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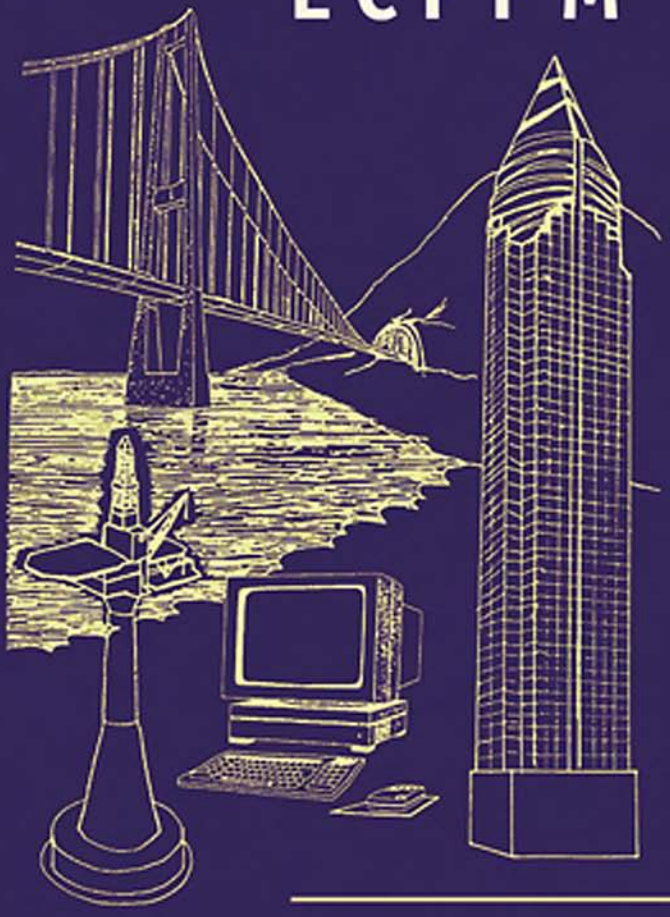
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eWork and eBusiness in Architecture, Engineering and Construction

Edited by Attila Dikbaş & Raimar Scherer

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eWORK AND eBUSINESS IN ARCHITECTURE, ENGINEERING AND CONSTRUCTION

PROCEEDINGS OF THE 5th EUROPEAN CONFERENCE ON PRODUCT AND PROCESS MODELLING IN THE BUILDING AND CONSTRUCTION INDUSTRY—ECPPM 2004, 8–10 SEPTEMBER 2004, ISTANBUL, TURKEY

eWork and eBusiness in Architecture, Engineering and Construction

Edited by

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Preface

The global community has stepped into the next revolutionary phase of the long-term evolution of the information society and is now facing a new challenging phenomenon: Ambient Intelligence—providing and getting the right information to the right people in the right configuration at the right time anywhere. Our business processes have started to change. New working methods are available and asked for; new forms of organizations have been proven to be efficient and effective—the vision of the previous decade have been conquering practice. Ambient intelligence is the final keystone for a breakthrough and the industry-wide business revolution, in particular for our one-of-a-kind multi-shareholder and hence very complex projects.

Intelligent management of the right information has become the focus of research. Computing power is now available on the Web and basic technologies—like P2P, Grid, Agents and Web services—have been developed to ripeness by the informatics community for application in AEC/FM. Apply it to your benefit—this is the offer of the informatics community—and also the challenge.

Making intelligence happen requires more than solely utilizing the basic technologies and computing power on the Web. It means algorithms, either numerical or reasoning ones and it means enhanced semantic data structures, in which the information and knowledge is integrated and can be retrieved on request—when and where and how desired. Intelligence does not mean merely powerful numerical algorithms for solving and simulating complex engineering systems—as understood in computational mechanics. In this context intelligence means autonomous problem specification, decision preparation for problem solving and to some extent even problem solving itself.

Such systems, not necessarily located on one computer and eventually distributed throughout the Web, should be capable of recognizing, deciding, retrieving and providing any piece of information, not only explicitly stored data, and at the same time support the co-operation with the end-user to serve him/her intelligently and polite. Data structures and hence product and process modelling are as important as the respective algorithms to make this happen, in particular for recognising the context, which is the prerequisite for any autonomous action. Data structures, i.e. data schemata must inherit meanings, semantics must be more than an identifier. They have to encapsulate knowledge on the objects. This knowledge must be re-usable in a flexible way and provide for reasoning to interrelate it with knowledge on other objects and their status described by the object data in order to build up the current context. Recognizing the effective state and crystallizing

the particular problems and various actors in an instantaneous process we are able to finally provide the right and focused information. This makes ambient intelligence happen.

Research on and building of ontologies besides product data models have increasingly been the focus of research activities in AEC/FM. However, do ontologies really replace product data models? Or if not, do they subsume them? It is neither of them. Ontologies extend product models adding a new functionality, namely carrying knowledge, which is simply another objective. The main objective of product models is the very generic representation of real world objects as well as their respective general relationships to form a generic object net from the singular units, the objects to model a very generic skeleton for any kind of application. Other extensions to the generic product model are already on the way. For instance, product models are favoured, being the anchor for project documents and structuring the document information space. Data and text mining methods are increasingly applied to identify the representative semantic items of the documents and mapping them to the semantics of the product model in order to interpret the meaning of the document, i.e. recognizing its information contents and further multi-interlinking it with the product model. Again, being accessible via a VR building environment, ambient intelligence makes document information tangible. The user is no longer required to search for the right document in order to get the right information, he only has to identify the building object in his VR model and the information system provides him with the right information at any place and any time. The power of the automatic selectiveness depends upon the capacity and power of the underlying context-sensitive system—and again context-sensitivity is first of all determined by logic reasoning on product and process models based ontologies. We can subsume generic product models and ontologies as well as any other knowledge-related extensions of product models to be intelligent product models.

In recent years, the quality of product models has reached a level that allows for the design of reasoning systems to check architecture and engineering systems consistency as well as conformity with building codes and guidelines. The few existing and very successful examples have to be considered first attempts, looking at the great variety of reasoning methods provided by basic informatics—this new area has just been touched on. However, the results gained are more than promising. The consistency checking methods are an important pre-requisite for co-operative and concurrent working, namely the consistency problems arising from long-term transactions in complex data bases, as it is the case in our AEC/FM data bases. We have now the confidence that they can be handled, but practically sufficient solutions still need valuable research and development efforts to cope with the whole AEC/FM domain.

In this context, the numerical and reasoning algorithms are utilised in a new, separate information process, namely the information configuration process, so that we can now distinguish among processes on three different levels. Besides modelling the tangible work processes such as the production, organizational as well as the planning and controlling processes, we have to consider the intangible communication processes supporting formal information management and information logistics as well as the configuration processes to determine e.g. the user's information needs, critical notification events or the optimal configuration and presentation of the information. In the future our research efforts will more and more shift from basic product and tangible

process modelling to enhanced intelligent product modelling and information process modelling.

In recent years, new business concepts and modelling techniques have been developed for the virtual enterprise that have demonstrated their proficiencies in several best practice cases. Again ambient intelligence and additionally mobile computing are expected to provide for a push to flexible adopt the formal business models in AEC/FM practice. It will be of utmost importance to the industry to extend these organisational models to efficient autonomous teamwork across enterprises anywhere and in any team. Flexible systems and automatic configuration methods are required to install immediately operable virtual teams within short lead times, that are supported by sound organization structures, team-focused information spaces and corresponding information logistics. Virtual enterprises will no longer be limited to strategic alliances providing interoperability on a corporate and/or product level, but will also be able to significantly reduce the management cost of true interenterprise collaboration on the team level.

Focusing on a few selected but outstanding topics of today's research on Product and Process Modelling the papers of the ECPPM 2004 draw a very good overview on the current state of the art in practice, emerging new business models as well as on the cutting edge technologies available for architecture, engineering and construction. It thus provides for solid fundament to explore the outlined possibilities of applying ambient intelligence in our domain.

The Istanbul Technical University, Turkey has been selected to host the ECPPM in 2004. After holding the ECPPM 2002 in the former candidate state of Slovenia, the EAPPM therewith again takes a clear stand for integrating researchers from all over Europe and aligning the various activities in product and process modelling for a better future. Today, Turkey is potential new EU member state of great importance and an agile economy. Moreover, it is the bridge between Europe and Asia and it has been a melting pot of cultures for more than 3000 years.

In Istanbul the ECPPM 2004 again introduces a new platform to share knowledge and transform it into an active, fimctional asset ready to be shared, integrated and traded. Latest research results and businesses applications in the areas of eWork and eBusiness, product and process modelling, collaborative working, mobile computing, knowledge management, ontology will enable research and industry organisation to develop new lines of services and usher in a new breed of research areas. The committees of ECPPM 2004 have selected the best papers and organized attractive sessions for their presentation. The number of abstracts submitted was again unusually high and their quality was remarkable.

Numerous people have made conference and the proceedings possible. We thank the authors, the scientific committee members and the ITU Project Management Centre for their contribution, support and encouragement in compiling this book. Sincere gratitude to each and all of them.

Attila Dikbaş and Raimar Scherer
Istanbul and Dresden, June 2004

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Evaluating competitiveness in construction industry: an alternative frame

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ABSTRACT: Competition is defined as the core concept in non-monopolistic markets and competitive strategy and competitiveness of firms become an important area of interest among researchers. Accordingly, various frameworks and tools for analyzing competitiveness have been suggested mainly for manufacturing industries. Some colleagues also applied these frameworks for construction industry. However, there are some vague points emerged while analyzing competitiveness associated with scale and environment differences of construction industry. This paper analyzes appropriate categorization of construction environments for competitiveness tools application and aims at providing an alternative outline about examining competitiveness.

1 INTRODUCTION

The start of the new century has brought new challenges for firms, industries and countries. Throughout its long history, competitiveness is highlighted once more as a crucial concern for enterprises to survive. Accordingly, numerous studies evolved for analyzing competitiveness issues. However, most of these studies aimed mainly for manufacturing industries and produce frameworks for analyzing different aspects of the term. These frameworks are usually employed for construction industry in second hand and scholars commonly apply these models to construction to see the immediate results of these tools. However it is obvious that there are major differences between the manufacturing industries and construction industry. So, application of these manufacturing industry oriented tools makes these analyses weak and suspect regarding construction industry environments. Competitiveness issue is important since it would provide different points of view to construction management studies and related applications.

It is seen that despite growing concerns and research conducted about 'competitiveness' in construction, it is still a diffuse concept, and subject to many interpretations. These varying interpretations also make the term difficult to define properly and apply fittingly. Moreover, the actual scene about construction industry is usually distorted by these varying competitiveness models and tools and their applications. For this point this paper issues applicability, scope, strengths and weaknesses of some well-known competitiveness models and tools in construction industry and aims at bringing a categorization to business environments of construction industry for the changing characteristics of the competitiveness term.

2 DEFINITIONS

In following subsections, characteristics, environment of construction industry and competitiveness related issues are highlighted.

2.1 *Characteristics of the construction industry*

In literature there are various definitions for the characteristics of the construction industry. The classification made by Sugimoto (1990) provides a more theoretical and fundamental one and the following list is formed to address some well-known and provisional characteristics of construction which diversify it from manufacturing industries.

Experience-Good and Customization Characteristics: Customization of construction activities makes the output of construction production an 'experience good' and compared to a 'manufacturing good', whose quality is evident on inspection before purchase, the quality is understood only by using it after purchase.

Specialization and Vertical Integration in Functions: The distinction between different types of firms is defined by Sugimoto (1990) as often blurred through vertical integration in functions. To illustrate, an engineering firm, which is basically considered as a design firm could 'vertically integrate' with all sorts of pre-construction activities and engage in project management and contractor branches.

Unique bidding basis: According to Ball (1988) speculative construction can be seen as an extension of manufacturing in construction industry but bidding arrangements are special for construction for that every project is priced separately and distinctly in the form of a bid for that particular project.

Relative subcontracting system: The subcontracting system is special in the construction industry since it permits the kind of flexibility required whereby various mixes of contractors and crafts must be mobilized to suit the unique requirements of a project.

Ambiguity of goods and service production of construction firms: Particular to the specialization of functions of construction firms, there is a difficulty in defining their production: Although the construction industry is usually categorized as a service industry, firms in the construction industry produce both goods and services.

International Involvement of Construction Firms: Manufacturing firms usually supply foreign markets in three primary modes: export, foreign direct investment (FDI) including equity-base joint venture etc. However, in construction industry, the ways of serving a foreign market is defined to be less straightforward because of the unique production process and subsequent industrial structure of the industry.

Finally construction industry differs from manufacturing industry in referred points. According to Sugimoto (1990), theoretical treatment of construction production has not been sufficient enough to address these ambiguities in a systematic way and if construction industry and its productions are unique, it is theoretically misleading to apply ideas established for other industries to the construction industry and its firms.

2.2 *The environment of construction industry*

The structure and the environment of an industry directly influence the nature of competition between firms and accordingly the competitive strategies available to them (Porter, 1980). Construction is often reported as being a fragmented industry which is defined as ‘one in which no company has a significant market share and is able to influence considerable outcomes within the industry’. Furthermore, it is also defined as a geographically dispersed projectbased industry with markets that operate from local to the international level. Within this frame, the industry can be characterized as first, geographically dispersed and over-lapping market structures and second, is hierarchically structured in terms of company size (Langford, 2001).

3 COMPETITIVENESS

Competitiveness, which is usually handled at three different levels, country, industry and firm level in literature, is a multi dimensional notion and originates from the Latin word ‘competer’ which means involvement in business rivalry for business markets (Momaya, 2004). Currently, institutions and academicians have been very prolific in proposing a definition for competitiveness (IMD, 2003) and this diversity can be seen as an indicator of the popularity of the subject but also of its complex nature.

To draw upon the common elements of various approaches Lall (2001) defined competitiveness in industrial activities as a means of developing relative efficiency along with sustainable growth and should be understood more like a process than an absolute state, assessed in a relative sense as well.

3.1 *Firm to national level competitiveness*

The fimdamental principle, which allows the distinction between concept of competitiveness of nations, industries and enterprises, concentrates on where the creation of economic value takes place. In current literature it is assumed that economic value is only created within the context of an enterprise and a nation’s environment hinders or supports this process through its policies (Lall, 2001).

Momaya (2004) also states that understanding the competitiveness dynamics at the firm level is crucial for competitiveness.

3.2 *Competitiveness related frameworks and models*

There are various competitiveness related frameworks exist in literature. Porter’s (1990) ‘Diamond Model’, ‘National Competitiveness Indices’ and Lall’s (2001) ‘Competitiveness Triangle’ are apparent ones in national level competitiveness issues. Five competitive forces model, value chain, segmentation matrix and three generic competitive strategies of Porter (1980, 1985) provide a base for industry and firm level competitiveness concepts.

Most of these models are criticized for being weak or some improvement possibilities such as linked diamond models (Rugman, D'Cruz, 1993). In general, these models are also criticized for having business school or power school approaches (Lall, 2001); static/ dynamic characteristics, and analysis/deterministic point of views. Their scope of application is also varying from one model to another. Toprakli (2004) provides the scope, strengths and weaknesses of some models (Table 1), it is concluded that, qualities depending on microeconomics, 'five competitive forces' model and 'value chain' provide a backbone for all level of competitiveness studies.

Table 1. Strengths and weaknesses of competitiveness models and concepts (Toprakli, 2004).

	Scope of application	Strengths	Weaknesses
Diamond framework (Porter, 1990)	National industries	• Provides an analytical point of view • Supposed to be dynamic	• Business school approach • Culture and government impacts are lacking for construction • Multiple diamonds can provide a more realistic framework
Five competitive forces model (Porter, 1985)	Industry and firm level	• Provides an analytical point of view • Depends mainly on microeconomics • Can be used in all levels	• Presents a static understanding • Provides an analytical point of view rather than a deterministic one
Value chain	Industry, firm and national level	• Provides an analytical point of view • Have a generic quality and applicable to all levels	• Usually there is a complex procedure to apply
APP model (Momaya, 2004)	Generic application	• Can be used in all levels • Meaningful to practitioners • Have qualitative features	• Presents a static understanding • *Entrepreneurship* and *product* issues are not identified.
KPI model (CBP, 1998)	Firm level	• Meaningfiil to practitioners • Can also be used among industries and nations • Systematic questionnaire and presentation	• Presents a static understanding • Based on indicators rather than theory

TCV model (Shen et al. 2003)	Firm level	• Dynamic methodology through changing weights	• Lacks theoretical link • Depends solely on indicators • No qualitative side is identified

3.3 *Applications of competitiveness frameworks in construction*

Several authors used theoretical frameworks to analyze construction industry. To illustrate, Betts and Ofori (1992) used Porter's diamond model (1990) to provide a framework for strategic planning by construction enterprises and Oz (2001) applied it for Turkish Construction Industry. Yates et al. (1991) compare the US national construction industry by using Porter's (1980) five forces model. Huovinen and Kiiras (1994) build up 'spearhead strategy' by analyzing several frameworks such as the product-market matrix proposed by Ansoff (1965) and the five competitive forces framework of Porter (1980). Seymour (1987) reviews multi-national enterprise (MNE) theory and general theories such as Dunning's (1977) eclectic approach which is criticized by Sugimoto (1990) as having a straightforward application of such modes unsuccessful for providing an appropriate interpretation for construction (Ofori, 2003). Lastly, Pheng and Hongbin (2004) extend Dunning's eclectic approach with specialty advantages and developed OLI+S model to estimate international construction performance.

There are also numerous models developed without particular reference to existing theoretical frameworks (Ofori, 2003). To exemplify, Momaya and Selby (1998) developed APP model for quantifying international competitiveness of the Canadian construction industry. The model is also used for firm level competitiveness understanding by Momaya (2004) for a different industry. There are also indicator based quantifying models exist for competitiveness. Accordingly, Hatush and Skitmore (1997) assembled a systematic multi-criteria decision analysis technique for contractor selection. Lai and Guan (2001) developed a model to assess a large contractor's competitiveness by using several parameters (Shen et al., 2003). The last example of a similar study is conducted by Shen et al. (2003). Their study covers an assessment of contractor's competitiveness by an examination of multiple parameters which is named as Total Competitiveness Value. Also, starting from 1998, Construction Best Practice (CBP) initiative in UK has developed Key Performance Indicators (KPI) as a comparative benchmark tool for construction industry.

Finally, it can be concluded in parallel with Ofori (2003) that 'there is no perfect framework for analyzing competitiveness for construction' and 'not any one in itself is sufficient for all sectors'. Similarly, Segev and Gray (1994) found out that there is no single appropriate model exists for constmction firms and advised to evaluate individual business units in terms of two or three typologies.

It is seen that in one side there is a high use of theory in applied competitiveness frameworks for construction industry and on the other side, a gap between the indicator based models and theory. However indicator base and generic models are more meaningful to practitioners. So, there is a need to define a base to categorize relevant competitiveness studies, application areas and their interrelations for construction industry point of view. Furthermore, if Sugimoto's (1990) conclusion about theoretical

treatment of construction industry mentioned before considered, defining a new competitiveness framework for construction industry can be argued.

Table 2. Combined environment types: a frame for analyzing competitiveness in construction.

Environmental types (Lansley, 1979 & Flanagan, 1994)	Characteristics	Useful models and tools for Competitiveness issues
Supra-national level		
Global environment	• Firm level characteristics dominate competitiveness • Suppliers/Buyers (global level) highly important • Financial packages crucial • Importance of configuration and coordination (Porter, 1986) • Impact of global and multi-domestic competition (Porter, 1986)	Firm level competitiveness models can be applied
Multinational environment	• Importance of firm level characteristics increase in competition • Alliance-specific advantages, system-based advantages and culture-based advantages highly important • Suppliers/Buyers (multinational level) • Financial packages important • Government support can be seen	National level competitiveness models can be partly applied. Firm level competitiveness models can be applied
Industry and national level		
International environment	• National and firm level characteristics dominate (Seymour, 1987) • International and national level suppliers are important • Government supports highly important • Culture, location is highly important	Diamond framework (Porter, 1990)
Common industry/ National environment	Common to all firms in the industry/national environment • Affects firms both directly and indirectly • Affected by demographics, technological and societal changes • The industry's eisting and potential clients effective	Diamond framework (Porter, 1990) Five competitive forces model

	• Suppliers (national level) are important • Central and local government departments	
Firm level		
Competitive environment	• Localized to the firm • Dealing with industries and markets • Structure of demand • Procurement forms used by clients • Suppliers (local), competitors • Availability of materials • Labor and subcontractors	Value chain (Porter, 1980) Five competitive forces model (Porter, 1985)
Sub firm level		
Operational environment	• Unique to each firm • Subcontractors, human resources • Technology	Value chain

3.4 *Key findings and suggestion*

Ofori (2003) stated 'most of the authors in construction did not critically examine, or suggest refinements to, the frameworks they applied' which also brings out another question; when they are modified according to the objectives of the construction industry whether it would cause any vital change in the models or not, remaining unanswered.

Having analyzed the outcomes of Ofori (2003), and Momaya (2004), authors believe that a competitiveness understanding for construction industry could only be achieved by bringing a classification to the application areas of these models. Though having analyzed firm level competitiveness of software industry in India, Momaya (2004) also noticed that 'Many questions about competitiveness remain unanswered despite rich literature about concept. Some of the key questions such as: how can frameworks and models be adapted for a particular firm in a particular stage of development…remain unanswered' (p. 53) and proposed a simple graphical matrix of firms' survival and growth stages for the applicability of competitiveness models corresponding to capability. He adds that 'There are many frameworks, models, theories on competitiveness; (however) integrated frameworks that can help practitioners to take key decisions on competitiveness are few. There is need for frameworks that can help select right tools from the industry perspective.'

Accordingly, authors suggest for construction industry extending Lansley et al.'s (1979) environment classification (Operational/Competitive/Common-National) by Flanagan's (1994) three stage construction environment, i.e., international, multinational, global and to obtain a final base to evaluate competitiveness issues in construction (Table 2) which is also presented to take comment by the wider research community.

4 CONCLUSION

Having the main objective as providing an alternative frame about evaluating competitiveness, which has been the growing concern in construction industry and a crucial field of interest among researchers; appropriate categorization of construction environments for competitiveness tools application is suggested in the paper.

As understood from the stated vertical classification, better frameworks could be developed for future use in construction industry for researchers and practitioners. Another important point to be emphasized in the suggested categorization is it would help in determining hierarchical weightings for quantitative evaluations in a more systematic way. Considering the chaotic environment of competitiveness related terms and their applications, a process model could also be offered to guide practitioners about competitiveness issues in eonstruction industry. Besides, IT based applications could also be employed related with the developed process models.

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