Sustainable Industrial Site Redevelopment Planning Support: A Case-Based Reasoning Approach

Tong Wang, Eindhoven University of Technology, Eindhoven, Netherlands
Qi Han, Eindhoven University of Technology, Eindhoven, Netherlands
Bauke de Vries, Eindhoven University of Technology, Eindhoven, Netherlands

ABSTRACT

Abandoned industrial sites could be redeveloped in a sustainable way with the help of previous experience. This paper presents a case-based reasoning (CBR) approach to support sustainable industrial site redevelopment. For a target site that needs to be redeveloped, qualitative important key concerns are identified and quantitative attributes, which are important for sustainability, are calculated. The key concerns are generated from zoning documents and the attributes are calculated from spatial data sets. Machine learning techniques are used to find the most influential attributes to determine transition forms. Similar cases from the constructed case base are retrieved based on the algorithm the authors have proposed. The North Brabant region in the Netherlands is used as a case study. A web application is presented to illustrate the approach. The e-planning method provides a straightforward way to retrieve transition forms from similarly redeveloped cases for new regional planning tasks with a focus on sustainability.

KEYWORDS
Case Representation Structure, Key Concerns, Natural Language Processing, Planning Support, Sustainability

INTRODUCTION

Industrial Site Redevelopment in the Netherlands

The Netherlands is a densely populated country, with 501 people per square kilometers in 2014 (World DataBank, 2014). According to the Dutch national industrial site database IBIS, 1052 industrial sites exhibit signs of obsolescence, equaling 28% of all industrial sites in 2012 (Nijssen & Kremers, 2013). Reducing the amount of obsolete industrial sites by means of redevelopment is important for regional sustainability.

Recently, attention is directed towards industrial site redevelopment to improve city vitality, to reduce pressure on the available land and to stimulate the economy (Louw & Bontekoning, 2007). In 2012, 13% of the identified obsolete places are planned for redevelopment, which amounts to a total area of 11,582 hectares. These changes bring significant environmental, social, economic impacts on the complex and interdependent urban systems. The outcome of a redeveloped project is difficult to foresee, such as the environmental impacts and economic output. Policy makers seek insights into redevelopment impact evaluation methods in planning a sustainable future.

The combination of geoscience and computational tools, such as planning support systems, can help to guide the sustainable urban planning process (Chen et al., 2012). Such tools help to predict
future trends in land use changes, to form several possible scenarios and to quantify important attribute values. It is also beneficial to communicate among stakeholders by making the process more transparent and easily understandable using e-planning methods (Petrov et al., 2009; Pettit, 2005). However, industrial site redevelopment is still a new trend. Clear guidance is missing on how policy makers can redevelop an industrial site in a sustainable way with the help of e-planning tools.

Case-Based Reasoning

Case-based reasoning (CBR) provides approaches to solve problematic situations at hand by finding similar cases from the past. A case is a contextualized piece of knowledge representing an experience that teaches a fundamental lesson to archive the goal of the reasoner, which normally contains a problem description and the solution to the problem (Biswas et al., 2014). CBR allows incremental and sustained learning by retaining solutions each time a problem has been solved, successfully or unsuccessfully.

The case-based reasoning approach has been formalized into four steps: retrieve, reuse, revise and retain as stated in (Aamodt & Plaza, 1994b). The first step helps to find similar cases in the constructed case base. The second and third steps are to check whether users can directly reuse the strategies from the past or whether they need to revise the strategies before applying them. In the last step, the new case and its solutions are stored or retained in the case base for future use (Aamodt & Plaza, 1994; Kolodner, 1992; Slade, 1991). For different purposes and domains, these four steps are performed selectively. In most cases, CBR is mainly used as a case retrieval system (Biswas et al., 2014). This is due to the fact that the revise process is not easy to automate.

CBR has been applied in many domains. In drilling industry, CBR helps to improve the drilling planning and operation. For example, possible risks can be identified from past experiences that are similar to the current planning task. An overview paper of the use of CBR in the drilling industry can be found in (Shokouhi et al., 2014). CBR has also been widely applied in weather forecast applications, in combination with algorithms such as fuzzy set theory and fuzzy logic for more accurate prediction (Riordan & Hansen, 2002). In this domain, historical weather conditions are stored in the case base for future prediction activities to consult and to retrieve similar cases. In addition, CBR has been proven to be an appropriate method to explore in a medical context where symptoms represent the problem, and diagnosis and treatment represent the solution, as has been stated by Begum et al. (2011). For example, Neshat et al. (2012) has proposed a method using CBR to diagnose hepatitis disease with an accuracy of 93.25%.

Case-Based Reasoning in the Urban Planning Domain

For a complex urban planning task, it is important to prevent unfavorable decisions in the early stage so that costs can be minimized to a large extent. Therefore, CBR can be of practical help in the urban planning field (Aamodt & Plaza, 1994a). Compared to other domains, the application of CBR in the urban planning field is limited. Yeh and Shi (1999) claim that CBR can help overcome the knowledge elicitation and black-box operation problems of rule-based and model-based knowledge-based systems. They give an overview of CBR’s potential for urban planning tasks.

CBR applications in the urban planning field are mainly combined with geographic information systems (GIS), in which planning regions and their attributes represent the case at hand. A system is proposed to assist planners in dealing with planning applications in development control in Hong Kong. It integrates a CBR shell and GIS package (Yeh & Shi, 2003). In another research, CBR software jCOLIBRI 1 and GIS data are applied to support the planning process in the region of Çeşme Peninsula (Çınar, 2009). Furthermore, CBR has been applied in cellular automata models to improve land use change simulation results (Li & Liu, 2006a). In this particular occasion, the case base stores information about land use cells, their surroundings and their transition potential to other uses. Based on the stored cases, a new cell’s transition potential is predicted.
Towards a Method for Research Interviews using E-Mail
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