
DIGITAL SERVICES FOR CONSTRUCTION SMALL AND MEDIUM ENTERPRISES: A CONCEPTUAL BUSINESS MODEL

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ABSTRACT

The rapid deployment of web technologies delivers information from diverse sources in the world of digital business in a unified way. Within the construction industry the demand for investments in the digital dimension has raised very fast indicating a trend towards on-line collaboration services usually offered through a web portal. The main purpose of this research is to examine how the use of a web portal enhances the mission of construction Small Medium Enterprises (SME) in the local, national and international economy. Therefore, features and services captured from existing construction web portals are listed quantitatively to indicate those that are important to support the enterprise needs of construction managers and directors. Additionally the common practical and essential features considered in the technical and contextual design of a web portal geared for the use within the domain of construction SMEs in order to promote enterprise continuity in digital business are briefly presented. Results indicate potential support of interaction and collaboration among partners in the construction industry due to direct information accessibility as well as an attractive web platform developed based upon their daily needs. Therefore the need to develop a web business model is suggested to enhance the role of construction SMEs with a focus on online collaboration (online services). This model aspires to provide potential practical on-line dissemination of knowledge within construction SMEs to help the world of construction managers and directors in order for them to be more efficient, effective and creative when developing new businesses, new ideas and new projects. This model is partitioned to accommodate for flexible and scalable technological infrastructures that offer the necessary web services addressed to construction SMEs.

Keywords: Construction SME, Web Portal Technologies, Web Services, Virtual Organisation, Communication.

1. INTRODUCTION

The construction sector is dominated by a high degree of fragmentation with a large number of factors affecting the continuous operation of SMEs due to low productivity, low level of innovation, delays, low quality and high cost of maintenance. This phenomenon is seen in both the Academia and the construction industry. The problem caused by this is that in the Academic world although there is rapid reaction from Research & Development (R&D) the industry is reluctant to follow the innovation. In the industrial world, problems are caused in reaching decisions concerning project timelines, budget estimation and allocation as well as dissemination of new ideas.

All of the above-mentioned construction constrains are relying to human behaviour due to human involvement during the Product Lifecycle Management (PLM) defined as ‘...the process of managing the entire lifecycle of a product from its conception, through design and manufacture, to service and disposal’. Stark (2007) in reality a project/product does not run sequentially or in isolation from other

product/project developments. Information is flowing between different people and systems. A major part of PLM is the co-ordination and management of product definition data. Stark (2007) includes managing changes and discharge status of components; configuration product variations; document management; planning project resources, timescale and risk assessment. In terms of software support for systems at the corporate level there is Enterprise Data Management (EDM) software which is used to assemble and organise engineering departments. This can be linked with other corporate systems such as Supply Chain Management software system, Customer Relation Management software system, and Enterprise Resource Planning software system. Associated with these systems are Project Management Systems for Project/Program Planning.

The broad array of solutions that compose the tools used within a PLM were initially used by practitioners who invested time and effort to gain the required skills. In the case they do not have these skills they have to be qualified. Designers and engineers worked wonders with any engineering system; manufacturing engineers became highly skilled users; analysts, administrators and managers fully mastered their support technologies. However, achieving the full compensation of PLM necessitates the participation of many people of various skills from throughout an extended enterprise, each requiring the ability to access and operate on the input and output of other participants. Requirement for this is all enterprise members have to the ability of excellent organisational communication, which is "... a process of exchanging energy and exchanging information"(Heeks, 2008).

As such there is an urgent need to favour communication between the above factors by bridging this gap so the clients which are different partners in the construction process - producers of construction materials, products and equipment; designers; consultants; contractors; owners and operators of buildings, plants, infrastructure and facilities; standardisation agencies and technical approval bodies; research institutes, universities, local and national governments – feel more confident. This will help develop trust as the major element towards effective and efficient communication. When this procedure ends, collaboration is achieved. Henceforth effective and efficient partnerships are accomplished successfully something that will be enabled with the web business model.

2. CONSTRUCTION INDUSTRY AND CHALLENGES

All organisations, including construction companies, have two dimensions: project and function. The prime axis depends on the corporate strategy in terms of customer relationships, products and services creation. Most organisations tend to be structured to deliver high customer value and they use their project organisation to assess their performance.

From a management point of view this can be seen as a series of projects that compose a project portfolio – as is identified project dimension. Each project is managed independently while maintaining mutual procedures. This portfolio summarises to the Board a) the states of projects (project progress) and b) the returns on stakeholders' investments (Return on Investments - ROI). The budget of every project is managed according to the project objectives. Project management is responsible for the management, administration and the qualitatively delivery of individual project upon the client's previously agreed timescale, cost and quality constraints. From a project perspective particularly where capital goods are concerned, the delivery process can be described with the use of product life cycle. This corresponds to a very high-level description of workflows and it shows the evolution of products from concept to produce and then to recycle.

The other dimension, identified as the functional dimension of an organisation depends on its competences or skills set. It mainly corresponds to the soft asset of an organisation and it can be changed in profile according to the strategic sector the company serves (Alshawi, 2009). Increasingly this implies a slow change in the electronic/computing capability as products become more intelligent.

The stages of life cycles take different approaches and exploit the organisation competences in different combinations depending upon the skills required. For example, design will take advice from maintenance personnel to reduce the through life-cost, and maintenance personnel will require advice from design if an unexpected problem occurs during the operational phase of the life cycle. Henceforth internal interactions can be complicated due to the distribution of the stakeholders and to their very

different skill sets and working cultures. An increased involvement of suppliers also amplifies the needs for collaborative infrastructures with control and facilitation supplied by the project management capability.

The main role of Directors, Managers and Project managers is to plan the resources required for a project or product, negotiate with the discipline leads and then to control and maintain the project. The web as a useful tool can address the control, negotiate and optimise time, cost and quality. Hodgson (1998) during his presentation implied the challenges of construction industry development were to a) increase the contribution of the industry to GDP b) meet basic infrastructure needs c) promote best practice and value for money to clients d) promote equity and the emerging sector. Eleven years later KPMG on its report on the global construction industry presented the fallen demand that industry has to deal with due to the recession period. A number of construction companies acted by reducing staff numbers. Some other companies may prefer to hang on to their talent in the hope of an imminent turnaround in fortunes. Another number of companies focused on the risk management as the more critical as ever to help ensure future success, considering pressure to cut back on such expenditures.

But the future challenges as presented in this report correlated the findings from the International Financial Reporting Standards (IFRS) is the probability of the changing nature of the construction sector may impact its structure. The growth in mixed use, inner city developments, may lead many smaller construction industries to rise in joint ventures. Furthermore, the increasing complexity of projects, restricted access to capital, and more stringent planning regulations (often for environmental reasons) all favour larger businesses, which could mean more achievements. Particularly the challenges involved are: evaluating and exploring future demand; continued investment in talent; fully integrated risk management and seeking innovation into sustainability.

Comparing eleven years ago and today what is observed is the huge need for effective and efficient partnerships in order for construction industry to be alive. On top accurate data and information is required regarding the correct analysis of risk management and innovation into sustainability. Knowledge (tacit and explicit) is entailed into the criticism of evaluating and exploring the future in terms of the resources towards the concept and the implementation of new projects and new ideas.

Henceforth the construction industry in order to achieve the above objectives shall find alternative methods of approaching them. The web as a proved alternative channel of communication hides a number of potential services could be used by the directors and manager as well as the end users or the potential partners.

3. CONDUCTING THE RESEARCH

The web as an alternative channel of business is increasing rapidly in the five main industries: automotive, tourist, media, banking and construction. Successful examples in the digital business world are the tourist and banking industries.

The Construct IT Business Center at the University of Salford conducted a preliminary research regarding the exploration of existing online web portal services and design features in the construction industry. The objectives of this research are a) to identify what kind of features are enabled on the web portals and what kind of services are offering to customers or end users, b) to test which of these features and services are in use, c) to examine the quality of the services (technological and operational) and d) to propose conceptual business web model that promotes the use of these services and increases enterprise value on behalf of the business users.

The sample was based on 30 construction web portals and online directories collected by using online resources during the period between July 2009 and October 2009. These were chosen and analyses according to their content that was relevant to the construction industry and addressed common market needs. The evaluation criteria for these were chosen on a preliminary research based on published work done by the Lab of Human Computer Interface at the University of Patras, which captures the qualitative criteria/constraints of a portal in order to be useful and operational to end users.

3.1. Features and services available

Features as defined by the IEEE are distinguishing characteristic of a software item (e.g., performance, portability, or functionality). What kind of features and their action enabled on the web portals based upon the above research are listed on the following table 1.

Existing Services on Web Portals	Feature Action
<ul style="list-style-type: none"> • FAQ 	<ul style="list-style-type: none"> • Frequently Asked Questions.
<ul style="list-style-type: none"> • Profile 	<ul style="list-style-type: none"> • Information about the portal's company.
<ul style="list-style-type: none"> • Technical Error 	<ul style="list-style-type: none"> • During the browsing period technical errors appear on screen.
<ul style="list-style-type: none"> • Site Map 	<ul style="list-style-type: none"> • Orientation within the portal in case contextual information is hidden or is not clear.
<ul style="list-style-type: none"> • Browsing or Navigation 	<ul style="list-style-type: none"> • During the navigation in the web portal are the right signs to assist user orientation.
<ul style="list-style-type: none"> • Links 	<ul style="list-style-type: none"> • Connections within the web portal or other external hyperlinks.
<ul style="list-style-type: none"> • Language 	<ul style="list-style-type: none"> • The web portal translated in other languages English instead.
<ul style="list-style-type: none"> • Graphics 	<ul style="list-style-type: none"> • Up dated information. • Are visual presentations on a web portal or website.

Table 1: the design feature list

Equally the web services are listed on the following table 2. Web portal services are defined by [7] a software system designed to support interoperable machine-to-machine interaction over a network. There are developed using Application Programming Interfaces (API) or web APIs that can be accessed over a network such as the Internet and executed on a remote system hosting the requested services.

The state of the art Web Services use Extensible Markup Language (XML) messages, which follow the Simple Object Access Protocol (SOAP) standard and have been popular with traditional enterprise. In such systems, there is often a machine-readable description of the operations offered by the service written in the Web Services Description Language (WSDL), which is not a requirement of a SOAP endpoint but a prerequisite for automated client-side code generation in many Java and .NET SOAP frameworks.

Existing Services on Web Portals	Feature Action
<ul style="list-style-type: none"> • Personalisation • Forum • Chat • Stock • Up-Dated • Links • Digital Marketing • News • Agenda • Events • Search Engine 	<ul style="list-style-type: none"> • Activation of register user • A public meeting or assembly for open discussion. • A private meeting or assembly for discussion • On line updated news from the stock market. • If the information are up to dated the current date of search • Connections within the web portal or other external hyperlinks • Promotion of brands by using the Internet, mobile and other interactive channels • Up dated information • Information about Meetings, Research • Information about Social Events • A designed tool to search particular information within the portal and its files (*doc,*pdf,*xls etc)

Table 2: Web services list

3.2. Features and services in use

What is observed so far is that the technology resources that are available today are advanced enough to deliver support for the development of the web portal services and the features with enough potential in keeping the registered members satisfied and with the feeling of confidence regarding the tools they are using. The next stage is to represent statistically a comparison between the features and web services, which will lead us towards the development of a unique business model.

In particular based upon the lists the following chart present which of the above features and services are used (blue line) and which not (red line).

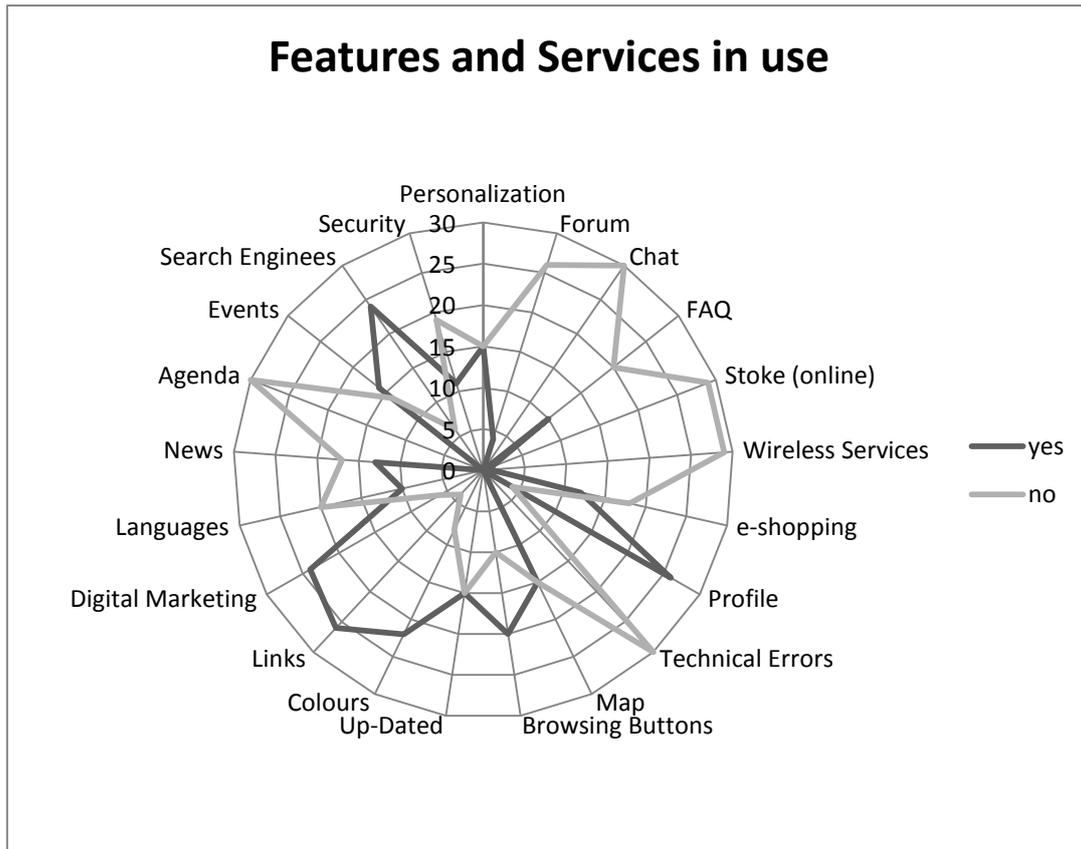


Figure 1: Features and Services in use

By analysing the existing practices on design features it is observed that they are working promptly for 57.8% of the web portals as shown in figure 1, while in 42.2% of these the features are not working as shown in figure 2. In terms of the services they are commonly used in 34.9% of the web portals as shown in figure 3, while 65.1% of these do not offer any use of services. From these findings it can be seen that the majority of the portals offer less use of services and more use of design features. The presumably reasons for this could be the lack of expertise to deploy and activate these design features, lack of interest in investments on Information Communication Technologies (ICT), low availability of accurate information and low levels of motivation towards the use of digital technologies as an alternative channel in doing business.

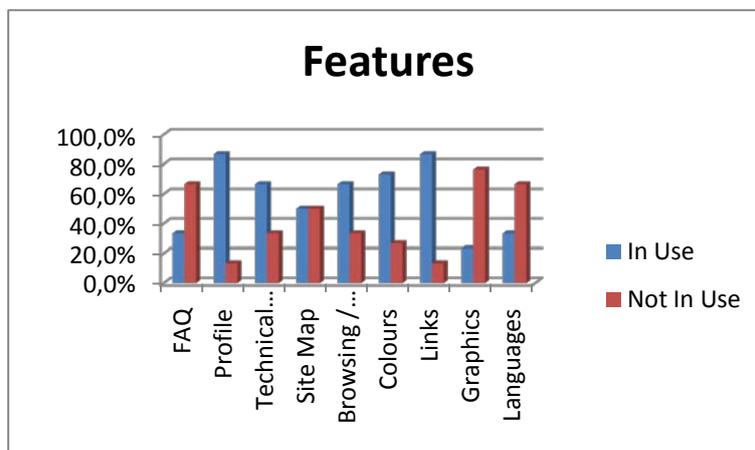


Figure 2: Analogy of features in use and not in use

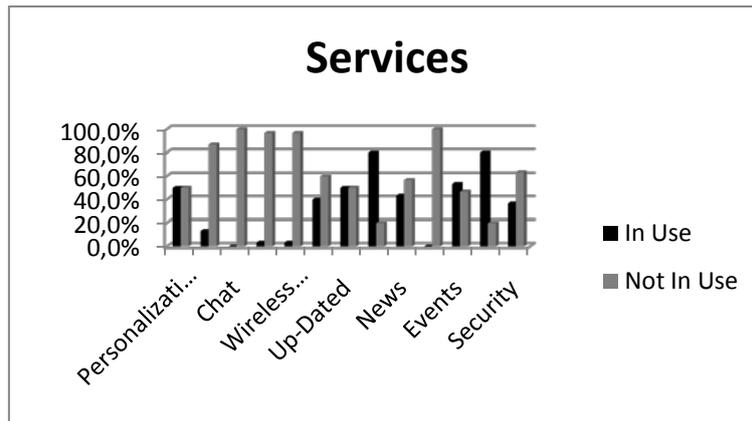


Figure 3: Analogy of services in use and not in use.

3.3. Quality of features and services

Based upon the Figure 1 and Figure 2 search engines, news, digital marketing, links, colours, browsing, map buttons, links, profile are the features and services which are offered. But between the red and blue line there are contradictions. In particular the case of the existence of search engines which are not operational for example they do not retrieve the latest information (there is algorithmic error), they cannot search within documents or portable document format (pdf) files. Another good case is that there are links which are broken.

Therefore, there is high demand to eliminate the technical errors and to offer wireless/mobile applications, frequently asked questions, forums, construction companies' online representation, to increase to security level within the portals, to provide an agenda with the local national events, to provide opportunities the site to be translated, to provide updated resources and to offer more electronic transactions.

Partnerships can potentially increase the quality of products and may provide better conditions for investments as they can decrease risk due to information sharing. In addition the management of projects or products can benefit through the use of digital business and web services. The way to achieving is by providing advanced services upon the real construction industry needs. These will be supported by using the majority of on line web portal design features and services as collaborative online tools which will be that bring potential partners closer.

Therefore, since the moment a web portal is developed based upon the above features and services without any contradictions then end users would be attracted to use it due to the plurality of the provided services (Figure 1 and Figure 3). The only requirement for those end users who want to make use of the above portal is to invest on the relevant current technologies. Paradoxically the above organisational strategy by investing on Information and Communication technologies reflect on company's operational process as well have impact on making profit. Henceforth this change reflects the total business model as long as drive the company to another exit of making profit. How this business model work is the content of the following section.

3.4. The conceptual business model

Based upon the above research (figure 1) the lack of providing dynamic features and services to the end users, the lack of communication and collaboration, the lack of technical knowledge (web development) worked as catalyst towards the need of enhancing both the current web portals and the current management style of construction companies.

The proposed business model presents the development of new strategy within the construction SMEs organization by investing in ICT. This initial stage will be the vehicle to change the style of managing their organizations due to the power of the web. Therefore the need to merge both ICT/Web and construction management will lead towards the development of a new market. This market will offer a number of different services – digital services which will assist managers, directors and senior

staff members of construction organization to optimise organizational processes, to attract new clients towards the development of new ideas and projects, to optimise project and product processes, to open new business networks and to meet international business opportunities.

Henceforth this conceptual business model is based on the following mainstream hierarchy of understanding known as DIKW (Rowley, 2007) as shown in figure 4 Data is represented as pieces of information that represent the qualitative or quantitative attributes of a variable or set of variables (Beynon-Davies , 2009). Information as a concept has a diversity of meanings, from everyday usage to technical settings. Generally speaking, the concept of information is closely related to notions of constraint, communication, control, form, instruction, meaning, mental stimulus, pattern, perception, and representation (Stewart, 2001). Knowledge is defined by the Oxford English Dictionary as expertise and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject, Philosophical debates in general start with Plato's formulation of knowledge as "justified true belief". Wisdom is an ideal that has been celebrated since antiquity as the application of knowledge needed to live a good life. Beyond simply knowing/understanding what options are available, "Wisdom" provides the ability to differentiate between them and choose the one that is best. What this means exactly depends on the various wisdom schools and traditions claiming to help foster it. In many traditions, the terms wisdom and intelligence have somewhat overlapping meanings; in others they are arranged hierarchically, with intelligence being necessary but not sufficient for wisdom (Rowley, 2002).

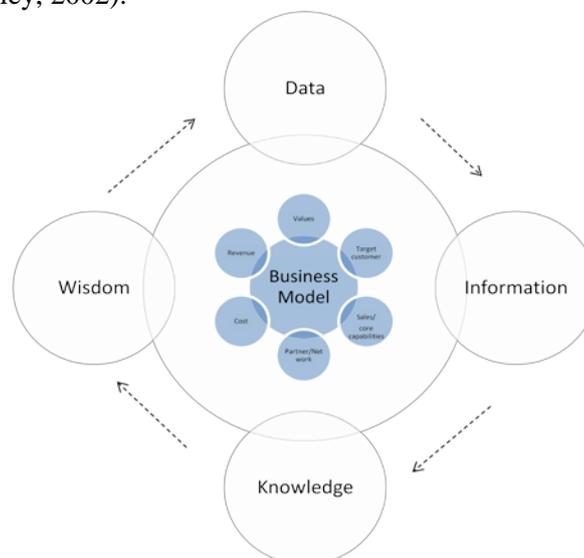


Figure 4 The reaction between a Web 2 Business Model and the Hierarchy of human understanding.

In order to make the above model operational based upon the current Information and Communication Technologies and the power of the Web, the development of the Business Model 2.0 as it is defined by Zott.C. *at all* (2010) is required. Simultaneously, in order to secure data accessibility the development of a web portal is required. The portal will be hosted, developed and administrated by a private or public no profit organization. These data and information shall be entered, analysed, filtered and updated in regular basis in order to secure the quality of the data and to pretend high reputation for the portal and the hosted company.

Significantly, the knowledge shall be distributed and disseminated between the registered scholars (CEO, senior staff members and managers) within a private communication channel, in which the members will discuss, share and exchange problems, ideas, products, services or projects with other potential partners. In addition within this communication channel or collaborative environment will allow further consultation, on line meetings, searching for new staff or running online training courses. Nevertheless the accessibility to tender databases will allow the registered members to find potential projects.

Notably, the daily usage of the above portal and the digital services will give the chance to SMEs companies to be more active within the construction industry within the local, national and

international market in order to secure viability. Henceforth the primary daily accessibility to the latest state of the art information from anywhere at any time as well the development of proactive behaviour (Kapogiannis, 2010) will give to the businessmen the power of making efficient decisions by eliminating the business, financial and project risks down to the minimum. The figure 5 represents the proposed business model.



Figure 5: Proposed Business Model

The above proposed business model has been theoretically validated from another research which conducted during the second phase of the same project. In total 135 invitations to construction SMEs executives have been submitted electronically via mail in local and national level. The final collected sample was 12. The data collection period was during the period October 2009 and February 2010. The techniques followed were both questionnaire and semi – structured Interviews. The purpose of this evaluation was to identify whether the proposed business model would be a challenge for them in order to apply it within their organization. 100% of the interviewers responded positive. In addition the interviewers had further ideas in order to enhance some of the limitations of the proposed model. The explicit technical analysis of the proposed business model is beyond the scope of this paper.

4. CONCLUSIONS

Sum up the purpose of the proposed business model is to enhance the construction Small Medium Enterprises in order for the senior staff members to be more efficient, effective and creative when developing new businesses, new ideas and new projects. At the same time collaboration is achieved within and outside the construction companies. The better humans' communication is, the most productive they get and fewer failures occur. Henceforth the human capability to interoperate the business needs via a dynamic business model will give better viability opportunities. The human centric development of the business model does not allow the substitute of the human entity but enhances the human contribution within a system that has already failed. This revolution will give further power to small and small medium enterprises to growth within healthier business and economic environments.

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