Abstract: In order for organisations to effectively exploit their knowledge assets, it is important that they effectively identify where knowledge resides. This is at the heart of “knowledge mapping”. Knowledge mapping aims to track the acquisition and loss of information and knowledge. It explores personal and group competencies and illustrates how knowledge flows throughout an organisation or ‘network’. This paper reports some of the findings from an Engineering and Physical Sciences Research Council (EPSRC) funded project entitled “Knowledge mapping and bringing about change for the sustainable urban environment”. This research project investigated the different types of knowledge mapping techniques to bring about change from a sustainable urban environment (SUE) perspective. In this paper, discussions are provided on the different types of knowledge mapping that exist and the challenges associated with their implementation. The paper also provides recommendations with regards to strengths, benefits and evaluation of the suitability of knowledge mapping techniques in different contexts. It is concluded that if chosen and used effectively, knowledge mapping is useful for decision makers working in the area of sustainability. Such benefits include: improved ability to locate knowledge in processes, policies, people, and repositories; and improved awareness of organisational cultural issues, reward systems, knowledge sharing and value, legal process and protection (patents, trade secrets, trade marks) associated with knowledge exploitation in organisations. The full exploitation of knowledge mapping techniques is also dependent on a variety of factors the main purpose of their use.

Key words: Decision making, knowledge mapping, sustainable urban environment

1. INTRODUCTION

Many industries are facing pressure to increase the sustainability of their practice (Parkin, 2000). This pressure, in many cases, imply significant change of an industry’s understanding of the demands of society and of its clients, as well as its own corporate social responsibility, and can entail major changes in its work practices. Sustainability issues inherently cut across many boundaries; and are trans-disciplinary and trans-organisational.

This brings to the fore issues of how individuals, groups and organisations make knowledgeable interpretations for sustainability within organisations and professional structures and, in industries based on multi-firm and multi-professional projects, across these boundaries. The above discourse would suggest that the vagaries of different industrial sectors are likely to impact on how knowledge for sustainability is created, transferred and applied. Egbu and Suresh (2005) defined sustainable urban environment (SUE) as “a complex integrated urban system (a mix of natural elements and the built environment) with an ability to absorb changes to key sustainable urban development variables (environmental, economic and social), while answering the needs of the present and future urban users (business and citizens)”.

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Knowledge in the field of sustainability is also subject to ideological pressures that can be at odds with what makes both business and ecological sense. Under these pressures, from many sources at many different levels of power, decision-making can be either paralysed or pushed into unsatisfactory directions.

The challenge of knowledge management is to understand how to create practical solutions to support individuals and groups as they generate or acquire this multifaceted knowledge so as to suit the particular requirements of their application context (Van Beveren 2002, Armistead 1999, Alexander et al 1991, Storey and Barnett 2000, Despres and Chauvel 1999, and Coulson-Thomas 1997). Organisations must also grow the capability to share knowledge between specialists and across internal and external boundaries (Quintas 2002).

In a recent research Buckley and Carter (2002) examined the process of knowledge sharing, intra-organisational governance of knowledge, knowledge frontiers within and between multinationals and concluded that both application strategies (use of a given portfolio of knowledge) and discovery strategies (new combinations of knowledge) are important goals of knowledge governance structure. Meeting these challenges would produce great leverage, since it would release more of the untapped value in existing knowledge and will make its communication across a spectrum of uses a more realistic proposition. This is also at the heart of using knowledge more creatively and facilitating knowledge based innovations.

The ability to generate new technological knowledge is now viewed to be linked to a specific learning capability which draws from diverse knowledge bases and is able to activate a systemic recombination process (Antonelli, 1999). The principal purpose and clearest benefit of a knowledge map is to show people in an organisation or within a network/supply chain where to go when they need expertise. A knowledge map can also serve as an inventory. It is a ‘picture’ of what exists in an organisation or a ‘network’ of where it is located. It therefore can be used as a tool to evaluate the corporate knowledge stock (e.g. knowledge for sustainability) revealing strengths to be exploited and gaps that need to be filled (Davenport and Prusak, 1998). Knowledge maps are excellent ways to capture and share explicit knowledge in organisational context.

In order for organisations to effectively exploit their knowledge assets, it is important that they effectively identify where knowledge resides. Organisational knowledge also has to be co-ordinated. Knowledge mapping aims to track the acquisition and loss of information and knowledge. It explores personal and group competencies and proficiencies and illustrates or maps how knowledge flows throughout an organisation or ‘network’. Knowledge mapping is being experimented within education (O’Donell, 1993), business (Huff, 1998) and healthcare (Birbaum and Somers, 1998).

Knowledge mapping in a sustainable urban environment context is in its infancy and has the potential to address a number of challenges that organisations are currently facing (Suresh and Egbu, 2004). This paper reports some of the findings from an Engineering and Physical Sciences Research Council (EPSRC) funded project entitled “Knowledge mapping and bringing about change for the sustainable urban environment”. This research project investigated, inter-alia, the different types of knowledge mapping techniques to bring about change from a sustainable urban environment.
environment (SUE) perspective. This paper also discusses the challenges associated with their use and implementation.

2. TYPES OF KNOWLEDGE MAPPING TECHNIQUES

A thorough literature review leads to the identification of seventeen knowledge mapping techniques (Table 1).

Table 1: Types of knowledge mapping techniques

<table>
<thead>
<tr>
<th>Description</th>
<th>Application</th>
<th>Schematic presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concept map</strong></td>
<td>Express a particular person's knowledge about a given topic in a specific context; explore prior knowledge and misconceptions; problem-solving tool, shorthand form for organising and sequencing ideas</td>
<td><img src="concept_map.jpg" alt="Concept Map" /></td>
</tr>
<tr>
<td><strong>Mind Map /idea map</strong></td>
<td>Note-taking technique; a way to capture and reflect the processes in the brain; used for training scheme manual</td>
<td><img src="mind_map.jpg" alt="Mind Map" /></td>
</tr>
<tr>
<td><strong>Concept circle diagram</strong></td>
<td>Show the existing and desired relationship between concepts, organisations, departments etc.; organise ideas into categories</td>
<td><img src="concept_circle.jpg" alt="Concept Circle" /></td>
</tr>
<tr>
<td><strong>Semantic map</strong></td>
<td>Used for artificial intelligence and machine translations but also previously used in philosophy and languages</td>
<td>(see concept map)</td>
</tr>
</tbody>
</table>

(see concept map)
### Cognitive map
Mapping of thoughts a person has about a particular situation or problem of interest; from concept mapping to word webbing

Refer to the mental models that people use to perceive, contextualise, simplify, and make sense of otherwise complex systems.

### Process map
Blocks of activities or tasks sequenced in a logical way to achieve a specific goal/ objectives include factors like timescale, resources etc.

Define the sequence of tasks which link the actions of people within & across functions in order to achieve a specific goal.

### Social mess map / Cross boundary causality map
Problems are situated in a tangled mess of causal factors that cross the boundaries of stakeholders, processes, industries and social arenas

Summarise a particular group's understanding of the problems, causes, influences and relevant data about the mess.

### Conceptual map
Graphical means to compose concepts and conceptual relations

Used as a communication language between individual and computer systems

### Knowledge flow map
High-level knowledge models in a transparent graphical form

Used to map and measure relationships and flows between people, groups, organisations and information/ knowledge processing entities.
<table>
<thead>
<tr>
<th><strong>Causal map</strong></th>
<th>Structure of people's causal assertions and generation of consequence following those assertions</th>
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<tbody>
<tr>
<td><strong>Ontology</strong></td>
<td>Working model of entities and interactions either generically, or in some particular domain of knowledge or practice; 3 types: domain-oriented, task-oriented and generic</td>
</tr>
<tr>
<td><strong>Petri net</strong></td>
<td>Abstract, formal model of information flow; consists of places, transitions and directed arcs; 2 types: stochastic and generalised stochastic</td>
</tr>
<tr>
<td><strong>Cluster Vee diagram</strong></td>
<td>Road map showing a route from prior knowledge to new and future knowledge</td>
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<tr>
<td><strong>Thesauri</strong></td>
<td>Set of concepts in which concept is characterised by hierarchical, synonymous, horizontal, and other relevant relations</td>
</tr>
<tr>
<td><strong>Visual thinking network</strong></td>
<td>Meta-cognitive and knowledge representation strategy that encourages the user to integrate multiple ways of thinking that inform concept formation</td>
</tr>
</tbody>
</table>

- To explore beliefs of individual or groups in order to establish cause & effect relationships; 'what-if' scenarios
- Tool in searching all of the available information in a given field
- In search for natural, simple, powerful methods for describing and analysing the flow of information and control in systems
- It has been developed to help students studying science make explicit essential elements to constructing scientific knowledge
- Used in retrieval system and modern information (e.g. Web, bibliographic records etc.)
- A technique by which the user can represent, organise and revise their meaning-making of knowledge by grouping and linking symbolic and pictorial visualisations into a coherent whole
### 3. CHALLENGES IN KNOWLEDGE MAPPING IN SUE CONTEXT

In creating graphical representation of an organisation’s knowledge asset, some of the major challenges that would be encountered are the handling of the dynamic aspect of the organisation’s environment and the dynamic character of the knowledge base itself. Some knowledge loses its value over time, other knowledge may be replaced with superior knowledge, and some knowledge may simply be forgotten. This calls for a dynamic approach to knowledge mapping. Sustainability, as a dynamic process, supports continuous changes in economy, society, environment, technology, culture and value etc., namely developments. However, under the context of sustainability, development does not automatically equate to growth infinitely or stagnation, but developments evolve in a way that adapts to changes and improves the connection between economy, environment and society, rather than fixing one area while causing problems in another.

Therefore representing the knowledge processes to bring about change in sustainable urban environment would be a challenge. This is because most knowledge mapping techniques are static in nature and they can only symbolise one concept at a specific time. Sustainable urban environment has parallel factors or concepts on which its delivery is dependant. Some of these factors are man-made and some are natural and most knowledge mapping techniques may not be able to consider these factors in parallel time while mapping the original concept unless knowledge is represented with the help of artificial intelligence.

Also, mapping of knowledge between different users with different perspectives and purpose is a key challenge because of the possibility of miscommunication in maps between map-makers and map-users who might not share the same language, or do not see eye to eye. This is because knowledge maps are abstract, they capture representations and these representations, to be useful, must be shared and understood. The only way to successfully increase the probability of knowledge map communication is to ensure that the map-makers and the map-users share the same symbols or representations or the “legend” which accompanies the knowledge map is sufficiently clear, simple and useful. This integration has always proved very difficult to achieve in practice (Seeman and Cohen, 1997).
4. BENEFITS OF KNOWLEDGE MAPS IN SUE CONTEXT

To a large extent, organisations will only reap benefits from mapping their knowledge depending on the strategies they have in place. Such strategies should be geared towards ensuring that the knowledge map encourages sharing of information and identifies areas of expertise. This will ensure that bridges of co-operation are built to increase productivity.

Essentially, knowledge map encourages the re-use of ideas and processes. It also prevents the re-invention of the wheel. Knowledge maps improve the ability of organisations to locate knowledge in processes, relationships, policies, people, repositories and context. Knowledge maps can help in the recognition of barriers to the flow of sustainable knowledge within and across organisations. Hunt (2003) also suggests that knowledge map may provide a possible answer to the challenges of how to locate new forms of useful knowledge, and the flow of knowledge within and across the organisations, including new directions for training employees, stimulating and facilitating knowledge sharing, and establishing useful links with external stakeholders.

Knowledge maps can quickly connect experts with each other or help novices identify experts promptly. As a consequence, knowledge maps can speed up the knowledge seeking process and facilitate systematic knowledge development since they connect insights with tasks and problems. Knowledge maps also assist in communicating the results of restructuring, re-engineering and organisational changes to those involved.

Other benefits of knowledge map are:
1. It helps in finding critical information quickly and highlights islands of expertise,
2. It provides an inventory and evaluation of intellectual and intangible assets,
3. It improves awareness of organisational cultural issues, reward systems, knowledge sharing and value,
4. It provides legal process and protection (patents, trade secrets, trademarks) associated with knowledge exploitation in organisations,
5. It improves decision making and problem solving by providing applicable information,
6. It provides insights into corporate knowledge, and,
7. It increases the ease of access to all in the organisation.

5. RECOMMENDATIONS AND CONCLUSIONS

Knowledge mapping techniques can be applied successfully in order to facilitate the change in sustainable urban environment (SUE) by mapping best practices and identify the gaps in process of sustaining the urban environment. Knowledge mapping forms a key technique for knowledge management initiatives, since key competitive decisions can be taken based on the resulting transparent overviews of knowledge maps.

When creating knowledge maps within the context of SUE, the following two factors needs considered:
During the development of knowledge maps, a three dimensional approach is required which maps the knowledge within the economic, social and environmental context.

Most knowledge maps tend to include technical knowledge for processes and skills but it is recommended that knowledge maps should also include the ‘generic processes and skills’ which are required to facilitate the change in sustainable urban environment.

It is also recommended that within the context of SUE, we may have to come up with an innovative way in terms of representation of knowledge maps. Sustainability is a socio political process and to represent the knowledge within this context, we can not wholly rely on computer based representation of the knowledge. Human factor is essential to representing the knowledge within the SUE context. One of innovative way in capturing the socio-political tacit knowledge is to establish a community of practice for sustainability knowledge sharing and perhaps representations.

Knowledge mapping tools have the ability to effectively identify and coordinate organisational knowledge. Knowledge mapping tools also aim to track the acquisition and loss of information and knowledge. It maps how knowledge flows throughout an organisation or ‘network’. This paper has shown the different types of knowledge mapping techniques that could bring about change from a sustainable urban environment perspective. The most important challenge associated with the use and implementation of knowledge mapping tools is the need for a dynamic approach to knowledge mapping. This is due to the dynamic characteristics of sustainability and knowledge itself.

Presently, most knowledge mapping tools are static and might require the help of artificial intelligence to make it dynamic. But all is not lost as strategic implementation of knowledge mapping tools within a sustainability urban environment is very useful for decision makers working in the area of sustainability. Some of the benefits of knowledge maps are improved ability to locate knowledge in processes, people, repositories and context; and improved awareness of islands of expertise and evaluation of intellectual and intangible assets, improved decision making and problem solving by providing applicable information, and effective knowledge sharing associated with knowledge exploitation in organisations. The full exploitation of knowledge mapping techniques is also dependent on a variety of factors and the main purpose of their use. While knowledge mapping for sustainability urban environment has been deemed important this has been relatively under studied by researchers. Research in this area has the potential to contribute to an improved understanding of how to continue to exploit knowledge mapping for improved sustainability urban environment performance.

6. REFERENCE

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