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Development of a Key Performance Indicators System in Urban Planning by Utilizing the Logic Model

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Abstract

This study proposes the methodology and process to develop a Key Performance Indicators (KPIs) system in urban planning by utilizing the logic model. Firstly, the study introduces the role of KPIs in urban planning for measuring the performance of the whole planning process, and the logic model as a powerful tool for selecting KPIs, as well as the ability to apply it in urban planning issues. Secondly, methodologies are given, including: building a KPIs system from the logic model's components, data collection for KPIs, and data analysis. Thirdly, the case of the Hanoi master plan is presented, to investigate how the logic model works for KPIs development. The process of the logic model application includes: identification of planning policies; zoning Hanoi for the simulation of the policies' effects; utilizing the logic model for selecting KPIs; analysis of logical linkage between the logic model's components; and Hanoi urban data availability for KPIs.

Keywords

Urban Planning, Logic model, KPIs, Hanoi

Introduction

"Urban planning" is a technical and political process concerning a whole set of social activities aimed at anticipating, representing, and regulating the development of an urban or a regional area (Pinson, 2007), while "urban plan" is a product of economic negotiation between land-owners and the local planning agency (Pradoto, 2012). According to Breuer (1999), planning implementation fits well with the view of planning as a process rather than a product. Wapwera *et al*. (2015) also mentioned that implementation is a continuous process, with no clear-cut endpoint. Inside the field of urban planning, a master plan is a tool to guide and manage the future growth of cities in a planned manner and the soul of a master plan lies in its implementation framework (Hameed and Nadeem, 2008).

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How do you measure the performance of the urban planning process during the implementation of an urban plan? And which factors can be used to measure the effects of policies? The solution is to have a key performance indicators (KPIs) system for monitoring during the planning process until goals/objectives are met, to measure the planning process, and to test and incorporate feedback before being committed to implementation. From this point of view, it raises the question of how to develop a KPIs system for a physical urban plan in a logical way.

KPIs are utilized in both urban development plans and government policies and initiatives. Indeed, many ideas and research articles have shown the benefits of KPIs in city development. The use of KPIs is critical to measure and to quantify efficiency improvements in city services through the implementation of master plans (Bertuglia *et al*., 1994). Mega and Pedersen (1998) supposed that KPIs are based on policy principles and goals, so KPIs are meaningless without specified objectives, and they cannot contribute to the improvement of the urban quality of life if there is not a policy framework. A similar idea shows that KPIs have to be measured and relevant to urban planning outcomes, in that they reflect local objectives and priorities or processes (Zhang *et al.*, 2008). In general, the development and implementation of KPIs are essential to provide a basic set of criteria to evaluate existing cities and to measure the results of different projects, with the aim of increasing sustainable urban development. KPIs can be beneficial in measuring the results of the urban planning process and the implementation of policies, and in supporting decision-making. However, the development of a KPIs system is definitely not a simple process and will have to be checked and updated periodically.

The logic model, as known for several years, is a tool for program planning, management, and evaluation (Chen, 1990). A logic model can be used for telling the program's performance story by describing the logical linkages among program resources, activities, outputs, customers reached, and short, intermediate, and longer term outcomes (McLaughlin and Jordan, 1999). Figure 1 illustrates the simple logic model. Accordingly, *resources* include the inputs that are dedicated to or consumed by the program; *activities* show the way the program is working; *outputs* include the products from the program; and *outcomes* indicate benefits resulting from activities and outputs (Figure 1).

The logic model has been popularly used in health and community-based programs to support development and evaluation. In the field of evaluation and program planning in recent years, the process of developing a logic model will clarify the project's goals and assign responsibility of participants for tasks and outcomes by guiding program participants in applying the scientific method to their project development, implementation, and monitoring (Kaplan and Garrett, 2005). One of the important purposes of using a logic model is developing KPIs to check performance and measure success for evaluation. It is useful to translate the logic model's components into indicators to check progress in inputs, activities, outputs, outcomes, and goals, and to provide necessary feedback to the management system (Jody and Ray, 2004). However, there are limited studies that have brought the logic model into urban planning issues, although it is completely possible to apply measuring planning policies' effects, in order to develop KPIs system.

The idea of developing KPIs system in urban planning field is not new. Indeed, KPIs are built for cities in development, mostly focus on Information and Communication Technology (ICT) and sustainable development (European Commission, 2014; Candiello and Cortesi, 2011).

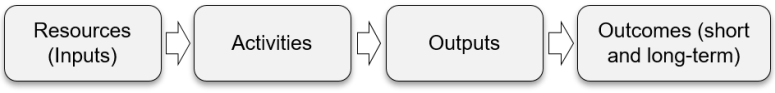

Figure 1. The Logic Model

Henning *et al.* (2011) developed indicators system in urban transportation for performance measures. Hanoi master plan (MOC, 2009) only selected a few KPIs in the field of land use. Generally, many studies and projects did not cover all KPIs of cities in development. Also, they used several ways, except the logic model, to develop KPIs. To the best of our knowledge, the logic model has been used popularly in health and community-based programs with an important purpose of developing KPIs. However, it has almost been ignored in urban planning utilization.

In Hanoi urban planning and development, evaluation in urban planning is still a rare consideration, from which the KPIs development is generally weak. In addition, urban plans normally focus on giving planning products, rather than on the process and implementation. The newest master plan "Hanoi Capital Construction Master Plan to 2030 and Vision to 2050" (MOC, 2009; Decision No. 1259, 2011) is considered the largest-scale plan in recent history and gives Hanoi the opportunity to become a megacity in Asia. To achieve new goals and visions for Hanoi, it is necessary to evaluate the implementation process of the plan to identify the way the government and organizations achieve their goals/objectives. For the successful implementation of an urban plan, at the initial step, it is crucial to propose a comprehensive KPIs system in different areas of development.

Developing a system to measure the performance of urban planning is not a simple task; generally, it needs to manage the policies' effects quantitatively to determine planning progress, formulate goals and outcomes, and must reflect local realities. For quantitative management of policies' effects by output-KPIs and outcome-KPIs, the logic model can be an extremely helpful tool to conceptualize the planning process by an array of actions to achieve specific impacts and goals. This study aims to propose a concrete process of developing a KPIs system in urban planning by the logic model, and applying it for the case of the Hanoi master plan. In more detail, the logic model will be utilized to understand the plan's components and their linkages, and then select KPIs based on the model's outputs and outcomes, and based on Hanoi urban data availability and quality.

Methodologies

Building a KPIs system from logic model's outputs and outcomes

In this methodology, firstly, the application of the logic model will illustrate how planning policies (inputs) work (through activities) to get results (outputs) and benefits (outcomes), as shown in Figure 2.

Secondly, outputs and outcomes will be translated into measurable KPIs, as output-KPIs and outcome-KPIs, respectively. Output-KPIs and outcome-KPIs must be measurable and observable, and linked to accumulated urban data. The availability and quality of urban data would bring useful information in order to set up a comprehensive and transparent KPIs system. For selection of KPIs, we use the SMART principle (NAMS Ltd., 2007) which can cover all of the criteria for performance measurements, including: Specific, Measurable, Achievable, Relevant, and Timebound.

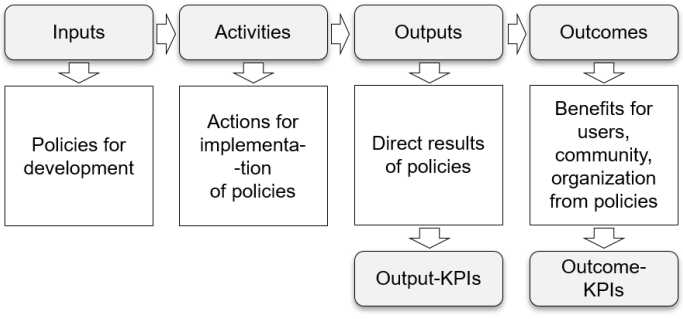

Figure 2. The utilization of the logic model to develop KPIs

Each KPI should meet all of these five criteria, otherwise they will suffer and be less useful. KPIs may be qualitative and quantitative, however, in urban planning, we enhance a simple and quantitative system, rather than a completed qualitative one. When selecting and systemizing KPIs, we may face some cases such as more than one policy shares the same outcome, so those policies will share the same KPI; or, one policy can have more than one outcome, so each outcome will have an outcome-KPI. Therefore, developing KPIs inevitably takes more than one try, and arriving at the final set of KPIs will take time.

Data Collection

In the process of identifying urban data for KPIs, we need to clarify what sources of information can potentially supply relevant data. Can data sources provide qualitative and quantitative data? And can we access the data source timely? Indeed, we only need to collect the data items intended to be used in our project. For example, for selecting KPIs in an urban plan, the collected data must be related to urban planning issues and their goals. In addition, data can be directly collected by the organization or secondarily outside organizations.

When we indicate data sources, we have to clarify what methods can be used to collect data (direct collection, survey, and technologies, etc.). It is difficult to answer which method is the best way to collect data because it depends on the availability and time constraints of an organization's resources. We may combine different methods for the best result in building an urban data system for KPIs.

Data Analysis

For the development of KPIs, the Hanoi urban data has to be identified and organized by units, periods, items, and sources. It will show how to analyze the urban data for KPIs and how available and qualitative the urban data are. The urban data needs to be organized and analyzed in terms of their relationship to urban planning policies at the city and district levels, among several areas of development from the Hanoi master plan.

Results and Discussion

The newest construction master plan "The Hanoi Capital Construction Master Plan to 2030 and Vision to 2050" is considered the largest-scale plan in Hanoi and gives Hanoi the opportunity to become a megacity in Asia. The Hanoi master plan has identified two big targets: economic development and reduction of overcrowding in the city center (by planning satellite cities and promoting the development of sub-centers). Following that, Hanoi will achieve urban agglomeration including: the city center, 3 sub-centers, 5 satellite cities, and 3 eco-cities.

There are several studies that mention the development of KPIs in Hanoi cases with several ways of approaching the problem (Dung, 2009; Hai, 2013). However, this study illustrates the first time the logic model is utilized to develop KPIs for a large-scale project, such as the Hanoi master plan.

This section investigates how the logic model works for building a KPIs system for the Hanoi master plan, and from that, the possibility to reach the urban master plan's performance. Accordingly, we identify planning policies to support the planning goals. Then, the application of the logic model for developing KPIs is presented in detail, including: zoning Hanoi based on the logic model simulation, KPIs selection, and analysis of the logical linkage between model's components.

Identification of planning policies

To develop a KPIs system, it is necessary to clarify the goals of the Hanoi master plan. Indeed, we have to identify the details of the planning policies, as inputs, from the Hanoi master plan in the strong relationship with its general planning goals.

The planning policies of Hanoi master plan were listed up to support the three general planning goals. The full list of policies in the Hanoi master plan are presented in a wide range of development areas at different levels, so we need to limit them by priority. While the goals describe long-term and widespread improvements in society, outcomes present

intermediate effects of outputs on users. In order to identify outcomes to move closer to the goals, the prioritization of selecting policies has to focus on urban planning issues, goals of the master plan, and availability of urban data systems. We identified the list of planning policies from the Hanoi master plan, as shown below, with the type of policies consistent with the 1st, 2nd, and 3rd goals, as 1st, 2nd, and 3rd general outcomes, representatively:

- 1st general outcome: "Ensuring the sustainable development of the urban structure" - policies focus on:

- spatial development orientation;

- spatial connection (transportation planning);

- planning and development of strategic areas (satellite cities and sub-urban centers, etc.); and

- production (agriculture and industry).

- 2nd general outcome: "Exploit the potential value of geographic landscapes/knowledge - technology/history, culture, tradition" - policies focus on:

- landscape issues (open space and green space, etc.); and

- history and culture (conservation and tourism, etc.).

- 3rd general outcome: "Using land effectively and having a synchronous, modern, and environment-friendly urban infrastructure system" - policies focus on:

- technical and social infrastructure planning; and

- environment protection.

Therefore, in this study, our hypothesis suggested that KPIs must relate to Hanoi master plan outcomes and policies, the number of KPIs should be limited in urban planning issue, and each KPI should be comprehensive and observable enough to measure the correlative policy.

The KPIs system will be developed by filling the logic model in inputs, outputs, and outcomes as shown in the next section.

Zoning Hanoi for simulation of policies' effects

As shown in Figure 3, the coverage area is subdivided into 5 regions (within 29 districts) by district borders for the logic model simulation, including: R1-Central Region (7 central districts), R2-North Region (3 districts), R3-West Region (8 districts), R4-South Region (9 districts), and R5-East Region (2 districts). This zoning system was based on the Hanoi expansion and policies of spatial orientation development from the Hanoi master plan, in which, Hanoi has expanded mostly in the West, South-West, and South.

In this section, it raises a question why we do not use the administrative zoning system of individual 29 districts? If using narrow district borders, it is difficult to clarify the effects of policies during their implementation process. Thus, we have to cross the district borders to evaluate the policies' effects by wider regions.

Utilizing the Logic model for selecting KPIs

For selection of the KPIs system for the Hanoi master plan, a logic model was developed to give an explanation between the resources and results of the plan. The inputs were the planning policies that provided support to the three planning outcomes, and to the urban planning and development issues related to Hanoi urban data quality and availability. From the inputs, activities were undertaken to transform to outputs and outcomes. Accordingly, outputs and outcomes were observed as direct results and benefits for users, communities, and organizations from those policies, respectively. Finally, KPIs were selected as factors to measure outputs and outcomes, as shown in Table 1.

The KPIs proposed in this study allow for performance measurements in the main areas from the Hanoi master plan: spatial development; transportation development; service and trade network; housing development; open and green space; university network; health network and community healthcare; agriculture; industry; and conservation.

In this study, we have proposed the full KPIs system for an urban master plan to measure planning policies. This is in contrast to the previous studies that imply the current study has been considered diverse areas of urban planning and development for a whole city master plan, and utilized the logic model to develop KPIs from model's components. Moreover, the model's outcomes have to be selected based on intermediate effects or benefits from outputs on users, not policy providers.

Analysis of logical linkage between logic model's components

In this section, we will show three illustrations from Table 1 to explain the logical way to select KPIs from the planning policies in four different areas: spatial development, transportation development, health care development, and industrial development.

In the first case, as shown in Figure 4, if 3 sub-urban centers are developed and 5 satellite cities are planned, the demographic movement will happen from the city center to the 3 sub-urban centers and 5 satellite cities. As a result, both the population and growth rate in the city center (R1) will decrease, and the growth rate of population in sub-urban centers and satellite cities, regions 2, 3, 4, and 5 (R2, R3, R4, and R5) will increase at a higher speed at the same time. Those KPIs are close to the planning objective of reducing population pressure in the city center by planning satellite cities. In detail, the output-KPI (the population in R2, R3, R4, and R5) is used to measure migration from the city center to sub-centers and satellite cities; the outcome-KPI (population in R1) is used to measure the population growth rate in the city center.

The second case illustrates positive impacts of the UMRT system to Hanoi, measured by 5 KPIs. Indeed, the operation of UMRT lines will attract users, and thus it will increase the percentage of users using public transport in the whole city. Further benefits for users include that the UMRT system will help to increase traffic safety, as well as decrease traffic congestion, air pollution, and also growth rate of population in the city center (by changing household's choices of living). Those outcomes can be measured by KPIs respectively as shown in Figure 5. Accordingly, we measure traffic congestion by travel time, traffic safety by

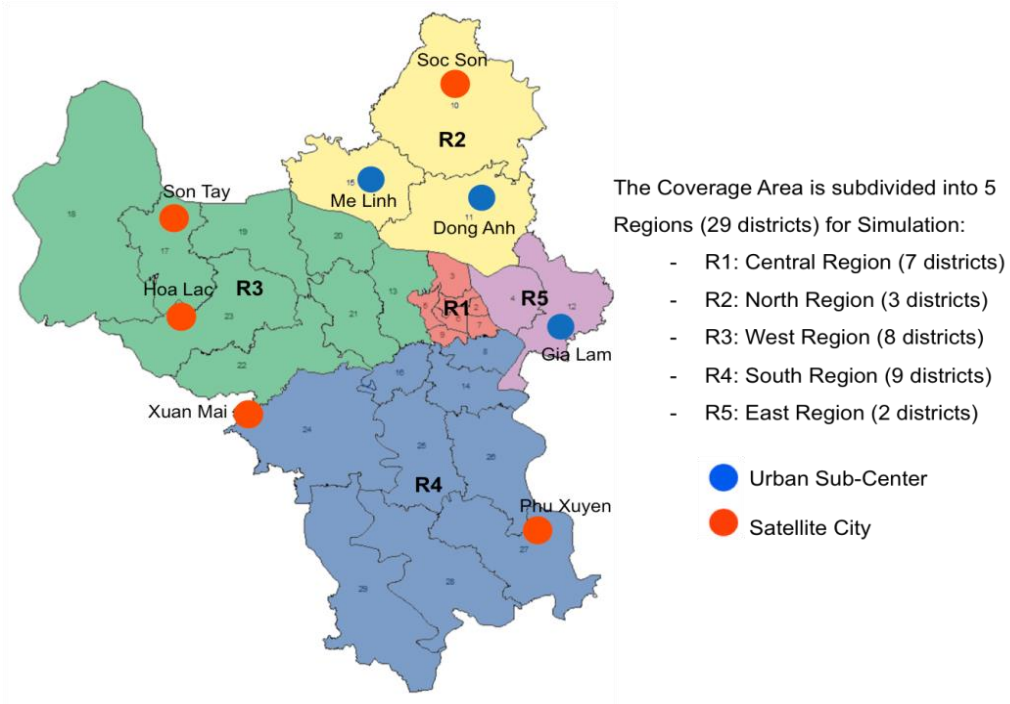

Figure 3. Zoning by regions

Table 1. KPIs selection by Logic model in the Hanoi master plan

Areas	Inputs	Outputs	Output-KPIs	Outcomes	Outcome-KPIs
Spatial Development	Planning 5 satellite cities and development of 3 sub-urban centers around Hanoi center	Increase migration from city center to satellite cities and sub-centers	Population in R2, R3, R4, and R5 a1	Decrease growth rate of population in city center	Population in R1 b1
	Development of industry and aviation services (for Noi Bai International Airport) in Soc Son	Increase population in Soc Son and surrounding districts	Population in R2 a2	Increase laborers in industry Increase laborers in service	Number of laborers in industry b2 Number of laborers in service b3
	Development of education, science, and technology in Hoa Lac	Increase population in Hoa Lac and surrounding districts	Population in R3 a3	Increase laborers in science and education Increase number of students	Number of laborers in science and education b4 Number of students b5
	Development of small industries and handicrafts in Xuan Mai	Increase population in Xuan Mai and surrounding districts	Population in R3 and R4 a4	Increase laborers in industry	Number of laborers in industry b2
	Development of cultural history, ecotourism, and handicrafts in Son Tay	Increase population in Son Tay and surrounding districts	Population in R3 a3	Increase laborers in industry Increase tourist visitors	Number of laborers in industry b2 Number of times tourist visitors stay in Hanoi's hotels b6
	Development of industry, warehouse, and transport hubs in Phu Xuyen	Increase population in Phu Xuyen and surrounding districts	Population in R4 a5	Increase laborers in industry	Number of laborers in industry b2
	Development of high-tech industries, commercial services, international trade, ecotourism with Co Loa relics, Van Tri swamp, and sport center of Hanoi (ASIAD) in Dong Anh sub-center	Increase population in Dong Anh sub-center and surrounding districts	Population in R2 a2	Increase laborers in industry Increase laborers in service Increase tourist visitors	Number of laborers in industry b2 Number of laborers in service b3 Number of times tourist visitors stay in Hanoi's hotels b6
	Development of services, and clean, high-tech industries associated with aviation services in Me Linh sub-center	Increase population in Me Linh sub-center and surrounding districts	Population in R2 a2	Increase laborers in industry Increase laborers in service	Number of laborers in industry b2 Number of laborers in service b3
	Development of industries and high quality services in Gia Lam sub-center and Long Bien district	Increase population in Gia Lam sub-center and surrounding districts	Population in R5 a6	Increase laborers in industry Increase laborers in service	Number of laborers in industry b2 Number of laborers in service b3
	Planning new residential areas in 5 satellite cities and 3 sub-urban centers	Increase housing floor area	Total newly built area of residential housing in the year a7	Increase housing floor space ratio Decrease growth rate of population in city center	Housing floor space ratio b7 Population in R1 b1
	Construction and improvement of main axes from the city center to satellite cities and between satellite cities	Increase travel demand	Number of trips per day between different districts a8	Decrease traffic congestion	Travel time b8

Transportation Development	Complete the ring roads IV and V	Increase travel demand	Number of trips per day between different districts a8	Decrease traffic congestion	Travel time b8
	Planning the Urban Mass Rapid Transit (UMRT) system combined with other public transport systems to create an efficient and interconnected network	Increase users of public transport	Percentage of passengers using public transport a9	Decrease traffic congestion	Travel time b8
				Increase traffic safety	Number of fatalities and injuries per year due to accidents b9
				Decrease air pollution from transportation	Air Quality Indicator (AQI) b10
				Decrease growth rate of population in city center	Population in R1 b1
	Planning the Bus Rapid Transit (BRT) system	Increase users of public transport	Percentage of passengers using public transport a9	Decrease traffic congestion	Travel time b8
				Increase traffic safety	Number of fatalities and injuries per year due to accidents b9
				Decrease air pollution due to transportation	Air Quality Indicator (AQI) b10
				Decrease growth rate of population in city center	Population in R1 b1
	Construction of two-level roads	Increase travel demand	Number of trips per day between different districts a8	Decrease traffic congestion	Travel time b8
				Increase traffic safety	Number of fatalities and injuries per year due to accidents b9
Service and Trade network	Planning network of trade and service enterprises	Increase productivity in trade and service	Gross domestic product at current prices by service a10	Increase laborers in trade and service enterprises	Number of laborers in trade and service enterprises b11
	Planning and managing network of establishments in private trade and services	Increase productivity in trade and service	Gross domestic product at current prices by service a10	Increase laborers in private trade and services	Number of laborers in private trade and services b12
Housing development	Moving residents from the city center to new towns in sub-centers and satellite cities	Increase migration from city center to sub-centers and satellite cities	Population in R2, R3, R4, R5 a1	Decrease growth rate of population in city center	Population in R1 b1
	Planning and improving new towns in districts surrounding city center and 5 satellite cities	Increase housing floor area	Total newly built area of residential housing in the year a7	Increase housing floor space ratio	Housing floor space ratio b7
Open and green space	Improvement of green spaces and city parks: Co Loa, Den Soc, Ho Tay, Thu Le, Thong Nhat, Yen So, and Me Tri, etc.	Increase open and green spaces	Area for open and green spaces a11	Increase open space ratio	Open space ratio b13

University network	Building new clusters for universities in Hoa Lac, Son Tay, Xuan Mai, Phu Xuyen - Phu Minh, Chuc Son, and Soc Son	Increase area and space for colleges and universities	Number of colleges and universities a12	Increase number of students Decrease growth rate of population in city center	Number of students b5 Population in R1 b1
Health network and community healthcare	Construction of new general health clusters in Hoa Lac, Soc Son, and Thuong Tin-Phu Xuyen	Increase number of health establishments	Number of health establishments a13	Increase number of patient beds Increase number of health staffs Decrease growth rate of population in city center	Number of patient beds b14 Number of health staffs b15 Population in R1 b1
Water supply	Construction of surface water factories in Hong and Duong rivers; Improvement of surface water factory in Da river	Increase fresh water consumption	Average output of water per day a14	Increase percentage of population using fresh water	Percentage of population in using fresh water b16
Electricity supply	New construction of 4 transformer stations 500KV, 21 transformer stations 220KV, and improvement of 5 transformer stations 220KV	Increase output of electricity	Average output of electricity per day a15	Increase percentage of households with access to electricity	Percentage of households with access to electricity b17
Agriculture	Establishment of high-tech agricultural zones	Increase gross domestic product by agriculture	Gross domestic product at current prices by agriculture a16	Increase gross output of agriculture per capita	Gross output of agriculture per capita (at current prices) b18
Industry	Moving out polluted industrial zones in the core urban area to new positions determined in the Master Plan	Increase gross domestic product by industry	Gross domestic product at current prices by industry a17	Increase gross output of industry per capita Increase laborers in industry	Gross output of industry per capita (at current prices) b19 Number of laborers in industry b2
	Establishment of 3 industrial regions (7000 – 8000 ha): the North, the South, and the West	Increase gross domestic product by industry	Gross domestic product at current prices by industry a17	Increase gross output of industry per capita Increase laborers in industry	Gross output of industry per capita (at current prices) b19 Number of laborers in industry b2
Conservation	Conservation of Hanoi Citadel, Ancient Quarter, French Quarter, Thang Long bridge, and Duong Lam village, etc.	Increase tourism	Number of times tourist visitors stay in Hanoi's hotels b6	Increase tourist visitors	Number of times tourist visitors stay in Hanoi's hotels b6

Note: a1, b1, a2, and b2, etc.: Numbering of KPIs.

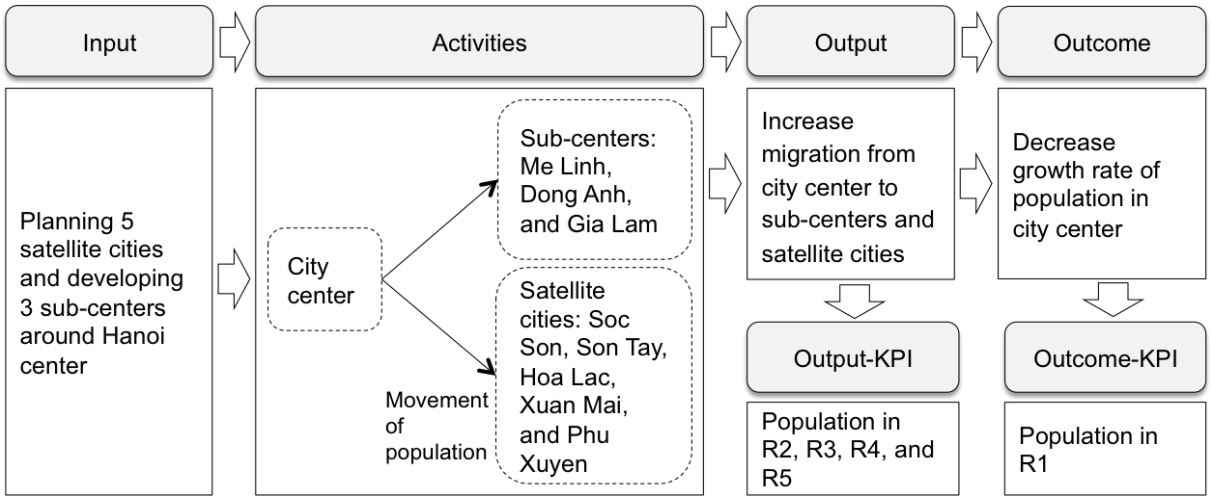

Figure 4. Logic model for the policy "Planning satellite cities and development of sub-centers"

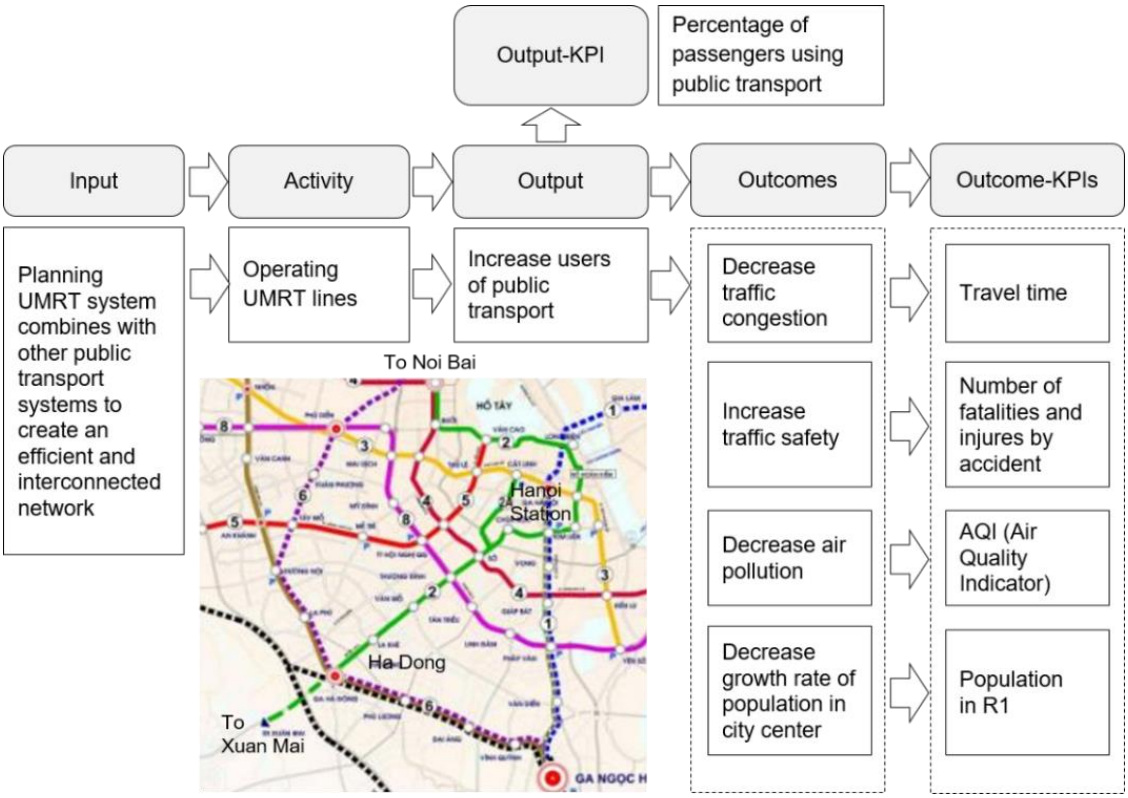

Figure 5. Logic model for the policy "Planning UMRT system"

number of fatalities and injuries due to accidents, air pollution by AQI (Air Quality Indicator), and population growth rate in the city center by the population in R1.

The third case, as shown in Figure 6, is about industrial development. In detail, 3 large industrial regions will be established in the North, the West, and the South of Hanoi city, with 7000 - 8000 ha for each. This strategic policy was placed in the master plan to promote industrial development of the new Hanoi, as well as to provide job opportunities to the changing population. As a result, the number of industrial establishments will be increased.

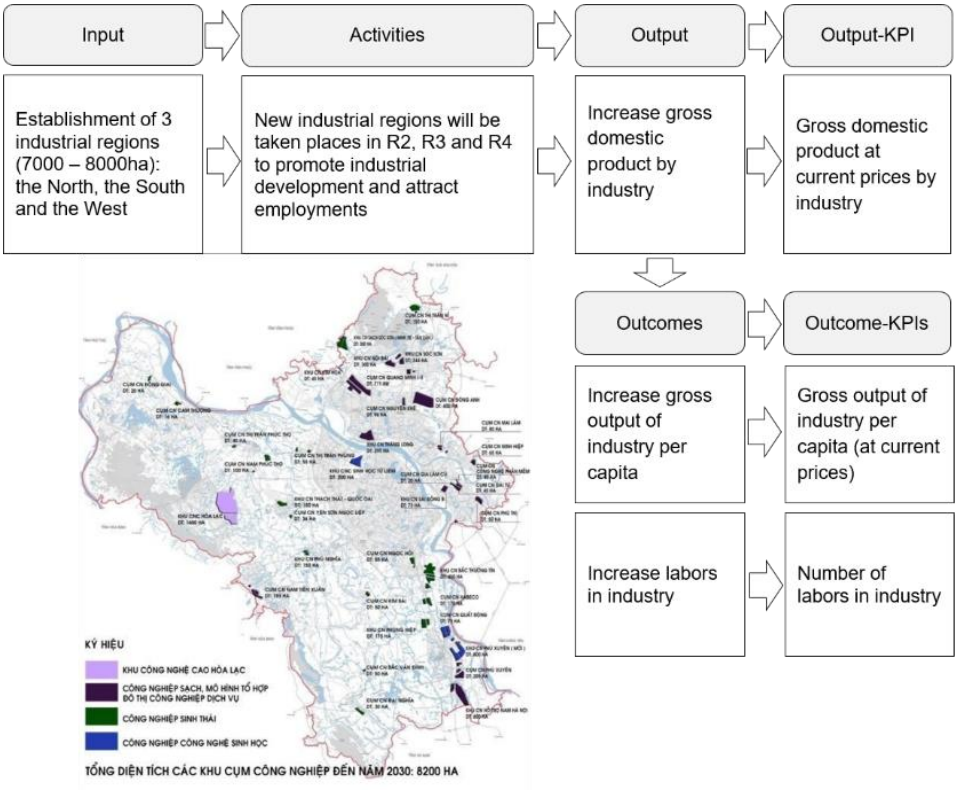

Figure 6. Logic model for policy "Industrial development"

Because there are many types of industrial production in Hanoi (from small to heavy industries), we can measure this result by KPI as the gross domestic product at current prices by industry. For further results, industrial productivity as well as labor force in industry will be increased. Those can be measured by two outcome-KPIs as the gross output of industry per capita (at current prices) and the number of laborers in industry, respectively.

From the above illustrations, we found that it is significant to make detailed analysis of the logic model's operation, which is less considered in urban planning issue. From inputs, activities, as the tasks personnel, have been undertaken to transform to outputs and outcomes. To measure direct results of policies (outputs) and benefits for users, communities, or organization (outcomes), the selected KPIs must be specific and relevant to urban planning issue, measurable by data, achievable to outcomes, and updated over time to reflect major changes in the policies and direction.

Hanoi urban data availability for KPIs

As noted earlier, the urban data system is crucial to the availability of KPIs. Therefore, we need an information system to produce data for estimating KPIs. During the process of selecting KPIs, it is crucial to establish an urban data system to measure KPIs by available unit, available period, concrete data item, and data source for each type of KPIs.

The urban data belongs to many areas of development of Hanoi, such as demographic data (population and employment), transportation data (road network and personal trips, etc.), and land use data (production and resident, etc.), etc. However, there are several challenges of the current availability and quality of Hanoi urban data because of management issues and transparency of the data system.

At the present time, the available data for cases related to Hanoi can be roughly grouped into two types: (1) data from statistics, which is annually collected by HSO; and (2) specific data, which is collected from other references. The Hanoi urban data system for KPIs in this

study was mostly collected from the Hanoi Statistics Office (HSO, 2016), Ministry of Construction (MOC, 2009), Person Trip Survey (PT Survey) (2011), and other sources.

In general, this study has indicated that Hanoi urban data availability and quality are important considerations in deciding which KPIs should be included; clarified data items with available units and periods intended to be used; and clarified what source of information potentially can supply relevant data. Obtaining urban data available and qualitative in several areas of a city is definitely not simple. Also, for selecting KPIs, the data is collected must be related to urban planning issue and the master plan's goals. From those points of view, it raises questions of can we get the full available urban data system by units for KPIs in Hanoi? Can data sources provide qualitative and quantitative urban data? And can we access the data source timely? The scope of this study is limited to the development of a general KPIs system, so these questions are hopefully answered in further studies of building urban data system in the near future.

Conclusions and Recommendations

This study has shown the concrete process of developing a KPIs system for the Hanoi master plan by utilization of the logic model, and by the identification of the relationship between planning resources and results. The use of a KPIs system in urban planning is not new, and generally functions to assist in measuring the planning process until goals/objectives are met. However, the utilization of the logic model to develop a KPIs system is less common in the urban planning field.

From the illustration of a physical urban plan, it can be seen that the development of a KPIs system is essential to provide a basic set of criteria to evaluate the urban planning process. Indeed, the KPIs system can be beneficial in monitoring and evaluating planning projects; in measuring the results of the urban planning process and the implementation of policies; and in supporting decision-making. Furthermore, a KPIs system is not just used to measure processes but as a reminder of the scope and definition of sustainable urbanism. For the development of a KPIs system in urban planning, the logic model has been shown to be a powerful tool in order to identify the logical linkage from planning goals to outputs and outcomes, and measure the outputs and outcomes by suitable KPIs.

Each of the results presented in this study has been analyzed, but still needs to be further investigated and answered. For a more precise KPIs system for the Hanoi master plan, it is necessary to investigate over a long period, with more contributions and feedback from both academic and practical perspectives. Importantly, the KPIs system is built based on the availability and quality of the urban data system which can assist local authorities and stakeholders in monitoring and evaluating the urban planning process until achieving the final goals/objectives.

The scope of the study is limited to the development of an overall KPIs system for an urban plan, rather than evaluation of those KPIs. For further research, to achieve the goals/objectives of the urban plan based on the logic way, the KPIs system needs to be calculated and compared to the actual development. The target value of each policy will be predicted to reflect the desired policy goals or objectives, by specific KPIs and available performance data quality and availability. This step shows how far the planning goals have been achieved by checking the deviation, appropriateness, and completeness between the actual and expected results.

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Table 2. Hanoi urban data availability for KPIs

Types of KPI	Available unit	Available period	Data items	Sources
Population	By district	Every year	Average population by district	Hanoi population and housing census - HSO
Labor	By economic sector	Every year	Laborers in Hanoi by sector	Hanoi labor and employment census - HSO
Percentage of passengers using public transport	By district	Based on programs of urban development	Percentage of passengers using public transport	PT survey
Travel time	By district	Based on programs of urban development	Travel time simulation	PT survey
Fatalities and injuries per year due to accidents	By city	Every month and year	Report of accident status	Traffic accident survey report - National Traffic Safety Committee
Air Quality Indicator (AQI)	By city	Every hour	Statistics of air pollution of cities around the world by hours	Observation of air quality by hours - US Embassy and Centre for Environmental Monitoring, General Environmental Department, MONRE (Aqicn.org)
Number of trips per day between different districts	By district	2011	Number of trips per day	PT survey
Total area of newly built residential housing	By city	Every year	Area of newly built residential housing in a year	Hanoi population and housing census - HSO
Area for open and green spaces	By city	Every year	Open and green spaces	MOC
Housing floor space ratio	By city	Every year	Housing floor space ratio	MOC
Open space ratio	By city	Every year	Open space ratio	MOC
Number of colleges, universities, and students	By city	Every year	Number of colleges, teachers, and students in colleges and universities by management level	General census on civil service - HSO
Number of health establishments, patient beds, and health staffs	By city	Every year	Number of health establishments, patient beds, health staffs, and contagious diseases	General census on civil service - HSO
Average output of water per day	By city	Every year	Development of urban infrastructure	Observation of water output - Fresh Water & Environmental Sanitation Center, DONRE
Percentage of population using fresh water	By city	Every year	Status of using fresh water	Census of population in using fresh water - HSO and DONRE
Average output of electricity per day	By city	Every year	Output of electricity status	Observation of electricity output - EVN Hanoi
Percentage of households with access to electricity	By city and district	Every year	Status of using electricity	Census of population in using electricity - HSO and EVN Hanoi
Gross domestic product at current prices (by agriculture, industry, and service)	By economic sector	Every year	Gross domestic product at current prices by economic sector	Economic census - HSO
Gross output of industry and agriculture (in current price) per capita	By city	Every year	Some main indicators per capita	Economic census - HSO
Number of tourist visitors	By city	Every year	Activities of tourism in Hanoi (annually on 31st December)	Tourism Survey Report - HSO

Notes: By city: data is available from the whole city of Hanoi. By district: data is available by the 29 districts in Hanoi. By economic sector: data is available by each sector. Ex: industrial sector, agricultural sector, and service sector. MOC: Ministry of Construction. MONRE: Ministry of Natural Resources and Environment. DONRE: Department of Natural Resources and Environment EVN Hanoi: Electricity Vietnam Hanoi.

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