areas produces high investment value. (Hapsariniaty et al., 2013), (Serlin and Umilia, 2013)
	6	Access to public facilities (hospital, mall, sport centre, etc.)	The residential area is adjacent to public facilities. (Ding et al., 2010), (Frenkel et al., 2013)
Social	7	Social participation of residents	Residents are involved in community activities. (Hoornweg and Freire, 2013), Talen (2014)
	8	Cohesion and social connection	Some activities can strengthen the cohesion and social connection of residents in the residential area. (Winston and Eastaway, 2008), (Le, Ta, and Dang, 2016)
	9	Residents' engagement medium	Recitation, worship services, social gathering, joint sports, mutual cooperation, etc. (Hoornweg and Freire, 2013), Talen (2014)
	10	Adoption of local cultural values	The residential area adopts local culture, reflected in the area's openness to local people and appreciation of local culture. (Amado et al., 2017), (Rosenstein, 2011), (Grodach, 2017)
	11	Security	Reduction of criminal acts (theft, robbery, muggings, etc.) (Winston and Eastaway, 2008)
	12	Integration of neighbourhood association and citizens'	Neighbourhood association and citizens' association of residential area merge with neighbourhood association (Karim and Rashid, 2012)

		association (intra- and inter-residential area)	and citizens' association of the local neighbourhood.	
	13	Health	The residential area adopts the health aspects of the environment, both physically and mentally.	(Liu et al., 2017), (Barbato et al., 2017)
	14	Residents' hospitality	Residents greet each other, give a smile every morning and every time.	(Bell, 2007)
Environment	15	The quality of public open space	Public open spaces are available (parks, sports facilities, etc.).	(Mulliner et al., 2016)
	16	Compliance with spatial planning regulations	The built residential area is compliant to the spatial plan set by the government.	Novelty
	17	Low noise pollution	Low motor vehicle traffic.	Talen (2014), (Winston and Eastaway, 2008)
	18	Integrated waste management	Existence of waste management in the community ("Bank Sampah")	(Suryani, 2016)
	19	Energy efficiency	Residents in the residential area practice energy-saving ways of life.	Talen (2014), (Addanki and Venkataraman, 2017)
	20	Preservation of local ecological and biodiversity environments	Maintaining environmental cleanliness, separating organic/nonorganic waste, planting trees, etc.	(Hoornweg and Freire, 2013)
	21	The efficiency of groundwater use	Groundwater is consumed sufficiently for household use. Residents are aware of the importance of efficient consumption of groundwater.	(Garcia et al., 2013), (Loubet et al., 2016)
	22	Involvement into location	Comfort in the residential area.	(Hoornweg and Freire, 2013)
	23	Water quality	Clean water is available in adequate quantity.	Strategic Plan of the Ministry of Public Works 2015-2019, Republic of Indonesia (Ministry of Public Works of Republic of Indonesia, n.d.)
				(Leisch, 2002)
Infrastructure	24	The closed gate of a residential area	Open the entrance of a residential area.	(Leisch, 2002)
	25	Adoption of local culture in residential architecture	Building architecture adopts local culture.	(Le et al., 2016), (Rid et al., 2017), (Amado et al., 2017)
	26	A speed bump in a residential area	Existence of a speed bump. The distance between the speed bump, the shape and material of the speed bump, and the speed bump height.	Decree of the Minister of Transportation No. KM. 3/1994(Ministry of Public Transportation of Republic of Indonesia, n.d.); (Dinh and Kubota, 2013)
	27	Physical adaptation of residential buildings to disaster	House unit in residential area adapts to physical buildings against disasters.	(Renald et al., 2016)
	28	Security guards	The existence of a security guard in residential area.	(Leisch, 2002)
	29	Distance of residential area to social facilities (mosque, polyclinic/community health centre/hospital, school)	Residential areas close to social facilities (mosques, polyclinics/health centres/hospitals, schools).	(Le et al., 2016)
	30	Distance of residential area to market	Residential areas close to market facilities.	(Le et al., 2016)
	31	View of a residential area	The residential area provides a refreshing view.	(Hapsariniaty et al., 2013)

Technology	32	Accessibility for people with disabilities	Accessibility in residential areas supports disabled people.	(Le et al., 2016)
	33	Access to workplace	The housing area needs to be close to access places of work.	(Mulliner et al., 2016)
	34	Street lighting	The existence of street lighting that includes the number and quality.	(Mulliner et al., 2016)
	35	Internet connection and its speed	Availability of internet network with quality connections.	(Kummitha and Crutzen, 2017)
	36	Public transportation	Public transportation facilities are available that can be accessed by residents in the residential area.	(Miralles-Guasch and Domene, 2010), Talen (2014)
	37	Social media group (intra- and inter-residents)	Residents are incorporated into WhatsApp, Line group, etc., in each neighbourhood association and citizens' association.	Novelty
Governance	38	CCTV cameras	Housing areas need to be equipped with CCTV cameras.	(Leisch, 2002)
	39	Program innovation	The local government designs a breakthrough program related to the housing and residential area.	(Hoornweg and Freire, 2013), (Addanki and Venkataraman, 2017)
	40	The vision of local leaders about the residential area	There is a clear vision of local leaders in the governance of housing and residential area.	(Hoornweg and Freire, 2013), (Priyarsono, 2017), (Addanki and Venkataraman, 2017)
	41	Participation in the planning process	The government provides a medium for citizen participation in supporting housing and residential area governance.	(Rid et al., 2017)
	42	Permitting of residential transaction	Permitting is accessible, concise and fast, and without illegal fees.	(Buchori and Sugiri, 2016), (Rid et al., 2017)
	43	Waste recycling program	The government initiates a waste recycling program and its management.	Talen (2014)
	44	Proactive neighbourhood association and citizens' association	The proactivity of neighbourhood association and citizens' association institutions in informing and publishing local government policies, especially citizenship services.	Novelty
	45	Neighbourhood association and citizens association facilitate formatting social media communication (intra- and inter-residents)	WhatsApp, Line group, etc.	Novelty
	46	Coordination in neighbourhood association and citizens' association related to the residential area	It is implemented in regular meetings.	World Bank (2017)
	47	A credible commitment of the local government	Proactivity in socialising government programs and its activities and monitoring residential development.	(Ostrom, 1990), (World Bank, 2017)
	48	Design activities that can strengthen social connections between residents	The design of activities initiated by the local government such as youth association activities (<i>karang taruna</i>), women's association activities, cooperation (<i>gotong royong</i>), etc.	(Le et al., 2016)
	49	Suburban farming incentives	The local government provides incentives for citizens to develop urban farming.	Novelty
	50	Certification for sustainable systems	The government needs to develop a certification of sustainable residential areas for housing developers.	(Rid et al., 2017)

51	Transparency	Transparency of government actions through information and communication technology media.	(Arwati and Latif, 2019)
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Table 5. Low and eliminated indicator load factor values

Indicator code	Construct/indicator	Loading factor
Economic		
Ec ₁	Economic network connectivity	0.075
Ec ₂	Adoption of local labour	0.284
Ec ₃	Small-scale suburban farming	0.407
Social		
So ₁	Social participation of residents	0.476
So ₂	Cohesion and social connection	0.598
So ₃	Residents' engagement medium	0.715
So ₄	Adoption of local cultural values	0.562
So ₆	Integration of neighbourhood association and citizens' association (intra- and inter-residential area)	0.468
Infrastructure		
In ₁	The closed gate of the residential area	0.314
In ₂	Adoption of local culture in residential architecture	0.140
In ₃	A speed bump in the residential area	0.203
In ₄	Physical adaptation of residential buildings to disaster	0.620
In ₇	The distance of residential area to market	0.618
Technology		
Te ₃	Social media group (intra- and inter-residents)	0.459

Table 6. Construct reliability (result of indicator eliminated)

Construct	CR	AVE	Standardised Regression Weights	Annotation
Economic	0.737	0.489	0.691	Established
Environmental	0.916	0.550	0.737	Established
Social	0.767	0.525	0.722	Established
Infrastructure	0.844	0.521	0.719	Established
Technology	0.732	0.480	0.689	Established
Governance	0.970	0.713	0.843	Established

Based on the 51 indicators, we only have 36 that could be considered as a measure of the SRA (Table 7, Figure 5). Regarding the number of selected indicators, (Sors, 2001) states that, for a number of indicators, ranging from 20 to 50 is sufficient to measure sustainability.

Table 7. Selected SRA indicators

Indicator code	Construct/indicator	Loading factor
Economic		
Ec ₄	Price	0.596
Ec ₅	Value of investment location of a residential area	0.624
Ec ₆	Access to public facilities (hospital, mall, sports centre)	0.850
Social		
So ₅	Security	0.626
So ₇	Health	0.770
So ₈	Hospitality	0.768
Environment		
En ₁	The quality of public open space	0.725
En ₂	Compliance with spatial planning regulations	0.568
En ₃	Low noise pollution	0.617
En ₄	Integrated waste management	0.568
En ₅	Energy efficiency	0.763
En ₆	Preservation of local ecological and biodiversity environments	0.844

En ₇	The efficiency of groundwater use	0.828
En ₈	Involvement into location	0.725
En ₉	Clean water	0.780
Infrastructure		
In ₅	Security guards	0.642
In ₆	The distance of residential area to social facilities (mosque, polyclinic/community health centre/hospital, school)	0.749
In ₈	View of the residential area	0.662
In ₉	Accessibility for people with disabilities	0.739
In ₁₁	Street lighting	0.804
Technology		
Te ₁	The internet connection and its speed	0.733
Te ₂	Public vehicle	0.747
Te ₄	CCTV cameras	0.586
Governance		
Gov ₁	Program innovation	0.816
Gov ₂	The vision of local leaders about the residential area	0.889
Gov ₃	Participation in the planning process	0.911
Gov ₄	Permitting of residential transactions	0.829
Gov ₅	Waste recycling program	0.866
Gov ₆	Proactive neighbourhood association and citizens' association	0.846
Gov ₇	Neighbourhood association and citizens' association facilitate formatting social media communication (intra- and inter-residents)	0.801
Gov ₈	Coordination in neighbourhood association and citizens' association related to the residential area	0.860
Gov ₉	Credible commitment of the local government	0.918
Gov ₁₀	The design of activities that can strengthen social connections between residents	0.828
Gov ₁₁	Suburban small-scale farming incentives	0.838
Gov ₁₂	Certification for sustainable systems	0.716
Gov ₁₃	Transparency	0.837

Furthermore, we evaluate the overall model, aiming to assess whether the model has validity or not. Table 8 presents the results of the model test. Results of the first evaluation reveal that two components still have not produced a value according to established criteria, indicating that the model cannot be the best. In generating a better model, we modified the model based on Arbuckle's (1996) theory, which discusses how to modify the model by looking at the resulting modification indices. Arbuckle (1996) explained that the modification indices provided several recommendations for adding links between indicators to reduce the chi-square value to make the model more fit. After the modification, all the criteria are a good fit. Likewise, the criteria for GFI, TLI, and CFI, which were initially only able to achieve a marginal fit, increased to a good fit after the modification.

Figure 5. Selected SRA's indicator

Achieving residential area sustainability in suburban areas becomes critical when associated with the fact that more than 70% of the land in this area is used for housing and residential areas, both in residential areas built by developers and built individually by the community. The SRA will ensure regional sustainability. Therefore, in the economic pillar, for example, the price of a house in a residential area should be affordable for society. In addition, residential areas must also have access to public facilities (hospitals, malls, sports centres, etc.). Here, these findings clarify the classic theory about von Thunen's economic location.

In terms of the CCTV camera criteria, this becomes the best criteria assessed by stakeholders in realizing SRA. CCTV cameras are complementary infrastructure of a residential area. This facility plays a role in efforts to minimize incidents of criminality. Many studies agree that people's preference to live in residential areas is due to a sense of security. The purpose of safety is manifested in the form of completeness of supporting facilities, one of which is the presence of CCTV cameras ([Leisch, 2002](#)). In the context of SDGs, the fulfilment of CCTV cameras in residential areas supports the 16th goal, that is peace, justice, and resilient institutions. Thus, the following are three related indicators: the decrease in the number of murder crimes in the past year, the decrease in the proportion of the population who are victims of violent crimes, and the increasing proportion of people who feel safe walking alone in the area of residence.

In infrastructure aspects, public facility availability (roads, waterways, public lighting tools, landfills, etc.) becomes the best criteria that policymakers must choose in developing sustainable housing areas. Lastly, in the technology aspect, the availability of internet networks should get the attention of policymakers because this criteria obtains the highest degree of interest compared to other measures.

We would say that the model could be considered a system of interrelated systems to one another. In some literature reviews, the structure consists of the elements that are related to each other. In contrast, a system is a group of entities that interact or are interconnected to form a unity. The system is characterized by (1) a collection of materials and processes that together form several functional groups or uses and (2) the linkages of several processes characterised by causal trajectories (Grant 1986 in [Solimun et al., 2017](#)).

Table 8. Model evaluation result

Criteria	Cut-off Value	First-stage evaluation		Second-stage evaluation (model modification)	
		Estimation result	Annotation	Estimation result	Annotation
Chi-square (χ^2)	636.087	1496.070	Bad fit	509.028	Good fit
Significance probability	≥ 0.05	0.000	Bad fit	0.069	Good fit
RMSEA	≤ 0.08	0.078	Good fit	0.020	Good fit
GFI	≥ 0.90	0.751	Marginal fit	0.905	Good fit
CMIN/DF	≤ 3.00	2.584	Good fit	1.099	Good fit
TLI	≥ 0.95	0.865	Marginal fit	0.992	Good fit
CFI	≥ 0.95	0.876	Marginal fit	0.994	Good fit

By considering the results of the evaluation of the model, we can state that the built model can measure the SRA. All constructs consisting of economic, social, environmental, infrastructure, technology, and governance can be considered as new interrelated parameters in measuring SRA. A summary of indicators based on extensive literature studies can produce parameters and indicators that are more comprehensive than those of previous studies.

6. CONCLUSION

The concept of "triple bottom lines" (economic, social, and environmental) cannot sufficiently answer urban sustainability challenges, particularly in specific cases such as residential areas. We generate 51 SRA indicators grouped into economic, social, environmental, infrastructure, technology, and governance parameters based on extensive literature studies. Adding infrastructure, technology, and governance, we find that those parameters could answer the sustainability challenges of residential areas in Suburban Metropolitan Jakarta. We argue that infrastructure responds to the challenges of urban-suburban communities characterised by middle-class commuters who require a high speed of service and accessibility. Technology responds to sustainability challenges in an era of disruption in a complex urban context, especially the demand for services. Furthermore, governance provides the policy direction that government must take to achieve sustainable development.

By using SEM CFA, 36 selected indicators were produced that could be used as measurements to assess the SRA. The measurement model obtained also produces a robust and compact model because the model parameters are estimated simultaneously. This study provides that the model could be considered a structure and system that enhances the SRA. Although infrastructure, technology, and governance variables are built for the context of the SRA, they could be a novelty idea for further studies related to the development of sustainability, both for regional and sectoral and even for global contexts. In this study, some indicators were deemed useless at the policy level due to difficulties in using concrete policy. Nevertheless, as an empirical discourse, these indicators can be an initial thinking point for making them more operational.

In responding to technological change (disruption), further research can be conducted by developing extensive indicators within the technological parameter. However, improvement and even extension of indicators in other constructs are still possible in the future because some indicators in the economic construct produce unsatisfactory values. In terms of sampling

techniques, this study uses nonprobability sampling. The limitation of the sampling technique is yielding samples that are less representative of the population. After all, the procedures include our subjectivity. The reason for this is that a complete list of population members to be sampled is not available. Therefore, we recommend using probability sampling to produce better estimates for future studies.

In terms of its application in public policy formulation, the results of this research are helpful in the efforts to improve the draft concept of sustainable housing in Indonesia. Moreover, the study improved the various indicators devised by the National Standardization Agency of the Republic of Indonesia in 2014.

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