

## **An Overview of Enterprise Resource Planning (ERP) Systems in Small and Medium Sized Organizations: Case of Florida Contractors**

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### **Abstract**

Parallel to the increasing importance of and requirement for managing construction information more efficiently, Enterprise Resource Planning (ERP) systems have become a highly appropriate data integration tool for construction organizations. With the advancements and innovations in ERP technology, these systems have not only been preferred by large organizations but also become affordable by small and medium sized organizations (SMOs). Albeit limited in number, the researchers studying ERP implementations in construction have only focused on large size organizations. Therefore, the objective of this paper is to explore SMOs' awareness of ERP systems and the current implementation practices among small and medium sized contractors. Our research has been formulated from the hypothesis that SMOs are not knowledgeable about ERP systems, and they do not have a sound plan to assess and implement ERP systems, which may lead to inappropriate decisions and unsuccessful implementation of ERP projects. This paper presents the preliminary results of a query conducted in Florida, including the level of computerization of business processes, experiences with ERP systems and the concerns of SMOs. This research concludes that SMOs, who are challenged by financial and organizational constraints, need to have an Information Strategy Plan to get the optimal return on an IS/IT investment.

### **Keywords**

Enterprise Resource Planning (ERP) , Small and medium sized organizations (SMOs), contractors, Florida

### **1. Introduction**

Within the last couple of decades, business organizations have realized the importance and critical role of information systems (IS) and information technology (IT) in supporting the decision-making process at every level in their organizational structures. With the proliferation of IS and IT, it has become easier and more feasible for small-and medium-sized organizations (SMOs) to invest in these technologies, as SMOs are typically described as “resource poor” in terms of human, financial and material terms (Mintzberg, 1979). Furthermore, the role of IS/IT has expanded to cover more strategic issues, rather than just automation and computerization, such as supporting corporate strategies and even reshaping the strategies already developed.

The distinctive industrial characteristics of the construction industry have resulted in the need for automation and computerization by organizations (Rivard, 1999), not only at the project level but also at the corporate level (Ryoo et al., 2005). As companies have become more interested in the strategic use of IS/IT, the need for adopting enterprise-wide information systems [i.e. Enterprise Resource Planning (ERP)] by construction companies has become more significant. However, due to the incongruity of the characteristics of ERP systems and construction organizations (Ryoo et al., 2005), ERP systems need to be customized based on the features of construction organizations and projects. Shi and Halpin (2003) answered the relevant question of how to optimize the utilization of internal and external resources of a construction organization to meet the goal of maximizing the organization's business objectives, by proposing an integrated ERP system for construction. Despite the obvious need to integrate vast amounts of data that is generated during construction business transactions, only a very limited number of construction researchers attempted to provide ERP solutions for construction organizations (examples are: Dodd, 1999; Lee et al., 2002; Chia and Ling, 2003; Voordijk et al., 2003; Tatari et al., 2004; Barthorpe et al., 2004; Chung and Skibniewski, 2005).

The increasing dependency on IS/IT in parallel to the mentioned requirements, has made the IS/IT investment a critical concern for top management. The importance of this only amplifies as the IS/IT projects grow in size and complexity. Thus, the gap between expectations and actual return on investments has become a primary concern (Stewart et al., 2002). In order to be able to get the optimal return on an IS/IT investment, the SMOs need proper IS/IT management. Peña-Mora et al. (1999) described required management processes as: setting strategic and technical direction for IT applications, making decisions about funding, executing IT business strategies, and reviewing performance of IT investments over the entire project duration. With the intention of minimizing complexity of these processes and other challenges, it is suggested that construction organizations should have a structured plan to assess and evaluate the IS/IT projects (Jung and Gibson, 1999; Peña-Mora et al. 1999). An Information Strategy Planning framework will guide them in assessing and implementing any kind of IS/IT applications and decision making for investment. An Information Strategy Plan aims to help an organization to reach their business goals by aligning IS/IT strategies along with their business strategies.

This research is based on the hypothesis that construction companies, still, are not aware of the potential benefits of ERP systems for their organizations and have not been following a structured planning methodology to assess IS/IT projects. Therefore, the objective of this paper is to gain insight about the current use of ERP systems in construction organizations and the perceptions of construction contractors regarding ERP systems. The scope of the study is limited to small and medium sized construction contractors in the Florida region in the United States, who will be referred as SMOs throughout this paper. The methodology to demonstrate that the current perception is correct, will be described as the results of a preliminary survey conducted among the SMOs.

## **2. Background Research**

The popularity of ERP systems in the manufacturing industry started in early 1990s, where it was referred as the most important IT innovation, with the aim of supporting corporate management (Davenport, 1998). With the saturation of ERP utilization in production- or service-oriented industries (such as manufacturing and banking), ERP vendors have begun to face an increasing rivalry in the ERP market. This has forced ERP vendors to look for unexplored markets, such as construction. The high level of inherited risks connected with ERP implementations, on the other hand, has resulted in the fact that only those organizations with high financial capacity and organizational maturity could manage and absorb those risks. Additionally, the absence or mismatch of specific data fields necessary for construction processes in the off-the-shelf ERP packages make ERP adoption very questionable for construction (Tatari et al. 2004; Vlachopoulou and Manthou, 2006). This has led to lower implementation rates among

construction companies as compared to those in production- and service-oriented industries. Furthermore, one of the latest ENR articles on this subject (Sawyer, 2007) has drawn attention to the pressure on construction companies to manage corporate information more effectively due to factors which include: increasing complexity of projects, popularity of the use of building information modeling (BIM), and the need for proper documentation of new regulations (i.e. Sarbanes-Oxley Act) and green building certification. Thus, to be able to meet needs and take advantage of this high potential market, ERP vendors have started componentizing the ERP systems into smaller interoperable modules, which then gives flexibility to construction companies to follow an incremental implementation strategy based on their needs making the systems affordable.

Aside from the studies focusing on ERP system development, use and analysis in the construction industry, a recent research project conducted by one of the authors analyzed the optimal strategies for ERP vendors in penetrating the SMO market by addressing the needs of the construction industry. The research includes an inquiry of construction companies in which SMOs constitute around 86% of the respondents. The preliminary findings of this research revealed that 43% of the companies still do not have knowledge about ERP systems, whereas 75% of those showed interest in enterprise-wide data integration. Furthermore, only 14% of the companies mentioned that they have the sufficient resources to develop an in-house system, highlighting the need for off-the-shelf solutions.

An important research to explore the technology diffusion among construction organizations was initiated by ENR in 2003 (ENR, 2003). The research aimed to determine the type of hardware and software use prevalent among ENR members as well as the factors considered in IS/IT investments. The respondent companies (n=418) had an average firm size and average value of construction projects of 182 employees and \$US 61.8 million, respectively. The research findings demonstrated that those companies have mostly computerized their monetary business functions, i.e Job Costing/Accounting/Payroll, at a rate of 68.5%. Further examination of the types of software used in this specific functional area revealed that the respondents preferred to use the solutions provided by the vendors that have extensive experience in either construction industry or accounting principles. Not surprisingly, the implementation rates of financial and accounting modules of larger scale ERP systems (e.g. J.D. Edwards 5, Oracle Financial, Deltek Costpoint and SAP) were very limited (8% each for the first 3 solutions and 5% for the SAP solution). The respondents also preferred solutions provided by construction-specific software developers for other crucial functional areas, including project management, scheduling and estimating.

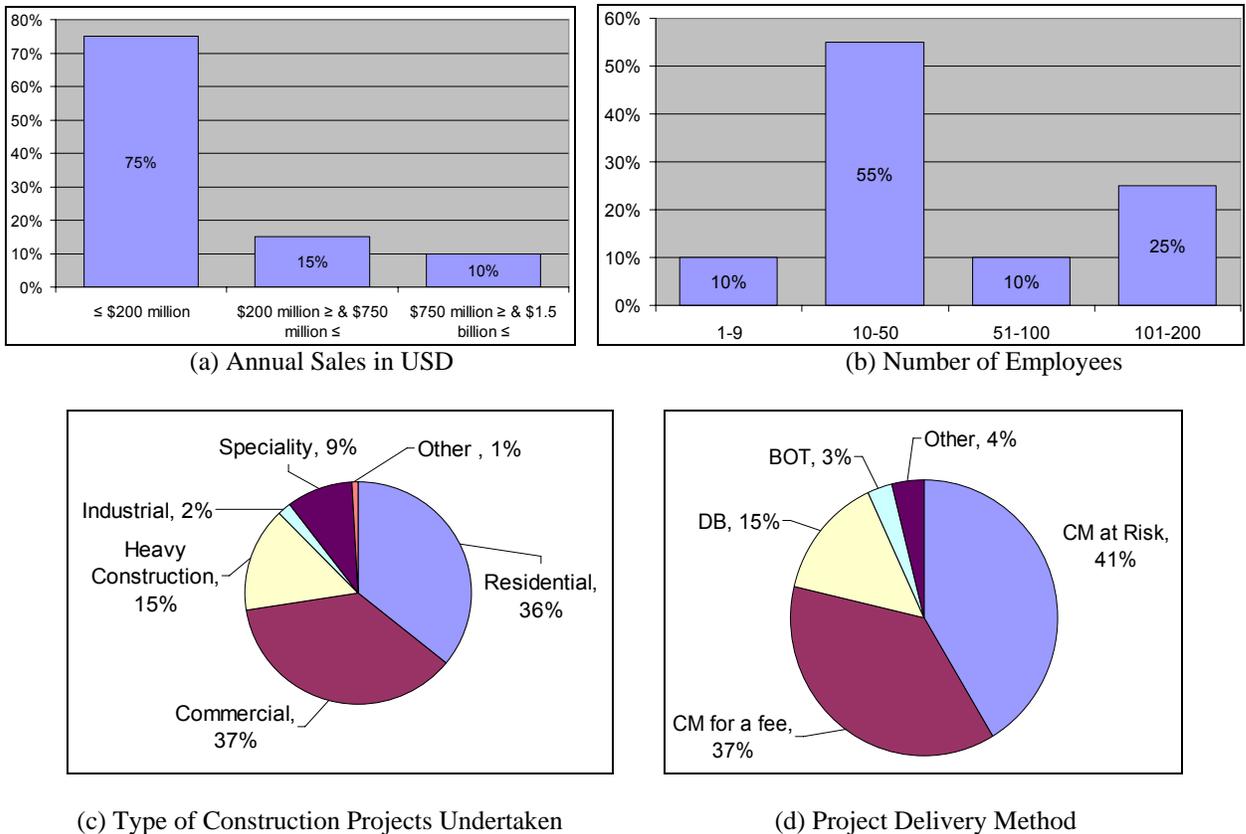
### **3. ERP Perception among Small and Medium Sized Contractors: Methodology and Analysis**

Based on the discussion in the above sections, it is apparent that ERP vendors have started pursuing a componentization strategy in the software development process to enable scalability and interoperability with other systems. This also is considered as a very beneficial approach from the SMOs perspective, as they are usually described as 'resource poor'. However, it is presupposed that SMOs are still not aware of the benefits of ERP systems and that the major risk of implementation of these systems is that they do not have a structured plan and strategy regarding IS/IT.

With the purpose of exploring the perception of the companies, a questionnaire was developed and distributed to SMOs performing construction projects in Florida. Despite some current decline in construction projects in Florida (especially in residential construction), the region still remains one of the most active markets within the nation (U.S. Census Bureau, 2005). The questionnaire was composed of three parts: company-related information, IT profile and ERP solutions. The questionnaire is distributed to SMOs in the Florida region, and preliminary data collection included a total of 20 SMOs. The following sections discuss the analysis of questionnaire components.

### 3.1. Part 1: Company Information

The majority of the respondent companies are small in size with an average annual turnover of less than US \$200 million, whereas 25% represent medium size organizations [Figure 1(a)]. Also, 75% of the companies reported an average of permanent company employees less to be than 50 [Figure 1(b)]. Thus, the demographics show that the respondent companies can be used as a representative of the SMOs in the Florida construction market. Considering the size of the organizations and high activity in commercial and residential construction in the Florida region, the companies are undertaking construction projects in these disciplines, adding up to almost three-quarters of the total [Figure 1(c)]. A majority of the respondent companies are undertaking construction projects either as Construction Management-at-Risk (41%) or as Construction Management-for-a-Fee (37%) (Figure 1(d)).



**Figure 1: Respondent Company Information**

One of the important findings in this section is regarding the growth strategies of the respondent companies. Growth strategies can provide a vital picture of future goals of companies. The responses revealed that 73.5% of the companies are operating only within the State of Florida, and 86% of these are planning to specifically serve South Florida. The rest of the companies serve either the national market (10.5%) or the international market (16%).

### 3.2. Part 2: IT Profile

IT profiles of the companies were studied with respect to the computerization of business functions. This was crucial in order to have an insight of the IT maturity of the respondent companies. The companies were asked if they use off-the-shelf commercial software packages or customized/in-house developed software for commercialized business functions. In the business disciplines where computerization has

not been achieved, the companies were asked if they have any implementation plans within the following 2 years. Table 1 displays the top 10 business functions (out of 60) that were found to be the most commonly computerized by the companies including the dominance of commercialized off-the-shelf software preference.

**Table 1: Most Common Business Functions Computerized by Respondent Companies**

<b>Business Function</b>	<b>Discipline that the function belongs to</b>	<b>Rate of Computerization</b>	<b>Use of Commercial Off-The-Shelf Packages</b>
Billing	Project Management	90%	67%
Payroll	Workforce Management	90%	72%
Time & Expense Management	Workforce Management	85%	77%
Financial Management	Enterprise Management	80%	75%
Project Accounting	Enterprise Management	80%	75%
Cost Accounting	Enterprise Management	80%	75%
Managerial Accounting	Enterprise Management	75%	80%
Contract Management	Project Management	75%	73%
Planning and Scheduling	Project Management	75%	67%
CAD Integration	Engineering & Design	75%	87%

This summary table (Table 1) indicates that SMOs appear to have a very high tendency to computerize and standardize the fundamental money-related business functions such as accounting, financial management and payroll, as well as those specific to the construction business such as contract management, planning and scheduling, and CAD integration. Contrary to the high percentages of computerization of the functions shown in Table 1, 38 of the business functions contained in the questionnaire have been computerized by less than 50% of the respondent companies. These business functions are more management and decision-making related, such as risk management, business planning, bid evaluation, waste management and employee relationship management. Furthermore, a number of important functions show a relatively low rate of computerization such as strategic management (20%), business planning (25%), purchase order management (40%), risk management (45%) and material procurement (45%). Even though the level of computerization within each company has not been investigated in detail, these results indicate that the SMOs have computerized just the fundamental business functions such as accounting and finance, whereas diffusion of IT is relatively low in other areas.

The companies that have not computerized the fundamental business functions (those shown Table 1), do have a plan to computerize these business functions within the following two years. However, an important limitation has become clear when the other 'non-computerized' functions are examined. Considering the business functions that are computerized by less than 70% of the respondents, 84% of these companies do not have plans for implementing new systems for automating their non-computerized business functions. This finding may not be surprising, as SMOs, in general, do not have a sound decision making process or business/IS strategy development in place, due to factors such as organizational structure, size, non-corporate management and lack of resources. This supports the hypothesis of this paper: SMOs do not have a structured planning methodology for IS/IT assessments. However, it is crucial for SMOs to have an Information Strategy Plan to find an optimal solution for maximizing the benefits from IS/IT.

### 3.3. Part 3: ERP Solutions

Similar to the findings of the majority of studies concerning SMOs, this research also demonstrates the low implementation rate of ERP systems among SMOs in construction. While 35% of the companies have mentioned their awareness of these systems, only 25% (5 companies) have stated that they have implemented an integrated enterprise system. However, none of them are using ERP solutions offered by big ERP vendors such as SAP, Oracle, J.D. Edwards, etc. The facts regarding the use of ERP can be summarized as follows:

- Average implementation duration is 2.3 years, where 1.8 years is required to achieve full use of the system.
- The cost of the systems implemented was found to be less than US\$ 500,000 for 4 companies (80%), whereas the total cost for the last company (20%), ended up to be within the range of US\$ 3 million to US\$ 10 million.
- The most commonly implemented modules are FI (Financial Accounting), HR (Human Resources), AM (Asset Management) and PS (Project Systems). Other modules that have been implemented are CO (Controlling), MM (Materials Management) and WF (Workflow Management). The types of modules implemented pinpoint the high interest in money-related modules, except the case of the HR module, the use of which is inevitable for organizational management.
- Training programs for company staff is provided by only 60% of the implementers, either by external consultants (2 companies) or in-house IT professionals (1 company). However, 2 companies reported that they did not have a training program due to insufficient funds.
- The average satisfaction of companies utilizing ERP systems turned out to be 4.0 on a 1-5 Likert scale, where 1 and 5 indicate “Highly Dissatisfied” and “Highly Satisfied”, respectively.
- Considering the responses of all 20 companies, almost 50% of the companies stated that the key players in the purchase of these systems are representatives of top management. This is followed by an IT group (24%) and a Project Management group (14%).

One of the critical issues with regard to the implementation of ERP systems is the expected benefits of using these systems. Based on the experience of the ERP implementers, it has become clear that the companies are experiencing more operational benefits as compared to organizational, managerial, and strategic benefits. A summary is provided in Table 2, based on 1-7 point scale (1: strongly disagree, 4: neutral, 7: strongly agree).

**Table 2: Experienced Benefits from ERP Implementation**

<b>Experienced Benefits</b>	<b>Score</b>
Productivity improvement	6.40
Cycle-time reduction	6.20
Better resource management	6.00
Generating/sustaining competitiveness	6.00
Improved decision making and planning	5.60
Quality improvement	5.40
Faciliate business learning and broaden employee skills	5.40
Building a common vision	5.40

When the companies that have not implemented an enterprise-wide IS are questioned about their future strategies or plans regarding the ERP implementation, it was found that only 14% are planning to implement such a system within 2-3 years. As a result of their lack of knowledge, familiarity and experience with these kinds of systems, a large portion of these companies, i.e. 86%, have no specific plan vis-à-vis ERP system implementation. Furthermore, 57% of these companies indicated that their

organizations are not ready for undertaking such an enterprise-wide IT project. Some of the reasons listed for unreadiness are described by the companies as follows:

- Size: Since the company size is small, the companies usually have a single office where they are not in need of a ‘fancy’ IT system. However, most of the companies reported that they may need and be more interested in these systems when they grow.
- Culture: Some of the companies mentioned that their organizational culture has not been evolving as much as the advancement in IT, which would lead to a misfit between organizational and technology culture.
- Business relations: Small sized companies also pointed out that, since the amount of work that they are performing is also small in size, they have their business relations on a more informal level. In other words, they consider that the use of ERP systems may limit their flexibility in the way they do business with their clients.
- Enterprise management: Outsourcing is a common business practice in the construction industry as the majority of the work done is performed by subcontractors. The respondents stated that this practice usually leads them to keep core personnel small in number and outsource additional workforce requirements. Even at satellite offices, having a few key individuals backed up by the main office is accepted to be sufficient for project management.

#### **4. Conclusions and Suggestions**

The fragmentation of the construction business has also led to fragmentation in the type, quality and amount of data and information generated throughout a project’s life cycle. This has been mentioned in the literature as the “islands of construction information”. To connect these islands, ERP is suggested to be an appropriate solution. Findings of the research presented in this paper shows that, despite the low rate of ERP implementation by SMOs in construction, none of the implementer companies reported any suffering from high costs and low benefits. On the contrary, the results showed users are satisfied with the systems that they have been using. Likewise, the companies reported operational benefits as a result of the use of ERP systems. This highlights the potential of ERP systems for construction organizations regardless of their size.

However, this paper was conducted based on the hypothesis that SMOs in the construction industry are lacking sufficient knowledge about ERP systems and that the implementation of ERP systems within this market is low because these companies do not have any implementation plan. The preliminary results of the questionnaire distributed to 20 SMOs revealed that 35% of these companies are aware of the existence of ERP systems. An important finding of the questionnaire study demonstrated that a great portion of the companies, 84%, still do not have any plan for implementing ERP systems. These two vital findings highlight the validity of the original hypothesis. On the other hand, SMOs in the construction industry are usually challenged by financial and organizational constraints. This makes the decision for ERP investment (and on a broader view, any IS/IT investment) more difficult. Although there exists some research aimed at developing implementation frameworks for construction companies, this has been limited to large organizations and case studies. Thus, it is recommended that, in order to enhance the success of investing and implementing ERP systems (any IS/IT on a broader scale) by a greater number of SMOs in construction, an Information Strategy Plan (ISP) Template should be developed. The template is suggested to include the decision factors, success factors and performance indicators that may support both the decision for and the implementation of an ERP system by construction companies. Considering the fact that the characteristics of organizations in construction vary, the template should not be in the form of quizzing a company about the way they do business but rather guiding them to take pre-defined factors and indicators into account before taking an action. This will provide a more structured, consistent and well-defined methodology for construction companies to evaluate if they need ERP systems for their organizations, and they are lacking any resources to have an ERP system implemented.

## 5. References

- Barthorpe, S., Chien, H-J., and Shih, K.C. (2004). "A Survey of the Potential for Enterprise Resource Planning (ERP) in Improving the Effectiveness of Construction Management in the UK Construction Industry". *International Journal of Computer Applications in Technology*, Vol. 20, No. 1-3, 120-128.
- Chia, S.Y., and Ling, F.Y.Y., (2003). "Implementation of Enterprise Resource Planning in Firms Operating in the Construction Industry". *Architectural Science Review*, Vol.46, No.3, 323-331.
- Chung, B.-Y., and Skibniewski, M. (2005). "Cost-Benefit Analysis of Integrating ERP Systems with Project Management Systems in Construction Firms". *Proceedings of First International Conference on Construction Engineering and Management (ICCEM) (CD-ROM)*, Seoul, South Korea.
- Davenport, T.H. (1998). "Putting the Enterprise into the Enterprise System", *Harvard Business Review*, Vol. 76, No. 24, 121-131.
- Dodd, S.C. (1999). "Enterprise Resource Planning Software Systems and Capital Facility Delivery". M.Sc. Thesis, University of Texas at Austin, TX, USA.
- ENR (2003). *ENR Technology Study*. <[www.sagetimberlineoffice.com/company/include/files/2003%20ENR%20Technology%20study.pdf](http://www.sagetimberlineoffice.com/company/include/files/2003%20ENR%20Technology%20study.pdf)>; (accessed on 03/10/2007).
- Gable, G., and Stewart, G. (1999). "SAP R/3 Implementation Issues for Small to Medium Enterprises", *Proceedings of the 5th Americas Conference on Information Systems*, Milwaukee, WI, pp.779-781
- Jung, Y., and Gibson, G.E. (1999). "Planning for Computer Integrated Construction". *Journal of Computing in Civil Engineering*, Vol.13, No.4, 217-225.
- Lee, S., Arif, A.U., and Halpin, D.W. (2002). "Simulation Modeling by Enterprise Resource Planning Implementation in Medium Sized Corporations". *Proceedings of First International Conference on Construction in the 21st Century (CITC)*, 25-26 April, Miami, Florida, USA, 663-670.
- Mintzberg, H. (1979). *The Structuring of Organizations: A Synthesis of the Research*. Prentice-Hall, Englewood Cliffs, N.J., USA.
- Peña-Mora, F., Vadhavkar, S., Perkins, E., and Weber, T. (1999). "Information Technology Planning Framework for Large-Scale Projects". *Journal of Computing in Civil Engineering*, Vol.13, No.4, 228-237.
- Rivard, H. (1999). "A Survey of Information Technology in the Canadian Construction Industry", *Information Technology in Construction*, Editors: Lacasse M.A. and Vanier D.J., Volume 4, Vancouver, Canada. <also available online at <http://itc.scix.net/cgi-bin/works/Show?w78-1999-2338>>
- Ryoo, B.Y., Ahmad, I.U., and Zheng, J. (2005). "System Architecture for Integration of Construction e-Business Solutions: A Model for Enterprise Resource Planning and Project Management System". *Proceedings of First International Conference on Construction Engineering and Management (ICCEM) (CD-ROM)*, Seoul, South Korea.
- Sawyer, T. (2007). "Innovative Tools Help Companies Cut the Data Beast Down to Size". *ENR Technology Features Articles*, [www.enr.com](http://www.enr.com) (accessed 02/23/2007).
- Stewart, R.A., Mohamed, S., and Daet, R. (2002). "Strategic Implementation of IT/IS Projects in Construction: A Case Study". *Automation in Construction*, Vol.11, 681-694.
- Tatari, O., Ryoo, B.-Y., and Skibniewski, M. (2004). "Modeling of ERP System Solutions for the Construction Industry". *Proceedings of 5th European Conference on Product and Process Modeling in AEC Industry*, Istanbul Technical University, September 8-10, Istanbul, Turkey, 393-398.
- U.S. Census Bureau (2005). *2002 Economic Census – Construction Reports*. <[www.census.gov/const/www](http://www.census.gov/const/www)>; (accessed: 03/10/2007).
- Vlachopoulou, M., and Manthou, V. (2006). "Enterprise Resource Planning (ERP) in a Construction Company". *International Journal of Business Information Systems*, Vol.1, No.3, 339-351.
- Voordijk, H., Van Leuven, A., and Laan, A. (2003). "Enterprise Resource Planning in a Large Construction Firm: Implementation Analysis", *Construction Management and Economics*, Vol.21, No.3, 511-521.