

# THE RESILIENT CITY: A Platform For Informed Decision-Making Process

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Abstract: As over half of the world's inhabitants lives in metropolises, the rapid growth in urbanization has made cities becoming more and more exposed and vulnerable to a broad spectrum of threats and hazards. In order to respond to such difficulties, a concept of resilience is considered a significant component for the long-term planning and sustainable development of the cities. "Resilient City" is a new paradigm that challenges the idealistic principle of stability and resistance to change implicitly in sustainable development and success. However, building a resilient city requires a holistic approach, as well as the appropriate adoption of knowledge and application of tools during the planning and management process. Although there are many studies intended at enhancing the capacity of city resiliency, less were explicitly focused on developing practical sequential steps of resilience building that the city can follow. This paper aims to narrow a gap of that missing body of knowledge by describing a brief methodological framework, which includes procedural steps in assisting the planning and management processes of resilient city development and critical infrastructures protection. A platform is proposed for integrating the use of concepts and techniques, including project management, risk and vulnerability assessment based serious gaming, multi-criteria decision analysis, and object-oriented programming. To demonstrate the efficacy of a platform, the methodology is incorporated with the urban planning simulation computer game "SimCity", developed by Electronic Arts and the City of Norfolk in United States of America, as an example.

**Keywords:** Resilience, Smart City, Decision-Support Systems, Digital Infrastructures, Critical Infrastructures Protection, SimCity 2013



# **INTRODUCTION - THE NEED FOR NEW APPROACH**

Decision-making is a essential part of human life. Decisions can be made guickly and easily when the objectives are clear, the information necessary to evaluate alternatives is available, and the outcomes of decisions can be accurately predicted. However, as the complexity of the decision increases, the decision-making process becomes more difficult because of the number of factors that have to be taken into consideration for the analysis. In other words, the decision is directly related to the value assigned to its consequences or results, especially when it involves large-scale complex systems and can create major impacts on the population or a nation. In this case, Risk-Informed Decision-Making Process (RIDMP) is a method that was designed to fulfill this gap. The intent of this technique is that whenever there is a significant decision between design alternatives, the process can be used as a way to inform the decision makers about the risk involved in each alternative (Zio et al., 2015).

With resilience-based action approaches the decision-making process, it may be possible to reveal and select the most effective and viable

solution. Meantime, the RIDMP may also provide other benefits since it can enhance the analysis and deliberation results of alternatives. For instance, there may be some situation that an alternative can be selected if additional required actions are done to improve its resilience.

# **DEVELOPMENT OF RESILIENT INFORMED DECISION-MAKING** PROCESS PLATFORMS

In order to ensure the sustainment and resilience of existing and next generation decision makers and stakeholders must be well informed of past and current problems.

They also need the knowledge and tools to help them analyze, assess, and design a viable implementation plan for long term development. The result or output of studies and research must be able to apply to the decision-making process and resource allocation for solving the real-world problems (Pulfer et al., 2006).

Figure 1 shows that the structured methodology consists of constructing a platform that capable of analyzing technical strategies and actions required for the critical infrastructure's resilience. This platform is aimed to serve as a standard practice when developing resilient city systems.



Framework of Resilient Informed Process Platform



# PROJECT PLANNING AND MANAGEMENT

Project Management is a systemic process of strategic and organized endeavor to meet a certain requirement, achieve a particular objective, or accomplish a specific goal. A body of knowledge is usually referred to the development of critical phases under the domain of management science, including initiating, planning, executing, controlling, and closing. Project Management is not a trivial thing, but it is a set of activities that are focused on completion of expected results in an effective way for individual, organization, or society. A successful project planning and management are another key component to the success.

Software can be useful, but in particular, it will obviously get project teams on board and unmistakably keep all members on the same page without leaving confusion about roles, responsibilities, expectations, and deadlines.

## **MULTI-CRITERIA DECISION ANALYSIS**

Decision making can be considered a logical thinking process of suitable alternatives selection under different criteria or factors. In the process of decision analysis, decision makers and stakeholders must assess all possible positive and negative impacts and must also be able to judge the consequences of that decision.

Multi-Criteria Decision Analysis (MCDA) or Multi-Criteria Decision-Making (MCDM) is a framework of analytical techniques that helps decision maker choosing between multiple options when multiple objectives have to be pursued. It is a systematic process and pragmatic approach, which involves multiple criteria in making a rational decision (Holling, 1996).

There are many approaches to solve the MCDM problem, but depending on the nature of the problem, different methods can be applied to address the problem efficiently. The decision models of multiple criteria, attributes, and alternatives will be structuring and be offering with the implementation of two distinct MCDA methods through Decision Support System (DSS) tools.

# **MULTI-ATTRIBUTE UTILITY THEORY**

To make a decision on complex problems in the real world, the decision makers oftentimes have been challenging with multiple aims, various stakeholders, future or long-term consequences, and risk and adverse effects (Nikou, 2011). In particular, when the problems are bound with the constraint, namely uncertainty, one of the most effective form of approach for dealing with this type of problems is a use of "Expected Utility". In MCDA, this technique is formally called Multi-Attribute Utility Theory or MAUT.

For the question "Which alternative is the best option?", this method offers users the steps to assign scores and to compare possible alternatives in which afterward all of them can be identified and analyzed. It also allows a group of stakeholders to search and examine the consequences in the different ways for evaluating the options. (Ishizaka et al., 2013).

MAUT method works best when a decision maker consciously tries to optimize the performance of alternatives under a set of conditions and point of views (Ishizakaet al., 2013). Similar to other MCDA methods, MAUT methodology consists of four key steps:

•Constructing a decision problem by specifying the objectives and identifying the attributes needed to be measured;

• Setting up the alternatives and exploring the potential consequences caused by each of them in term of the attributes identified;

• Determining the preferences of the decision maker and stakeholders and assigning the weight of attributes reflecting their importance to the decision;

• Synthesizing the results by assessing the impact of a certain criterion of the decision and lastly comparing the alternatives.

A group of stakeholders can revise the weight of importance to assume the effect of changes in the overall ranking results and conduct a sensitivity analysis to see the effects on the ranking results due to uncertainty.

To support a decision-making process, it is recommended that there are required basic steps, which a user must complete, including model implementation, data collection, group



information and opinion, assessment aggregation, and analysis results presentation. Each of them can be briefly described following by:

### Problem Modeling

In Figure 2, The World Economic Forum Transformational Maps presents a model on how implementation in IDS (Intrusion Detection Systems) implies to the process of identifying the alternative courses of action, or simply choices, criterion weights, and evaluation scales for assessing selections on criteria (Xu et al., 2008).



*Fig. 2: WEF Transformation Map - Cities and Urbanization / Urban Resilience* 

#### Data Collection

With a completed problem structure in model implementation, individual participants can start to assess each option and to record their scores and opinions. Each of them just needs to check appropriate grades, and then ER algorithm will automatically generate a belief degree next to each answer. (Xu et al., 2008)

#### Group Decision Support

When utilizing IDS, individual participants may independently record and anonymously register their assessments of each alternative to prevent the risks of potential disagreement among them (Xu et al., 2008).

# Assessment Aggregation

With IDS functionality, the compilation is automatic and update real-time in the

background, whenever either an initial assessment data is modified, or an additional detail is entered for any criterion (Xu et al., 2008). Thus, a user should be able to obtain the original outcomes promptly if nothing is changed or to see the updated reports at any stages of revisions even before the assessment on some criteria is finished.

## Assessment Results Presentation

IDS can generate different types of analysis results in graphical formats to support decision communication, such as performance ranking, performance score range, and performance distribution.



# DESIGN AND DEVELOPMENT OF SIMULATION CITY BY USING THE GAME SIMCITY 2013 BY ELECTRONIC ARTS

The essential goal of playing the strategy game SimCity, by the developer Electronic Arts, is to build a city from scratch. The game provides a lot of freedom in what the player can build, so that many people tend to construct essential infrastructures and service facilities without the pre-design of city layout.

In this study, to use the application of simulation urban planning game for the nonentertainment purpose, especially at higher education level, the systematic urban planning is definitely inevitable (Minnery, et al., 2014). In SimCity 2013, the player will be assumed the role and duties as a city mayor. The central aspect of this character is all about construction and zoning, which comprise a wide range of responsibilities, including laying down the roads, manipulating the land areas, providing the essential facilities, maximizing the service capacities, and otherwise balancing between demand and supply of resources (Figure 3).

Further, the scope of evaluation covers only the existing technological inventions in the real world. Nonexistent innovations and fancy features in a couple of options of the game, particularly government and disaster, are not included in this example.



Fig. 3: Sim City 2013: In-Game Menu Bar



#### Roads and Traffic Density

The most important aspect of city planning is the roads. They play the most significant role and are considered a heart of SimCity. In the game, roads are differentiated by using two properties, the number of lanes and the level of supported densities.

Roads in SimCity can be difficult. They are

the blood vessels that connect the city to the other cities, provide accesses to the buildings, distribute power, water, and sewage to Sims, and allow Sims to travel from one to another location.

Designing them wrong or with too many flaws will waste money, limit the building sizes and densities, and undoubtedly cause the traffic conditions (Figure 4).



Fig. 4: SimCity 2013: Traffic Density

In a case of traffic, the congestion is an unavoidable problem that naturally occurs when having an increased number of populations. The events will cause many indirect effects in the city. For instance, if emergency services, like ambulances or fire engines, cannot get to the location or scene on-time, the Sims will die, or the buildings will burn down (Kroger, 2008).

## • Electric Power

Nearly every building in SimCity needs electric power to function. Energy is the first critical infrastructure and essential service that the mayor has to provide to run the city. So that without a power plant, the city will not grow, like in Figure 5.

Each is radically distinct in term of technological advancements, which can be arranged from, an old-fashion dirty generator like coal power plant, to a modern clean reactor such as nuclear power plant. Each of them has advantages and disadvantages. However, most are undoubtedly expensive, and some are unquestionably polluted.

Many other aspects of designing a metropolis from the scratch are necessary to be taken into consideration, in order for the complex sets of actions that a city deliver on a daily basis for the population to be kept into functionable state, like for example:

- Water
- Sewage
- Waste Disposal
- Fire
- Health
- Police
- Education
- Mass Transit
- Parks
- and many others ...





Fig. 5: SimCity 2013: Electric Power Distribution

# **CONCLUSIONS**

Management of risk and vulnerability is the fundamental element of building resilience. In this development, three analysis and assessment methods were performed and provided as examples. They were introduced to delineate some specific aspects of risk and vulnerability, which are prioritization of risks due to the major accidents related industries, integrated risk management in large industrial areas, and highway vulnerability for critical asset protection.

However, when it comes to the development of city resilience and critical infrastructure protection, all possible aspects of risk and vulnerability must be taken into consideration. Additional methodologies of analysis and assessment in different areas of risk and vulnerability can be incorporated to extend the parameter of the platform. Such a study will render extra advantages in analyzing the entire community resilience as well as identifying strategies and actions to cope with risk and hazards.

Initiative frameworks and serious gaming will lead to a tremendous effort by researchers and others in developing a more comprehensive resilience-building process framework or a better resilient city transformation platform in the near future.

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