

E-nvisioning the participation of European construction SMEs in a future e-Business scenario

Iñaki Angulo, Eduardo García, Nieves Peña, Valentín Sánchez

LABEIN Technological Center, Bizkaia, SPAIN

(angulo, egarcia, npena, valen@labein.es)

ABSTRACT: The integration and automation of enterprise business processes are still nowadays an open issue especially for the SMEs. This has forced the research community to do research on technologies to provide a more automatic and collaborative arena for the enterprises. But still this complex but advanced knowledge has not reached in a practical way the SME real world, especially in the Construction sector. It is just this consideration what has motivated the e-NVISION* consortium to do a bottom-up approach research from the construction SMEs standpoint to a complete infrastructure definition of a collaborative SMEs trading lifecycle scenario over the (Semantic) Web. In this paper we provide the current state of the art on this matter identifying also open research issues and we also describe the construction SME trading framework that will allow us to define an SME-oriented e-Business Model formally expressed by a set ontologies and a set of business contextual services enabling SMEs to incorporate legal, social, economic, and trust aspects in their business model.

1 INTRODUCTION

Over the last decade a huge effort has been done by the research community to become a reality the integration and automation of enterprise business processes. In parallel, the big companies have improved their business by introducing those innovative e-commerce ideas to their business processes and are, now, demanding, a more collaborative scenario where their inter-organizational processes and outside-organizational process work together providing an external collaborative business model to the outside.

All this, has forced the research community to carry on the research on technologies to provide a more automatic and collaborative arena to these enterprises, where process and rule based coordination and corresponding products and standards are being developed.

But still this complex but advanced knowledge has not reached in a practical way the SME real world, because today's Web Service (WS) and Semantic

Web Service (SWS) approaches, methods, techniques, and standards still require implementers to work at low very detailed implementation levels far removed from real business needs, practices, and contexts.

In this paper we provide the current state of the art on this matter identifying also open research issues and we also describe the construction SME trading framework that will allow us to describe an SME-oriented e-Business Model formally described by a set ontologies and a set of business contextual services enabling SMEs to incorporate legal, social, economic, and trust aspects in their business model.

2 CURRENT STATE OF THE ART

2.1 *SME Situation in the Construction Sector*

In this section we describe briefly the current situation of the construction SMEs from the point of view of ICT uptake and e-business. We have based our conclusions in some public reports from the European Commission, along with the information provided by the SMSs and SMSs associations taking part in the e-NVISION project.

Firstly, we report the general situation applicable to the whole sector. Secondly, taking into account that

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there are many differences between SMEs, we classify them into categories in order to analyse their situation separately. Finally an e-procurement scenario is presented, taking into account the differences between SMEs.

ICT uptake and e-Business deployment in Construction SMEs

According to e-Business Watch (e-business [W@tch](#), Report 08-I) , in terms of ICT uptake and e-business deployment, the construction sector today is characterised by:

- Highly fragmented ICT usage.
- A multitude of standards, technical specifications, labels, and certification marks as well as diversity in local, regional and national regulations.
- A low adoption and integration of relevant ICT in most business processes, especially by SMEs, which are often characterised by communication and knowledge sharing based on personal or telephone contact.
- Many small-sized companies which are typically either organisers of projects and project flows or suppliers to larger project-managing companies, with different ICT requirements.

This general situation has been confirmed by the Construction SMEs and Associations involved in e-NVISION project.

Construction SMEs characterisation

One important fact to take into account is that not all the SMEs in the construction sector share the same business processes and ICT uptake. It is necessary to classify them into a comprehensive set of categories.

A recent study of IT usage and needs in the Danish construction sector (Rambøll Management, 2004A) suggests that construction companies can be categorised into two main groups: “project-based companies” and “production/service companies” according to their business processes. The main process of “project based” companies is project management, which includes planning, tendering, facility management, site management and so on. On the other hand, “production/service companies” can be thought of as suppliers to project companies, providing products (materials, equipment, blueprints/design documents) or construction services (plumbing, electrical installation) on site.

Furthermore, suppliers (“production/service companies”) can be also classified into two

categories: suppliers of products and suppliers of services. Supplier of products are similar to manufacturing enterprises. They make the product in their own premises and sell or rent the finished product to the construction PMC (Project Management Company). However, the service companies have to work on-site, taking part of the construction processes. This classification is useful because it has implications on the kind of business processes and ICT needs of the suppliers.

e-procurement pros and cons

The e-procurement scenario is analysed now from the point of view of the implications of this scenario for the different types of construction SMEs.

The commercial relationship between “project based” and suppliers could be improved using an e-procurement system. This kind of system can be composed of e-tendering (finding and selecting suppliers) and e-purchasing (purchasing products, or services). The main benefits of e-procurement are savings on purchase price, and on the administrative costs for buyers and suppliers as well. The companies more interested in implementing e-procurement systems are the “project based” companies.

Although the increased use of internet has facilitate the deployment of this kind of systems, some barriers still remain: Cost of implementation, lack of standards (both technological and in product classification and terminology) and resistance among suppliers.

The last point is of special interest from the SMEs point of view. Nowadays, many commercial relationships between suppliers and Project Management Companies are based on location, previous work and personal relations. An European level e-procurement system could improve suppliers visibility and it can be seen as a threat to well established relationships. On the other hand it can be seen as an opportunity to reach other markets. Especially for product supplier SMEs, a global market can oblige them to compete on price with companies of any European country (good for Project Management Companies but bad for suppliers). In the case of services providers this effect is not so clear, due to the location based nature of their work.

2.2 E-Business Situation

Looking into the near future, business in Europe will be conducted through flexible networks of interdependent organizations. The future business scenario will be global, open and collaborative,

dynamic and adaptive, frictionless and consistent. This evolution is assumed to be electronically supported in what is known as the e-evolution ladder shown in the figure beside. In this respect, e-Business is the first and most critical step in which the companies must be established in order to guarantee their survival and stability.

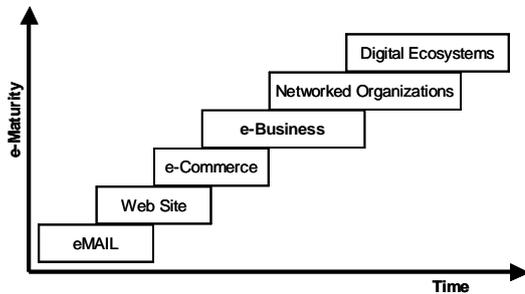


Figure 1 e-evolution ladder

Most of the current trading systems are Web-based **e-Commerce applications** featuring a number of critical limitations:

- They are specifically conceived and developed for the characteristics of the company (Clients profile, products/Services, navigation, etc.) with a very poor updating capability, usually only for the products/services catalogue.
- They are static and quite deterministic without any reaction capability from the behaviour of the partners and their environment.
- They have a very limited or non existent integration with other existing back-office application in the company.
- They do not consider business contextual aspects like legal, social, economical or cultural matters.

In parallel, the big companies have taken a step forward, improving their business by using proprietary **e-business platforms** that hardly interoperate with each other.

Some standardization initiatives are being carried out in order to facilitate interoperability between electronic business platforms. Some areas being standardized are:

- Business processes definition. (BPEL, ebXML BPSS, RosettaNET PIP).
- Document transfer and messaging. (WEB Services, ebXML MSG).
- Data and documents model. (RosettaNET, ebXML Core Components)
- Enterprises Directory and Search. (UDDI, ebXML Registry)

Following, it is described in more detail the main standardization initiatives, ebXML and SOA & BPEL.

ebXML

ebXML (Electronic Business using eXtensible Markup Language), sponsored by UN/CEFACT and OASIS is an international initiative to develop and promote a set of standards for electronic business with XML. ebXML is a complete solution, focused on B2B integration scenarios. It includes its own specifications for business registry, security, messaging and process definition and orchestration.

Using ebXML, companies now have a standard method to exchange business messages, conduct trading relationships, communicate data in common terms and define and register business processes.

The main two advantages of ebXML are:

- Creates a Single Global Electronic Market Enables all parties irrespective of size to engage in Internet-based electronic business. Provides for plug and play shrink-wrapped solutions.
- There exist complete commercial products implementing the ebXML specification, along with free and open source products available for companies willing to try the technology without a big investment.

However, it is also important to point out its more important drawback: EbXML does not consider the company conceptualization, that is, the processes inside the company.

SOA and BPEL

Nowadays, the “Services Oriented Architecture” (SOA) is emerging. Although it was initially an initiative to resolve Enterprise Application Integration (EAI) problems, SOA is now including areas of standardization work on electronic business.

This second area (e-business) is the natural evolution from the EAI domain, defining not only internal services but also business services. Although SOA is not really linked to any distributed background, emerging implementations are based on Web Services.

The Business Process Execution Language for Web Services (BPEL4WS) provides a language for the formal specification of business processes and business interaction protocols. It can be used as a part of a SOA approach in order to provide a

workflow to control the external and internal processes.

Semantic Web Services

Semantic descriptions of Web services are necessary in order to enable their automatic discovery, composition and execution across heterogeneous users and domains. Currently used technologies for Web services provide only descriptions at the syntactic level, making it difficult for requesters and providers to interpret or represent non-trivial statements such as the meaning of inputs and outputs or applicable constraints.

Three main approaches have been driving the development of Semantic Web Service frameworks: IRS-II (Motta, E et al. 2003), OWL-S (OWL-S Coalition, 2004), and the WSMO (WSMO 2005).

Digital Business Ecosystem

Recently, the UE has launched a new initiative in the field of SMEs innovation, called "Innovation Ecosystems": The European Innovation Initiative for e-inclusion of SMEs and territorial development, empowering Business Ecosystems through Digital Ecosystems technologies.

The DBE is an open, free environment where even the smallest specialist software developer can participate competitively in the massive global marketplace for business applications. The software makes use of some of the standards mentioned before (as BPEL, and Web Services Standards) under the hoods, but it does not rely completely in the standardization efforts. For example, it defines its own messaging system, which is not based in Web Services, although Web Services can be integrated in the digital ecosystem.

From our point of view, two main characteristics differentiate DBE from other B2B approaches. The first one is that it applies the P2P technology to the B2B field, using a decentralized business registry and constructing a network of business services.

2.3 Open Issues

The current global e-business solutions existing in the market are too general and complicated to be used by a small or medium company. Companies need to make big efforts to use the platform and are paying high extra for functionalities that are not relevant for them. Moreover, these solutions usually demand great changes in the way of making business because it is very difficult or impossible to integrate them with the back-office resources owned by the company.

On the other hand, more modular and scalable open source tools are emerging bringing the possibility to implant e-Business solutions in a more adapted, tailored and cost effective way to the SMEs real necessities. But these open-source solutions still lack the level of maturity and support provided by the commercial solutions.

Furthermore, the main barriers SMEs to exploit and adapt will be the lack of methodologies to migrate to e-Business practices, a target reference and proven SME-oriented e-Business model and a cost-effective, tailored and ubiquitous technological solutions and toolkit to support (automatically) these processes.

3 E-NVISION BUSINESS MODEL

3.1 E-NVISION project

e-NVISION "A New Vision for the participation of European SMEs in the future e-Business scenario", is a STREP project approved under the 4th call of the 6th Framework Programme of European Commission. Its main objective is the development and validation of an innovative e-business platform for the SMEs allowing them: to model and adapt in their organisations particular business scenarios requested by their customers and suppliers; to integrate all their enterprise applications following a service-oriented architecture; and to incorporate legal, economical and social services offered by external organizations, with the overall goal of facilitating the participation of SMEs, especially those coming from the New Member States, in European e-Business scenarios. The e-business platform will be validated in the Construction and Building Industry Sector taking as reference several cases executed in 4 different European Countries.

The first main outcome of the project will be a specific *SME-oriented e-business Model* where the structure of the companies, its activities, processes, information, resources, actors involved, behaviour, goals and constraints of the business, will be formally described by a set of ontologies.

The second main outcome of the project will be a semantically enriched web service-oriented architecture, providing modularity and integrability.

The following figure shows the global architecture proposed and the principal actors that could take place in a trading scenario: suppliers, customers other collaborating SMEs, legal and financial organizations, public administrations, construction clusters, associations, etc. The figure also shows the

way in which all the internal processes of the SME and the external organizations offer their services to the business environment. An SMEs e-business ontology will define the way all these services, both internal and external, will be used to contribute to particularise specific e-business scenarios.

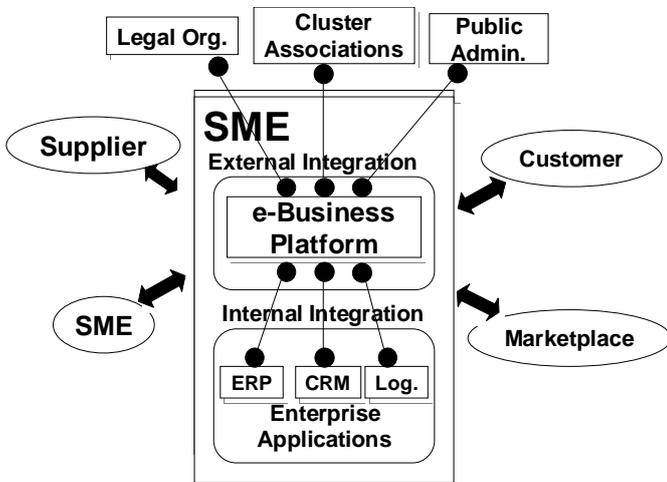


Figure 2 e-Business global architecture

External Services

This type of services will enable SMEs to incorporate legal, social-cultural aspects of the region, economic and trust aspects in their businesses. Some examples could be:

- Certification Bodies providing services to certificate a specific product or process.
- Financial Entities providing services guaranteeing the financial solvency of a company.
- SMEs Associations providing services informing and helping SME about international regulations and quality certifications needed in a foreign country.

Internal Services

This type of services will facilitate to the SMEs the integration of the most common enterprise applications. Some examples could be:

- Enterprise Resource Planning
- Customer Relation Management
- Knowledge Management Systems
- Logistics

Both Internal and External Services will be developed supporting semantic reasoning capabilities to allow SMEs of this platform interoperable and drive future advance forms of collaborative e-business.

3.2 Approach and Methodology

There are many different ways to approach the definition and implementation of an e-business platform and to define the business process.

- **Standardisation:** define standards for everything in the e-business area (from business processes, document transfer and messaging, data model and so on). E.g. ebXML, RossetaNet of WebServices and BPEL.
- **From a functionality point of view:** Try to define the generic functionality of the e-business platform. Usually this platforms make use of the standards being defined. (Many B2B commercial platforms)
- **Define standard processes in one sector,** generally from the point of view of the big companies in that business sector. (RossetaNEt is one example)

None of the above approaches take into account the valuable contribution of the SMEs to the definition of e-business processes and platform. However, the existence of *real-world services* (transactions) it's a well-known fact by these SMEs. But what they understand by services are not necessary software-based services, which differ significantly from the *Web Services* conception made by the ICTs, usually defined as software functionality accessible and configurable over the Web. Such a view (the technological) is very important but also incomplete because current Web Services ignore significant elements of the service context, that is the business itself and its surroundings.

It is just this consideration what has motivated the e-NVISION Consortium to do a *bottom-up approach* research from the construction SMEs standpoint to a complete infrastructure definition of a collaborative SMEs trading lifecycle scenario over the (Semantic) Web.

At this stage of the project, we are placed at the *bottom* side of this approach. Several business processes of a particular construction work have been described by the partners involved in it. And from those the four most relevant ones have been selected and are now being analyzed in more detail by the SMEs in order to provide the first draft of what will be the SME-oriented e-business model.

The SMEs are playing the leading role in this business analysis but always in short collaboration with the ICTs and RTDs in order to provide to this business analysis an also important technical view.

This technical approach will try to work as an implementer of today's Web Service (WS), Semantic Web Service (SWS) approaches, methods, techniques, standards and so on that are too complex to be understood by SMEs themselves.

Afterwards, these scenarios will be unified and finally envisioned in order to develop a formal SME-oriented e-Business Model for future B2B construction scenarios.

It is important to point out that these business scenarios include not only the external interaction, but also the internal workflow and even interactions with external agents not included in the Supply Chain (E.g. External Quality Certification Services or Regulation Providers). This approach will allow us to get a holistic view about the processes, not only the B2B view.

3.3 Business Model Definition Approach

A **Business Model** is defined as “*a viewpoint on the business and its environment that focuses on the scope and goals of the business, and the terminology, resources, facts, roles, policies, rules, processes, organizations, locations, and events of concern to the business. The Business Model is a model of the business in its environment, by the business, in the language of business people, for business (not necessary IT) purposes*” (Stan Hendryx, 2003)

It is clear from the above definition that the Business Models may include parts of the business that are not subject to automation but are also interesting to those who design and build the IT system.

As stated before, one of the main purposes of this project is the definition of a *SME oriented e-business model in the Construction and Building Sector*, in order to define it a UML-modelling approach has been initially chosen. As a consequence, the current Business Models defined by the SMEs are represented with UML diagrams.

The Unified Modeling Language (UML) is the industry-standard language for specifying, visualizing, constructing, and documenting the artifacts of *software systems*, and was designed with these primary purposes in mind:

- Process modelling with use cases
- Class and object modelling
- Component modelling
- Distribution and deployment modelling

Although the UML was initially designed to model software systems, it is a generic modelling language that can be applied to any kind of system. In fact,

some UML extensions have been defined in order to model business processes, for example the **UML extension** defined by Hans-Erik Eriksson and Magnus Penker. (Eriksson Hans-Erik, 2000)

In this project we are using the following UML diagrams:

- **Use Case Diagram.** They visualize the relationships between actors and use cases. Use cases represent the functionality of a system.
- **Sequence Diagrams.** They show object interaction arranged in a time sequence. It provides a time ordering of the messages
- **Activity Diagram.** They show the procedural flow of control between two or more class objects, while processing an activity.
- **UML extension** defined by Hans-Erik Eriksson and Magnus Penker to model business processes. See document “The Business Process Model”, by Geoffrey Sparks (Sparks Geoffrey, 2000) explaining how to use this extension. In order to elaborate these diagrams a UML extension is need. We think that these diagrams provide a more understandable vision about the processes that govern what the business does: events, input, output, goals, sources, etc.

UML is been used in this project just as a mean to formalize the SMEs process descriptions and make them understandable by the ICTs. The next step will be to transform the UML diagrams into ontologies that can be used to make the process models more flexible.

Ontologies have gained acceptance within the research community as the way to make applications interoperable and drive the next intelligent generation of the World Wide Web known as the Semantic Web that many consider as a future enabler of future advance forms of collaborative e-business. Moreover, this model can be both descriptive and definitional trying to distinguish what is and what should be, that is, what is the current scenario and what is the envisioning one.

3.4 Particular Case: e-Procurement

The procurement process is one of those four relevant scenarios selected and being at this moment analyzed by the SMEs and ICTs.

Summarizing, this process consist in the establishment of different kind of cooperation between the agents involved in order to satisfactory

marshalling machines and delivering material on time to a construction work. The agents involved are: the Project Management Company (PMC), who is the leader of the whole process; the Investor, who approves most of the actions; General Designer who elaborates Technical part of the inquiry and validates the Technical Part of the quotations and the suppliers, which are in general SMEs subcontracted by the PMC or directly by the Investor depending on the type of contract signed between PMC and Investor.

In this analysis is very important to isolate as far as possible this process. That is, be able to identify the tasks that affect this process but are not part of it and the tasks that are part intrinsic of it in order to define the specific SME-oriented e-business model per each of these processes.

The following diagram shows the tasks identified as part of the procurement process.

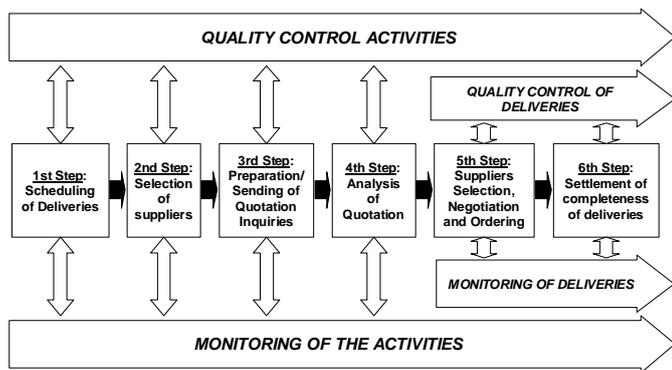


Figure 3 Task decomposition of the procurement process from the point of view of the PMC

Using the “Business Process Model” UML extension it is possible to add some context information to the business process definition. The Figure 4 shows an example of one of the steps in the e-procurement process (which is, in fact, another sub-process itself) from the point of view of the supplier company. It is possible to specify the inputs (and the actors who provide the inputs), outputs, goal, resources, and internal applications or systems that need to be accessed to get information (like the ERP or a Customer Database). In this diagram the internal workflow of the process is hidden.

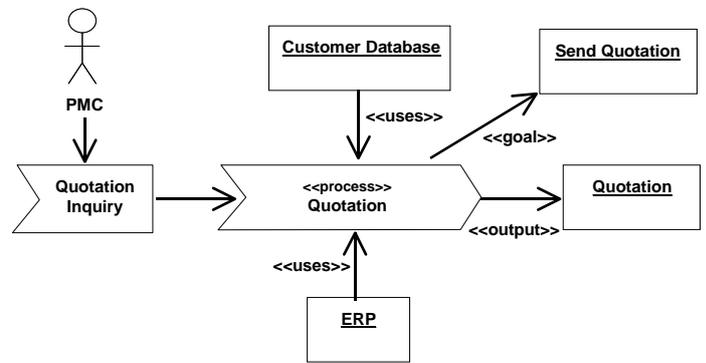


Figure 4 Sub-process context description using “The Business Process Model” (“Send quotation” from the point of view of the supplier)

Once you have defined the process context it is possible to use other diagrams to express the internal workflow of the process, the sequence diagram or the activity diagram. By using these diagrams new actors, interactions or systems can appear, like for example the Certification Body.

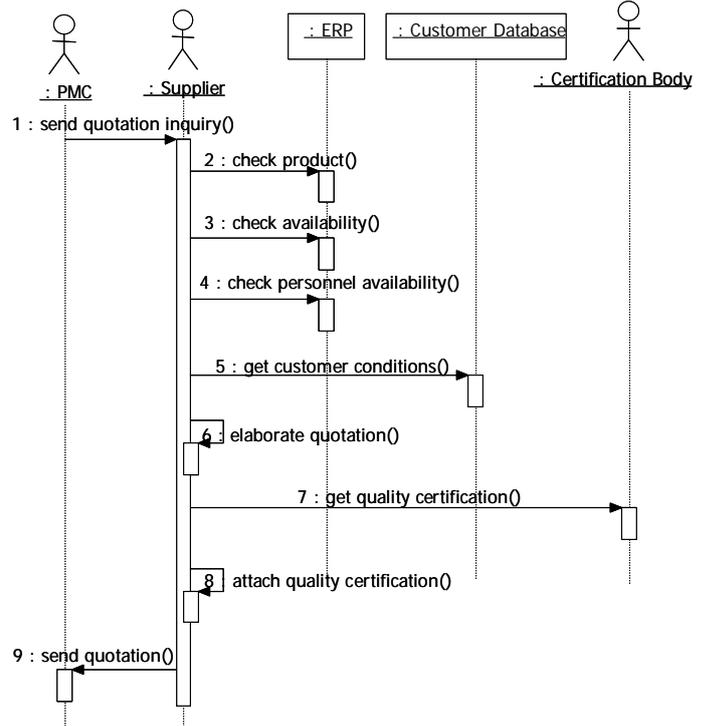


Figure 5 Send quotation process sequence diagram (supplier point of view)

This sequence diagram shows clearly how the definition of an internal process can lead us to discover business processes, internal services and even contextual or external services (Quality Certification).

4 CONCLUSIONS AND OPEN ISSUES

Since this article describes an on-going work it is still too soon to draw definitive conclusions. However, taking into account the work done until now, some general conclusions can be outlined.

The construction sector lag behind other sectors regarding ICT uptake and e-business adoption.

It has no sense to talk about construction SMEs in general, because they differ a lot in ICT and e-business adoption and also in the kind of business processes they conduct. Hence, it has been identified an initial construction SMEs classification: “Project based” companies and “supplier” companies. This second group can also be divided into “services provider companies” and “product provider companies”.

The envisioning scenarios for the future include not only the supply-chain actors, but also other external actors, as regulation providers, quality certification bodies, and so on (“external services”). Also the integration with the internal applications is considered in order to have an holistic view of the business processes.

The future business platform should describe the services using a semantic Web approach, taking into consideration the technical and business view points. This will allow in the future to discover the services needed in real time, making the business platform adaptable and completely independent of the technical details of the service providers.

There are still some open questions that affect the future e-business evolution in the construction sector. What business standard or approach will be successful in the long term, if any?, What will be the effect of having more automated and open e-procurement tools for the SMEs in construction?, What about the standardization efforts related to design documentation in construction (as IFC)?

The e-NVISION project will hopefully provide answers to some of these questions.

5 ACKNOWLEDGEMENTS

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