SUSS REVISITED: AN INTERACTIVE SPATIAL UNDERSTANDING SUPPORT SYSTEM (ISUSS) FOR COLLABORATIVE SPATIAL PROBLEM-STRUCTURING

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Collaborative planning theories emphasize the involvement of stakeholders from the earlier phases of planning such as scoping or problem formulation. To formulate the problem rightly, there should be a thorough understanding of the problematic situation. Analytical tools to support these participatory activities can be found in the notion of Spatial Understanding Support System (SUSS), that considers problem structuring paradigm rather than problem solving paradigm. However, they have been conceptualized to enhance public participation for structuring disputes, rather than providing deep insights on problematic situations.

This paper investigates how such system can help in spatial problem structuring with a heterogeneous group of stakeholders; from spatial planning and public health with regard to environment related spatial inequalities in health, in Dortmund, Germany. Grounding the concept of ISUSS on three research avenues- problem structuring methods (PSMs), SUSS and knowledge creation, we set up our system to enhance two way communication between stakeholders and the system and amongst stakeholders. The system is tested in a series of workshops in a face-to-face collaborative environment with a map table as the medium of interaction. The paper outlines the conceptual framework of the ISUSS, describes the setup of the ISUSS and stakeholder workshop for testing it; and presents the results on the usability of such system.

Keywords: Spatial Understanding Support System, problem structuring, collaborative planning

1. Introduction

"Tell me I forget, teach me and I remember, involve me and I learn"

Benjamin Franklin

Collaborative planning theories emphasize the involvement of stakeholders from the earlier phases of planning such as scoping and problem formulation. This endeavour of involving stakeholders for collaboratively constructing a joint understanding about the decision tasks ensures a unique opportunity for mutual learning and understanding for the system analyst and for the stakeholders about the problem situation at hand and the type of support needed by the stakeholders; in addition to bringing a sense of ownership to the problem and their commitment. Nevertheless, involving diverse group of stakeholders inevitably calls for challenges of multiple objectives and multiple perspectives resulting into decision tasks that are often "messy" (Ackoff, 1981) and "wicked" (Rittel & Webber, 1973) by nature. The complex interdependencies and intertwining of causes and effects inherent in wicked nature of messy problem brought to the situation as described by Trainor & Parnell (2010) "*the initial problem is never the real problem*". Moreover, when the problem situation is spatial in nature, is instigated by environmental justice controversies such as NIMBY (Not in my Backyard) and LULU (Locally Unwanted Land Use), its negative externalities lead to spatial inequalities in health, and there is dissensus among heterogeneous stakeholders, there are no simple formulations of the problem. Therefore, such problems require thorough investigation of complex structures embracing different values and worldviews of the concerned stakeholders.

Analytical tools to support these exploratory and participatory activities during the early phase of planning process can be found in the notion of Spatial Understanding Support System (SUSS), a concept that was originally coined in the early 1990s (Couclelis, 1991). The essence of such systems lies in supporting problem structuring paradigm rather than problem solving paradigm with its emphasis on the importance of understanding “what is really going on and why” before actually looking for a solution. Problem structuring (PS) have been argued useful for collecting and systematizing the stakeholder’s perceptions of the decision problem for use in the subsequent phases of the decision analysis by appreciating multiple perceptions of stakeholders (Hujala et al., 2013). However, in the planning process triangle of problem identification, problem modelling and problem solving as described by Martins and Borges (2007), Khadka et al (2013) notices that PS mainly falls within the problem modelling part and partly within the problem identification. While scrutinizing the phases of problem identification, Pound (1965) referred to it as problem finding phase; Mintzberg et. al. (1976) as problem diagnosing phase, Cowan (1986) as problem formulation phase. But we argue that problem identification phase incorporates both the problem finding and problem formulation phase. Whilst problem finding is an act of discovering and appreciating the gap between the initial state and the desired state, problem formulation is setting the boundaries (identifying what is included in the problem) in terms of space, time and people. In this regard we claim that there exists a need of support to find and appreciate the gap between the initial state and the desired state during the problem finding phase to better formulate the problem as importance of getting a good appreciation of the situation is paramount.

In recent years, there is a burgeoning literature [for instance (Jensen et al., 2007; Nonaka & Takeuchi, 1995; Te Brömmelstroet & Bertolini, 2010)] that claims the value of interaction between explicit or formalized knowledge and stakeholder’s implicit or tacit knowledge in solving the problem. Lee & Cho (2007) argue that such knowledge plays a central role during problem finding. In order to perceive that the situation is problematic one needs to draw on his or her existing knowledge. As such we acknowledge that providing platform where explicit knowledge and tacit or implicit knowledge interact reinforces the process of problem finding.

This paper develops and implements a framework of Interactive Spatial Understanding Support System (ISUSS). While we argue that the earlier conception of SUSS is still valid, we want to scrutinize the available problem structuring methods and knowledge conversion theories in order to strengthen the concept of the ISUSS. Hence, the main objective of this paper is twofold: **1-** to conceptualize and develop the Interactive Spatial Understanding Support System augmenting it with problem structuring methods (PSMs) and knowledge creation theory, **2-** to show the effectiveness of such system in an interdisciplinary setting with a heterogeneous group of stakeholders; from spatial planning and public health domains. The case study area chosen for this research is the district of Nordstadt, located in the northern part of the city of Dortmund.

The remainder of the paper is as follows: section 2 presents the theoretical position for ISUSS in the field of problem structuring (PS) and knowledge generation. Section 3 presents the conceptual framework of ISUSS that is based on the integration of PSMs and knowledge conversion model. Workshop design with setting up the components of the ISUSS and its implementation is discussed in section 4. Finally, presentation of result on its effectiveness and discussion with concluding remarks follow in section 5 and 6 respectively.

2. Strengthening the theoretical position of Interactive Spatial Understanding Support System

For dealing with ‘messy’ (Ackoff, 1981) or ‘wicked’ (Rittel & Webber, 1973) problems, a number of authors in operational research (Mingers et al., 2010; Munro & Mingers, 2002), are claiming the effectiveness of mixing two or more methods. Such a ‘multi-methodology’ or ‘multimethod’ approach considers the combined use of two or more methodologies (whole or part of) or methods within single intervention (Mingers & Rosenhead, 2004; Rodriguez-Ulloa & Paucar-Caceres, 2005). Following a multi-methodology approach for the conception of our ISUSS, we draw upon concepts, methods and techniques from specifically three research avenues:- problem structuring methods (PSMs) (Mingers & Rosenhead, 2004), the earlier concept of Spatial Understanding Support System (SUSS) (Couclelis, 1991) and knowledge conversion model (Nonaka & Konno, 1998; Nonaka & Takeuchi, 1995).

Problem structuring methods (PSMs) emerge in ‘soft OR’ when their progenitors recognize the need of approaches that could be implemented in situations where there is no clear agreement to the exact problem or solution, while at the same time can take into account the wider social, political, cultural context (Ackermann, 2012). Rosenhead (2006) noted that these methods aimed to support those problems that “*encompass multiple actors, differing perspectives, partially conflicting interests, significant tangibles and perplexing uncertainties*”. Since then PSMs are deemed to support situations in which people perceive the world in their own way and make judgements using standards and values which may not be shared by others. Such approaches are argued to provide simplicity in understanding for non-technical people unlike the hard style of many decision support systems. Whilst these include both methodologies and methods, Jackson (2000) made a distinction advocating the former as an organized set of methods and techniques with sequence of steps and process, for instance ‘soft system methodology (SSM), or ‘strategic options development and analysis (SODA); the latter are tools and techniques used by methodologies for specific purpose; which include cognitive maps, strategic maps, rich pictures, root definitions (Jackson, 2006).

Amongst a wide collection of PSMs one fully developed and wide in practice methodology is Soft System Methodology (SSM) (Checkland, 1981). Checkland (1981) noted that when the situation is considered messy and ill-structured, there is not a single ‘problem’ that is at hand but rather a problematic situation where it is not clear what exactly is the problem with shared sense of something not being right. A general description of SSM is that it is “*an action-oriented process of inquiry into problematic situations in which users learn their way from finding out about the situation, to taking action to support it*” (Checkland & Holwell, 1997). Since SSM considers that there is no single agreed idea of the problem, it commences with the activities relating to understanding the situation – rather than with any specific problem at hand. Apart from the seven stages, the value of SSM also lies in producing ‘rich picture’ of the problematic situation and ‘root definition using CATWOE’ (client, actor, transformation, worldview, owner and constraints) of the desired transformation (Checkland, 2001). ‘Rich picture’ is the pictorial representation of the problem situation as a whole, that provides a mechanism to reveal issues in the problem situation, their interrelations and interlinkages with affected group of people, relevant actors in the process, including different perspectives of the participants (Ackermann, 2012). Ackermann (2012) advocates that as such picture provides a view of the current situation it can be a powerful dialectic for conversation and learning and a useful mechanism to surface different concerns. Whilst ‘rich picture’ are representation of context in the real world, ‘root definition’ represents the desired transformation to be achieved by the system. Based on CATWOE (Checkland, 2001), root definition helps the participant to follow particular worldviews and define the transformation needed to be made for the problematic situation making it explicit the vulnerable groups in the situation, the actors responsible for the situation, group with power to act and the constraints that hinder such transformation.

Computer supported methods and tools can assist the stakeholders in dealing with complex information and knowledge (Geertman & Stillwell, 2003). As such advancement in computer graphics, computer networks, collaborative software, web-based technology and digital medium may potentially help in improving the cognitive memory in decision making process, engaging large group of people, accommodating multiple perspectives in decision tasks. Different technology supported methods and tools have been offering a range of opportunities in the practice of collaborative planning. As noted by Petkov (2007), however, those strands of work that include issues of problem definition and the development of DSS on problem formulation in the complexity of problem situations are two streams of such computer based tools that are not widely researched. Thus, approach that can assist in understanding complex problem situations so that the area where hard approach of DSS could provide effective support can be identified and the user requirements can be well established, become highly relevant.

Whilst looking at the computer supported aid in planning, Vonk (2006) confirmed that they are being widely used as "informing PSS" (top-down approach) and less as "communicating PSS" and "analysing PSS" (bottom-up approach). Such systems are found further less during earlier phase of planning process, except there are some conceptualization in Spatial Understanding Support System (SUSS). Earlier conception of SUSS (Couclelis, 1991) has been envisioned as any conceptual and technical tools providing support to get a good understanding of actual situation before going for the solution. In this regard, broad categories of problem structuring techniques were labelled as SUSS; indicating that further enhancement of such components could be directed integrating GIS techniques for incorporating spatial knowledge with wide range of visualization techniques and methods to speculate expert cognitive powers and skills. Later, a handful of works appeared in late 1990s and early 2000 (Couclelis & Monmonier, 1995; Horita, 2000; Jankowski & Stasik, 1997) that has explicitly labelled their computer assisted communication tools as SUSS. These tools are warranted to structure conflicts with their geographical, strategic and argumentative dimensions in spatial planning arena to resolve NIMBY controversies e.g. landfill site selection, enhance large public engagement for representing community disputes through online participation.

Recognition over the limited role of scientific and technical information in decision making process has brought attention to the value of personal, experiential or softer dimension of knowledge in the knowledge management literature. Amongst the two types of knowledge, explicit and tacit, introduced by Polanyi (1967), this personal, experiential knowledge falls into the category of tacit knowledge. Explicit types of knowledge are formal (e.g. data, scientific formulas and general/universal principles and theories) and are therefore, easily codified with a wide validity, whereas tacit knowledge or invisible knowledge are those which are highly personal and are therefore considered difficult to formalize, communicate or share (e.g. intuition, practical know-how). Further, Gibbons et. al. (1994) argued that tacit knowledge and information are related to people's individual experiences. In the same line Nonaka & Konno (1998) claim that "tacit knowledge is deeply rooted in an individual's actions and experience as well as in the ideas, values, beliefs or emotion he or she embraces."

Several authors (Gibbons et al., 1994; Innes & Gruber, 2005; Khakee et al., 2000) advocate the importance of tacit knowledge in formal decision making and hence its necessity to recognize in planning processes. Lee & Cho (2007) claim that such knowledge is related to problem finding as it would be difficult to conceive a problem without drawing on his or her own existing knowledge. As argued by Te Brómmelstroet & Bertolini (2010), in the planning process where the stakeholders need to address complex socio-economic planning problems, explicit knowledge and information become invaluable; however it need to be combined and confronted with the tacit dimension of the stakeholders' knowledge. Such combination and confrontation of tacit and explicit knowledge helps to make the explicit information understandable, more transparent and the chance of using such knowledge in daily practice becomes high which is also highlighted by Friedmann (1973); "that the expert knowledge should be wedded to experiential knowledge to achieve a greater rationality in decision-making" (Te Brómmelstroet & Schrijnen, 2010).

In order to link the tacit and explicit knowledge, Nonaka & Takeuchi (1995) proposes a "spiral" model of knowledge creation (figure 1). Describing knowledge generation and learning as a social process

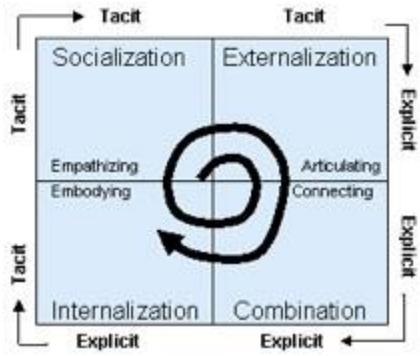

Figure 1 SECI model [adapted from (Nonaka & Takeuchi, 1995)]

the authors (Nonaka & Takeuchi, 1995) suggested that knowledge can be created and shared interactively through four key modes of knowledge conversion:- *socialization (tacit with tacit):* sharing of experiences to create new tacit knowledge, that are often contextualized and take place through observation and talk, brainstorming without criticism; *externalization (tacit with explicit):* articulating tacit knowledge explicitly through precise language, objects which can be shared; *combination (explicit with tacit):* breaking down and arranging the elements of externalized knowledge into a systematic whole; *internalization (explicit with tacit):* process of embodying knowledge through 'learning by doing', practice, reflection and action (SECI). The "spiral" in SECI model represents an iterative process acting on all four modes of knowledge generation, which implicitly operates on learning cycle in which new knowledge is generated.

We proclaim that this research contributes to the early stage of communicative aspect of planning process with computer supported methods and approaches; that is relevant to participatory spatial problem structuring methods with shared insights.

3. Design of the Interactive Spatial Understanding Support System (ISUSS)

In this section we present the concept of our system, the design rationale and the conceptual framework of the Interactive Spatial Understanding Support System

3.1 Objectives and assumptions of ISUSS

The purpose of the ISUSS is described by the following two objectives :

- To provide support, to a heterogeneous group of stakeholders in the form of a face-to-face collaborative environment for identifying and defining the problems to be addressed.
- To guide system designers/analysts in anticipating the users requirements (information needs, technical and methodical needs), in achieving a support system that serves the decision process

The following outputs are expected from stakeholder workshops on problem structuring support by the ISUSS:-a shared and common understanding on the definition and formulation of spatial problem in the case study area, which spatial planning and public health can address together and the information needs of the stakeholder to address the identified problem.

The following assumptions are considered for the ISUSS:-

- Collaborative environment with a map table as a medium of communication, can enhance interaction between the stakeholders (Arciniegas, 2012; Scotta et al., 2006)
- Collaborative problem finding helps to bridge the gap between the system analyst and stakeholders in identifying their requirements bringing towards shared and common understanding (Coughlan & Macredie, 2002)

- Visualization of “who is doing what” during stakeholder sessions encourage the stakeholders to participate actively, thus makes the power dependency more transparent (Janssen et al., 2007)

3.2 Design rationale and framework of Interactive Spatial Understanding Support System (ISUSS)

Problem finding and problem formulation are recognized as creative processes which need individual’s potential to acquire information clearly and rapidly and apply it correctly (Lee & Cho, 2007). According to Te Brómmelstroet & Schrijnen (2010), Soft System Methodology (SSM) stimulates both the developers and the users to reflect on their (mental) models with specific attention on linking tacit and explicit knowledge. In an iterative process, both developers and users engage in active learning throughout the process. Considering this aspect of SSM, the integration of SECI model into SSM forms a useful guiding principle of the ISUSS. Following the theoretical position as discussed in section 2, our design rationale of the ISUSS is to incorporate a sequential structure provided in SSM and to integrate it with the SECI model, with the specific focus on making the spatial understanding of problematic situation explicit.

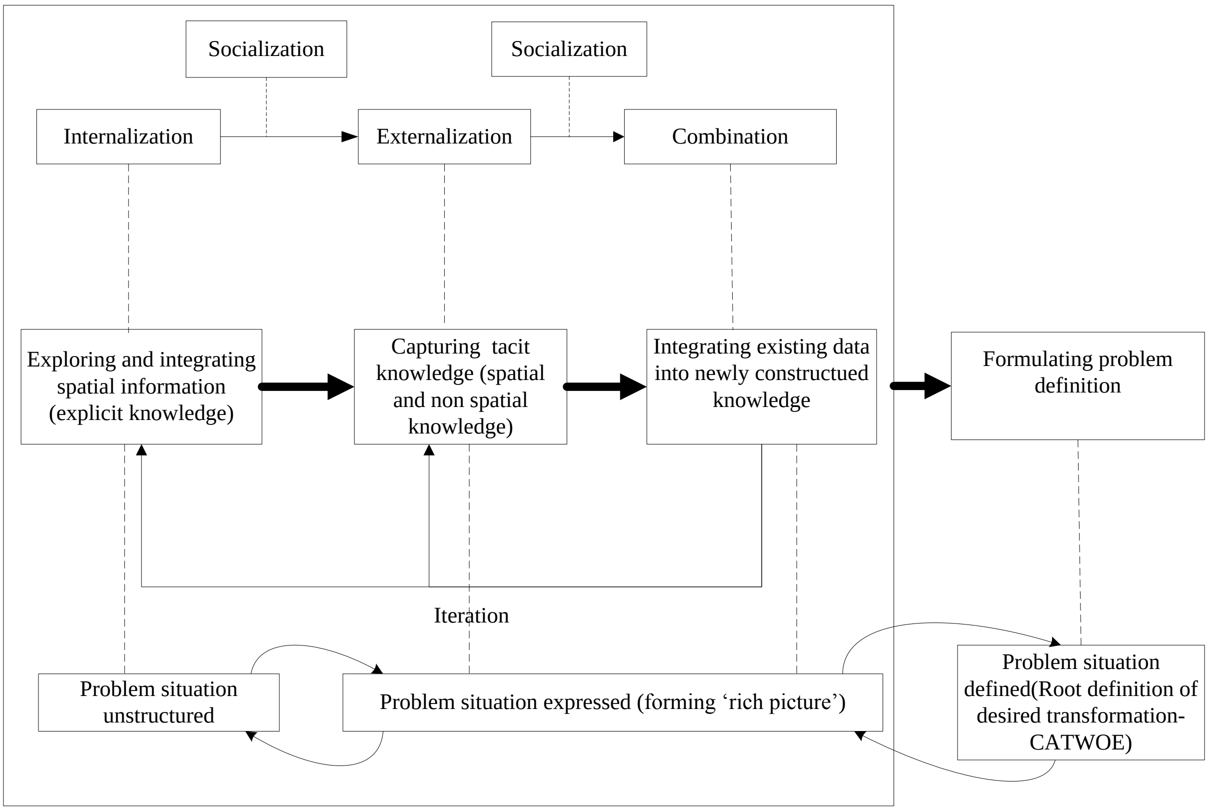

Figure 2 Conceptual framework of Interactive Spatial Understanding Support System (own source)

Figure 2 presents the conceptual framework of ISUSS. The framework shows that the process of interactive spatial problems structuring is divided into a sequence of iterative steps (horizontal) that are interrelated to different stages in SSM phases as well as to different phases of knowledge conversion within the SECI model. The centre part describes the sequence of steps taken by the stakeholders during the problem structuring workshop with support of the ISUSS. Whilst the stakeholders are engaged in carrying out the predefined tasks in each of these steps, they are also encouraged to engage in the cyclical process of knowledge creation: socialization, externalization, combination and internalization (SECI). Each of the steps is also integrated with the first three stages of SSM, which are:- *problem situation unstructured, problem situation expressed and root definition of relevant systems*. These stages of SSM are dedicated to help stakeholders in gaining insights on the problem situation and to explicate the relevant views that describe particular desired situations. Thus, integration of these stages from SSM to the steps of the ISUSS provides a clear view on the expected results from each of the steps.

The framework provides a structured aiding to the stakeholders in their deliberation process to move from the perceived situation of something not being right to clearly define the desired transformation, implicitly going through the process knowledge creation. The following section elaborates on each of the steps of the ISUSS framework.

3.2.1 Exploring and integrating spatial information

The first step concentrates on examining, understanding and providing rich appreciation of the context in the case study area. This step foresees exploring and integrating spatial information during the ISUSS workshop during which stakeholders are provided with data on different themes (such as socioeconomic, environmental goods and bads, etc.) relevant to the case study area. While doing so, explicit knowledge is internalized into individual's tacit knowledge bases in the form of mental models or technical know-how (Te Brömmelstroet & Bertolini, 2010). Furthermore, engaging stakeholders in exploring the provided spatial and information trigger their tacit knowledge, thereby making it explicit that is captured in the system as described in the next section 3.2.2.

Maps are advocated as an effective medium to aid human cognitive for communicating, perceiving, representing spatial relations in the process of constructing geographical knowledge and spatial information processing (Tversky, 2000; Wu et al., 2009). When used interactively, maps can be strong artefacts and effective organizers of geospatial data that facilitates the exploration of problem and solutions in geographic space, integration of spatial information, reasoning, deliberation, communication among stakeholders (Andrienko & Andrienko, 2006). For aiding the stakeholders to explore the spatial information, data and understand the context, the ISUSS provides the platform with the shared space where the stakeholders can use the layers of information in the form of map interactively.

3.2.2 Capturing tacit knowledge (spatial and non- spatial)

Moving from understanding and appreciating the existing situation, the stakeholders are then asked to make their views explicit, experiences, issues and concerns regarding the problem situation as a part of expressing the problem situation. Thus, they are presumed to undergo the process of externalization, i.e. articulating tacit knowledge into explicit.

Several ways of expressing the tacit or personal knowledge have been acknowledge, for instance through metaphors, analogies, models, information (Te Brómmelstroet & Schrijnen, 2010; Tee & Lee, 2013). When the stakeholders move from the mode of internalization through exploration of data and information to externalization, they make their knowledge and know-how of the issues related to the area explicit. In this process the stakeholder may need to express their perspectives or opinions, which are often related to certain locations or particular object in the maps. Research have shown that facilitating the individual to link their perceptions and views explicitly with related geographic object can improve the discussion, analysis and summarization of current status in conversations (Rinner, 2006).

To help the stakeholders to explicate their tacit knowledge, experiences, concerns, and so on, tools that help to add comments or annotate are thus useful. Annotation and sketching tools help individuals to illustrate spatial relationships among objects of interest, to mark specific location of issues which should be retrievable and reviewable later (Tversky, 2000). Such sketching tool also allows people to make their understanding and their perceive knowledge of the situation explicit in social interaction.

3.2.3 Integrating existing data with the newly formed knowledge and information

As a part of expressing the problem situation in totality, a 'rich picture' of the problematic situation area is produced. This includes making explicit the process, structure interrelationships of the issues and concerns as expressed by the stakeholders which is replicated as the process of combination. Combination is the process of systematizing, manipulating, sorting, adding, combining different explicit knowledge and includes breaking down and organizing discrete elements of externalized knowledge into more systematic whole so that it can be disseminated to others in different contexts (Tee & Lee, 2013). While carrying out the step of integrating existing data with the newly formed knowledge and information in the ISUSS workshop, the stakeholders need to produce 'rich picture' of the problematic situation.

Different forms of combination include, for instance in the form of model, indicators (Te Brömmelstroet & Bertolini, 2010). In our framework of ISUSS, such combination include in producing 'rich picture' as a part of SSM. The 'rich picture' can be seen in various forms such as 'cartoon-like' representation, 'causal maps' showing root causes' of the problem situation as a whole. When the problem situation has specific geographic location, then linking such picture on the maps can have added value.

3.2.4 Formulating the problem definition

The fourth stage of SSM comprises the definition of the problem and understanding of what constitute a problem (problem formulation). Moving from the real world to the system world in SSM, here effort is concentrated on setting the boundaries of the problem- identifying what is included in the system in terms of space, time and person based on alternative views on the problem. Thus the root definition is produced using the CATWOE mnemonic as discussed in section 2. Thus, this step is carried out during problem formulating step in the ISUSS workshop.

4. Design of the ISUSS workshop

This research will operationalize the ISUSS in a participatory spatial problem structuring workshop with the stakeholders from spatial planning and public health domain, in the Nordstadt, Dortmund. The workshop aims at structuring of spatial problems in the Nordstadt, within the scope of predefined focus where spatial planning and public health can address together. Based on the design rationale and conceptual framework as discussed in section 3.3, we setup different components of the ISUSS which is to be further refined in a series of workshops with various experts and practitioners (on going) before it will be implemented in a spatial problem structuring workshop with stakeholders from the case study area.

4.1 Case study area

Currently, throughout Germany there is growing tendency to address the issue of environment and environment related social and spatial inequalities with respect to urban health (UMID, 2011). In response to this issue, the research group "City as a healthy place to live regardless of social inequality" (Salus) sets out with its interdisciplinary and transdisciplinary approach (Junior-

Forschungsgruppe Salus, 2012). Two cities of Germany, Dortmund and Munich were chosen as case study areas, as they differ significantly in spatial structure and demographic factors. Moreover, the official statistics also reveal significant disparities in the health of the people in various districts of the municipalities. For this research, we focus on the city of Dortmund.

Dortmund is one of the ten biggest cities in Germany and the biggest one in the Ruhr District (situated in the state of North-Rhine Westphalia). The city inhabits nearly 600,000 inhabitants. The city has boomed from early 19th century to mid-20th century with coal mining, steel industries and beer brewing. While the industrial economy was flourishing, deindustrialization started in mid-20th century that caused radical structural changes in most of the cities in the Ruhr District, including Dortmund. The industrialization and deindustrialization has their impact not only on the employment sector, but also on the spatial structure of the city. During the industrial era the city has grown from moderate size to one of the largest city in the Ruhr District. Growing industrial production from industries in the city demanded large number of workers. As a result the city opened its door to the migrant workers from other countries. In order to accommodate these workers within the walking distance to these industries, housing were developed in close proximity to these industries. Later, deindustrialization brought another structural change to the city. The closing down and moving out of many industries led to job losses of many industrial labours on one hand and on the other many abandoned and derelict spaces arose which are termed as brownfields.

The district of Nordstadt, located north of the city centre of Dortmund, reveals such a structure in particular. The existing land use plan reflects the historically grown situation in the district having close proximity of residential areas with other mixed land use. Mixed land use structure have been deemed to have benefits in terms of increasing vitality, liveability of the city. However, this historically grown district has been instigated with negative connotation of mixed land use termed as "Gemengelagen". Additionally, the statistical data shows that there is higher percentage of migrants in the district and there is relatively higher mortality rate in the district.

4.2 Set up and components of ISUSS

The ISUSS consists of two main components, the hardware and the application or software component. A 'Map table[1]' is used as an interactive medium of communication during collaborative workshop. It allows three ways of interaction:- between users and system, interaction between different users and interaction between users and system analyst. The rationale behind the choice of a 'Map table' for this workshop is that it provides support for face-to-face group collaboration and encourage interaction between the system and user through its touch enabled tool. Furthermore, it facilitates the use of computer based tools without actually using computer devices by the stakeholders, and it provides shared map interface that can be integrated with capabilities of GIS for navigation, data layers, tools, map structuring, visualization, significantly encouraging the interaction between the stakeholders.

We use a multi-touch software, Phoenix 1.1[2]. It is a multi-touch spatial discussion platform specially made for a map table on which stakeholders can discuss issues and produce spatial content interactively. The application uses web map services (WMS) to provide spatial data and map layers.

In order to operationalize the conceptual framework of ISUSS (figure 1), the tools that are useful during the workshops are:

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[1] Map Table – It is horizontal table surface with touch sensitive screen that works as a common map interface to support user map interaction

[2] Phoenix 1.1 from Geodan, Amsterdam (http://www.geodan.nl/)

- *Exploring and integrating spatial information:* map layer management view and map library, zooming and navigating tools, distance measuring tool, google earth view and map view, overlaying tool through transparency management
- *Capturing tacit knowledge (spatial and non-spatial):* annotating on already existing spatial object or newly created object, colour coded sketch mapping which can be stored in the form of GIS layer
- *Integrating existing data with the newly formed knowledge and information*: symbol tools with sketching tool support in representing object of issues, drawing interrelationships between spatial and non-spatial issues on the map

4.2.1 Stakeholder identification

Stakeholders for the ISUSS workshops will be selected based on their professional roles, with the focus on spatial planning and public health, their expertise and knowledge on different issues in the Nordstadt (for instance representing migrant groups, conflict management in environmental issues) and their interest to participate. Potential participants will be identified based on personal knowledge and contact network through previous workshops held in Dortmund.

4.2.2 Operational task description in each of the step

The workshop will be designed for approximately 2-2.5 hours sessions. During the session the stakeholders will be asked to go through the series of tasks in each of the steps as discussed in the conceptual framework and with the aid of tools in map table. The tasks are structured in line with the conceptual framework of ISUSS (figure 2). The workshop will begin with general introduction on the aims of the workshop followed with brief description on the ISUSS, the tasks and the available tools. For each of the step of the ISUSS, the stakeholders will need to carry out some tasks following the guiding questions.

Exploring and integrating spatial information

In this step the stakeholders are needed to explore the data that are made available within a map table supported with different tools (zoom, layer overlay, distance measure) in the Phoenix application. To guide them, they are also encouraged to address some of the questionnaires in collaboration with each other.

- Explore the geographic location of Nordstadt (identify different land uses)
- Identify areas of environmental burden (based on single factors, based on multiple factors)
- Identify areas of environmental benefits
- Identify vulnerable groups to environment burdens

Capturing tacit knowledge (spatial and non-spatial)

With the aid of annotate and sketch tools the stakeholders are facilitated to express their own perceptions of the situation, their experiences, expertise and their know-how of the area by adding text referencing to spatial object on the map, or drawing sketches. Some guiding questions are:-

- What kind of problems in relation to environment related health inequalities exist in the area and where?
- What kind of opportunities are available in the area and where?

- What are the burning issues that are affecting the health of the people in the area and where?

Integrating existing data with the newly formed knowledge and information ('rich picture')

With the aid of symbol tools, sketch tools provided in the table, stakeholders are encouraged to prepare a 'rich picture'. To produce it, they are guided to analyse the data and the newly captured information, then map the issues, the beneficiaries/victims of the issues and their interrelationship with each other.

- Represent the issues, problems or problematic areas, opportunities with symbols, texts
- Show the interrelationship between different problems, opportunities as well as to vulnerable groups, the responsible authority
- What are the root causes of the problems?

Formulating the problem ('root definition')

In this step, the stakeholders are encouraged to observe the 'rich picture' in totality, and to form the 'root definition' i.e. to make it explicit what spatial situation need to be addressed to improve the situation by means of spatial planning and public health, in relation to environment related spatial inequalities in health. Such definition is structured using the CATWOE analysis:

- Who are the victims/ beneficiaries of that issues/ problems (C) ?
- Which authorities/ stakeholders should be included to address the issues considering distributional and procedural notion of environment justice with respect to spatial health inequalities (A)?
- What kind of changes/transformation need to be brought to consider the problem being solved (T)?
- What are the views and perspectives of the same problem from the viewpoint of different stakeholders (W)?
- Who holds the power/ is accountable to stop the process of intervention for improving the situation (national, local etc) (O)?
- What are the constraints that are relevant to that transformation (E)?

5. Evaluation of the workshop

The effectiveness of the ISUSS in supporting the stakeholders in spatial problem structuring will be evaluated. Based on the assessment criteria such as effectiveness and efficiency of the process and tools etc. data will be collected from a post-test questionnaire survey, interviews with the stakeholders, and observation protocols. Currently, we are in the process of organizing the test workshops. The result from the workshop will be presented at the conference.

6. Discussion and conclusions

Concerns pertinent to paying attention to the formulation of the problem at the very early stage as an important part of solving is paramount. However, it is superseded by the fact that in order to formulate the problem rightly, there should be thorough understanding of the problematic situation. When such problems have strong spatial dimension, then the need of computer supported spatial support system to aid the stakeholders with understanding spatial relationships in the problematic situation becomes importance. Therefore, this research sets out to develop such a support system, named as Interactive Spatial Understanding Support System (ISUSS), with the aim of providing aid to heterogeneous group of stakeholders from spatial planning and public health, during a spatial problem structuring workshop.

The research has developed the conceptual framework of such system. The testing and evaluation of the ISUSS will be carried out in a series of workshops for the Nordstadt district in the city of Dortmund, Germany. Some of the results from the workshop will be presented during the conference.

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