E-CONTRACTING FOR SMEs THROUGH AN ENGINEERING E-HUB

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SUMMARY: *This paper presents an e-engineering contracting system developed for Small and Medium-sized Enterprises (SMEs) by the EU funded e-HUBs project ("e-Engineering enabled by Holonomic and Universal Broker Services", IST-2001-34031). As a dedicated service within the Business to Business (B2B) arena, the engineering e-Hub is designed to facilitate the outsourcing of engineering services. The project developed a transparent, online collaborative project preparation and contracting workspace to enforce process and knowledge modelling, sharing and configuration, online contracting, and trust building. It lowers the major barriers that prevent SMEs from entering e-Business.*

KEYWORDS: *collaborative project planning, e-Hub, online contracting systems, SMEs*

1. INTRODUCTION

Small and Medium-sized Enterprises (SMEs) are considered as the backbone of the European economy, as well as a key source of jobs (i.e. accounting for approximately 66% of private employment and 57% of value added business in the EU; EC, 2005) and a breeding ground for the knowledge-based economy (e-HUBS, 2001). Flexible integration of resources and engineering collaboration by SMEs is expected to facilitate the strengthening of their competitive position in the global market through the acquisition of a critical mass in terms of necessary skills, capabilities and capacities. Recent surveys also show a great willingness by large companies to consider the outsourcing of non-core competency tasks to specialised SMEs.

However, the partnerships that SMEs are often involved in are typically created 'on-the-fly', rather than representing the "extended enterprise" model. Ad-hoc partnering in project specific, dynamic settings provides the agility that long-term, strategic alliance-based partnering cannot guarantee. Efficient integration of engineering services, on an ad-hoc basis, into engineering projects is of strategic importance for SMEs. These realisations have led SMEs to look for support to initiate and plan partnerships that are remote, time-critical and volatile. Such partnerships necessitate a new generation of contracting methodologies and services; a key enabler for the sustainable development of SMEs.

The emergence of engineering e-Hubs is expected to change the traditional approach towards marketing, business transactions and collaboration among clients and service providers. By taking advantage of the e-Hubs' services, SMEs will have more opportunities than ever before. To ensure the success of transactions, e-Hubs must devote considerable effort to contracting services and legal support so that users are confident about the new approach to working, which could lead to more trust and, hence, improved business relationships. To build an effective online contracting system for SMEs a deep analysis of the specific content and subjects of contracts is required, as well as an analysis of the procedures that are used to generate them.

This paper first reviews the problems, particularly legal- and contractual-related, facing SMEs in e-Business, before reviewing the general contracting solutions provided by various e-Hubs. It then presents the functional architecture of the engineering e-Hub and its engineering services. A testbed is demonstrated for the application of the engineering e-Hub. Finally, conclusions are drawn based on the study.

2. CONTRACTUAL PROBLEMS FACING SMES IN E-BUSINESS

A recent survey conducted in another EU funded project, SEEMseed (IST-1-502515-STP), has revealed some general problems facing SMEs in e-Business in Europe (UNINOVA, 2004). The principal results, essentially related to legal and contractual issues, are summarised below:

1. SMEs and e-Business

- There are 23 million SMEs in the EU, a key driver for economic growth, productivity increase and job creation;
- Particular attention should be paid to ensure that SMEs can obtain fluid connectivity at a similar level as large organisations;
- Broadband implementation should be increased, providing access for SMEs and enabling other organisations to obtain data from/provide data to SMEs;
- There is a need to consolidate standards for commerce and trading in order to ensure SME inclusion; and
- There are no specific provisions for supporting SMEs. Addressing the legal issues and contracting systems (such as trust and confidence, alternative dispute resolution and compensation) will provide a user-friendly environment for SMEs.

2. Key Legal & Regulatory issues inhibiting e-Business

- The principal inhibitors are now related to implementation, business and cultural barriers, mainly in cross-border trading such as contracts, jurisdiction and disputes resolution methods between countries; and
- Lack of trust and confidence due to the above problems are the key problems.

3. Key Business issues inhibiting e-Business

- Businesses still employ traditional business models, with traditional, strong players defending them. There are still difficulties with cross-border payment, and excessive transport costs; and
- SMEs are a key part of the supply chain, but they are still not fully prepared for e-Business. Also, many organisations still consider SMEs as ‘second order priority’ partners in a supply chain, reducing the viability of new business models.

4. Key Social/Cultural issues inhibiting e-Business

- Language is a major barrier, leading to reluctance to offer services in other countries, especially for SMEs;
- There is a significant lack of trust and confidence – but not only from a technical perspective – with SMEs not believing that an Internet order will be fulfilled; and
- Organisations are not aware of/do not care or dare to extend business across borders. They find it easier/are more secure trading within their legal environment, particularly for SMEs, and are often reluctant to offer cross-border services.

5. Technical issues inhibiting e-Business

- There is a lack of standard tools for the exchange of services and knowledge;
- There is a recognised need to establish normative processes for information access and exchange and for internationally agreed service-oriented architectures;
- Appropriate skills are available, but are not being adopted into business models; and
- e-Business is ready at a component level, but the system level is missing.

These results are supported by other SMEs studies. For example, Posthumus[1], Sakai[2] and Questel[3] summarise the major barriers for SMEs in e-Business as:

- lack of affordable, easy to use, and standard eBusiness infrastructure;
- few solutions tailored to the needs of specific sectors and regions;
- lack of solutions 'speaking' to others (i.e. interoperability);
- lack of trust and confidence;
- lack of necessary knowledge and skills; and
- lack of legal and regulatory support.

To remove these barriers, suggestions have been made on three major aspects: strengthening e-Business infrastructure (e.g. network and interoperability), clarifying marketplace rules (e.g. legal and commercial frameworks, financial issues and taxation and intellectual property protection) and building user confidence (e.g. security, privacy and consumer protection concerns). Studies (e.g. Shevchenko, 2002[4]) particularly emphasise the necessity for building a new generation of online contracting systems for SMEs, which should be tailored to address the major problems identified above (e.g. entrance costs, trust building, usability).

The e-HUBs project targets the conceptual development and implementation of a novel concept for the realisation of distant engineering collaboration of SMEs by offering transparent templates that enable the collaborative generation of project plans and service contracts. The introduction of the e-Hub into engineering partnerships lowers the barriers to the integration of SMEs into a dynamic global economy and facilitates the formation of new, advanced SMEs. Unlike other e-Hubs, the engineering e-Hub provides SMEs with an online contracting system, along with a platform for collaborative Project Planning (PP), which provides a firm basis for the engineering outsource contract.

3. ONLINE CONTRACTING SYSTEMS IN E-HUBS

e-Hubs are neutral, Internet-based intermediaries that focus on specific vertical industry sectors or specific business processes, host electronic marketplaces, and use various market-making mechanisms to mediate any-to-any transactions among businesses. e-Hubs create value by aggregating buyers and sellers, creating marketplace liquidity, and reducing transaction costs (Kaplan and Sawhney, 1999). Generally, there are two kinds of contract signed through e-Hubs; contracts built through tendering between or among competitors, and contracts signed through negotiation between or among providers and customers.

3.1 Agreements with Competitors

This kind of contract is built through auction or tendering (often used in Business to Customer, B2C), which normally contains two main components:

- First, the general contract conditions specify users' rights and responsibilities and rules for conducting business, and form the essential conditions and requirements of the contract. Most of such e-Hubs point users to the legal and contractual systems adopted for the service, and force users to knowingly accept it when they register in the system. These legal and contractual conditions are expressed either in the form of General Terms and Conditions or in particular legal statements (e.g. definitions, trade rules, services scope, fees and charges, compliance with laws, liabilities, etc.). Users have to accept these clauses as a condition of tender.
- Second, the item to be auctioned specifies the particular content of the contract. This section includes the detailed descriptions of the bidding items such as product model, features, description, photos, the final price agreed by the buyer, and payment and delivery approach agreed by both parties.

[1] http://www.excen.jalusta.com/files/download/eden_posthumus.pdf
[2] http://www.ecommerce.or.th/APEC-Workshop2002/ppt/slide/sakai7.pdf
[3] http://www.ecommerce.gov.tt/workshop/Session_Two/01_Quinten_Questel.pdf
[4] http://europa.eu.int/comm/enterprise/enterprise_policy/analysis/observatory.htm
http://www.the-sme.co.uk/whoare.html
http://www.oecd-istanbul2004.org/practical_info.htm

The contracts among competitors are normally legally binding unless some anticompetitive effect can be demonstrated, and are generally formal in nature. They are more likely to be embodied in specific contracts, rather than inferred from discussions, so there is less risk of ambiguity or misunderstanding. Some of the agreements which can raise legal questions are addressed in the general conditions such as exclusive dealing, requirement contracts, preferential treatment, or resale price restrictions.

eBay is a typical e-Hub adopting such a contracting system. eBay provides a series of standard contract clauses; it is the users' responsibility to understand the legal and contractual terms before they make a bid. Once a buyer wins an item, s\he is naturally bound with the seller by the contract based on: 1) the pre-contract conditions stated by eBay, 2) all the information listed by the seller to describe the item, 3) the winning price, and 4) the payment and delivery approach negotiated and agreed by both parties. To secure the contract, eBay also provides additional services such as reliable payment and delivery approaches, third party Dispute Resolution services, a dedicated Trust and Safety Team or a Buyer Protection Programme.

3.2 Agreements with Providers and Customers

This kind of contract is normally formed through negotiations between provider and customer in complex situations such as outsourcing of services, procurement of large goods or collaboration among partners in virtual enterprises. Users are normally enterprises rather than individuals. Negotiation is the key to this approach. It starts with an initial contract provided by e-Hubs or recommended by users. Based on the contract, customers and providers negotiate the details of the contract, which covers all the details of services or goods and the contract clauses.

Unlike the first kind of contract, where users only need to address very few items (often just the price), the agreements with suppliers and customers are designed to deal with complex situations, typically for engineering services outsourcing. This online contracting system requires a much clearer expression of contract clauses and responsibilities due to the complex contracting issues involved; it also requires the users to have good control of the contract content, format, authority and security. It is crucial for such online contracting system that no participant can influence the business domain of the others, and that an independent trusted third-party service is involved.

The design of an e-engineering online contracting system has to deal with all the engineering issues that may create a liability. The contractual issues involved in the engineering outsourcing process are much more complex than those involved in buying or selling products or general business services. To build such an online contracting system, a deep analysis of specific contents of actual contracts is required, as well as an analysis of the procedures to be applied. Thus, a conceptual framework for contractual practice, the specific contents and the subject of a particular contracting situation need to be carefully defined in order to select suitable and effective data modelling.

One example of an online contracting system built for such a contract is the eLEGAL contract editor[5]. eLEGAL concentrates on automating contracting processes related to the use of ICT in the construction industry. It developed a framework for specifying legal conditions and contracts to enable a legally admissible (exclusive) use of ICT in project-based business. The contract editor developed in eLEGAL has great potential for adoption during engineering outsourcing contract negotiation. Covisint[6] and SEEMseed[7] are e-Hubs that offer general business and engineering services, and can thus provide such online contracting systems.

A major drawback of existing online contracting systems is that they are developed for general e-business (B2B and B2C, and predominantly for commerce), rather than having been tailored for engineering outsourcing (e.g. eLEGAL) or for SMEs (e.g. Covisint). On the other hand, SMEs are particularly vulnerable to legal, contractual, trust and security problems in e-Business due to the lack of resources, knowledge, technology support and cultural barriers. Online contracting systems for SMEs should particularly address all these problems and provide SMEs with a simple, neutral, transparent and traceable environment for online contracting. The e-HUBs project (e-HUBs, 2001) also highlights the importance of online contracting systems integrating engineering service negotiation with the contract negotiation for SMEs. Finally, the online contracting systems should

[5] http://cic.vtt.fi/projects/elegal/public.html
[6] http://www.covisint.com
[7] http://www.seemseed.net/default.aspx

provide legal and contractual support to SMEs during contract execution (e.g. litigation, disputes resolution and compensation) (Ren *et al*., 2003). The engineering e-Hub was developed to meet such requirements.

4. THE ENGINEERING E-HUB

The project developed a functional architecture for the development of collaborative PP and contract negotiation for SMEs. It adopts a well-balanced approach, reflecting attention to business, technical and human elements in the deployment of the services. In particular, this responds to the recognition that current, technology-heavy solutions are not well balanced, and are failing as a consequence of this. Particular emphasis is given to how the system could best serve SMEs. The most advanced technologies for Internet-based communication and collaborative e-engineering form the core of the e-Hub. On top of this, incremental layers of additional services are built. Each service system offers dedicated e-engineering functions at increasing subsystem scales. The e-Hub is configurable by offering transparent collaboration templates to each of these systems.

4.1 Functional Architecture of the e-Hub

Supported by Web-based engineering services, provided by Engineering Service Providers (ESP), the e-Hub provides a generic collaboration and negotiation platform allowing users to define, plan and negotiate various engineering and contractual issues during the collaborative project preparation stage (Fig. 1). In the e-Hub, collaborative PP is regarded as an integrated part of the online contracting process. The purpose is to help SMEs address the essential engineering service issues clearly, and therefore eliminate potential problems in the contract caused by ambiguous engineering issues. This has been identified as a major contributor to the difficulties of SMEs involved in engineering outsource contracts (e-HUBs, 2001), and it is therefore vital to include an appropriate collaborative PP function for SMEs.

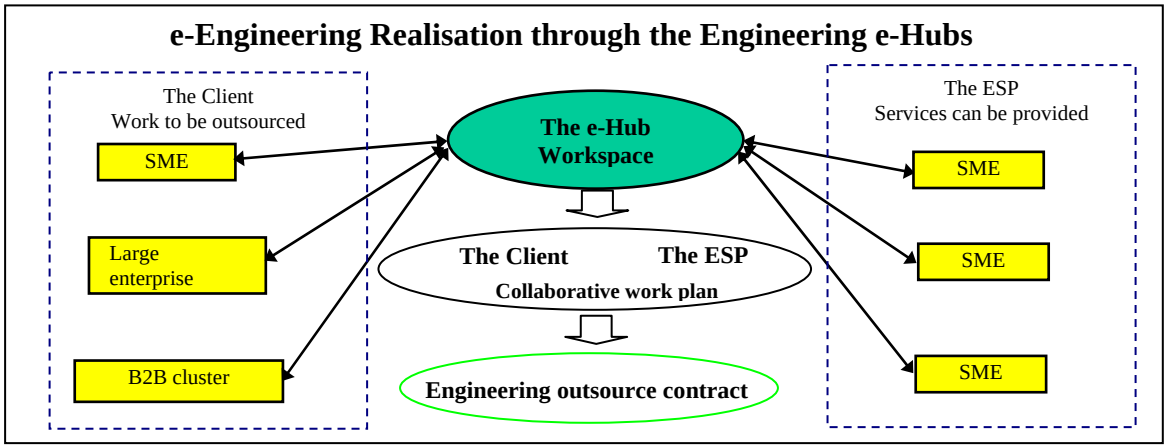


FIG. 1: The collaborative/intermediating role of the e-Hub

4.1.1 Theoretical Basis of Collaborative Project Planning

PP is paramount for successful project management; the basic methodology for PP is well known, proven by years of experience, and supported by many well-developed tools. Some of the important characteristics of PP can be summarised as (PMI, 2000): PP is structured and predictable; there are generic steps/parts of PP; also, the logic of PP is deterministic. PP is comparable in each particular project type. A Project Planning Model (PPM) was developed based on these characteristics, and forms the basis of the e-Hub's functional architecture. Three fundamental issues have to be addressed when studying collaborative PP:

The content of a project plan*:* The objective of classic PP is to define project scope, timeframe, budget and other key issues of project. With visible targets and constraints, PP defines a set of formal subtasks providing optimal resource allocation, and control and management of issues related to various aspects of a project. As a result, a number of sub work plans are generated at different stages, such as project summary, project charter and general scope statements, work breakdown structure, schedule, estimated cost, resource plan, delivery plan, risk plan, and quality plan. As most of these plans have predictable and generic components, various templates e.g.[8]

[8] http://www.dis.wa.gov/pmframework/templates.htm

have been developed to summarise the contents of each plan. Also, standards institutions, agencies, and large corporations often have their own well-defined formal document templates to address these plans. By adopting these templates, users – even those not experts in project planning – are able to address the key issues of a project plan.

Process of project planning*:* PP normally has two main phases; preliminary planning (process to generate expression of interest, draft of a business plan, analysis of technical feasibility or potential deliverables) and detailed planning (in-depth study to create plans for process quality, finance management, quality assurance, and time-line scheduling). The PMBOK (PMI, 2000) classifies PP as c*ore processes* (e.g. scope planning, activity definition, schedule development, resource planning, and cost estimating) *and facilitating processes* (e.g. quality planning, communication planning, and risk planning). The core PP processes have clear inter-dependencies and are thus generally performed in the same order in the majority of projects, while the facilitating processes are dependent on the nature and structure of the project. Such general PP processes are considered as generic and structured. Based on these theoretical studies, a generic PPM for engineering service outsource projects has been developed. By following the PPM, and using related attribute templates, SMEs are able to define and negotiate the details of the engineering services.

PP dedicated collaboration*:* PP offers an opportunity for project participants to share and balance their objectives, resources, expertise and constraints. PP generally has a form of iterative loop, or of a dialogue, in which client's requirements and provider's proposals are continuously discussed and gradually refined. Clients, usually have problems with clarification of what is possible and what is desirable to expect from the project in return for invested resources, while providers want to balance available resources and expected efforts, associated with fulfilment of a client's requirements. The generic PPM provides structured guidelines for SMEs to collaborate, detailing what should be defined at which stage.

4.1.2 Functional Architecture

Collaborative PP is viewed by the e-Hub as a managed process that transparently generates a set of comprehensive planning documents that may contain both structured models and unstructured documents. The added value of the e-Hub is that the generation process is collaborative in nature and logically ordered, driven by structured content exchange. These aspects are embodied in a formal PPM that companies develop and agree on at the strategic and international trade level. This represents the business intelligence of "how companies want to engage in remote partnerships". The PPM is not one single model, but a collection of models. Each of these models consists of a PP process model, represented by workflow models (WFM) that incorporate the coordination logic of how project planners negotiate and reach resolutions for the aspects that need to be tactically agreed (Augenbroe, 2004). Each WFM is based on one or more content templates. The key aspects of the functional architecture are summarised as follows:

- A Basic Collaboration Platform (BCP) forms the essential platform of the e-Hub[9]. The BCP offers various basic collaboration functions such as: user management, collaboration features, document management, security, etc., with the interface provided in various local languages. In addition to these fundamental functions, the BCP also provides some advanced engineering services such as a PP whiteboard, workflow configuration and runtime environments, as well as an annotation function which allows users to mark and track all changes and the reasons for changes made by project participants during the collaborative PP definition and contract negotiation processes.
- A WFM is adopted to facilitate the project definition, planning and contract negotiation process. The WFM is a dedicated process management tool, which controls who has read or write access to each field by defining the rules, routes, roles, processes, policies and practices in a process. A Workflow Management System supports the specification, execution, and dynamic control of workflows involving humans and information systems. All parts of the PPM are grouped in "packages", each of which may contain a set of (sub) process models. Each process model is defined as a WFM that adheres to the Workflow Management Coalition standard (WfMC, 2000). In the PP platform of the e-Hub the workflow models are enacted, initiated by the project planners. These workflows are embedded in the BCP as a generic PP process template. The enactment of the

http://michigan.gov/dit/0,1607,7-139-18391_22016-58009--,00.html
http://www.cio-dpi.gc.ca/emf-cag/ppto-gtpss/projplantemplate/ppt-mpptb_e.asp

[9] http://elf.eurodyn.com:8080/edos/index.do

workflows guides users through the key project definition, planning and contracting stages. Meanwhile, a generic negotiation workflow, embedded in the BCP, leads users through the general negotiation process.

- Besides the generic PP process workflow, various attribute templates (i.e. an ordered set of fields with specific meaning) for each of the project plans have been developed and embedded in the e-Hub. These templates, based on both theoretical studies (e.g. PMI, 2000; University of Salford, 1998) and industrial scenarios (Ren et al., 2003), include all the key elements that engineering outsource project plans should cover. The negotiations between a Client and ESPs regarding project plans and contracts address the attributes specified in the templates. These templates are also the basis for the development of the sub-workflows.
- Finally, the execution of the PP workflow requires certain supporting engineering services to be implemented in, or deployed in co-existence with, the e-Hub. For example, in the seismic engineering testbed, a spread sheet is used to facilitate the execution of cost estimation workflow; GanttProject[10] is adopted to facilitate the enactment of scheduling workflow; and, in particular, the eLEGAL Contract Editor is used as an e-contracting platform for the contract negotiation workflow (Augenbroe et al., 2004).

Fig. 2 illustrates the generic model of the functional architecture. Fig. 3 shows a specific model of the functional architecture based on the generic model in the e-HUBs project.

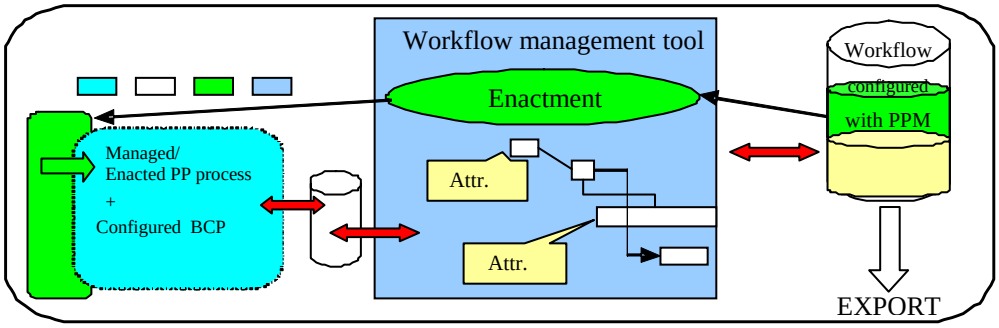


FIG. 2: Generic functional architecture model of the e-Hub

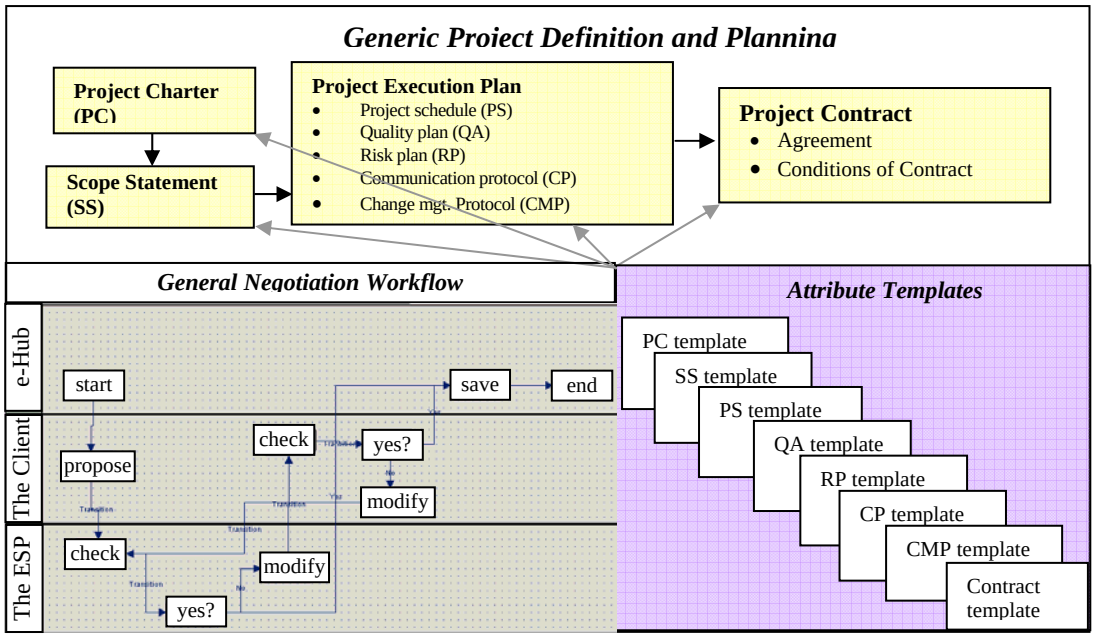


FIG. 3: An example of functional architecture (Ren et al., 2004)

[10] http://ganttproject.sourceforge.net/

4.2 Contract Negotiation

Based on the defined work plan, the e-Hub facilitates contract negotiation between client and ESPs. By adopting the developed functional architecture, the e-Hub provides the contract negotiation process model and essential engineering service contract templates covering the key issues of engineering services in each particular engineering field. The enactment of the contract negotiation workflow leads users through the key steps of contract negotiation and specifies the details of the contractual and legal issues. The contract negotiation is mainly concerned with two aspects:

- **Agreement:** The agreement covers the key features of the particular type of engineering service contract, including general work description, activities to perform, expected outcome, overall contract value, project schedule and milestones, payment terms, applicable laws and attachments. The collaborative project plans developed at the early stage are also attached to the agreement. The e-Hub provides various agreement templates to suit different application situations.
- **Conditions of Contract***:* The Conditions of Contract further specify the contract, particularly those complex but general issues such as general responsibilities and authorities, legal frameworks, claims and dispute resolution, collaboration support, suspension and termination, defective work, and defect liability. Similarly, the e-Hub provides several standard Conditions of Contract commonly adopted in different industries. Users can select and modify the clauses in the standard Conditions of Contract according to the particular project requirements.

There are two particular advantages of this approach:

- The agreement template highlights the key contractual issues for each particular engineering service outsourcing situation so that users can finalise all the key issues before they sign the contract.
- The collaborative work statements generated through previous workflows are integrated into the agreement template, which provides a sound basis for the service outsource contract.

5. APPLICATION

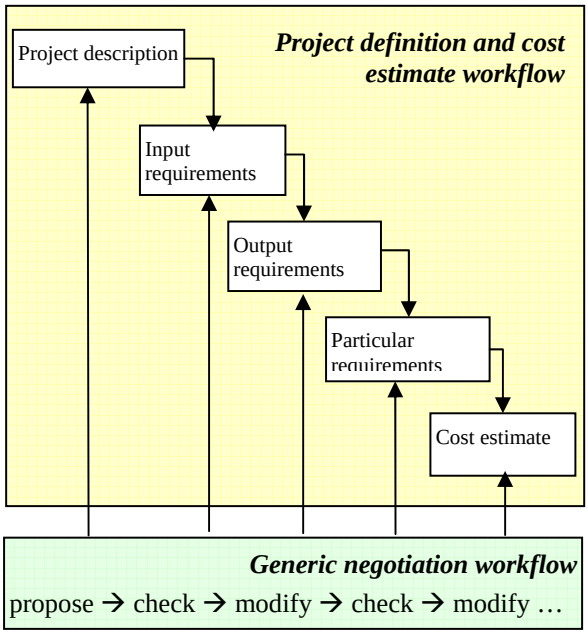
The e-Hub concept has been tested in construction and manufacturing testbeds. These SME driven testbeds demonstrated how SMEs, by taking advantage of the e-Hub's services, can gain contracts for large enterprises' non-core engineering work. In the construction testbed, Geodeco (a consulting company based in Italy specialised in geotechnical, geo-seismic, geo-environmental and earthquake engineering) provides engineering services to a Dutch design firm that is seeking advice on seismic risk assessment for a paper mill through a Web Portal (the eRiskZone portal[11]).

Three key project preparation stages have been identified in the seismic engineering scenario: (1) initial project brief and cost estimate, (2) project execution plan definition and (3) contract negotiation. Accordingly, three workflows and related attribute templates are defined with each representing a key phase of the PP process.

- **Workflow 1**: This workflow defines the process of preliminary project definition and initial project cost estimation. This process extends the project participants' hand-shaking process conducted in the eRiskZone portal. Based on their previous discussion in the portal, project participants further define the project and negotiate the most important element for cooperation (i.e. the cost for service) in the e-Hub platform.

Fig. 4 illustrates this collaborative project definition process. A generic negotiation workflow is embedded in this workflow, which allows users to negotiate each project definition item. The figure also lists the attributes to be negotiated in the negotiation workflow, which are summarised from Client/Geodeco industrial experience.

[11] http://81.74.125.197:8080/jportal/portal



Item	Attributes to address
Project description	• Project ID • Project title • Project description • …
Input requirements	• Input ID • Input items • Input description • Level of requirements • …
Output requirements	• Deliverable ID • Deliverable items • Deliverable description • Type of service • Level of service • …
Method/ resource/ quality of the work	Particular requirements? • …
Cost estimate	• Cost system • Amount • Payment approach • Liquidated damages • …

FIG. 4: Project description and cost estimate WF

- **Workflow 2**: After both parties reach an agreement on the essential project definition and initial cost estimate, they – together with other partners – enter a stage to define various detailed project work statements. These work statements address the most important collaborative issues for the execution of the project. In this scenario, the project schedule is particularly important for the Client; therefore the related workflow and attribute template are fully developed and implemented.
- **Workflow** 3: After defining the collaborative work plans, the Client and Geodeco enter the contract negotiation stage (Fig. 5). An agreement template was developed based on standard engineering service outsourcing contracts. A contract negotiation workflow was then developed to facilitate the negotiation of the key contract items in the agreement template. In this case, there are four key items (i.e. no. of test samples, final service cost, liquidated damages, and governing laws) to be addressed in the agreement template; the contract negotiation workflow guides the negotiations between the Client and Geodeco through these items step by step. The items agreed by both parties are inserted into the 'right place' in the agreement template, which is stored in the eRiskZone database.

Meanwhile, the eLEGAL contract editor (URL7) provides another comprehensive contract negotiation tool. Contract negotiations conducted using the contract editor are tightly integrated with the e-Hub workflow. Guided by the contract negotiation workflow, the contract editor provides both offline and online contract negotiation platforms. In this example, the contract editor is mainly used to negotiate the Conditions of Contract, which often involves complex contract clauses to be specified in workflows. A Conditions of Contract template for engineering services has been developed, which is stored in the eRiskZone database and linked with the contract editor.

6. EVALUATION AND DISCUSSION

The e-Hub prototypes (URL13) have been evaluated using various approaches: internal evaluation by the development team, expert clinics, virtual interviews and online demonstrators (Crehan, 2003; Crehan, 2004; Baessler et al., 2004). Four aspects (i.e. fitness, usability, utility and business impact) have been evaluated.

6.1 Fitness

A simple ratio of available features to desired features in the e-Hub was used to evaluate the fitness of the e-Hub. The list contained a total of 118 features (see D2.1), which were classified into three main categories: novel feature, supporting feature and deployment feature. The evaluation result showed that most of the required features have been implemented in the prototype (Table 1).

TABLE 1: The result of the evaluation of fitness

Feature	Novel feature	Supporting feature	Deployment feature	Overall fitness
Percentage	51%	85%	94%	65%

6.2 Usability

This evaluation focused on the usability of the novel features of the engineering e-Hub. The idea was to know if a novice user could use the e-Hub without requiring help or guidance. Before the conceptualisation of the e-Hub training manual a usability test was performed, which showed that the current version of the e-Hub prototype could hardly be used on an intuitive basis. Online help and initial training is mandatory in order to use the e-Hub prototype effectively and efficiently.

6.3 Utility

- **Future expectations and needs:** all evaluators saw the emergence of markets for e-engineering services in their domain over the next 10 years. This expectation was less from the sample not involved in product development compared to those involved in product development. This suggests that the market for e-engineering services is likely to be greater for product development-specific services.
- **Need for e-engineering services:** in the opinion of all evaluators, there was a clear need for e-engineering services in new product development. Even the sample currently not involved in product development was also more optimistic than the sample currently involved in product development.
- **Ranking of e-engineering services:** of the potential services provided by the e-Hub (i.e. (a) partner finding/selection, (b) project planning and preparation, (c) project execution, (d) project close out, (e) integration with company backend systems), evaluators involved in product development saw (e) as the most important e-engineering service followed by (c) and (b).
- **Engineering services for project preparation:** Even though the arithmetic mean of the evaluators' scores for project planning and preparation was not high, 89% of the evaluators did think that there was a potential for the provision of services dedicated to good project preparation in the domain of collaborative engineering. However, only one third agreed that the current e-Hub prototype could fulfil its potential.

6.4 Business Impact

Due to the time constraints, the business impact of the e-Hub was not fully evaluated. Nevertheless, the comments from the evaluation indicated that evaluators were convinced that the e-Hub platform would be able to support the improvement of tactical and strategic tasks of middle management to optimise whatever business goals they care to prioritise though such a result still needs to be examined carefully.

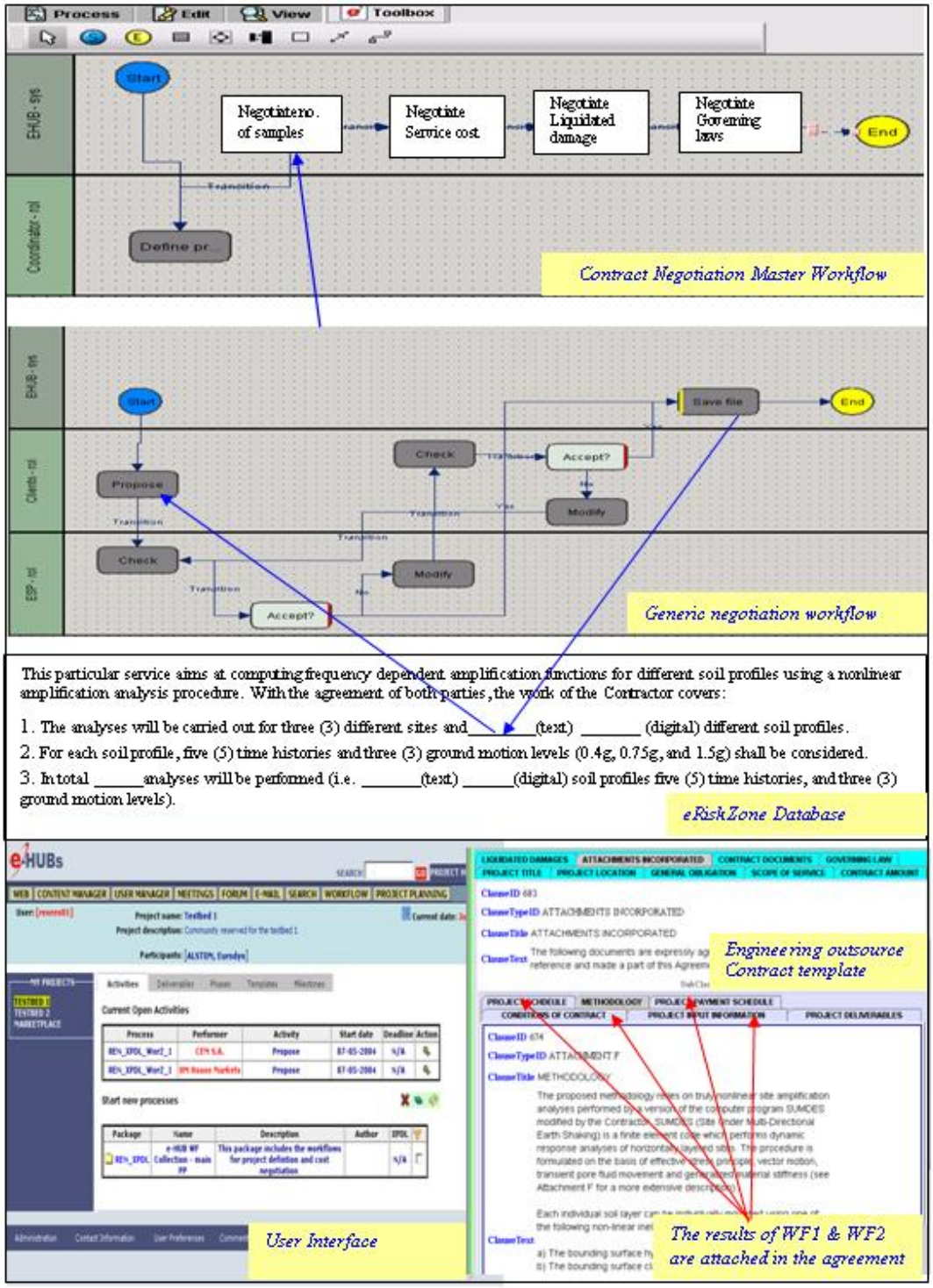


FIG. 5: Contract negotiation in the e-Hub

7. CONCLUSION

As large companies become leaner, the opportunities for dedicated SMEs are growing. However, difficulties with collaboration, legal and contractual issues and trust building remain as barriers preventing SMEs from expanding their services. The engineering e-Hub concept is a response to this, which removes these constraints in collaborative engineering. In SME dominated industries, this approach is expected to lead to a rapid uptake of ICT technologies by SMEs. Moreover, the e-Hub targets significant economies of scale advantages for SMEs. Surveys have shown that the cost of technology-heavy e-Business solutions is the biggest barrier preventing

smaller companies from entering the global e-business community. The engineering e-Hub concept removes this barrier by facilitating the engineering service outsourcing process between large enterprises and SMEs. Finally, the e-Hub is recognised as a bridge between first generation B2B services and future, sustainable forms of true B2B collaboration, involving shared enterprise processes, collaborative product development and the ultimate – but hitherto elusive – 'Virtual Enterprise'.

Despite the great benefits brought by various e-Business tools, they also bring drawbacks to contract negotiation. Extra noise unavoidably appears in the online contract negotiation process. Problems which could easily be solved through face-to-face negotiation, such as different understanding of contract terms and clauses caused by different language, culture, expertise and background, etc., could be made worse. Risks are particularly high if unclear or uncertain technical items are involved in the work plan; unclear contract clauses would lead to disputes during the project execution phase. Furthermore, SMEs often find that it is difficult to clarify some ambiguous contract clauses even in face-to-face meetings. The innovative approach developed in the e-HUBs project provides a solution to these problems.

Supported by e-engineering services, the developed e-Hub's functional architecture offers users (and in particular, SMEs) a unique workspace for collaborative project planning and contract negotiation. One particular advantage of the e-Hub is that users are able to plan the details of the work to be outsourced collaboratively, and negotiate the contract with the support of the generic PP workflow and attribute templates. It makes the e-Hub a transparent and traceable environment for collaboration. Such a functional architecture is innovative in terms of its approach to facilitating collaborative planning and contract negotiation. The generic engineering services supported by this functional architecture will enable the e-Hub to act as a universal broker to facilitate the engineering outsourcing work in different industries.

The e-Hub therefore adds innovation to the marketplace of ASP based e-services in the following areas:

- Job procurement, contracting and collaborative process facilities, including handshaking, process sharing and process mediation;
- Low entry level access for SMEs to the global marketplace for the outsourcing and fulfilment of engineering subtasks;
- Configurable e-Engineering process and contract templates, thus harnessing proven procedures for remote collaboration;
- Providing a trusted engineering gateway for SMEs;
- Supporting new organisational development in e-collaboration; and
- Consolidation of best practices, exemplified in quality assurance procedures and certification of SMEs.

The evaluation of the system revealed both the limitations and the great opportunities of the e-Hub. First of all, to fully achieve the promises of the e-Hub, the prototype needs to be further developed with consideration of the usability of the system. It also should be recognised that the low usability is not only an interface problem; it also reflects the immaturity of the overall e-Hub concept. Further development of the e-Hub should consider the integration of the collaborative project planning with the project execution process. Currently, the e-Hub concepts have been adopted in the SEEMseed project (Study, Evaluate, and Explore in the Domain of the Single Electronic European Market). As a novel concept, the engineering e-Hub needs to be implemented in more cases so that the concept could be testified and further improved.

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