A Logic Programming Approach to the Conservation of Buildings Based on an Extension of the Eindhoven Classification Model

Guida Gomes, Henrique Vicente, Joaquim Macedo, Victor Alves, and José Neves

***Abstract*—The identification, classification and recording of events that may lead to the deterioration of buildings are crucial for the development of appropriate repair strategies. This work presents an extension of the *Eindhoven Classification Model* to sort adverse events root causes for *Building Conservation*. *Logic Programming* was used for knowledge representation and reasoning, letting the modelling of the universe of discourse in terms of defective data, information and knowledge. Indeed, a systematization of the evolution process of the body of knowledge in terms of a new factor, the *Quality of Information* one, embedded in the *Root Cause Analysis* was accomplished, i.e., the system proposed led to a process of *Quality of Information* quantification that permit the study of the event's root causes, on time.**

***Index Terms*—Building conservation, Eindhoven classification model, knowledge representation and reasoning, logic programming, quality of information.**

I. Introduction

THE use of information systems as a tool for acquisition, storage and manipulation of data represents the minimum level that may be required from the information technology. In fact, presently more than the automation of processes and the increase of the data repositories are required. The focus is placed on the ability of the information systems to be an autonomous process of evaluation, decision and learning. This configures a transversal dimension that encompasses various scientific areas.

The application of methodologies emanating from the Scientific Area of Artificial Intelligence to solve problems in the field of Civil Engineering is not new, dating from the early 90s of XX century. Since then several studies have been published where techniques like Artificial Neural Networks and Genetic Algorithms have been applied to solve some specific problems within the Civil Engineering portfolio [1]. Recently Lu et al. [2] presented an overview of the application of new methodologies developed in the field of Artificial Intelligence to Civil Engineering. Among them some should be highlighted, like Evolutionary Computation, Swarm Intelligence, Fuzzy Systems, Reasoning Based Systems and Chaos Theory.

Dukić et al. [3] present a model to facilitate the planning of maintenance activities, in order to rationalize costs through preventive interventions. The system can store the information obtained in the regular inspections and based on them, infer about possible failures and/or loss of the buildings' functional characteristics. Furthermore the database allows monitoring the behavior of the various elements of construction. Motawa and Almarshad [4] developed an integrated system for archiving information and knowledge regarding the maintenance of buildings. The proposed system aims at the understanding of the causes of building deterioration, but also acts as a decision support system regarding preventive or corrective maintenance actions. This system comprises a registration module, a database and a knowledge extraction module for the construction of a knowledge base.

However, the machinery mentioned above does not work with incomplete, unknown and/or forbidden information. In fact, for many situations that occur daily in building conservation complete information does not exist at all. Instead, the information available is insufficient or incomplete.

Undeniably the building conservation area is complex and multifaceted and various types of adverse events may occur. An adverse event may be defined as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim, and includes problems in practice, relationships, procedures and systems. The most effective way to prevent adverse events is to attack directly their causes. Preventing the adverse events' root causes improves significantly the conservation/maintenance of buildings. Thus, the proposed model will focus primarily on preventing the adverse events' root causes. The model planned serves as the formal foundation to an adverse event reporting and learning computational system.

II. The Computational Model

An extended version of the *Eindhoven Classification Model* (*ECM*), with the extensions and adaptations for the area of

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