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A PROPOSAL FOR KNOWLEDGE MANAGEMENT, COOPERATION AND TRAINING IN EARTHQUAKE STRUCTURAL REHABILITATION

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Abstract *The project was motivated by the increasing number of complex works of rehabilitation of buildings that require rapid and systematic access to specific knowledge. The approach was to facilitate access to proper knowledge through collaborative business networks formed by companies and research and development partners. This project aimed at: (a) providing a learning community of fundamental knowledge and an organization of tacit knowledge of SMEs and (b) allowing closer business collaboration between SMEs and R&Ds. The project planned to develop solutions based on information technology and communication that are adequate for SMEs, including knowledge sharing and training for engineers.*

1. PROJECT OVERVIEW

The project title was "Advanced Infrastructure for Knowledge Based Services for Restoring Buildings". It made part of the funding program of Theme 4 - of the 7th Framework Program of the European Commission. It is a sub-program entitled Project Collaboration Aimed at Small and Medium Enterprises (SMEs). The project had a total funding of about 1.9 M € and a total cost of about 2.6 M €. It had fifteen partners from five countries: Portugal, Italy, Germany, France and Spain. The increasing number and complex work in the Earthquake Structural Rehabilitation industry, particularly for the renovation, restoration and maintenance of buildings affected by earthquakes, often belonging to buildings of architectural and cultural heritage, suggests a systematic and sophisticated approach allowing access to advanced and knowledge about the processes and materials of Earthquake Structural Rehabilitation in this area. Innovative solutions using collaborative networks of knowledge and involving business partners, SMEs, and research and development (RD) need to be created and tested. Thus, SMEs that deal with the maintenance and repair of buildings are faced with two problems like:

a) Being able to respond to increasing demands for the implementation of the rehabilitation processes, application expertise, process technology and new materials, and ensure a high satisfaction of the work owners. All this is accompanied by pressure to reduce material and energy consumption and hence create a need for SMEs to have access to knowledge about other works and other contractors in the industry. To facilitate this ongoing access to knowledge components for application in different projects the project proposes an efficient collaboration between SMEs and RDs. Such knowledge will be of added value for purposes of learning and training. Innovative solutions in collaborative networks of knowledge are based on learning in a two-way procedure between SMEs repositories and RDs functioning.

b) Establish closer collaboration within the sector through an alliance of SMEs and RDs. This may create cooperative teams to handle complex works. Networking will ensure higher efficiency of processes and integration of services with added value for engineering rehabilitation. Solutions may support pace of economic development based on knowledge-based systems that have been developed using Information and Communication Technologies (ICT). This may be used in infrastructure, in tools and in services supporting the creation of integrated knowledge networks. Such systems need to be integrated with learning systems that must support the organization with training on topics specific to engineers and technicians. These solutions for users of ICT should be accessible, friendly and intuitive to use by SMEs in terms of cost and complexity.

2. GENERAL SPECIFICATIONS

2.1. Project Objectives

Concerning the two challenges described above the project plans to develop a solution

based on ICT with two goals: (1) knowledge and training for SMEs that are innovative and (2) support for advanced development and for ways of networking of SME–RD. The system must provide ability to share, to create and to reuse information and knowledge in an interactive fashion. To meet the needs of SMEs to network innovative knowledge-based, the project developed an electronic platform, in which the services of knowledge management was complemented by services for virtual collaborative networks (VCN).

This management of knowledge allowed an effective combination of an advanced system of provision of knowledge and training with an innovative support system of networking. It responded to the following requirements: (1) Internet-based, (2) usable by SMEs (in terms of costs investment and human resources), (3) ensuring permanent access to specific resources of knowledge and experts, (4) recording the knowledge generated through the work of rehabilitation and structuring it in formats for learning and reutilization, (5) using open formats supporting cooperation in the rehabilitation process, (6) supporting mobile users access to a structure anywhere and at any time. To achieve these objectives the proposed project included research on:

a) The methodology for creation of VCN for SME-RD, supported by a set of models and methods for creating the network and the procedures for structuring and managing knowledge, tailored specifically for SMEs.

b) Platform support, hosting a range of services to (1) manage interactions, (2) ensure knowledge management and (3) provide e-learning. The platform should allow the interactive share knowledge between SMEs and RDs within VCN.

c) All ICT services encouraging collaboration, allowing workers in SMEs to provide answers in different contexts.

d) Services of knowledge management within RD-SME networks.

e) Definition and development of adequate e-learning establishing the link between the knowledge created and used in rehabilitation projects taking into account the SME needs and level of education.

Each case study originated a contribution to a specific field of rehabilitation work in Earthquake Structural Rehabilitation, creating and using specific knowledge. The system is open for adding and structuring knowledge in all areas of rehabilitation (restoration and maintenance) of the Earthquake Structural Rehabilitation industry. The project aimed at using emerging technologies to create collaborative networks based on principles of a service-oriented architecture as an optimal approach for dealing. It was intended that the combination of e-learning and knowledge management provided the desired skills for the benefit of all and allowed the creation of innovative training.

2.2. Work Plan

The organizational structure was implemented to apply the approach of architecture-based services using the collaborative system of reference. The platform included the tasks outlined that are directly connected to the set of information related to knowledge and learning resources. The experiences of previous projects that used a similar architecture, including collaboration on the production of services were carried out for various industrial applications. The CSR combined services with the specific services of various collaborative applications to support the SME-RD teams directly in specific activities of rehabilitation.

The analysis of requirements from users indicated that these uses required different support for: (a) collaborations with different patterns with a predominance of temporal aspects: patterns synchronous, asynchronous and multi-synchronous, (b) the workplace environment in VCN, including identification experts, staff training, availability, etc.., (c) actual delivery (online) knowledge about processes and about actors, (d) effective knowledge management, (e) changes of the dynamics of collaborative work during the development process, (f) decision-making in VCN. The proposed solution included common services, which dealt with generic applications, independent features to support collaboration, dealing with common activities such as demand for resources, registration of previous collaborations, providing knowledge, etc..

It was a project oriented towards end-user. The division consisted of seven stages in the working groups, which are:

a) at the beginning of the project end-users, RDs and SMEs, may define the desired scenarios and identify solutions to validate the outcome of the project;

b) at the same time, there was a survey of methods, tools and technologies so that scenarios can be created for evaluation by potential end users;

c) after identification of the requirements of end users the project developed methods, platforms and services in order to validate the results of the project;

d) the methodology and ontology of the project were developed to test knowledge relevant to the project;

e) a prototype that was developed in order to test, with end users, the features and capabilities of the model;

f) the prototypes that were installed on servers for end-users of the project to create a work environment that enables collaboration;

g) the four models of the project involving partners from five countries were installed and used as a demonstration in the rehabilitation of buildings.

2.3. Training of Engineers

The training envisaged for engineers and technicians involved in building rehabilitation imposed certain specifications that were supported by ICT. This is being denominated in the project as Technology-Enhanced Learning (TEL). The TEL services were based on an existing Moodle platform that works as an open Learning Management System (LMS). The application of these services for the users and for the users tasks were defined with emphasis on using proven authoring tools to create learning content that is reusable and can be recomposed. The user types of these TEL learning services are based on the description of the project business cases that were researched during the first part of the project. The roles can be course organizer, teacher, mentor, learning material or course participant. The tasks performed by the users can be organizing a course, managing a course, create a learning object or a lesson and participate on collaborative learning.

The functions required for the Moodle platform for course creation and use are:

a) Learning Objects/Lessons creation: create learning object/lesson; define instructional goal; request specific content/knowledge, on a particular topic; compile learning object/ lesson based on specific content/knowledge; adjust learning object/lesson to the intended audience.

b) Learning group composition: compose learning group; define minimum expertise necessary for joining the learning group (prerequisites); search candidate learning group members; select candidate learning group members; invite members to join the learning group.

c) Course organization and management: organize and manage course; search appropriate course attendants from an existing learning group, based on criteria like availability and expertise; define lessons planned for the course; define course dates and time period; define list of mentors associated to the course; define preferred communication ways and collaboration patterns; define course schedule/flow; notify course attendants; enrol course attendant; enable learning path; allocate access rights; services for collaborative learning; learn collaboratively; use virtual classroom; audio/video chat; share applications.

3. LEARNING AND TRAINING

As a result of the previous considerations there are some decisions taken to implement the learning and training for continuing engineering education (CEE) in the project. The CEE courses created by the project platform will be organized in general areas and sub-areas that will be defined with the help of SME's and of R&Ds. The project provided a system that allowed that:

a) Platform users, including non-registered users, should be able to see not only a list of free courses but also the courses with costs that the network has to offer. This is a tactic to promote collaboration among participants, to share useful knowledge and to attract new

users to the project VCN.

b) Courses offered by the platform present general information like: name, summary, contents, modules, costs and access procedure.

c) The project platform used for knowledge management and networking is based on a Drupal open source content management system. To interact with the LMS Moodle a single sign-on procedure was created allowing exchange among the two environments.

d) Allow online creation of the learning objects and development of lessons/courses with, for instance, learning objects delivered by SME's know-how and by R&D organizations.

e) Classifying training courses with two options as free courses or paid courses.

The junction of different types of electronic knowledge management and collaboration systems was the strategy adopted to respond to the different requirements of the project. It was expected that this option would bring cohesion and added value to handle the knowledge management, the cooperation environment and the learning and training resources to the engineering community. Rehabilitation of buildings is a difficult area of work and only with proper handling of information or knowledge, of professional networking and of training it is viable to increase productivity and quality.

4. CASE STUDY

An example of application of the platform is a cooperation between a SME and a R&D that have decided to prepare a virtual course of training for the staff that will apply techniques related with masonry reinforcement. This course is developed in the application Moodle associated with the project platform. The SME has utilized and mastered the use of a special system of connecting masonry Earthquake Structural Rehabilitation elements. It is a system based on the use of mechanical elements, created in 1984, of Earthquake Structural Rehabilitation ties, of masonry fixings and related masonry repair systems. The SME has trained their technicians and workers to design, plan, implement and test the fixing system during several years. This expertise has been accumulated for some years in terms of enriching the added value of the human resources in different phases of old building restoration. It was decided to use the project platform to create a course to train other company technicians or workers on how to use this connecting system.

The targeted potential users are other restoration companies, acting as subcontractors or partners, and organizations responsible for managing restoration projects where the system was used. The goal was to increase the quality assurance of the application of the system in projects where the SME is involved. Among the four models of courses available in the platform the choice was the modular format. The reason was that it was not adequate for an innovation course, wiki model or complete case model. The schedule for the course was defined by the tasks to be performed and by the targeted participants.

The participants were distributed in two groups: technicians and workers. The technicians group was composed by engineers, supervisors and foremen. The second group of course participants was composed by workers with no design or management responsibility. For the first group the tasks are to attend modules 1 to 5 in accordance with the needs of each situation. Modules 1, 3 and 5 are mandatory. If design of the restoration solution is necessary then modules 2 and 4 are necessary. For the second group it is expected that module 5 and module 4 is recommended. The course was tested with the staff from a SME project partner. Two groups were formed and the five modules were tested. According to the reviews changes were proposed in accordance with the surveys.

5. CONCLUSIONS

The platform has proved to be reliable for cooperation between organizations involved in building restoration. The three components of knowledge management, of virtual networking and of distance training are a possibility for all stakeholders of building restoration. There is also a follow-up phase that can be participated by SMEs, R&Ds and other organizations related with building and built heritage interested in taking advantage

of the platform. For instance in terms of analysing the life-cycle of a building the building after restoration the platform can be an effective support.

In this case registered users of the platform interested in following the behaviour of the building was divided into two groups. The first group was created to collect data from the building and store it in the platform. In this group are included all users that can also furnish data about similar buildings and about same techniques and materials used in a building restoration. The second group was composed by the registered users that are interested in analysing the data provided by the other group so conclusions can be obtained for future application in other case studies.

The follow-up was provided to registered users relevant knowledge for future building restorations. These advantages may be a) information about the performance of materials used; b) comparison between techniques adopted; c) costs of maintenance for the restored elements; d) information about life-cycles of fixing systems, of materials and of rebuilt elements; e) exchange of information with other related registered users; f) creation of cluster of companies and research institutes; and g) innovation concerning the problems found. The users may be invited to register in the project platform according to the nature of the activities of the SMEs, R&Ds and organizations.

It was expected that the project partners become registered users. These initial users could invite similar organizations to engage in the follow-up of the business case. Some of the advantages were already identified but it is natural that others may arise as a result of the users´ activities and of the implementation follow-up. The platform provided the adequate support to this follow-up phase through the virtual collaborative spaces, the information management tools and the provision of proper training.

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