PREFACE

Nowadays, there is an increasing recognition of the value of effective information and knowledge management (KM) in the construction projects. Infact, Knowledge-based Process modelling is used in many fields and even in construction to support various simulation tasks. In this field, ontology-based semantic modelling is seen as an important means of addressing this problem to construct robust knowledge-based systems. In parallel, the advancement of information technology in the AEC industry makes available in a construction project a richness of design information offered by Building Information Modelling (BIM) IFC-based. The development of an ontological version of the IFC schema has been largely promoted and now the ifcOWL Ontology is available in the sector. But, in the construction planning and scheduling task, BIM has progressively shown limits in terms of semantic representation and efficiency of supporting scheduling processes and systems. Moreover, when we think of a process in any given domain, we generally figure it out as a series of actions that leads to a certain outcome. For a construction project, when it comes the execution phase, the process of site planning and activity scheduling can be assumed as what the planner does in the search for the solution of a complex and faceted problem whose variables are numerous (building design, site characteristics, boundary conditions, technology, materials, labor, etc.) and most of the times, if not unknow, at least highly uncertain. As a matter of facts, the planner deals with this problem (process) on the base of his experience or, in other words, of the knowledge he owns about the problem. Furthermore, in the construction sector the overall project performance is strongly dependent on the site management activity. In this regard, process planning is well-known to play a crucial role and, despite the long-lasting efforts, most of the related issues still need to be fully addressed. In fact, project control is based on a specific project schedule determined considering beforehand numerous constraints such as resource availability, completion deadlines for tasks and budget limitations. Cost increases or delays can easily result from poor estimates, schedules or decisions related to tasks decomposition and choice of construction technologies. The planner, in turn, generally identifies constraints, evaluates interactions and solves the related conflicts on the base of the experience he acquired from previous projects.

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This means that having available models and tools able to support construction managers and designers in the task of construction activities planning and scheduling strictly depends to make available a Knowledge Base which maps in a formal way and in machine readable way the construction planning and scheduling domain.
The book deals with the aforementioned issue that are deeply felt both by researchers, tools developers and construction professionals. It is divided in two parts.
Part I is composed by three chapter that stands for a theoretical introduction to approaches and technologies based on Knowledge modelling and management. The basic concepts on "ontologies" are presented to the reader in terms of ontology representation languages, development environments and ontology visualization. After a presentation of ontology theory, a specific chapter is dedicated to present the use of Knowledge Modelling in developing Expert Systems (ESs). The chapter starts with an introduction of ESs with a description of the most important and currently addresses problems that ESs is designed to solve. Then a paragraph is dedicated to provide the reader with an overview ESs for the specific field of construction planning.
Part II is the natural consequence of the part I in which the author presents an application of ontology development for the field of construction planning and scheduling based on the theory of the part I. The application is a research developed by the author himself.
In this part, which represents the core of the book, a Knowledge-Base (KB) which maps the construction planning and scheduling domain by using an ontology-based modelling approach is presented. When building an ontology for knowledge mapping of a particular domain of interest, it is important to reflect on the different variable the domain depends on. In the presented case, the problem of modelling the construction process for construction planning and construction activities scheduling is the result of a complex process involving many decision variables, defined as modelling domains. For this reason, the proposed Knowledge Base does not follow an all-in-one modelling approach but analyzes the individual models by considering singularities of each domains separately. This choice of a multi-ontologies system for modelling the construction process will be justified on the ground that further interrelations can be specified in order to provide a higher flexibility to the knowledge base so that it is open to other extensions in terms of others domains (e.g., risk analysis, health and safety management, paths planning, monitoring systems, etc.).
The KB presented consists of four integrated ontologies and, in order to guarantee the reader an understandable vision of the development process, they are presented by using a unique stepwise framework as following:

- Investigation of the knowledge resources focusing on reviewing already existing ontologies, taxonomies, or other sources within the investigated domain, and on how to reuse them.
- Specification of ontology modelling objectives in order to figure out classes, relations and properties comprised in the ontology by using a list of competency questions such as: Why is the ontology being built? What type of information should be involved in the ontology? A clearly visible structure of the objectives with a graphical representation is provided to the reader for each ontology.
- Definition of the topological structure of the ontology which means the core of the ontologies in terms of classes and class hierarchies defined in detail, relationships between classes, properties and attributes.
- Ontology computation in an ontology editing environment: *Protégé*.

Chapter 4 presents a Construction Scheduling Ontology composed by a reusable and extensible base of concepts and relations for representing the scheduling problem in the domain of construction process. Chapter 5 deals with the presentation of a Construction Workspaces Ontology in order to incorporate the workspace planning domain in the knowledge-base architecture. Chapter 6 presents Construction Product Ontology which is the ontology used to connect the KB to the data structure of Building Information Model according to the IFC-data schema. Then Chapter 7 presents the ontology dedicated to the description of temporal properties of site entities in their evolution across time. It also comprises objects to describe possible relations between time periods in order to define the temporal positions among activities, workspaces and building objects. Finally, Chapter 8 is dedicated to present the architecture of an Ontology-based Expert System called "OnSITEsimu" – developed by the author– which is based on the ontologies presented in the monograph. The aim of this chapter is not to provide details on the ES but to provide the reader with knowledge of how ontologies can support automated reasoning mechanisms.