How Bandung Smart City Policy Influences Its Citizen's Quality of Life:

I. Model Development

Lidia Mayangsari[1,2], Takeshi Arai[1]

[1]Department of Industrial Administration, Faculty of Science and Technology, Tokyo University of Science, Japan.

[2]Department of Science in Management, School of Business and Management, Institut Teknologi Bandung, Indonesia.

Abstract

This study analyzes the significance of the decision of Bandung city government on implementing smart city policy to the citizens' quality of life (QoL). This study applies the system thinking logic of the Causal Loop Diagram (CLD) adapted from the system dynamics (SD) approach to track the appropriate variables of QoL in Bandung city which is sufficient to be evaluated by the smart city framework. The outcome resulted from the modeling process is causal feedback loops and interrelationship which is employed to assist the analysis of issues that hamper both the dynamics of QoL and the development of smart city framework in Bandung city as the case study. Reflected from its initiation in 2010 and characteristics of development trend until 2014, this explorative study identifies the cause and effect relationships between the QoL variables and the six main dimensions of Bandung Smart City program: smart people, smart living, smart economy, smart environment, smart government, and smart mobility. This study proposes a result of Bandung Smart City strategic planning which has been adapted to the maturity, readiness and capability of Bandung as smart city resulting in an increase in the dynamics of the QoL in its society. This study promotes a holistic view and carries system thinking spirit in the decision making process and prejudice clarification of the uncertain and unpredictable shortcomings resulted from city problem.

Keywords: 8 kata

Smart City and Quality of Life

The interest to improve the quality of life (QoL) in cities as a result of the increasing city sprawls has become the emerging focus of attention for both academicians and practitioners. Along with the interest, measuring and analyzing the factors that affect QoL have also been the subject of both theoretical and empirical work from various disciplines. One of the promising city sprawl tackling concepts proposed by cities is the smart city concept which contains an objective of improving QoL for the people living there. There are only limited numbers of studies focusing on how to evaluate the dynamics of QoL resulted as the output of smart city framework.

It is natural that developments can only be managed instead of stopped. One of the cases is the world population growth which shows steep increase with 1.1% rate per year or 75 million in number (UN-FPA 2007). Additionally, more than half of the world's population now lives in urban areas (Dirks & Keeling 2009). With this rapid increase of the urban population worldwide,

cities face a variety of risks, concerns, and problems from both hard, deteriorating infrastructure conditions for instance, and soft, like social segregation, aspects (Nam & Pardo 2011). Bringing out the 'smart' identity of a city is currently emerging as a strategy to mitigate and manage city problems (Chourabi et. Al 2012). The smart city concept has become the central idea to which cities are now turning to face their challenges and pursue the demands put on them (Veldhuis 2014). Despite of many debatable definitions available to smart city label, for example a self – congratulatory fashion (Holland 2008), soft and ICT capital with triple helix city management (Allwinkle & Cruickshank 2011), and city performances measurement (Giffinger 2007), smart city is positive attribute of a city. One possible smart city definition preferred in this work is a city that, through public and private sector collaboration, has invested in ICT infrastructure, human capital to drive economic growth, facilitate the exchange of information between sectors, and produce resource-efficient operations that enable citizen QoL improvement through city services and local wisdoms. This definition embeds a final massive purpose of smart city which is the improvement of the Quality of Life (QoL, Saphiro 2006). However, only limited numbers of academic research have discussed the dynamics of the smart city phenomenon (Chourabi et. al 2012) and what those studies do not provide is a system view of how each smart city characteristics bring to the QoL of its citizens (Veldhuis 2014). Urban dynamics model by Forrester (1969) captured how the urban framework gives impact to the QoL. The limitation is that the variables used are less applicable to nowadays city dynamics. Over time, researches study and state more appropriate QoL variables to be employed in modern life as new decision-making approach (

This study inventories some of the variables by prior researches and also provides a system view of the dynamics of smart city development affect the level of QoL in a city. The case study is the capital city of West Java province, Bandung, which is currently in progress of becoming one of the smart cities in Indonesia. The CLD acts as a generic template of how the causally interrelated QoL variables describe the dynamics of smart city as the framework and QoL as the outcome.

Review on QoL

Questions and wonders about the essentials constructing a good life have captured the attentions of the greatest thinkers across time and cultures, from Aristotle to Emmanuel Kant, from Eastern Philosopher to modern authors (Diener & Suh 1997). Several definitions and perspectives concerting the measure of QoL arise these days. Diener & Diener (1995) found that measuring the wealth is significant to be correlated as QoL indicator. Constanza (2006) defined QoL as a representation of comparison between human needs and their satisfaction perceived when they fulfilled those needs which came from various life domains. Many perspectives and scales could be considered in measuring QoL, especially for the urban life.

Number of authors arranged various measures or variables that represent the QoL ranging from social indicators such as health and levels of crime, subjective well-being measures (assessing people's evaluative reactions to their lives and societies), to several economic indices (Diener & Suh 1997). Currently, International Organization for Standardization (ISO) also released ISO 37120:2014 as the benchmark of the city services and QoL measure. Of the various QoL measures El-Din et al. (2013) proposed seven categories which are environmental, physical, mobility, social, psychological, economical, and political. Those seven dimensions are

theoretically studied and described with thirty basic measures which are applicable and combinable to achieve QoL. The categorization proposed by them is actually in line with the clustering of smart city system from Giffinger (2007) that mentioned six interrelating characteristics: smart people (individual and social), smart living (physical and social), smart environment, smart governance (political, policy, and management), smart economy, and smart mobility. According to this clustering, several QoL measures from literatures can be summarized in Table 1.

People Cluster	**Living Cluster**
public safety/crime [1,2,3,4,7,8,12,13], **education level** [1,4,6,7], arts/cultural diversity [1,3], lifestyle opportunity [5], relationship [8,10], health [8], social life [8], spiritual life [8], heritage preservation [9], human capital [10,12], productivity [10], number of population [10], community availability [10], suicide rate [11], literacy rate [11], **homicide rate** [11,14,15], labor & social process [12], individual resilience [12], self-organization [12,14], income disparity [12], work-life balance [14], skill assessment [14], long life learning participation [14], volunteering level [14], social support potential [14], social contact frequency [14], survival rate of education [15], female in school [15]	**housing cost & access** [1,2,3,4,6,7,8,9,13,14], **recreation** [3,4,15], food cost [3,4], **living atmosphere** [5,6,7,12], leisure activities [8], Eco-building [9], compact neighborhood [9], open space [9], public gathering space [9], physical needs fulfillment [11], social living condition [12], health [12], social cohesion [12], duration of residence [12], urban planning quality [12], health care expenses [12], housing quality [12], physical safety [12], vacant housing [12], cultural facility [13], sport facility [13,14], building quality [13], life expectancy [14], infant mortality [14]
Environment Cluster	**Economy Cluster**
pollution [2,3,4,5,7,8,14,15], **climate** [3,4,5], clean air [9], water quality [9,15], **green area** [8,13,15], non-toxic material [9], ecosystem services [10], durability awareness [10,12], deforestation [11], ecological footprint [12], use of non-renewable [12], consumption of raw material [12], sustainable tech [12], information of sustainability [12], sanitation [13,15], energy use per capita [15], energy consumption of public buildings [15], use of renewable energy source [15], green house gas emission [15], waste management [15]	**business climate** [1,2,6], **employment** [4,5,13,15], **wages** [1,6,10,12,14], commercial space [6], **job availability** [8,9,10,14], economic activities [9], local business promotion [9], economic attractiveness [10,12], economic vitality [12], land value [12], fraction of companies with environmental impact [12], working hour [14], wealth indicator [14], ability to face unexpected expenses [14], poverty [15], debt service ratio [15]
Governance Cluster	**Mobility Cluster**
health care [1,2,3,4,6,7,13,14,15], **education provision** [1,3,4,6,7,13,14], **political involvement** [1,2,8,14], state tax/dev. aid [4,6], disable people services [9], social participation [9,12], adaptable regulation & policy [9], integrated governance [9], purchasing parity power [11], quality of public service [12], institutional flexibility [12], media coverage of safety [12], quality of urban policy making [12], quality of information provision	**traffic flow** [4,6,7,12], proximity to supplier/market [6], pedestrian friendly streets & facilities [9], public transport [9,13,15], walking distance area [9], interconnecting streets to promote walking [9], traffic safety [12], fraction of cars durable [12], quality of road network [12], city accessibility [12], quality of transport network [12], quality of ICT infrastructure [12], number of Internet connection [15], number of cell phone

[12], financial health of the city [12], degree of CSR [12], urban political facility [13], emergency response facility [15], disaster victim [15], participation in election [15], women in politic [15]	connection [15], number of automobile [15]

Table 1. The quality of life measures collected from literatures: [1] Smith 1973, [2] Liu 1976, [3] Boyer & Savageau 1981, [4] Rogerson et. al 1988, [5] Burnley 1988, [6] Hart et. al 1989, [7] PCC 1990, [8] Bowling 1995, [9] El Din et. al 2012, [10] Beck 2013, [11] Diener 1995, [12] Veldhuis 2014, [13] Lotfi & Solaimani 2009, [14] European Commission 2014, [15] ISO 37120:2014

From above inventory, it is plausible to conclude that the urban QoL commonly measured using about seven fundamental measures (printed bold in Table 1): education, health care, safety, living condition, environment, economy (employment, wages, and job opportunity), mobility (and connectivity), and social participation (political involvement etc.). These measures can be viewed from individual perspective as indicator of citizens' QoL and also can be considered as aggregate for assessing the quality of city services. For now on, these measures act as the fundamental variables for system dynamics model development that is suitable to describe the situation of Bandung city QoL.

Challenges and Opportunities in Bandung City

Bandung is the provincial capital of West Java and also the third largest city in Indonesia with the total area of 167.30 km^2. Bandung has grown rapidly over the past decades and is expected to continue to grow. Its number of inhabitants is expected to grow from 2.4 million now to 4 million in 2030. Citizens and urban communities will have rising demands towards their quality of life. Their standards for living, needs of sufficient working and public space, assurance of clean and sustainable air, water, energy, waste management and transportation availability will become more important. Citizens will also expect better services from Bandung city, as the service provider where they live in, for health, education, and financial stability through job opportunity.

Bandung city has the chance to achieve the dream of becoming a better city with higher quality of life through the latest elected Mayor, Ridwan Kamil, who is also a city planner and architect by profession. He is taking the lead and intends to make Bandung the most livable city of Indonesia and one of his strategies is by embracing the principles of smart cities and communities. Smart city principles are at the core of his approach and should be applied to existing urban areas, infrastructure and social patterns as well as to new developments.

From the general perspective, Bandung city can be considered as a modern city with trading, tourism, and manufacture as its leading economic drivers according to the contribution of each sector to city's domestic product (BPS Bandung, 2014). From demographic point of view, statistics says that about 60% of Bandung citizens are below the age of 40 which is also categorized as productive age with their dynamics and creativity.

System Dynamics Model using Stella

System Dynamics (SD) has a well-defined normative apparatus with rules on how to decide which factors shall be part of a model, reasoning the mental model, define types of variable to construct it, quantify it, and validate it (Schaffernicht 2007). SD is a method to enhance causal thinking of mental model which are used to study causal reasoning of a problem (Richardson 2006). To that function, causal loop diagram (CLD) simply maps the causal links among variables with arrows from cause to its effects (Sterman 2000). It circulates in the same direction as the loop to which it corresponds. In other words, it follows the rules of clockwise or counterclockwise for one complete loop. Each arrow that brings causal link is assigned a polarity, positive (+) or negative (-), to indicate how the dependent variable changes when the independent variable changes. CLD as one of the main features of System Dynamics (SD) is appropriate to be used in this study as its objective in this part is to reason the causal relationship among variables describing the city QoL model and how smart city policy influences it. Stella software is employed for constructing the CLD.

This study compares some previous works using SD approach with similar topic discussion on the city, QoL, and smart city. The first study is done by Abby Beck in 2011 on understanding urban sustainability and QoL using SD approach. This study stresses on the statement that QoL can be understood as the capital per person. Disproportionally grow capital cannot satisfy people live within and encourage them to leave and abundant capital attracts new people that subtracts from the capital per person ratio. Adapted from Forrester's Urban Dynamics (1969), Beck (2011) identified four most important capitals to the city population: economic capital, natural capital, social capital, and human capital. Although the study uses the term of urban sustainability, the idea of smart city as one of the method to achieve urban sustainability is still relevant to this study. Smart city manages capital more effectively which is the objective of urban sustainability.

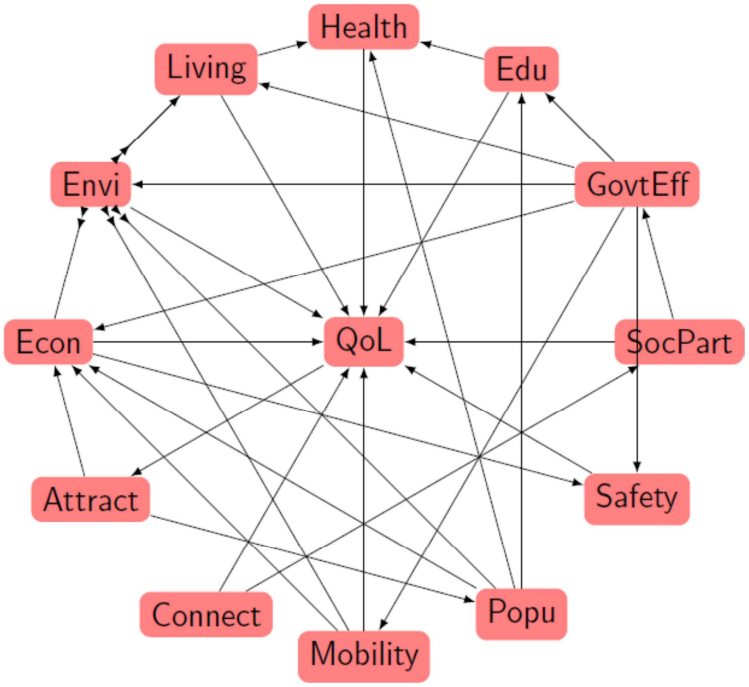
The second study is conducted by D.K. Das in 2012 which elaborates the conceptual modeling of smart city in South Africa using SD principles. Das adopts the smart city categorization made by Giffinger (2007): smart people, smart living, smart economy, smart environment, smart government, and smart mobility. The general template has been modified to suit the local condition of smart city development with more focus on the change on economic scenario. The study location is developing country which approximately has the same situation as Indonesia, the country where Bandung city located. Some variables used in the study can be adopted to the case of Bandung city.

The third study is the work of Veldhuis, Scheepstal, and Vink in 2014 on the development of generic smart city model using Method to Analyze Relations between Variables using Enriched Loops (MARVEL). Despite of the new approach, some important variables can be adapted to this study such as the systemic framework to support diverse sets of stakeholders in the development and analysis of future smart city initiatives. The three previous studies arises some variables which are suitable to be applied in the case of Bandung city and its smart city initiative.

Regarding the three previous studies, the causal relationship between the smart city policy and its impact to the city QoL is more discussed in this study.

Causal Loop Diagrams

Referring to the literature review on city QoL, variables employed in this study are education, health care, safety, living condition, environment, economy (employment, wages, and job opportunity), mobility and connectivity, and social participation (political involvement). The variables are chosen because they describe the situation of city QoL of Bandung in term of smart city policy implementation. Besides, the variables are quantifiable so they can be transformed to the next stage of SD approach which is the stock and flow diagram. Although they don't implicitly describe the smart city clusters, the ten variables are derived from the six smart city clusters by Giffinger (2007): smart people (population), smart living (living condition, health, education, safety, and city attractiveness), smart economy (economy), smart environment (environment condition), smart governance (government efficiency and social participation), and smart mobility (mobility and connectivity). Those variables are critical factor for analyzing the impact of broad policy intervention of smart city to the level of citizens' QoL using the conceptual causal loop and feedback relationships featured in system dynamics. Each variable is analyzed by its endogenous parameters, their causal relationships, and their influences on other variables to construct the understanding of city QoL to then develop policy intervention based on both positive and negative impacts. The causal loop diagram is derived and discussed as follows.



Population

The local population of Bandung city is influenced by the natural birth rate and death rate. Other factors that gives impact to the increasing population in Bandung city is the fact that Bandung attracts so many people coming to the city. Bandung has city attractiveness from education

opportunity, health facility, environment quality, and live economic function such as shopping facilities. In term of education, Bandung has 80 universities and higher education facilities which invite all promising students from all around the country and the world to study there. Although Bandung has only one public hospital, many private hospitals and smaller health care facilities are provided to maintain city health level. From environment perspective, Bandung offers a lot of natural tourism spots such as white crater, mountains, and hills. The natural capitals that Bandung owns give it fresh air and comfortable condition to live or only leisure. All the variables in the population sector gives positive to the QoL variable which means that supporting factors from city attractiveness improves the citizens' QoL.

Education

Education is one of the crucial aspects to be considered in the QoL. In Bandung city, the ratio is playing important role to measure the education quality. The first ratio is between the number of students enrolling to the school and the number of schools available to accept them. This study assumes that public and private schools are categorized as one variable school. The second ratio is between the number of students and the teachers handling them. From the statistical data released by Bandung city government in 2009, the student-teacher ratio for 939 elementary schools is 28:1 which means that one teacher handles 28 students. There are 214 junior high schools in Bandung and one teacher handles 57 students. This shows that the numbers of teachers for primary level of schools are very insufficient which therefore influence the citizens QoL.

Health

Healthy citizens resemble a healthy city. The statement is also applicable in the case of Bandung city. TMedi

Living Condition

Citizens QoL is influenced by the level of living condition in Bandung city. This study divides the living condition into two major parts which are physical and social living condition. The physical living condition is determined by the housing quality. More population means more demands for housing. The increasing rate of house price decreases the access of people to their housing facilities. However, there is a good quality for a good price. People with more money can get easier access to the housing with good quality as well as city amenity. Housing quality influence the citizens QoL.

Mobility

Mobility describes the level of accessibility and citizen movement by transportations available in the city. The more settled mobility infrastructure in the city influences positively to the city development which also improves the quality of public transportation. However, more numbers

of public transportation increase the density of road users, cause traffic, and again decrease mobility. This balancing loop in the mobility sector reflects Bandung city condition in terms of insufficient regulation for public transportation especially. Reckless drivers and random stopping spot are often done by Bandung's public transportation. There should be a better management for leading Bandung city mobility to a better way.

Connectivity

One of the backbones for smart city initiatives is the connectivity which is supported by ICT infrastructure. Connectivity increase the level of information coverage of the city to attract people come and visit Bandung city. City attractiveness gained can open the investment interest by private sector to the city. Investment collaborated between Bandung city and private sectors as public-private partnership is the most possible way to gain economic vitality and achieve the smart city initiatives come true. This relation between ICT infrastructure, connectivity, city attractiveness, and investment shape a reinforcing loop that improves citizens' QoL.

Future Works

The model develop in this study employs CLD as the constructing tool. The next step of the study is to transform the CLD models into a more quantitative stage of SD principle which is the stock and flow diagram (SFD). The ten main variables are stated as stocks with a flowing rate adapted from each growing rate per year taken from statistical record of Bandung city. The smart city programs which have been fixed by Bandung city government then perform as the intervention of the dynamics of citizens' QoL.

Discussion

Reference

Beck, A. & Stave, K. 2011. Understanding Urban Quality of Life and Sustainability, Proceeding of the 29th International Conference of the System Dynamics Society, Washington, DC

Beck, A. & Stave, K. 2012. Understanding Urban Quality of Life and Sustainability Model Development and Validation, Proceeding of the 30th International Conference of the System Dynamics Society, St. Gallen, Switzerland

Bordieu, P. 1986. The Forms of Capital, In A. H. Hasley, H. Lauder, P. Brown, & A. S. Wells (Eds.), Education: Culture, Economy, and Society. Oxford: Oxford University Press

Boyer, R. & Savegeau, D. 1981. Places Rated Almanac: Your Guide to Finding the Best Places to live in America. Chicago: Rand McNally.

Burnley, I. 1988. Population turnaround and the peopling of the countryside? Migration from Sydney to country districts of New South Wales, Australian Geographer, 19, 268

Das, D. 2013. Using System Dynamics Principles for Conceptual Modelling of Smart City Development in South Africa, Conference Proceedings, Sustainable Building (SB) Conference: Creating a Resilient and Regenerative Built Environment, Cape Town, pp. 74-91, ISBN- 978-1-920508-23-4.

Diener, E. D. & Diener, C. 1995. The Wealth of Nations Revisited: Income and Quality of Life. Social Indicators Research, 36, 275

Diener, E. D. & Suh, E. 1997. Measuring Quality of Life: Economic, Social, and Subjective Indicators. Social Indicators Research, 40, 189

El Din, H. S., Shalaby, A., Farouh, H. E., & Elariane, S. A. 2013, Principles of Urban Quality of Life for a Neighborhood, HBRC Journal, 9, 86

Europe Union. 2013. Quality of Life in Cities: Perception Survey in 79 European Cities, Luxemburg: Publications Office of the European Union

Forrester, J. 1969. Urban Dynamics. Cambridge: MIT Press

Giffinger, R., Fertne, C., Kramar, H., Kalasek, R., Pichler Milanovic, N., & Evert, M. 2007. Smart cities – Ranking of European medium-sized cities, Final project report, pp. 1-25

Liu, B.-C. 1986. Alternative explanations for inner city gentrification: a Canadian assessment, Annals of the Association of American Geographers, 76, 521

Lofti, S. & Solaimani, K. 2009. An Assessment of Urban Quality of Life by Using Analytical Hierarchy Process Approach (Case StudyL Comparative Study of Quality of Life in the North of Iran), Journal of Social Sciences, 5, 123

Rogerson, R. J. 1999. Quality of Life and City Competitiveness, Urban Studies, 36, 969

Saphiro, J. M. 2006. Smart Cities: Quality of Life, Productivity, and the Growth Effects of Human Capital, The Reviews of Economics and Statistics, 88, 324

Smith , N. I1973. Geography of Social Well-being. New York: McGraw-Hill

Veldhuis, G., van Sceepstal, P., & Vink, N. 2014. Development of A Generic Smart City Model Using MARVEL, Proceeding of the 32nd International Conference of the System Dynamics Society, Delft, Netherland

Schaffernicht, M. 2007. Causality and Diagrams for System Dynamics, Proceeding of the 25th International Conference of the System Dynamics Society and 50th Anniversary Celebration, Boston

Richardson, G.P. 2006. Concept Models. Proceedings of the 24th International Conference of The System Dynamics Society, Nijmegen.

Sterman, J. 2000. Business Dynamics – System Thinking and Modeling for a Complex World. John Wiley.