Spatial Planning in Redevelopment of Kuala Lumpur Inner City Brownfields

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Key words: Multi-criteria Evaluation, Planning Support System, Spatial Planning, Impact assessment.

SUMMARY

The task of synthesizing enormous amount of data and criteria is one of the greatest challenges faced by spatial planners, policy and decision makers recently. In addition, the spatial planners and decision makers have accomplished different state of the art and systems to perform complex analyses and anticipate the future behavior of complex systems like cities. This requires a well organized problem definition as well as a dynamic spatial data modeling. The objective of this paper is to describe development of an integrated model by adopting Multi-criteria Evaluation (MCE) and Planning Support System (PSS). The model will control the redevelopment plan of Kuala Lumpur City Center from four points of view, namely, Environmental, Heritage, Height control, and Transit Planning Zones (TPZ). There are controlling regularities for each of abovementioned criteria that need to be organized in dynamic databases during the process of planning. Consequently dynamic assumptions are initialized based on Kuala Lumpur Development Control Plan 2008 (KLDCP 2008), using CommunityViz extension of ArcGIS software. The range of ratios based on Residential, Retail and Office in Mixed-use redevelopment areas are considered in setting up the scenarios. Heritage and TPZ controls are required to be verified automatically based on relative location of site in controlling maps. But for the other two factors, the number of stories and dwelling units are estimated first and consequently resident and employee population in each scenario are projected. The priority of each scenario also is retrieved by Analytic Network Process (ANP) as a MCE which is completely based on expert knowledge. Finally, the environmental and socioeconomic impacts of future population such as Annual Carbon Dioxide Auto Emissions, Average vehicle Trip length, Daily Household water use, Labor force population and other parameters, are computed. The results of the computation help to decide which scenario meets the requirements of KLDCP 2008. This research illustrated how a well-designed spatial model can take into account almost all considerable factors in a planning process for a highly complex system.

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1. INTRODUCTION

The inherent complexity, intricacies, and interconnectedness of social, economic and environmental phenomena are increasingly considered by scientists, policy-makers and spatial planners. Thus the processes and systems that can evaluate the impact of societies on both natural and built environment are highly interested by scientist's inquiry (Pettit, 2007). In addition the concurrency of the evolving view of planning with information sciences developed the popular topic of Planning Support Systems (PSS) which is contributed to planning process (Klosterman R. E., 2001).
Planning Support Systems (PSS) are specialized form of tools to assist undertaking spatial planning tasks. Pettit (2007) introduces three types of systems in PSS: first type includes systems dedicated to planners' analytic, forecasting or design tasks. The second type involves systems to improve the presentation and communication of planners. The third type is about systems designed to assess the land use change impacts. All these three types are combined in a policy and decision-making framework which is supported by a data infrastructure consisting of social, economic, environmental and physical datasets.
This paper intends to illustrate the application of PSS framework in a redevelopment process of brownfields in Kuala Lumpur city center.

The components of policy and decision support framework are described in next section. Consequently a planning of data model which is developed based on Kuala Lumpur Development Control Plan 2008 (KLDCP 2008) are explained in section three. The sequence of inputs and outputs along with the organization of Multi-Criteria Decision Making (MCDM) are outlined in same section. In section four, the paper describes the structure of three different scenarios. Then in section five the methods of visualizing and evaluating the redevelopment scenarios are given in details. Finally, in section six the paper evaluates the outcomes of redevelopment plan and the advantages of a well-organized planning process using PSS framework are highlighted.

2. POLICY AND DECISION-MAKING FRAMEWORK

Looking back to history of Planning Support Systems and the evolving expectations of them, the current framework illustrates a most completed version that we can rely on it in a planning process. Klosterman and pettit (2005) identified two main groups of PSS, which are designed for analysis, forecasting and task designing or designed to make a sound communication and readily presentation possibility. Pettit (2007) added the third group which considers the land use transformations impact assessment. Adding the third group, the concept for introduction of policy and decision-making framework was completed.

Besides, Brail (2009) evaluated a limited set of tools that have five dimensions in common. These are a) Spatial mapping, b) Visualization tools, c) Models or rules that project futures or estimate impacts, d) Integrative use of multiple datasets, e) Accessible framework offering the potential of community involvement. providentially, all the five dimensions can be found in Pettit (2007) framework. Althought Brail (2009) suggests a further development in PSS to fill out the gap between user and technology, but we still have not seen a considerable and succeful application of state-of-the-art systems in practice rather than academic experiments.

In this section the PSS framework is explained in more detail and its application will be described based on each components in further sections. There are three components in policy and decision-making framework, namely, integration, iteration and interaction between the main actors and stages. There is an argument that no single technology can facilitate all qualified planning expectations. Therefore, loose coupling of PSS or tightly coupled experiences can convey the integration component. For instance the University of Wisconsin-Madison used CommunityViz PSS in conjuction with What if? to investigate how future residential and commercial developments will affect one of significant Dane County's (U.S.) natural resources. Moreover, the city of Tacoma, Washington, used CommunityViz PSS to evaluate different development scenarios based on infrastructure and public facilities' accessibility. The project also used SiteBuilder 3D component of CommunityViz to enable the decision makers examining different height proposals.

The iterative component of framework reveals the fact that each outcome from evaluation phase will be used to test policy and consequently re-formulate alternative scenario modeling. This can easily be reached by Cellular automata modeling techniques (Klosterman R. E., 2001; Klosterman & Pettit, 2005). There are also interactions between the modeling, visualization and evaluation components. The iterative process along with interaction of components enables the spatial planners to collaborate with stakeholders and local communities. For example, the maximal, moderate and minimal case scenarios can be formulated by considering the different input factors and parameters to explore the reliability of them based on the problematic.

The aforementioned components are related to evolving concern of information technology in which the third stage (1980s) relates to dealing with ill- or semi-structured decisions. This stage was regarded as decision support systems and knowledge (Klosterman R. E., 2001). Moreover, Kolsterman suggests utilizing a different range of technologies to come out in a comprehensive PSS. It was called PSS and Intelligence.

Figure 1 illustrates the PSS framework, in which the relation between three components is shown explicitly. The feedback loop also based on local and expert opinion outlines the interaction component of process. The supporting part which is consisted of data infrastructure essentially improves the policy and decision-making process.

Scenario modeling in a planning process is normally defined as the organization of current situation, of a desirable or possible future as well as of the series of procedures that lead from the current regularities and policies to the future state. Visualization enables to envisioning the planning outcomes and enriches the planning process by engaging the actors. The evaluation of future developments through each scenario against a set of social, economic and environmental indicators is regarded as “Triple Bottom Line” (TBL) evaluation.

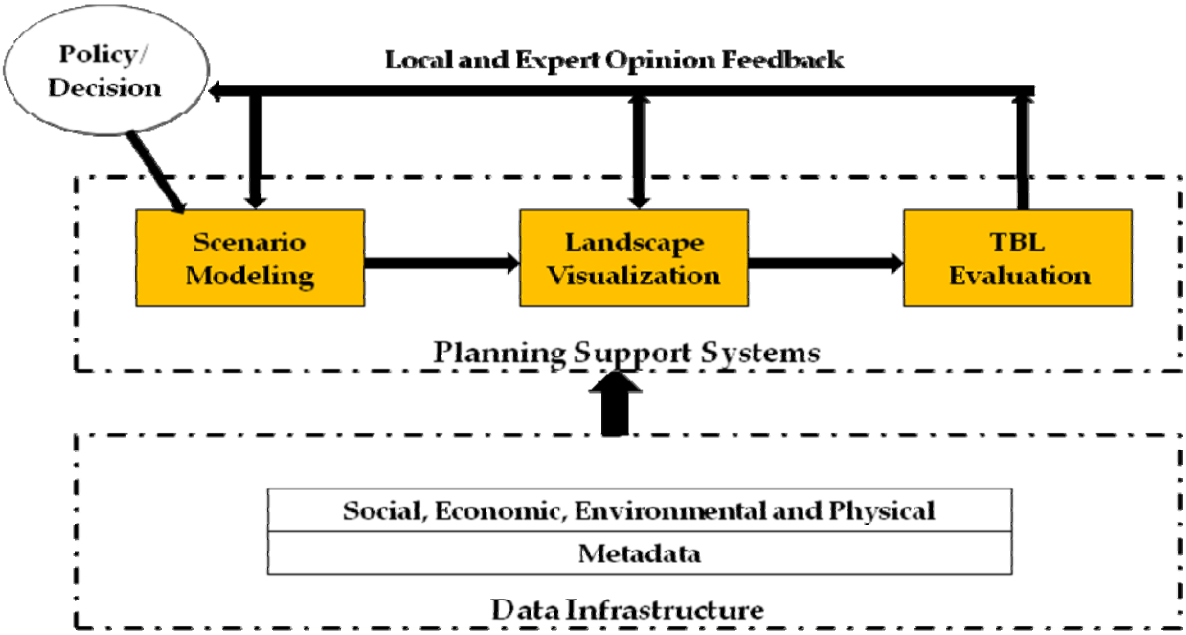


Figure 1Policy and Decision Support Framework (Adopted from Pettit, 2007)

The redevelopment model of brownfield areas in City Center of Kuala Lumpur is organized based on this framework. Noteworthy, the expert knowledge itself involves a sophisticated method that can be regarded as a complement in integration part of policy and decision support process. There are plenty of examples in the literature that explain the process of achieving thresholds and weights of factors to feed the evaluation process in a PSS (Li & Yeh, 2001; Wu, 1998). In this paper a multi-criteria decision model (MCDM) is used to obtain the weights of parameters in each scenario.

3. DATA INFRASTRUCTURE

The organization of data in PSS is directly determined by bearing in mind the three of five components of PSS defined by Brail (2009) along with the objectives of this project. The three components are spatial mapping, modeling data to project future and estimate impacts, and integrative use of multiple datasets. In case of Kuala Lumpur there are some controlling approaches that can simply be applied to cover the objectives of this research project. Those are accurately defined in KLDCP 2008 as data layers or regulations.

3.1 Planning Data Model (PDM)

Geographic information systems (GIS) now provide only a part of the required scope of an urban planning data model (Hopkins, Kaza, & Pallathucheril, 2005). This research intends to use Planning Support Systems for dynamic data modeling with geodatabase approach. For that reason, the CommunityViz tools are utilized to develop a dynamic geodatabase.

The organized PDM enriches the model in three ways: First, it enables to specify scenarios considering combinations of more complex and dynamic plans and regulations. Second, it enables to work with more than one redevelopment model in case study area, therefore the implications of different results can be investigated from partially substitutions in the model. Third, it enables to link models of different perspectives, such as environmental protection, heritage, height control, and transit planning.
Figure 2 shows the diagram of PDM which is consisted of static and dynamic data layers and attributes. Data layers and their attributes are in two types: The first type is existing data layers and attributes retrieving from Kuala Lumpur City Hall (DBKL, 2006). The second type is the data layers and attributes that are creating in PDM using Assumption and Formula components of PSS.

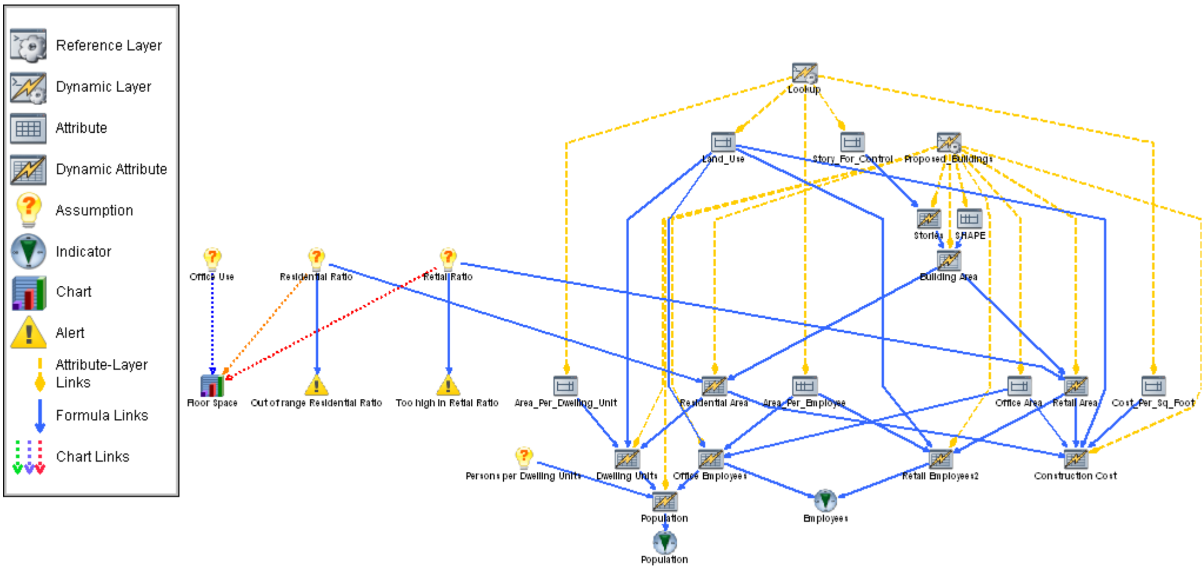


Figure 2 The Diagram of Planning Data Model (PDM)

Land use for example, is the existing data as a feature class with variety of attributes that supports the planning procedure as the base map (figure 3). Lookup table is another data that is created based on the regularities of KLDCP 2008. The lookup table is normally comprised of fixed attributes that don't change very often. Table 1 shows the attributes of Lookup table.

Table 1 The Attributes of Lookup table

Attribute Name	Description
Area_per_DU	The area for each dweling unit based on residential type in term of density
Area_per_employee	The area is assigned in Office and retail use for each employee
Land_use	The main allowable use for the land or building in the respected zone
Persons_per_DU	Number of persons are living in each dwelling unit (Household size)
Cost_Per_Sq_Foot	The construction cost per square foot for each land use

The attributes of lookup table are extracted from KLDCP 2008 information provided in data layers or regularities. This information are such as zoning plan, Acreage of residential area, Allowable plot ratio (PR), Floor Area Requirement (FAR), Residential Unit Size by cost, Household Size and so on.

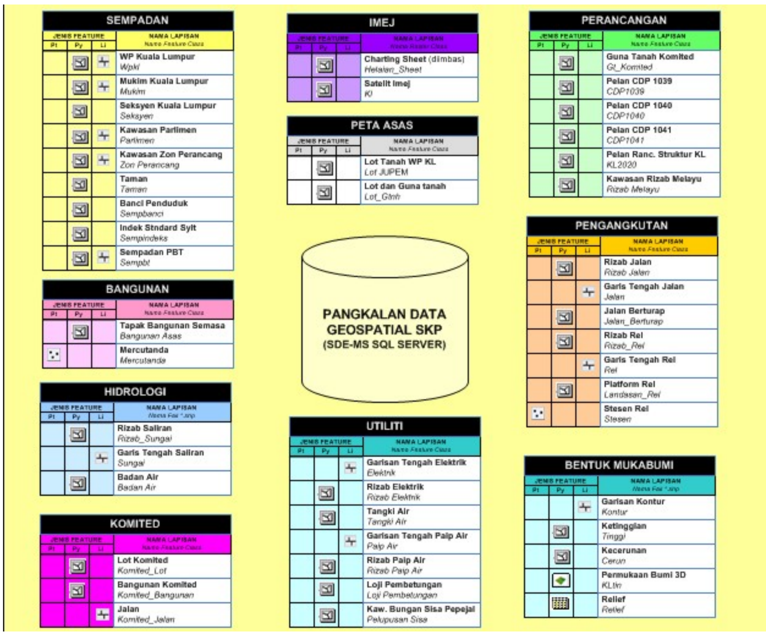


Figure 3 Feature Classes in Kuala Lumpur Geodatabase (Adopted form DBKL, 2006)

Assumptions are created based on allowable rates of buildings in each zone and planning scheme. There is a possibility in assigning the rates of buildings to increment the rates of building in different land uses, so that variety of alternatives can be examined in each assumption. Table 2 illustrates three assumptions along with the respected values for three main land uses.

Table 2 Assumptions and their valid values

Assumption	Category	Valid Values (%)			Alert
		Default	Maximum	Increment	
Residential Ratio	general	45	60	5	If the value is lower than Retail and/or Office Ratio and higher than Max
Retial Ratio	general	50	80	5	If the value is higher than Max and/or Residential Ratio
Office Ratio	general	30	45	5	If the value is higher than Max and/or Residential Ratio
Persons Per Dwelling Unit	general	4	6	1	If the value is higher than Max and/or Residential Ratio

The combination of assumptions and existing data through each scenario will generate the different outcomes that are visualized in charts and indicators. The indicators are consisted of population, employees and construction costs which can be used to evaluate each scenario. Moreover, the common impacts of each development are measured using the Common Impacts Wizard in CommunityViz PSS. Table 3 illustrates the common impact criteria.

Common impacts are other types of assumptions that are defined in PSS as default criteria. These can be adjusted based on study area. The common impacts focus on environmental and socio-economic as well as transportation aspects. Determining of each impact needs to carry out the formula wizard and the different ranges in each criterion facilitates the planner to observe dissimilar alternatives.

These combinations are the structure of data model which are planned in respect to study objective. The relative importance of each criterion is another issue that this research intends to find a solution by conducting a Multi-Criteria Decision Making technique (MCDM). In following section the arrangement of MCDM technique is described.

Table 3 Common Impact Criteria

Impact Category	Indicator	Description
Environmental	Annual CO Auto Emissions	Total carbon monoxide emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer.
	Annual CO2 Auto Emissions	Total carbon dioxide emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer
	Annual Hydrocarbon Auto	Total hydrocarbon emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer
	Annual NOx Auto Emissions	Total emissions of oxides of nitrogen generated by vehicles associated with residential buildings in the Common Impacts buildings layer
	Residential Energy Use	Total carbon monoxide emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer
	Residential Water Use	Total annual water use by dwelling units in the Common Impacts building layer for all indoor and outdoor applications.
	Commercial Energy Use	Total carbon monoxide emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer
Socio-Economic	Commercial Floor Area	Total carbon monoxide emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer
	Commercial jobs	Total carbon monoxide emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer
	Commercial jobs to housing ratio	Total carbon monoxide emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer
	Labor Force Population	Total carbon monoxide emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer
	Residential Dwelling Units	Total carbon monoxide emissions generated by vehicles associated with residential buildings in the Common Impacts buildings layer
	School Children	Total number of school children living in the dwelling units in the buildings layer.
Transportation	Vehicle Trips Per Day	Total number of motorized trips taken each day, on average, by residential households (dwelling units) in the Common Impacts buildings layer.

3.2 Multi-Criteria Decision Making (MCDM)

In general, MCDM problems are consisted of a set of choices that are evaluated on the basis of "conflicting" and "incommensurate" criteria (Malczewski, 1999). Two classes of MCDM based on the generic term of criteria are called MADM (multiattribute decision making) and MODM (multiobjective decision making) in literature (Malczewski, 1999; Wey & Wu, 2008). These are related to attribute and objective components of planning process. In This research each one of assumptions are considered as objectives and their respective values are regarded as attributes. Before explaining the structure, the hierarchical and feedback structures are compared to define the best method for evaluating the criteria. Followings are a brief description of Analytic Hierarchical process (AHP) and Analytic Network process (ANP).

3.2.1 AHP & ANP

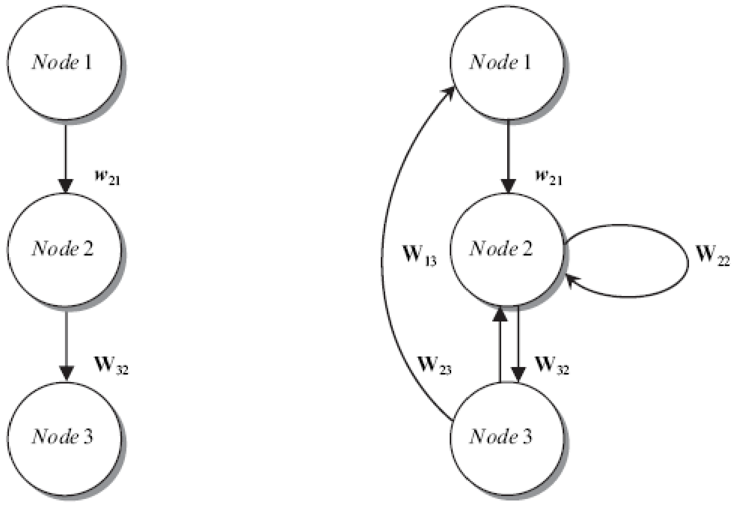
The Analytic Hierarchy Process (AHP) for decision-making is a theory of relative measurement based on paired comparisons used to derive normalized absolute scales of numbers whose elements are then used as priorities. Matrices of pairwise comparisons are formed either by providing judgments to estimate dominance using absolute numbers from the 1 to 9 fundamental scale of the AHP, or by directly constructing the pairwise dominance ratios using actual measurements. The AHP can be applied to both tangible and intangible criteria based on the judgments of knowledgeable and expert people, although how to get measures for intangibles is its main concern. The weighting and adding synthesis process applied in the hierarchical structure of the AHP combines multidimensional scales of measurement into a single “uni-dimensional” scale of priorities. In the end we must fit our entire world experience into our system of priorities if we are going to understand it (Saaty, 2007).

Many decision problems cannot be structured hierarchically because they involve the interaction and dependence of higher-level elements on a lower-level element (Saaty & Vargas, 2006). Structuring a problem involving functional dependence allows for feed-back among clusters. This is a network system. Saaty (2006) made a comprehensive study of this problem. He suggested the use of AHP to solve the problem of independence of alternatives or criteria and the use of ANP to solve the problem of dependence of alternatives or criteria. The ANP addresses the determination of the relative importance of a set of activities in a multi-criteria decision problem. The process utilizes pairwise comparisons of the alternatives as well as pairwise comparisons of the multiple criteria. Figure 4 is a standard form of a `supermatrix' introduced by Saaty in 1986 to deal with the interdependence characteristics among elements and components. He suggested a supermatrix for solving network structure (Saaty & Takizawa, 1986). The supermatrix is column stochastic, as all its columns sum to unity. This matrix is such that any column of the limiting power $\lim_{k\to\infty} A^{2k+1}$ gives the outcome of the cyclic interaction of the alternatives and the criteria.

$$
\mathbf{W} = \begin{array}{cc}
 & \begin{array}{cccc} \begin{array}{c} Cl_1 \\ e_{11}e_{12}\cdots e_{1m_1}\end{array} & \begin{array}{c} Cl_2 \\ e_{21}e_{22}\cdots e_{2m_2}\end{array} & \cdots & \begin{array}{c} Cl_n \\ e_{n1}e_{n2}\cdots e_{nm_n}\end{array} \end{array} \\
\begin{array}{cc} Cl_1 & \begin{array}{c} e_{11}\\ e_{12}\\ \vdots \\ e_{1m_1}\end{array} \\ Cl_2 & \begin{array}{c} e_{21}\\ e_{22}\\ \vdots\\ e_{2m_2}\end{array} \\ \vdots & \vdots \\ Cl_n & \begin{array}{c} e_{n1}\\ e_{n2}\\ \vdots\\ e_{nm_n}\end{array}\end{array} & \begin{bmatrix} \mathbf{W}_{11} & \mathbf{W}_{12} & \cdots & \mathbf{W}_{1n} \\ \mathbf{W}_{21} & \mathbf{W}_{22} & \cdots & \mathbf{W}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \mathbf{W}_{n1} & \mathbf{W}_{n2} & \cdots & \mathbf{W}_{nn} \end{bmatrix}
\end{array}
$$

Figure 4 A Supermatrix proposed by Saaty (1986)

Source: Wey & Wu, 2008.



$$\mathbf{W}_h = \begin{array}{c c} & \begin{array}{ccc} Node\,1 & Node\,2 & Node\,3 \end{array} \\ \begin{array}{c} Node\,1 \\ Node\,2 \\ Node\,3 \end{array} & \begin{bmatrix} 0 & 0 & 0 \\ w_{21} & 0 & 0 \\ 0 & \mathbf{W}_{32} & \mathbf{I} \end{bmatrix} \end{array}$$

$$\mathbf{W}_h = \begin{array}{c c} & \begin{array}{ccc} Node\,1 & Node\,2 & Node\,3 \end{array} \\ \begin{array}{c} Node\,1 \\ Node\,2 \\ Node\,3 \end{array} & \begin{bmatrix} 0 & 0 & \mathbf{W}_{13} \\ w_{21} & \mathbf{W}_{22} & \mathbf{W}_{23} \\ 0 & \mathbf{W}_{32} & \mathbf{I} \end{bmatrix} \end{array}$$

a) A linear Hierarchical process b) A nonlinear Network process

Figure 5 Comparison of AHP and ANP concepts
Source: Wey & Wu, 2008.

3.2.2 <u>Analytic Network Process of Redevelopment Plan</u>

According to the structure of ANP we need to define the clusters and elements in each cluster. The mother cluster in this research is consisted of three main scenarios (Base scenario, Economic, and Social scenario). Other clusters are defined based on TBL concept utilizing the common impact indicators in PSS. This structure can evaluate the planning process in two stages: the first stage a comparison of TBL indicators and their respected elements. The second stage is evaluating scenarios based on expert knowledge which can be based on analysis outcomes.

Thus table 4 is an illustration of the ANP structure in SuperDecisions software, from which the relative importance of clusters and elements are extracted.

Table 4 Main structure of ANP

Alternative(s) in it:	• Base Scenario • Economic Scenario • Social Scenario
Network Type:	Bottom level
Formula:	`Not applicable`
Clusters/Nodes	• **Alternatives:** *The automatically created alternatives cluster* o **Base Scenario:** o **Economic Scenario:** o **Social Scenario:** • **Economic:** o **Commercial Floor Area:** o **Commercial jobs:** o **Commercial jobs to housing ratio:** • **Environmental:** o **Annual CO auto emissions:** o **Annual CO2 auto emission:** o **Annual Hydrocarbon auto emission:** o **Annual NOx auto emission:** o **Commercial energy use:** o **Residential energy use:** o **Residential water use:** • **Social:** o **Labors Force Population:** o **Residential Dwelling Units:** o **School Children:**

4. SCENARIO MODELING

There are three scenarios to determine the best combination of building uses for redevelopment of Kuala Lumpur brownfields in inner city area. The remaining land of previous prison of Kuala Lumpur is considered to redevelop in Kuala Lumpur Structure Plan 2020. The site is located in City Centre zone which is quite the most important zone among all the six zones of the city. The reason for this is the concentration of commercial and tourist activities in City Centre area as well as the resident population decline during last 10 years in Kuala Lumpur City Centre (KLCC) (CHKL, 2004). Therefore, two main issues are considered in this area: the first issue is to bring back the residents, and the second issue is to take into account the economic potential of the area.

Besides, there are some limitations which should be considered during the planning for this area. City Hall Kuala Lumpur has provided the maps for controlling the height and activity types of future buildings based on environmental, heritage, view to land marks, and transit planning aspects. Therefore the structure of planning for this area is mainly divided to two parts. The first part is defining the scenarios which are a) Base Scenario b) Economic scenario and c) Social scenario. The second part is defining the categories to control the developments in each scenario which are a) General category b) Environmental protection category c) Heritage category d) Height control category, and e) Transit planning category.

Figure 6 demonstrates the model of relation between scenarios and controlling categories. Each scenario definitely has dissimilar arrangement in terms of the land uses and building functions. The Base scenario is defined based on the first allowable land use in zoning schedule of KLDCP 2008. The Economic scenario puts more emphasize on economic aspect of the area and considers more commercial and mixed use functions which are defined as allowable or conditional land uses in zoning schedule. The residential configuration of the Economic scenario considers the medium density residential buildings. The Social scenario in contrast, considers the high density buildings and less commercial activities in the area. Although, all the allocated activities are among the permitted or conditional uses that are defined by KLDCP 2008.

The initial configuration of scenarios is arranged in general category. The next step is to check all allocations by four controlling categories. In further steps the data layers which are provided by local authority will determine whether the site is located in each controlling zone or not. If so, the particular regularities in terms of height, activity and such like will be applied within each scenario. Consequently the final product is ready to be analyzed and evaluated.

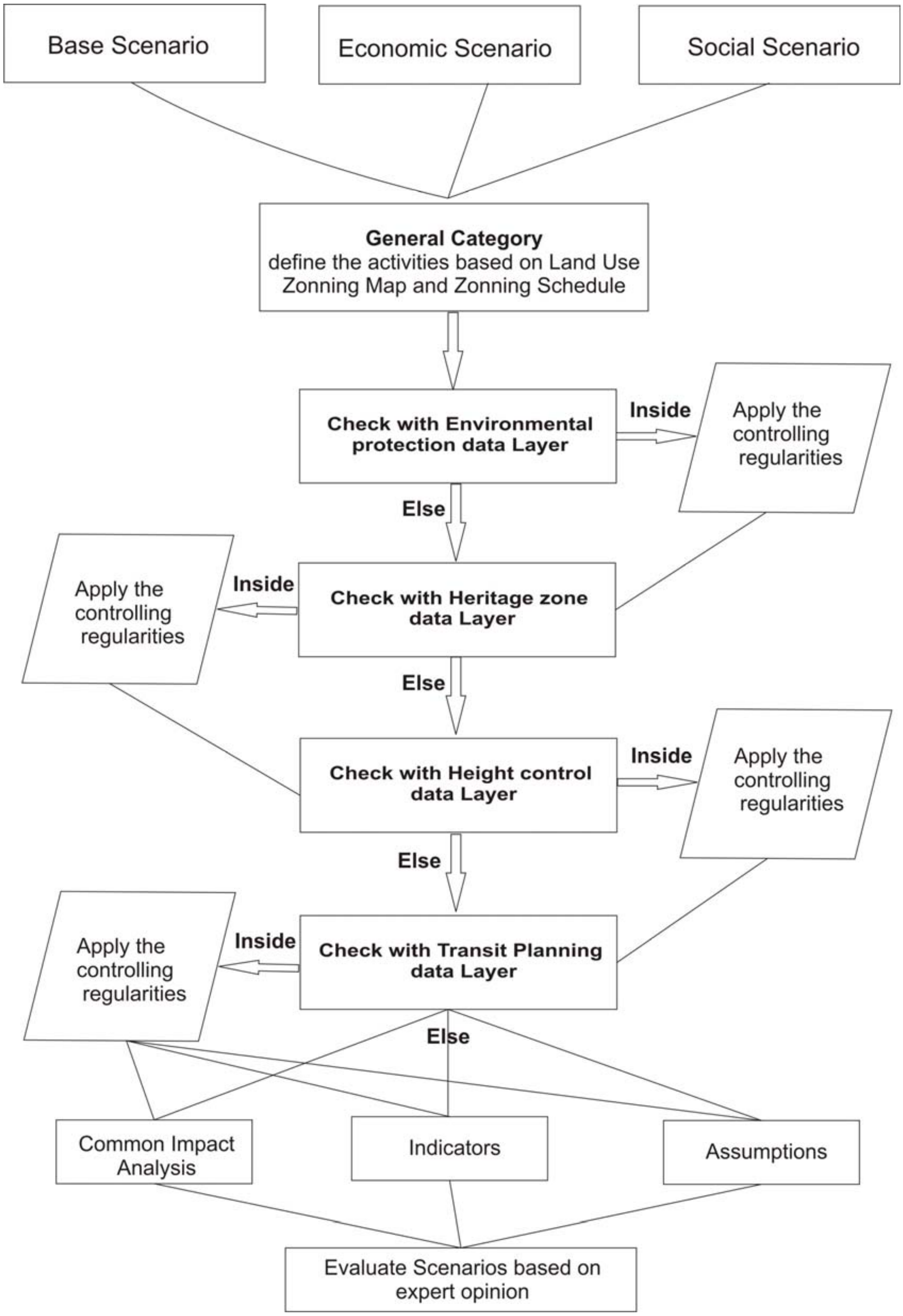


Figure 6 Flow of Scenario model

5. VISUALIZATION AND EVALUATION

Visualization as a tool can enrich the evaluating of planning scenarios by engaging actors and stakeholders. In this research the comparison of tree scenarios were visualized in order to better make a distinction between each scenario. Although, the main idea behind the visualization term is to create the 3D view of proposed plans, which is simply applicable by CommuniViz, but this research has been using the 2D representation of each scenario. This step would be part of future work in order to improve the current project. Figure 7 illustrates the scenario comparison by visualization.

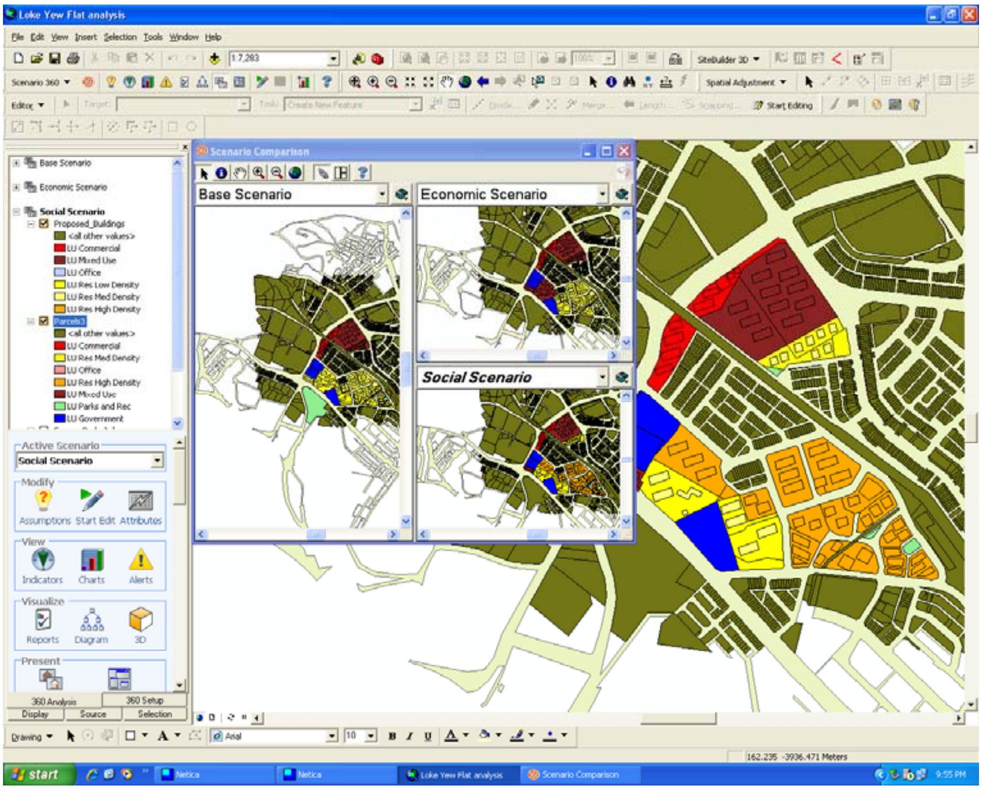


Figure 7 Scenario Comparison

Understanding the implication of planning options and policy decisions can be carried out by evaluating process. According to the framework of PSS, Triple Bottom Line (TBL) is the concept behind the evaluation process in this research that facilitates the assessment of likely future consequences of each plan. CommunityViz as a PSS is powerful enough to evaluate the scenarios based on social, Economic, and Environmental aspects. Moreover, the process of TBL evaluation was carried out using ANP.

According to the outcome values in table 5 and the evaluation result, Basic Scenario is considered as more reliable scenario. Therefore, the first allowable land uses can be applied for redevelopment of the historical prison.

Table 5 Scenario Comparison based on common impact assessment

Indicator	Base Scenario	Economic Scenario	Social Scenario	Units
Common Impacts - Annual CO Auto Emissions	882,120	992,385	992,385	lbs
Common Impacts - Annual CO2 Auto Emissions	8,267	9,300	9,300	tons
Common Impacts - Annual Hydrocarbon Auto Emissions	111,403	125,349	125,349	lbs
Common Impacts - Annual NOx Auto Emissions	55,304	62,217	62,217	lbs
Common Impacts - Commercial Energy Use	521,212	1,216,162	849,442	million btu / year
Common Impacts - Commercial Floor Area	569,003	1,327,675	927,330	sq meters
Common Impacts - Commercial Jobs	691	1,613	1,127	commercial jobs
Common Impacts - Commercial Jobs to Housing Ratio	0.73	1.51	1.06	commercial jobs / dwelling unit
Common Impacts - Labor Force	993	1,745	1,745	workers
Common Impacts - Population	2,428	4,268	4,268	persons
Common Impacts - Residential Dwelling Units	948	1,067	1,067	dwelling units
Common Impacts - Residential Energy Use	95,782	107,755	107,755	million btu / year
Common Impacts - Residential Water Use	135,342,220	152,259,997	152,259,997	gallons / year
Common Impacts - School Children	459	807	807	school children
Common Impacts - Vehicle Trips per Day	5,643	6,348	6,348	vehicle trips / day
Employees	12,078	15,872	13,870	persons
Population	12,810	13,257	13,415	persons

6. CONCLUSION

This research focused on Planning Support System and the framework that was suggested by Pettit (2007). The redevelopment process of a historical prison in central area of Kuala Lumpur was planned through three scenarios. The data model planning was conducted in a GIS environment using geodatabase concept.

The dynamic data and attributes were created utilizing CommunityViz as one of current sophisticated PSS tools.

The scenarios were modeled based on KLDCP 2008 considerations and the criteria for evaluation were defined considering to TBL component of PSS frame work.

MCDM and particularly ANP were integrated by GIS and CommunityViz to determine the relative importance of each criterion and elements inside.

The research highlighted a PSS tool's power in conjunction with a PSS conceptual framework. The integrated approach enriched the community participation part of frame work and provided the opportunity for a feedback process.

Future works should focus on more accurate data layer and evaluating the scenarios based on 3D shape. Besides, the ANP model can be improved by adding Benefit, Opportunity, Cost, and Risk model (BOCR) in SuperDecisions software to evaluate the alternatives more effectively.

Sensitivity analysis is another method that should be carried out in future to reduce the evidence of uncertainties.

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