

# A Review of Project and Programme Management Reference Models for the Construction Industry

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**Abstract** Project management information systems (PMIS) are socio-technical systems comprising people, organizational systems (processes and organizational structures) and an information technology infrastructure to ensure the effective flow of information. PMIS seek to provide all project stakeholders with the information necessary to undertake their tasks. These systems have changed considerably over the last decade. They no longer focus on scheduling and resource management alone. Instead, they have become comprehensive systems that support the entire project lifecycle. These improved systems have raised several difficulties in the development process which arise from the character of the information itself. Therefore, information models play an important role in the development of information systems, especially in the analysis, design and deployment phases. Reference models are one approach to accelerate the development of enterprise-specific models and provide companies and researchers with an initial solution for the design of organisation systems and mobile applications in the architecture, engineering and construction (AEC) industries. An understanding of project management information system reference models is critical to improving the quality of computerised system development in the AEC sector. This paper will review and compare the available information system models which are applicable to construction project and programme management. These reference models will provide guidelines for developing a computerised system for construction projects and programmes. The model can also be used for the design of project management software and the setting-up of the surrounding organizational system, as well as to decide on the software requirements that are essential to select a commercial project and programme management software system. Thus, these reference models are important to assist a stakeholder in selecting the right project management system.

**Keywords** Project Management, Information Technology, Reference Models, Book of Knowledge

## 1. Introduction

Information systems (IS) are technical systems with social consequences[1]. They comprise people, software, hardware, procedures and the surrounding organizational system. Most importantly, information models play an important role in the analysis, design and deployment of information systems [2]. Depending on the phase or level of IS design and implementation, three different types of such information models can be distinguished[3]: (a). Conceptual models help with documenting, analysing and understanding the requirements that an IS needs to meet.

These models do not take any technical aspects into consideration and focus on the problem that needs to be solved or the processes that need to be supported; (b). Design models specify the general architecture of the information

system by describing larger technical building blocks called components. Such components are not, however, analysed in detail and (c) implementation models depend on specific technologies and are closely related to software programming.

The term “reference information model” was first used by[4] when they combined their individual research activities on modelling in the architecture, engineering and construction domains. The resulting unified domain model is called IRMA (Information Reference Model for AEC)[4]. Reference models are one approach to accelerate the development of enterprise-specific models[2]. Reference models provide companies and researchers with an initial solution for the design of organisation and application systems[5]. Thus, the following sections review and compare the available project management reference models to be selected as the reference model in this research.

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## 2. Project and Programme Management Reference Models

One of the important reference information models for project management in the architecture, engineering and construction (AEC) industry was published by [6], who called it a “standard model”. Proprietary, object-oriented, modelling techniques are used to develop a project management domain model and a corresponding application system. This is followed by Sacks [7], who developed an integrated AEC information service using object methods and a central project model. Both models were designed for a single-project management system.

The first reference information model for programme management was published by Turner and [8]. This model requires the coordination of the objectives of programme directors, project managers and resource managers. It shows how the information requirements of all three sets of managers can be met by an integrated system. The integrated system consisting of three major elements [8] is as follows: (a) A master project scheduler (MPS) (that is used by programme directors to manage the priorities between projects and to assign resources to individual projects); (b) Traditional project-management systems (that are used by project managers to deliver individual project objectives in conventional ways, using the assigned resources) and (c) People schedulers (that are used by resource managers to assign people to the multidisciplinary teams working on projects, within the constraints set by the programme directors, but meeting the objectives of the project managers).

Ahlemann [3] presented a reference information model for enterprise-wide project management that covers all project management processes that are related to planning, controlling and coordinating projects (RefMod<sup>PM</sup>). RefMod<sup>PM</sup>'s primary target is to provide validated process and data structure descriptions, based on the literature and empirical research, for project management [9]. The model can also be used for the design of project management software and the set-up of the surrounding organizational system, as well as for the definition of software requirements that are essential to select a commercial project management software system. RefMod<sup>PM</sup> covers both single-project management and multi-project management. It is based on a single, uniform, information system architecture called M-Model [3] and makes use of the Unified Modelling Language (UML) Version 2. Within RefMod<sup>PM</sup>, the M-Model is divided into ten activity diagrams that correspond to the project life-cycle phases outlined in the scope of the M-Model in [3].

### 3. Comparison of the Reference Models

Based on the previous and current project management information system review, Table 1 compares four project and programme management information system reference models intended for construction management. Based on the

research study by [3], and for the purpose of comparison, to find the most suitable programme management information system model to be adopted in this research, the following general requirements were adopted: (a) PMIS models must clearly identify the applicability of the model to a project lifecycle phase or project status; (b) PMIS models must identify the project's information in a hierarchical system (at project, programme or portfolio level) for the purpose of multi-project management and (c) PMIS models must be identified on the topic covered according to the ten knowledge areas of the Project Management Body of Knowledge (PMBOK) by the Project Management Institute (2013) [10].

Based on the comparison in Table 1, it is clear that the RefMod<sup>PM</sup> model goes beyond the scope of previous reference models. However, this is not surprising, since RefMod<sup>PM</sup> uses some ideas from previous work and extends them according to additional requirements. Table 1 also demonstrates the extent to which RefMod<sup>PM</sup> represents significant research progress in the field of PMIS reference models. RefMod<sup>PM</sup> was found to be the most complete reference model because: (i) It has a significantly wider scope (covering project planning, execution, initiation and benefit realisation); (ii) It has been designed to serve both single and multi-project management purposes; and (iii) It covers almost all functional areas of PMI PMBOK 5<sup>th</sup> Edition.

## 4. Discussion

Although not all the PMBOK areas of knowledge are covered by RefMod<sup>PM</sup>, it can still provide guidelines for developing a computerised system for construction project and programme management by using an activity diagram that corresponds to the project lifecycle phases outlined in the scope of the M-Model. Further research and development of a reference model that meets all the knowledge areas in the latest PMBOK 5<sup>th</sup> edition are needed. This is due to the current needs of knowledge management and sustainability factors in system development.

The implementation of a computerised system with the right project management information system reference model can improve the quality and quantity of information flow in the current information systems for the construction industry. An important task of better information and communication flow is to provide an up-to-date organisational structure that will resolve the problems of multiple agents and hierarchies [11]. Therefore, to overcome problems caused by the complexity and fragmented nature of the construction industry, the lack of co-ordination and communication between partners and the increasing amounts of data and information [12]; necessitates the idea of using an appropriated reference models in AEC system development.

**Table 1.** Comparison of Project and Programme Management IS Reference Models

	<b>Froese Model</b> (Froese, 1992)	<b>Turner and Speiser Model</b> (Turner and Speiser, 1992)	<b>Sacks Model</b> (Sacks, 2002)	<b>RefMod<sup>PM</sup> Model</b> (Ahlemann, 2009)
<b>Domain Characteristics</b>				
Programme lifecycle phases	Planning	Identification, Planning, Delivery, Closure	Delivery,	Identification, Planning, Delivery, Closure
Management levels	Project	Project, Programme, Portfolio	Project	Project, Programme, Portfolio
Supported industries	Construction Industry	Many industries such as IT, Architecture, Engineering, Construction and Aerospace	Building Information	Many Industries such as IT, Architecture, Engineering, Construction and Aerospace
<b>Topic Covered</b> (According to the ten knowledge areas of the Project Management Body of Knowledge (PMBOK) 5 <sup>th</sup> Edition (Project Management Institute, 2013))				
Integration management	No	Yes	Yes	Yes
Scope management	Yes	Yes	No	Yes
Time management	Yes	Yes	Yes	Yes
Cost management	Yes	Yes	Yes	Yes
Quality management	No	Yes	No	Yes
Human resource management	No	Yes	Yes	Yes
Communications management	No	Yes	Yes	Yes
Risk management	No	No	No	Yes
Procurement management	Yes	No	Yes	Yes
Project stakeholder management	No	No	No	No
<b>Models available for:</b>				
Data structures	Yes	No	Yes	Yes
Organizational structures	Yes	No	No	Yes
Processes	No	Yes	Yes	Yes
Information Management	Yes	Yes	Yes	Yes
Knowledge Management	No	No	No	No
Wisdom	No	No	No	No

## 5. Summary

This paper has given an overview of the various reference models for construction management. Although not all the PMBOK areas of knowledge are covered by RefMod<sup>PM</sup>, it was found that RefMod<sup>PM</sup> is currently the most comprehensive reference model for construction management. Further research and development of a reference model that meets all the knowledge areas in the latest PMBOK 5<sup>th</sup> edition is needed. The study presented in this paper is part of an on-going research in developing a comprehensive reference model that meets the current project management standard.

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