Development of Support System Tools for Protect Cultural Heritage Sites from Flood Risk (PCH) Plug-in Tools
การพัฒนาเครื่องมือที่ใช้ระบบการสนับสนุนสำหรับการป้องกันความเสี่ยงจากน้ำท่วมของพื้นที่มรดกทางวัฒนธรรม

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Abstract

This paper demonstrates the procedure for development of a support system to protect cultural heritage from flood risk (PCH) plug-in tools in SketchUp that supports planners and designers in developing satisfactory design solutions in the conceptual design integrated with urban management and local neighborhood. As well as the outline of the support system, the results of system use the mapping for flood risk protection and urban cultural heritage in Ayutthaya. In this stage, two approaches are presented including an urban scale and local neighborhood scale which were mapping of cultural heritage distributions damage sites and neighborhood map making. To support decision maker and local people to identify more policies necessary for better living safety and awareness, protection of cultural heritage. A holistic view based on integrated flood risk assessment and cultural methods for establish a support system for the integration of spatial information from decision maker of flood risk and cultural heritage planning for multi-scale spatial planning is further.

บทคัดย่อ

บทความนี้แสดงถึงขั้นตอนในการพัฒนาระบบสนับสนุนเพื่อป้องกันความเสี่ยงจากน้ำท่วมของมรดกทางวัฒนธรรม (PCH) โดยพัฒนาเครื่องมือปลั๊กอินในสเก็ตอัพที่สนับสนุนสำหรับนักวางแผน และนักออกแบบในการพัฒนาทางเลือกที่ใช้ในการออกแบบตลอดจนการออกแบบแนวคิดบูรณาการกับการจัดการเมือง และพื้นที่ในระดับละแวกบ้าน เช่นเดียวกับขอบเขตของระบบสนับสนุน ตลอดจนผลของการใช้ระบบในการทำแผนที่สำหรับการป้องกันความเสี่ยงน้ำท่วม และมรดกทางวัฒนธรรมของเมืองอยุธยา ในขั้นตอนนี้สองวิธีการนั้นจะรวมทั้งระดับเมือง และระดับละแวกบ้าน โดยการซ้อนทับข้อมูลตำแหน่งของมรดกวัฒนธรรมที่ได้รับความเสียหาย และแผนที่ระดับละแวกบ้านเพื่อสนับสนุนการตัดสินใจของผู้บริหารในระดับท้องถิ่นหรือผู้ที่มีอำนาจในการตัดสินใจที่จะกำหนดนโยบายที่จำเป็นเพื่อความปลอดภัยของชีวิตที่ดีขึ้นและการรับรู้ การคุ้มครองมรดกทางวัฒนธรรมมุมมองแบบองค์รวมบนพื้นฐานของการประเมินความเสี่ยงน้ำท่วมแบบบูรณาการ และวิธีการทางวัฒนธรรมเพื่อสร้างระบบสนับสนุนสำหรับการบูรณาการข้อมูลเชิงพื้นที่จากการตัดสินใจของความเสี่ยงน้ำท่วม และการวางแผนมรดกทางวัฒนธรรมสำหรับการวางแผนเชิงพื้นที่ในหลาย ๆ มิติของขนาดพื้นที่ต่อไป

Keywords (คำสำคัญ)

Cultural Heritage (มรดกทางวัฒนธรรม)
Decision Making Process (กระบวนการตัดสินใจ)
Flood Risk (ความเสี่ยงจากน้ำท่วม)

1. Introduction

In the past, catastrophic damage to life and property are many. Urban floods are increasing worldwide and are likely to become even more damaging in future due to climate change (The World Bank, 2012, pp. 10-13).

Thailand is regarded as highly vulnerable to natural disasters caused by hydro-meteorological phenomena (floods, landslides, storms, droughts, etc.), shown Thailand Disaster Statistics, Natural Disaster from 1980 - 2010 (The United Nations office for Disaster Risk Reduction, 2013). Disaster had deteriorating by natural disasters and urban flood studies in the city and cultural heritage sites (CHS).

An effective and efficient knowledge support system is crucial for flood risk and cultural heritage (PCH) design process, as it has become a major design and planning issue in the last decade with the natural disaster. There are a limited number of Computer Aided Design (CAD) investigations on the nature of knowledge processing that supports the cognitive activities of flood risk and cultural heritage design process.

A suitable knowledge support system is also crucial for designing better built environments. In the last decade, the concept of universal design, which means creating products, environments and systems for all ages, abilities and sizes, has become a major design issue (Afacan & Demirkan, 2011, pp. 530-541). In Ayutthaya, there are currently three major challenges for flood risk and cultural heritage:

1) Information was difficult to understand and lack of engagement: The plan of the decision making project is usually presented using two-dimensional (2D) drawings. This form of presentation makes it very difficult to imagine being in the real level of flood or effect by flood of cultural heritage. There is no support system tool for decision making to propose inside the planning and view the scenes from their preferred perspectives.

(2) Lack of appropriate management: in the planning and implementation process, the appropriate management is crucial. Firstly, Integration knowledge from specialist (urban planner, urban designer, architects and engineers) with their plan and can contribute transfer of powerful experience to decision makers or local people for verify their results.

(3) Lack of information transfer of powerful experience: results for decision making usually involve complex specialist analysis, figures and geometric information. These can impede local people participants, who may not be experts, from understanding the contents and objectives thoroughly. Furthermore, most flood risk protection involve multi-dimensional information, such as the presentation of water levels or water depths in different flood return-periods on map. The communication may not be fully effective if the presenters can only present the information on statistical diagrams, 2D data and through chart (Lai, Chang, Chan, Kang & Tan, 2011, pp. 201-223).

2. Data and Methodology

The methodology used in this study is represented schematically in Figure 1. It consists of three interconnected parts. The first part deals with problem based on previous flood risk and cultural heritage solutions, Information was difficult to understand, lack of appropriate management and lack of information transfer of powerful experience. The second part deals with capacity based on urban scale and local neighbourhood scale. The development of urban scale based on GIS to classify characteristic of urban morphology types on cultural heritage sites. The development of local neighbourhood scale based on Sketch Up, development plug-in tool in SketchUp name “flood risk and cultural heritage” (PCH) plug-in tool. The last part output for alternatives of flood risk and cultural heritage by plug-in tool that supports designers in developing satisfactory design solutions in the conceptual design phase, resulting in a qualitative support system for flood protection of cultural heritage sites. Consequently, most of the data was collected in the field mapping and field survey.

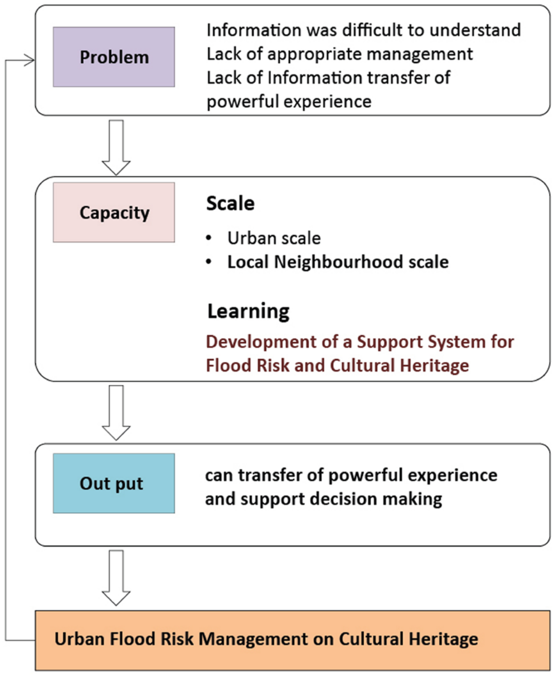

Figure 1. Protect Cultural Heritage (PCH) from flood risk plug-in tool.

2.1 Problem (Analysis) operation as the initial part of the conceptual design process requires defining a list of problem information are difficult to understand, lack of appropriate management and lack of information transfer of powerful experience and objectives as design specifications (Ozkaya & Akin, 2006, pp. 381-398). Described design specification and development as being parallel activities since design act is a cyclic process, where alternatives are checked against the initial set of objectives, and the set of objectives are redefined for the subsequent steps (Afacan & Demirkan, 2011, pp. 530-541).

2.2 Capacity is the ability of people in community by using available skills and resources to face and manage flood. The capacity to cope requires continuing awareness, resources and good management, safety building, both in normal times as well as during crises or adverse conditions in local neighborhood (Shook, 1997, pp. 77-88; Saltbones, 2006, pp. 26-43; Birkmann, 2007, pp. 20-31; Jha, Bloch & Lamond, 2012).

2.3 Output (Synthesis) operation is generating solution alternative solutions with respect to the specified requirements defined synthesis as the moment of externalization and description of an idea either in the form of a sketch, drawing or model (Afacan & Demirkan, 2011, pp. 530-541; Roozenburg & Eekels, 1994)

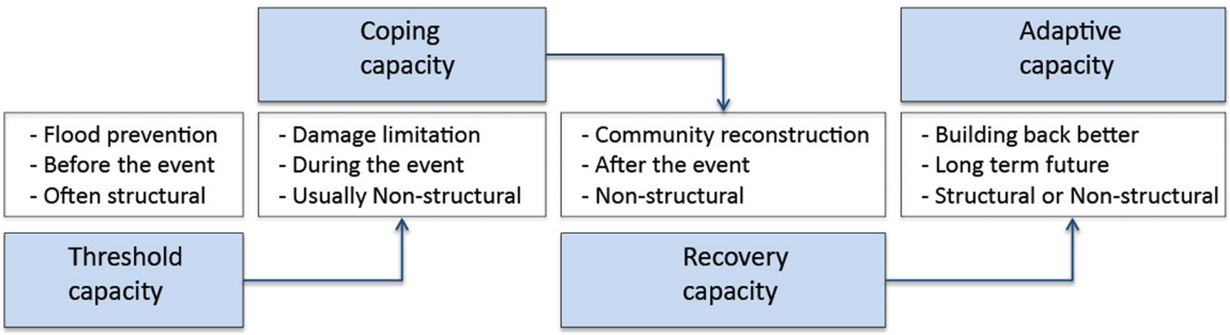

Figure 2. The four capacities towards increased resilience. (Modified from Robin Bloch et al., 2012)

3. Results and Discussion

3.1 Flood Risk and Cultural Heritage Knowledge Processing and Representation

A knowledge based tool should provide a medium for effective knowledge processing and expressive knowledge representation (Nalepa, 2010, pp. 1006-1023). Flood risk and cultural heritage processing and representation are difficult task. There is an important number of interacting design elements that should be considered (Lai et al., 2011, pp. 201-223). Although the Flood risk and cultural heritage principles inform urban planner and urban designers about usable environments, they are not sufficient to generate promising alternatives. It is usually difficult to follow. There is no unique parameter that can be optimized. Rather, there are sets of requirements regarding each damage type. Moreover, urban planner and urban designers must determine the relative importance and implementation order of each requirement because it is not possible to satisfy for all of them equally. Thus, flood risk and cultural heritage knowledge processing and representation should be considered in relation to correlation between water level and damage types.

In this study proposes a knowledge support system based on previous studies and the application of Geographic information system (GIS) techniques for identifying the disaster vulnerability areas, the result of GIS can be verified with the field survey to deliver priorities of intervention based on the multi-variable classification of morphology vulnerability types and characteristic on cultural heritage sites assets (Daungthima & Hokao, 2013a, pp. 35-39; Daungthima & Hokao, 2013b, pp. 739-748). For the present study, the result of urban morphology illustrates the procedure for development of a support system PCH plug-in tools in Sketch Up that supports planner and designers in developing satisfactory design solutions in the conceptual design integrated with urban scale and local neighborhood scale. As well as the outline of the support system, the results of system use the mapping for flood risk protection, urban cultural heritage and community safety.

The development of support system representation of multiple knowledge types, it provides a means for represent of flood risk and cultural heritage knowledge as a continuous process of urban planners, urban designer's cognitive interactions between problem formulation and solution generation. Although design activity is generally explained under the model of problem-capacity-output in literature (Afacan & Demirkan, 2011, pp. 530-541; Ozkaya & Akin, 2006, pp. 381-398; Shook, 1997, pp. 77-88; Saltbones, 2006, pp. 29-43; Birkmann, 2004, pp. 20-31; Jha, Bloch & Lamond, 2012; Roozenburg & Eekels, 1994; Anantsuksomsri & Tontisirin, 2013, pp. 1-14)

This study defines flood risk and cultural heritage representation as an iterative process composed of the three main operations: (1) finding the essence of the problem (analysis), (2) available skills and resources to manage flood (capacity), (3) generating alternative design solution in relation to problem and capacity (output or synthesis).

3.2 An Experimental System: Protect Cultural Heritage (PCH) from Flood Risk Plug-in Tool

An experimental system based on is developed to support system all the above deficiencies of flood risk and cultural heritage knowledge processing and representation during problem, capacity and output operation. The proposed PCH plug-in tool has user interfaces that facilitate creation, modification and display of the relevant knowledge. SketchUp 8, three dimensional (3D) conceptual design software program in SketchUp. The PCH plug-in tool is activated by choosing the relevant item from the 'plug-in' menu. Its' user interface is composed of message boxes, dialog boxes and web dialogs. Figure 3 Support scheme of the PCH plug-in tool and data flows among them throughout problem, capacity and output operations. The capabilities of these components add new knowledge processing and representation facilities to SketchUp that address cognitive challenges of the

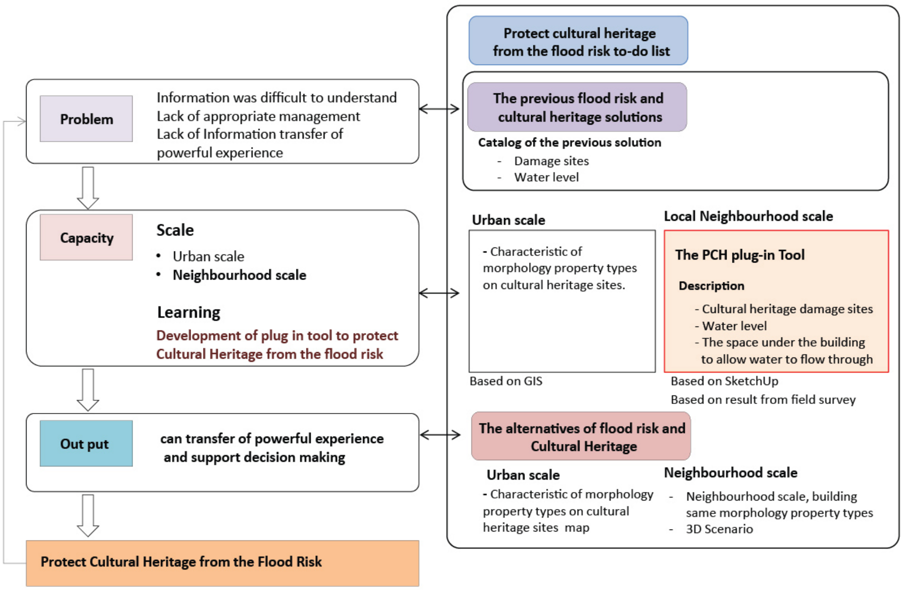

Figure 3. Support scheme of the PCH plug-in tool.

flood risk and cultural heritage process. They are acting as a key mechanism that supports the digital information flow from problem to capacity operation and from capacity operation to output operation.

3.2.1 The Previous Flood Risk and Cultural Heritage Solutions

The previous flood solution provides information to urban planner, urban designer, architects and engineers about case studies on disaster risk via a web dialog. The web dialog that interacts with web via a local filed opens and offers a mechanism to access both textual and graphic data. For the flood risk and cultural heritage domain, a case consists of relevant knowledge from the best PCH solution (damage sites, water level).

3.2.2 Local Neighborhood Scale

This stage learning to development of a support system for PCH plug-in tool, the three descriptions: cultural heritage damage sites, water level and the space under the building to allow water to flow through. Then, the result from previous studies develop category and crucial, develop in this stage for urban scale transfer to local neighborhood scale.

3.2.3 The Alternative of Protect Cultural Heritage from Flood Risk

The alternative operation is generating solution alternative solutions with requirements, local neighborhood and building by 3D scenario before and after flood. The output of result in this part can contribute decision making in this neighborhood scale and link gate to urban morphology types.

Process diagram of the PCH plug-in tool in SketchUp: start SketchUp program, drawing 3D SketchUp in neighborhood scale and drawing 3D SketchUp in building scale. The output had 3D in neighborhood scale and buildings scale before flood. The development of plug-in tool use ruby editor code allows creating and modifying ruby scripts directly within sketch (Schreyer, 2013). Start for develop code of flood risk and cultural heritage in ruby scripts, code based on result in previous studies (see Figure 4) and then, execute code in SketchUp, illustrates an exemplary dimensional standards interface it show (see Figure 5-7). Then can put water level, space under building and number of floor of 3D in neighborhood and building scale. The output show 3D during flood risk; master plan, elevation and perspective can contribute for decision making in neighborhood, building scale and Architecture design measures.

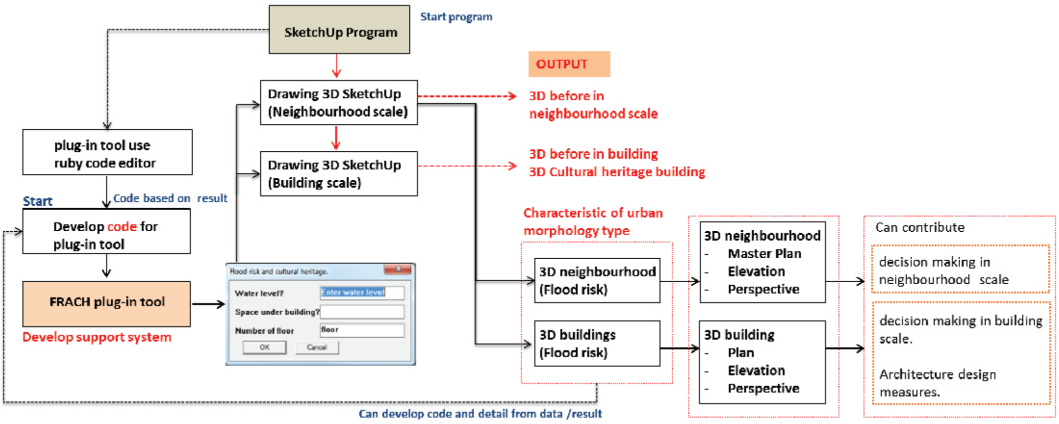

Figure 4. Process diagram of PCH plug-in tool in SketchUp.

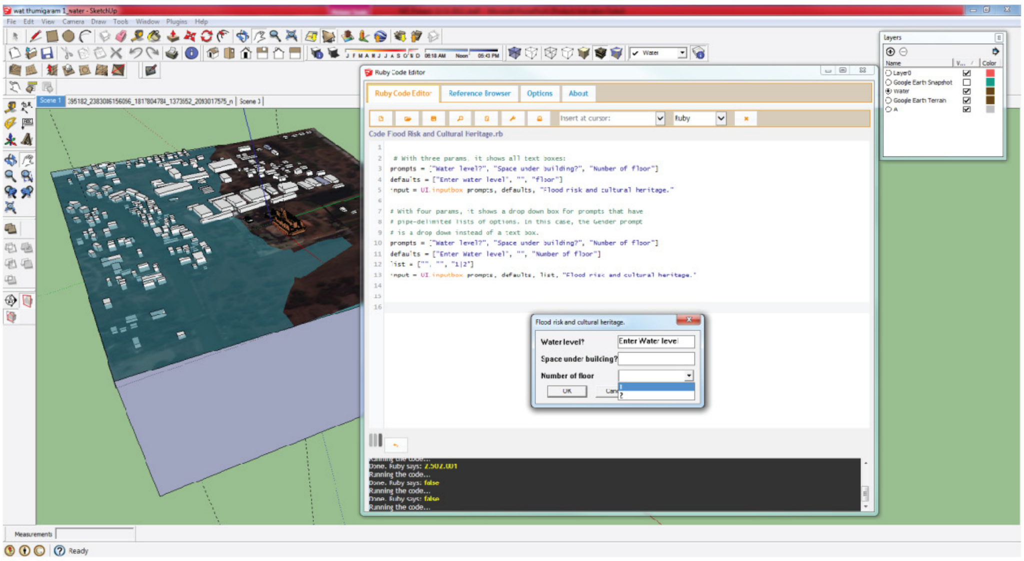

Figure 5. Support scheme of the PCH plug-in tool shown in SketchUp program.

Code Protect Cultural Heritage.rb

```
# With three params , it shows all text boxes:
prompts = ["Water level?" , "Space under building?" , "Number of floor"]
defaults = [ "Enter water level]" , "", "floor"]
input = UI. inputbox  prompts, desaults,  "Protect Cultural Heritage"

# With three params, it shows a drop down box for prompts that have
# pipe-delimited lists of options. In this case, the Gender prompt
#is a drop down instead of a text box.
prompts = ["Water level?" , "Space under building?" , "Number of floor"]
defaults = [ "Enter water level]" , "", "Number of floor"]
list = ["" , "" , "1l2"]
input = UI. inputbox  prompts, desaults, list, "Protect Cultural Heritage"

```

Figure 6. Code of PCH plug-in tool.

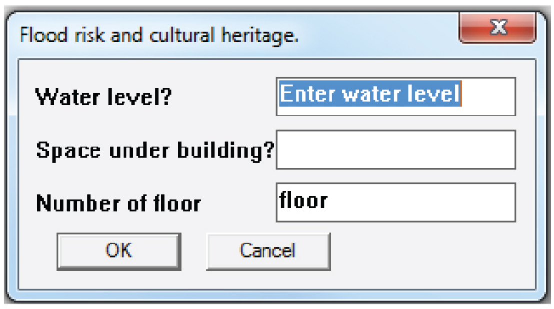

Figure 7. Illustrates an exemplary dimensional standards interface.

3.3 Communication system in public participation

The communication system between specialist (urban planner, urban designer, architects and engineers), decision maker and local people will efficiency and effectiveness of the consultation tremendously. Local people consultation is usually presented as a hearing that in turn will increase public involvement in decision making. The issues concerning the support system of flood risk and cultural heritage should be addressed in decision making process, where local people can have access to detailed information of result for implementing the decision.

The conventional communication system shown in figure 8., the data results separate from urban planner, urban designer, architects and engineers were presented to decision makers, usually through some paper-based medium, experiment data, 2D images and maps, but this often resulted in lack of integration with the information. Local people or decision maker needed to observe information about flood risk and cultural heritage, perform analysis of the data, and set the policy for flood protection of neighborhood. At the same time, they want to get support for the policy and feedback from the local people to revise the data and design of flood risk and cultural heritage. The local people, who are residents in and around the neighborhood, are mainly concerned about the safety of flood risk and properties during floods. Unfortunately, the traditional communication system always consumed much time and was stammered with many misunderstandings, which was also somehow contradictory from a participant's point of view and sometimes caused disputations.

They are need ability skill and need integration knowledge Urban Planner have sufficient in urban planning knowledge but didn't have 3D skill, Urban designer have sufficient in urban design knowledge but didn't have urban flood skill, architects have sufficient architecture knowledge but didn't have urban flood skill and Engineers have sufficient engineering knowledge but didn't have cultural heritage skill (see in Figure 9).

Generally, the local people faced difficulties in imaging the project's impact and the goals that the project ultimately would achieve because most of them had no 3D skill in relation to result of work, leading to difficulties in understanding plan for decision making.

To decrease communication gaps, specialist and decision makers need to explain the result or design details in language which is easily understood by local people. A support system for 3D (Lai et al., 2011, pp. 201-223) with advanced technology showing both flood risk and cultural heritage information, can be an ideal solution. Thus, the goal of local people involvement through user satisfaction with both the process and outcomes can be attained. The outcomes 3D from PCH plug-in tool can contribute communication between specialist, local people and decision maker support in the decision making process.

Figure 10 illustrates a new communication system that users a support system (PCH) in the planning and implementation process. Firstly, Integration knowledge specialist (urban planner, urban designer, architects and engineers) with their plan and verify their results. They then present their advice and provide consultation to the decision maker with the assistance of a support system (PCH) in hope obtaining greater decision making, the decision makers are able to give more concrete responses to local people queries, and the public can express their opinions more directly an effectively. Therefore, the communication system between specialist and local people is greatly enhanced by using 3D from PCH plug-in tool to support decision making process for select a decision making tool, apply to select a preferred alternative and check the answer to make sure it solves the problem.

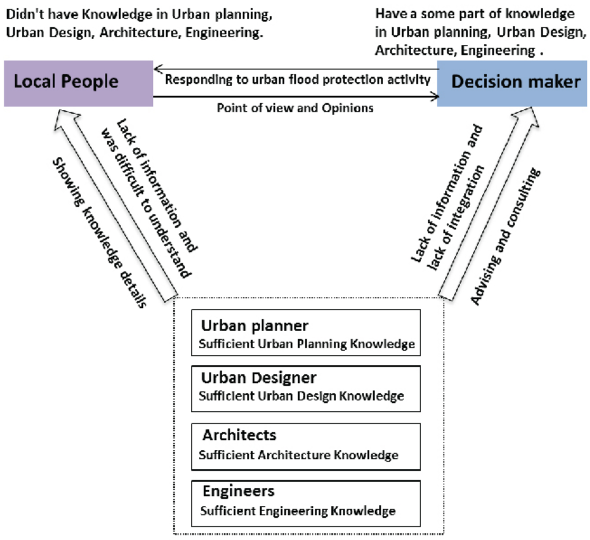

Figure 8. The conventional communication system between specialist, local people and decision maker (authors' figure, 2013)

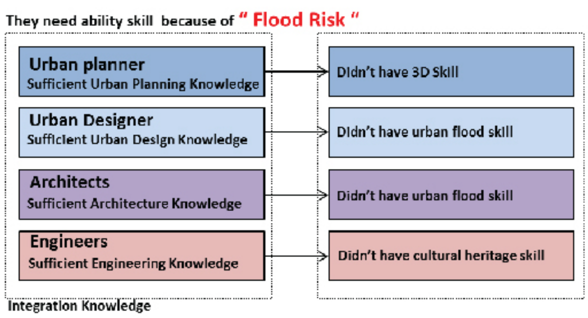

Figure 9. Integration knowledge between urban planner, urban designers, architects and engineers.

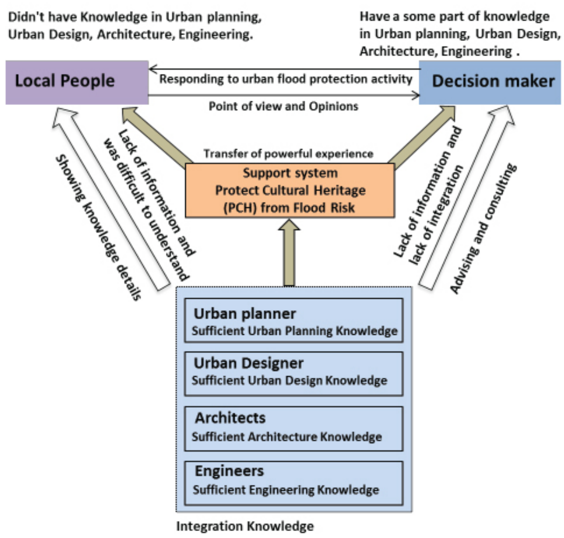

Figure 10. New communication system between specialist, local people and decision maker.

3.4 Integration with spatial information for support decision makers on cultural heritage distributions.

In this part, present system to classify urban and neighborhood scale. The urban scale classification of characteristic urban morphology types based on GIS, for neighborhood scale an experimental system: the computer-assisted to protect cultural heritage (PCH) from the flood risk, develop of plug-in tool for protect cultural heritage from flood risk and to establish of plug-in tool for the integration of spatial information data from urban morphology.

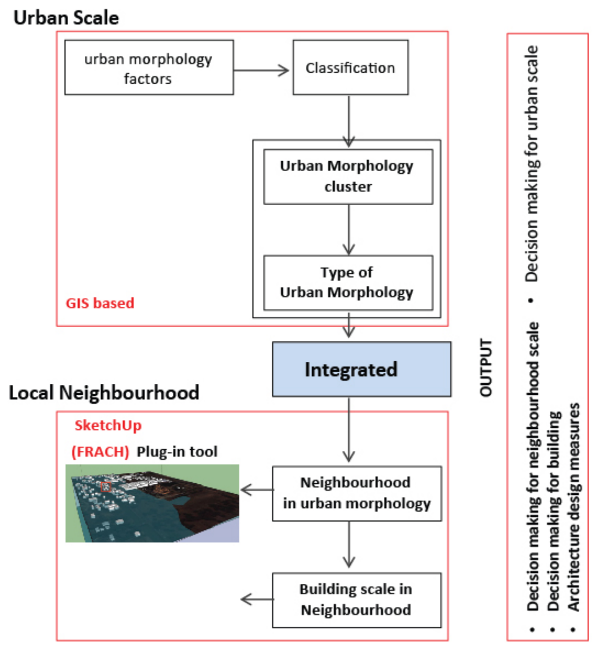

Figure 11. Integration spatial Information for Support Decision Making.

4. Conclusions

This study was to find a more efficient method to establish a support system for the computer-assisted PCH plug-in tool. That supports planner and designers in developing satisfactory design solutions in the conceptual design phase for urban planner and urban designer to work on projects in 3D plug-in tool. The system develop in this work can help the feasibility of decision maker be discussed in more detail before investments and complicated for flood risk and cultural heritage planning.

For 3D manipulation, the system uses SketchUp in local neighborhood and building scale, support system approach for the computer- PCH concept generation. Today, Flood risk and cultural heritage knowledge appears in various sources changing from technical documents to design representation. However, PCH applications should provide knowledge representations that can flexibly adapt to the requirements of the urban flood risk protection. Therefore, develop the PCH plug-in tool in SketchUp that supports planner and designers in developing satisfactory design solutions in the conceptual design phase together with outcomes of results transfer of powerful experience to local people and decision makers for decision making process.

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References

Afacan, Y. & Demirkan, H. (2011). An ontology-based universal design knowledge support system. *Knowledge-Based Systems, 24*(4), 530-541.

Anantsuksomsri, S. & Tontisirin, N. (2013). Review article: Agent-based modeling and disaster management. *Journal of Architectural Research and Studies, 10*(2), 1-14.

Birkmann, J. (2007). Risk and vulnerability indicators at different scales: Applicability, Usefulness and policy implications. E*nvironmental Hazards, 7*(1), 20-31.

Daungthima, W. & Hokao, K. (2013a). Analysing the possible physical impact of flood disaster on cultural heritage in Ayutthaya, Thailand. *International Journal of Sustainable Future for Human Security J-SustaiN, 1*(1), 35-39.

Daungthima, W. & Hokao, K. (2013b). Assessing the flood impacts and the cultural properties vulnerabilities in Ayutthaya, Thailand. *Procedia Environmental Sciences, 17*, pp. 739-748.

Jha, A. K., Bloch, R. & Lamond, J. (2012). Cities and flooding: A guide to integrated urban flood risk management for the 21st Century. Washington, DC.: World Bank.

Lai, J. S., Chang, W. Y., Chan, Y. C., Kang, S. C. & Tan, Y. C. (2011). Development of a 3D virtual environment for improving public participation: Case study – The Yuansantze Flood Diversion Works Project. *Advanced Engineering Informatics, 25*(2), 208-223.

Nalepa, G. J. (2010). Collective knowledge engineering with semantic wikis. *Journal of Universal Computer Science, 16*(7), 1006-1023.

Ozkaya, I. & Akin, O. (2006). Requirement-driven design: assistance for information traceability in design computing. *Design Studies, 27*(3), 381-398.

Roozenburg. N. F. M. & Eekels, J. (1994). *Product design: Fundamentals and methods*. Chichester: John Wiley & Sons.

Saltbones, O. A. (2006). Indonesia after the earthquake that hit Jave - May 2006. In *The Johns Hopkins and the International Federation of Red Cross and Red Crescent Societies*. Public health guide for emergencies. (pp. 26-43). Baltimore, MD.: Johns Hopkins University.

Schreyer, A. C. (2013). *SketchUp plug-in*. N.P.: n.p.

Shook, G. (1997). *An Assessment of disaster risk and its management in Thailand. Disasters, 21*(1), 77-88.

The United Nations office for Disaster Risk Reduction. (2013). *Serving the information needs of the disaster reduction community.* Retrieved March 11, 2013, from http://www.preventionweb.net

The World Bank. (2012). *Thai flood 2011: Rapid assessment for resilient recovery and reconstruction Planning*. Washington, DC: World Bank.