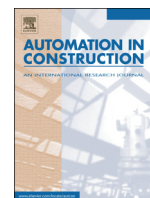




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## Review

## The application of case-based reasoning in construction management research: An overview

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## ABSTRACT

Case-based reasoning (CBR) has been widely adopted in construction management (CM) research due to the similar mind-sets of CBR and CM problem solving. However, to date, there has been no systematic review of CBR applications in previous CM studies, raising the question of what is the current *status quo* of CBR applications in CM research? By using the method of content analysis, this study provides a comprehensive literature review of CM CBR articles published between 1996 and January 2015. It is found that the popularity of CBR applications in CM research is increasing, especially after 2006, with a majority emanating from South Korea. In addition, 17 CBR application fields are identified, with the primary research interests focusing on construction cost estimation, construction tendering, bidding and procurement, and environment and sustainability management. Issues in previous CBR model developments are also identified, mainly related to model hypothesis-testing, reuse of case outcomes, selection of model development methods, use of derivational analogy and automated implementation, together with future research suggestions and directions. This study helps provide CM academics and practitioners with a more comprehensive understanding of the development of CBR applications and implications for future studies.

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## 1. Introduction

Soft computing techniques have been widely adopted to solve engineering issues, mainly because they can address problems intelligently through mimicking the human mind [1–6]. In the specific construction management (CM) domain, frequently used techniques comprise the genetic algorithm (GA), fuzzy techniques, artificial neural networks (ANN), case-based reasoning (CBR) and their various combinations [7–10]. Of these, CBR provides decision-makers with a framework for solving current problems through recalling and reusing knowledge and experience stored in prior occurring similar situations [11]. CBR has various advantages over other techniques. In particular, it is easier for to employ CBR to address unstructured issues (e.g., CM) by using historical cases instead of pre-defined rules, as defining such rules are hard and time-consuming [12]. Another advantage is that CBR can be used even if certain fields are not completely understood by users [13]. This makes CBR particularly suitable for CM novices.

CBR is a suitable technique for dealing with CM issues given the similar mind-sets of CBR and CM problem-solving. CM problem-solving is experience-oriented, and practitioners address CM issues by using their accumulated professional experience and knowledge [14]. Similarly, CBR mines established experience and knowledge to provide solutions to new situations [11]. Moreover, despite the unique features of each construction project, their used methods and procedures are similar [9], which suggests that successful CM practices adopted in prior projects can be applied in new projects, providing important opportunities for the application of CBR. As a result, CBR has attracted various research interests in CM applications such as construction cost estimation [15].

Despite the suitability of CBR in solving CM issues, its applications in the CM domain are still not clear. For example, its application trends, model development activities, application fields and problems are still largely unknown. Understanding these issues provides useful insights into the implications for future CM-CBR applications. However, no work to date has attempted to address this research gap. Therefore, this paper aims to bridge this gap by providing a comprehensive review of CM-CBR applications based on a robust content analysis of prior published studies. It should be noted that these studies were retrieved from peer-reviewed journals, and unpublished studies conducted in laboratory conditions are not included. First, the CBR mechanism is introduced followed by the content analysis research method. Based on the identified articles, CBR application trends and activities in model development are next described, and the identification and use of CM-CBR

application fields expounded in detail. Finally, application issues are identified, together with suggestions for future research directions. This review provides CM stakeholders with valuable information on the CBR approach and its applications in the CM domain.

## 2. Case-based reasoning

CBR solves a new problem by remembering a prior similar situation and by reusing information and knowledge of that situation [16]. The term ‘case’ means a prior concrete situation, and accumulated cases combining with an appropriate organization structure constitute a case-base [11]. As shown in Fig. 1, the use of CBR refers to a set of activities, mainly including case representation, indexing, case storage and a CBR cycle. Case representation refers to the information to be included about cases and identifying an appropriate structure to describe cases. Indexing assigns indices to cases to facilitate case retrieval. Case storage refers to organizing an appropriate case-base structure for the collected cases to enable their effective retrieval.

The CBR cycle comprises four sub-phases of retrieval, reuse, revision and retention [16]. It begins with the emergence of a new case/problem followed by case retrieval which involves measuring similarities between the new case and historical cases. This is the core stage of the CBR cycle, and its accuracy is heavily impacted by predetermined similarity assessment criteria [17]. Case retrieval results in the identification of similar cases. If the current case and retrieved cases are sufficiently similar, solutions of retrieved cases can be reused directly without any modification. Otherwise, the solutions should be revised by taking differences between the new case and retrieved cases into consideration. Finally, the new case and its solutions can be retained in the case-base for future reuse. In this sense, CBR is a self-learning system.

The first CBR system, *CYRUS*, was developed by Janet Kolodner, a question-answering system with rich knowledge of travelling and meetings [18,19]. Since the introduction of this system, various CBR-based systems have emerged, including those aimed at addressing CM issues such as *EQUAL* for contractor prequalification [20] and *CONPLA-CBR* for construction planning and scheduling [21].

## 3. Research method

Although different methods/techniques are available for reviewing literature, content analysis is used because of its fit for the research purpose. Content analysis can be used to systematically and objectively to make valid inferences based on collected data so as to describe and

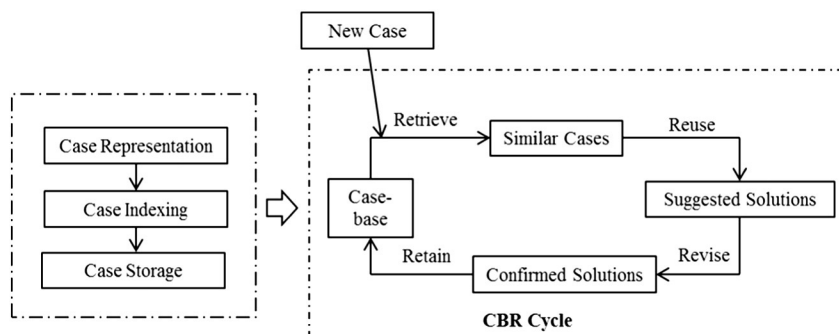


Fig. 1. Case-based reasoning process.

Source: Adapted from Aamodt and Plaza [16] and Watson and Marir [11].

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