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An Interactive Process Framework to Generate Knowledge Base for Walkability

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Since two decades, Nations aim to achieve sustainability through the advancement of walking activity and the creation of walkable environment. Despite the success of some communities to create social, health, economic and environmental benefits through the walkable city, there is a lack of scientific evidence. Creating walkable city- like other urban planning issue- involves different actors and tends to have a variety of influential factors with no a certain results. Therefore, they often exhibit complex and unstructured problems. The complex, unstructured nature of these problems originates from uncertain knowledge and from the existence of divergent perceptions among various actors. Consequently, this paper focuses on a complex, unstructured urban planning management issue in the creation of walkable city. Through this paper, the problem was defined by using the problem– solution combination, and adopts it in Causality Chain system. As a result, framework for interactive process to generate knowledge base of walkability has been developed. It has been found that different knowledge sources—expert and practical knowledge should be integrated to create a context-specific knowledge base, which is scientifically valid and socially robust. Furthermore, the measurement method and scale have been emphasized. In summary, the findings form a plea for practitioners in sustainable development to adopt a problem structuring approach in order to deal explicitly with uncertainty and ambiguity. It is hoped that this model will provide easement and clarification for researchers and decision-makers in their assessment of cities' form and function towards maximizing walkability to achieve sustainability.

Keywords: Walkable City, Knowledge Base, Sustainable Development, Decision-Makers

1. Introduction

For a long time, urban design research has remained in the realm of subjectivity. Urban design theory has often been built on intuition, observation,

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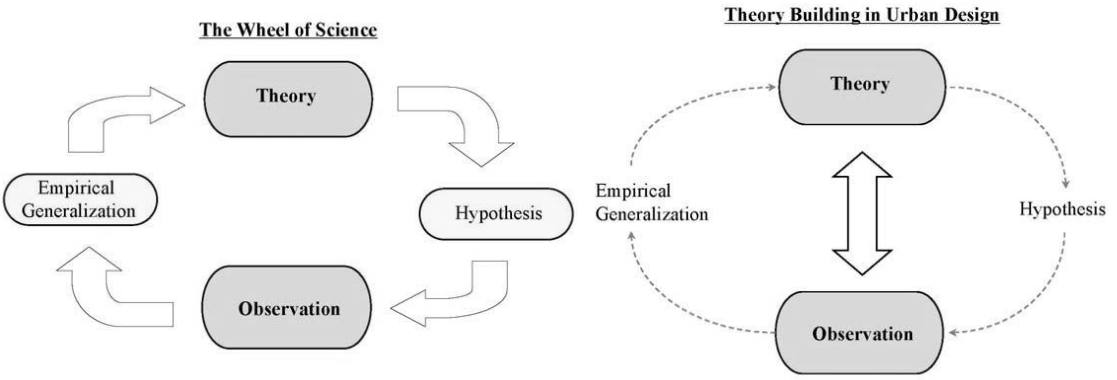
and experience, rather than on scientific research evidence as shown in Figure 1 *(Healey, 1999)*.

Figure 1: Scientific Theory Building Process



The lack of scientific evidence could lead to no interventions and no improvements, because there are no facts to convince policymakers. In the struggle for public money, those with the fact have more chance to get the funds. Walkability research is no exception. Many design principles and codes for good walkability have been established, claimed, and practiced. Most of them seem "right" – intuitive, logical, and circumstantially supportable but they are not backed by scientific research evidence *(Park, 2008)*.The connection between the walking environments and walking behaviour is still missing. One reason for the lack of research evidence could be linked to lack of cooperation between urban design and transportation researchers. While researchers with transportation backgrounds have often overlooked micro-level walking environment and thus not fully tested its effect on walking travel behaviour, the urban design researchers haven't been fully successful either in developing objective methods to measure and evaluate micro-level walkability *(Park, 2008)*. Moreover, Researchers in both public health and the urban planning and transportation fields have highlighted the importance of using objective measures to help better understand the relationships between physical environment attributes and walking behaviours *(Leslie et al., 2007)*. However, there seems to be a difference between perceived and objective measures of the environment. For example, the agreement between objective and perceived walking times to various closest destinations has found to be relatively poor *(Dewulf, 2012)*. These reasons lead to urgent call to structure process for bridging the gap between macro-level and micro-level of urban, understand the relation between physical urban design, urban design quality and walking

behaviour, as well as the role of each actors in this phenomena; decision makers, scientists and user .
The approach of this paper was to clarify the ambiguity and uncertainty of management process to support walking in cities. The following sections explain the development of problem structure providing the literature relevant of each step to model interactive process in generate knowledge base of walkability.

2. Methodology

The complex nature of developing walkability originates from uncertain knowledge and from the existence of divergent perceptions among various actors. The different knowledge sources—expert and practical knowledge—should be integrated to create a context-specific knowledge base, which is scientifically valid and socially robust – At the same time- for the convergence of actors' perceptions, it is essential that actors learn about the content of the process (cognitive learning) and about the network in which they are involved (strategic learning) *(Hommes et al. 2008)*. The findings of Hommes and his colleges form a plea to adopt a problem structuring approach in order to deal explicitly with uncertainty and ambiguity. Therefore, their method is applied. It is divided into: unstructured problem, knowledge base, actors' perceptions and conclude with Problems- Solution Combination.

2.1 Unstructured Problem

A problem occurs when a factual situation is in discrepancy with a desired situation. This implies that problems are not objective givens, but highly subjective social constructs *(Dery, 1984)*. Taking this subjectivity into account, two dimensions can be used to distinguish different policy problems. These dimensions are: consensus about values and norms (normative standards) and the certainty of the knowledge base or content. Using these two dimensions, four types of policy problems can be distinguished, as shown in figure 2.

Figure 2: Classification of Policy Problems

Knowledge base / Values and norms	Certain	uncertain
Consensus	1. Well Structured	2. Moderately structure
Disagreement	3. Moderately structured	4. Unstructured

Well structured problems (type 1) are problems for which a certain knowledge base and consensus about values and norms (normative standards) exists. Some problems are moderately structured because knowledge is uncertain (type 2) or because disagreement exists about values and norms standards (type 3). When knowledge is uncertain and actors disagree on values and

norms, a problem is unstructured (type 4) (*Douglas, 1982*). Developing walkability likes the rest of urban planning problems; are often examples of (partly) unstructured problems, i.e. type 2, 3 or 4.

2.2 Knowledge Base

Factors Influencing Walking Activity

The key factors to consider toward the goal of increasing walking and other non-motorized travel among the general population can be split broadly into the two realms of opportunity and motivation, as shown in Table 1(*Shay et al., 2003*).

Table 1: Factors Influencing Walking Activity

Opportunity (external)	Motivation (personal)
• Distance • Weather • Topography • Cost—time and money to travel • Traffic volume and speed • Safty (e.g., dogs, crime) • Infrastructure o Pedestrian facilities (presence, condition) o Access—proximity to destinations o Access—connectivity o Transportation alternatives o Streetscape	• Physical condition (age, health) • Family circumstances (life cycle) • Cultural (ethnic, social, peer group) • Education (formal and informal) • Profession • Habits, attitudes and values o Personal value of time o Personal value of money o Personal value of exercise and health o Personal value of independence o Personal appreciation of nature

The former includes aspects and features of the built and natural environment—real or perceived—that provide the setting for safe, comfortable, and convenient walking for various purposes. Motivation to walk depends on personal and household characteristics, such as age, health status, profession, education, and life cycle, as well as from habits, attitudes, and preferences. Only in the presence of opportunity do the motivational factors become relevant. Both opportunity and motivation are important to understand in promoting walking activity; a critical threshold of each is necessary to support a socially and individually beneficial level of walking among the general public. This division is imprecise and the line separating opportunity and motivation necessarily fluid, as a factor one person views as an external barrier to walking (e.g., child care duties) another may view as a motivator that prompts new trips to playgrounds or other destinations, if the environment and other personal circumstances permit.

Measurement of walkability variables

The variables classified under each physical construct were categorized based on the method of measurement as objective, subjective, or distinctive. While distinctive variables are more often unique to each study, objective and

subjective variables are more commonly used in most studies, Table 2 (*Praveen et al., 2011*). Distinctive variables require data available in spatial and non-spatial format specific for a region or a study, and its availability and application for other studies is remote. For example, the variable cautious driving is not commonly used to develop a pedestrian index and can be measured only through observation. While subjective or self-reported variables use individual's perception and behaviour as methods of measurement, they have shown to have low reliability as reported by Bauman et al. (*Bauman et al., 2002*). Objective variables on the contrary are used because the method of measurement can be replicated to capture the same variables (*Praveen et al., 2011*).

Table 2: Type of Built-Environment Variables

Variable type	Definition	Method of Measurement	Unit of Analysis	Examples
Objective	Variables that can be quantified using a standard method of measurement that can be replicated in other studies	GIS or Audit	Location, segment, or area	Intersection , street, land- use
Subjective	Variables that can be quantified using a standard method of measurement that may or may not replicated in other studies	Survey	Individuals	Perception, local architecture
Distinctive	Variables that can be quantified using a standard method of measurement that may not replicated in other studies. More often used in a particular analysis only.	Observation	Either of the above	Caution driving, line of sight

Scale of study

The lack of research evidence is linked to the absent of connection between macro urban attribute and the micro. Moreover, There is a lack of quantify and measure walkability at micro-level. Travel behaviour research has not been fully successful to embrace urban design attributes in defining and testing walkability, mainly because there has been little objective and systematic way to measure and quantify urban design attributes. Therefore, many studies overlooked street-level factors that urban designers believe to be important in walkability, such as street enclosure and façade permeability. Instead, many studies connecting the built environment and walking travel behaviour evaluate the walking environment based on macro-level urban form and land use attributes, such housing density and street patterns at the census tract level *(Park, 2008)*. By literature review, walkability studies have covered city level, neighbourhood-level and street level. This paper highlights the importance of considering the three levels in the process of generating Knowledge base of walkability.

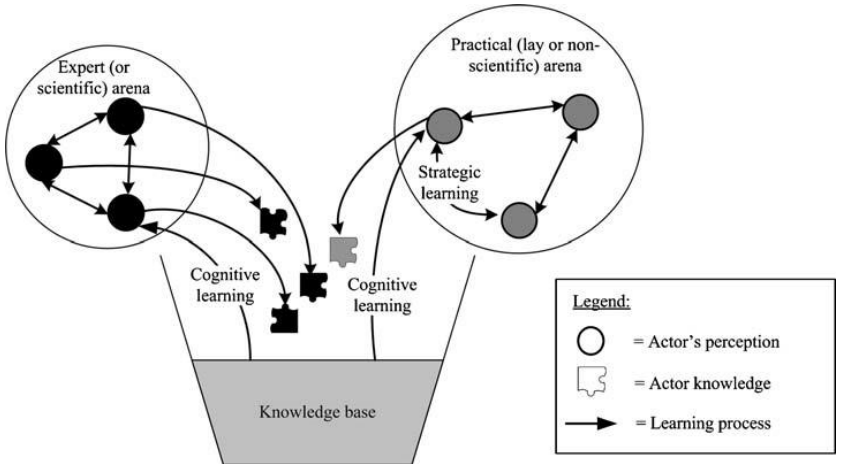
2.3 Actors' Perceptions

Actors' perceptions are based on frames (or frames of reference). These frames function as filters through which information or a problematic situation is interpreted. They encompass ideas of actors about facts, interests, norms and values regarding their environment and the problems and opportunities within it (*Koppenjan and Klijn, 2004).* Actors' perceptions possess certain stability, since they are formed gradually through experiences. Actors' basic assumptions about reality (deep core beliefs) rarely change *(Hommes et al. 2008)*. This paper classify actors in urban planning process into Practical (non scientific), expert (scientific) and public. Most of urban planning study omit that Local government has a crucial role to play in encouraging the creation of liveable active neighbourhoods that promote and wellbeing. They have a vital contribution to the promotion of walkability through their role in planning decisions affecting urban design and through community leadership (*Steele and Caperchione, 2005*).

2.4 Problems- Solution Combinations

A problem–solution combination, or the joint formulation of the problem and its solutions, is the substantive outcome of an interactive process. It is the result of a process of problem structuring in which various knowledge sources and actors with diverging perceptions are brought together in an interactive process. During a process of problem structuring, the challenge is to produce negotiated knowledge. Knowledge is negotiated if actors agree upon the (scientific) validity of the problem–solution combination and consensus exists about the significance and meaning of the knowledge base, Figure 3 (*Koppenjan and Klijn, 2004).* Generally, actors will be more likely to accept information if they have been involved in the production of knowledge (*Eshuis and Stuiver, 2005)*. If different knowledge producers are involved in a participatory process, the authoritativeness of knowledge is not derived from independence or scientific procedures. Rather, the resulting knowledge base consists of mutual inter-subjective interpretations of available knowledge sources (*Koppenjan and Klijn, 2004)*. If expertise from different practices, institutions and actors is used, the validation of knowledge within its disciplinary context does not suffice anymore. Therefore, socially robust knowledge should be aimed at as well. Socially robust knowledge is repeatedly tested, expanded and modified since it is also tested for validity outside the 'laboratory' by an extended group of experts (including laypersons) and society is an active partner in the production of knowledge (*Nowotny, 2003).* Using knowledge from different sources enhances 'learning in context' and the creation of knowledge which will be useful in different contexts (*Eshuis and Stuiver, 2005)*.

Figure 3: Conceptual Model on the Creation of a Knowledge Base and Related Learning Processes

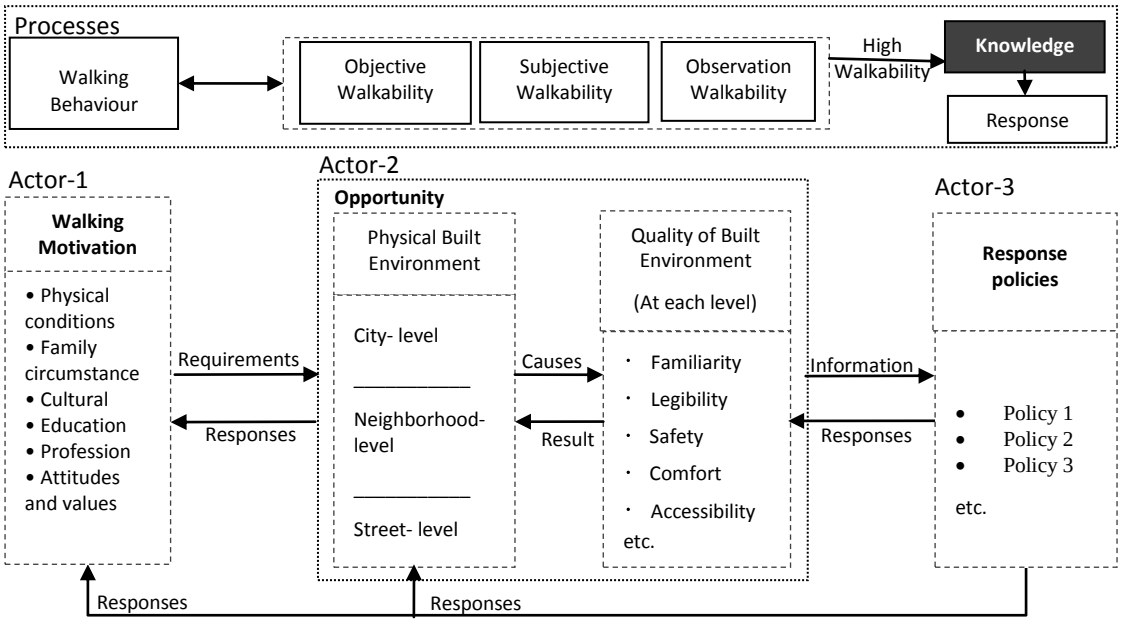


3. Results and Discussion

A problem– solution combination (or a problem formulation) goes beyond defining the discrepancy between a given state and a desired state. It includes the following three elements: description of present and future situation including causal structure; definition of criteria and objectives; and definition of direction(s) for solutions (*Dery, 1984)*. From the literature review of the tools for processes management in relation to new sustainability demands, the Pressure- State- Impact- Response (PSIR) Causality Chain system was selected to adopt problem– solution combination. It was modified in order to structure the process in which various knowledge sources and actors with diverging perceptions brought together, as shown in Figure 4.

The result is based on a simple causal relationship. As Walking is essential for the environment, the economic and the social sustainability, Actor 2 is required to developing walking Opportunity. The opportunity factors divided into two main categories: physical built environment and quality of built environment. The former is one system of three levels; community level, neighbourhood-level and street level which are interrelated at the causes and effects. The later is defining the quality of life such as familiarity, legibility, safety, comfort, accessibility and distinctiveness. When these changes in the physical environment system leads to certain impacts on the walkability, the economic system and the social system, to which society responds with policies and programs take action to prevent, mitigate, or repair the negative effect of its domain. The positive results are considered base knowledge.

Figure 4: Structure Model for Interactive Process to Generate Knowledge Base of Walkability

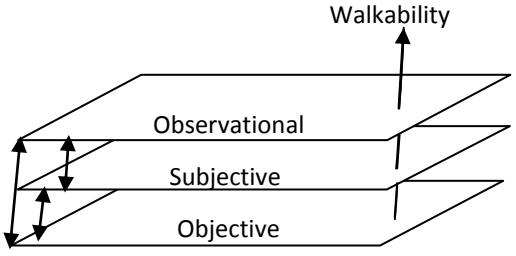


Literature about process management emphasizes that (scientific) research should not be organized as a separate phase in the process. It should be organized parallel to the negotiation actors *(De Bruijn and Ten Heuvelhof 1999; Koppenjan and Klijn 2004*). Furthermore, knowledge questions and conflicts emerging during a participatory process can be brought into the research arena as research questions, through a scientific forum. These research questions that emerge at various points in the game can be very different by nature and may not fit into a chronological order (*Koppenjan and Klijn, 2004)*. Therefore, connecting different knowledge arenas may cause content-related difficulties as well as process related difficulties. Temporal misfits may hinder the use of research in a participatory process, since research processes often ask time to generate some degree of clarity and certainty (*Douglas MT and Wildavsky AB, 1982).*

In this model, we argue that objective assessment of problem formulations or solutions is impossible because problem structuring is an ongoing process of formulating and solving a problem. Moreover, scientific validity should not be the only yardstick to assess the validity of knowledge within the context of participatory processes. Rather formulations become authoritative, i.e. accepted by all parties *(De Bruijn et al. 2002)*. The Objective, Subjective and Observation of walkability are the scientific- interactive process of problem-solution combination. The three related components should be considered

together to enhance walkability. Quantifying perceptive walkability requires a survey approach, and then compares those results with the objective and observational measures, as shown in Figure 5.

Figure 5: Method of Walkability Measurement



The PSIR Causality Chain system exhibits several serious limitations: In short, the suggested simple linear relationship might obscure more complex interactions present in our world. Despite the limitation, The Chain has been particularly helpful in the environmental area with relatively clear causality chains. It has been found to be useful in the communication with policy makers (*Rump, 1996)*. This system could be a helpful tool as an organizing system *(Hommes et al. 2008).* These results are expected from the Structure model for interactive process which has been developed in this paper. The limitation has been developed by track one clear goal which is the “walking”.

4. Conclusion

Some policymakers have not viewed improving walkability as a viable way to achieve sustainability, partly because of the lack of proofs that creating walkable environment control walking travel behaviour. In this paper, this problem has been defined and addressed by intensive literature review. The ambiguity has been clarified based on Knowledge base process management. By integrating problem-solution combination and the PSIR Causality Chain system, the structure model for interactive process has been developed to generate knowledge base of walkability. It is hoped that Structure model for interactive process improving bridging the planning, public policy and public health fields among other. Further studies are required to apply this framework for better understanding factors that encourage walking behaviour in urban environments and that therefore can affect natural environment, used energy, individual health and population health. Finally, knowing those factors can allow for informed knowledge based planning decisions to be made to increase the social justice for all levels of urban structure and function with regards to encouraging healthy lifestyles.

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