Education Using ICT for Construction Management

Alfredo SOEIRO

Dept Civil Engineering, University of Porto
Porto, Portugal

ABSTRACT

A project carried through between institutions of higher education and construction companies was co-financed by the European Commission. The project lasted three years where the main objective was to develop the staff training in using and applying the Information and Communication Technologies (ICT) in construction management. The results of the project have been also used in a new course of the senior year in specialization area of construction of the Civil Engineering degree of the University of Porto. Some conclusions of the diverse experiences of the project partners are also presented indicating future developments in this area.

Keywords: Information and communication technologies, ICT, construction management, education, training.

1. ICT IN CONSTRUCTION MANGEMENT

Technological developments have influenced the daily life to an unexpected rhythm and with significant changes in the areas of design and construction. The tools and ways that are used in communication and exchange of information have had an influential and crucial role. They have modified the format, the way, the support and the amount of information in the activities of construction management. These changes form a set of reasons enough for this initiative to search and to investigate the possible improvements and benefits in this construction activity.

Management tasks of construction imply a large-scale administration of information and with a significant diversity. It is an activity where the data on construction is manipulated intensively and where the quality and hazard may condition the success of construction management. On the other hand the tools of ICT are the support for the retrieval, analysis, filtering and dissemination of information.

ICT uses electronic processes to allow the use of resources at a lower cost and in a shorter period of time. Therefore, engineers, technicians, administrative staff and any related type of staff in the construction have to face this fast change in construction management. For example, changes can involve the internal communications, the data bases to control the productivity, the administrative procedures and the qualification of the staff in terms of abilities and capacities.

On the other hand and, in general, the technical staff is not aware of the capacities of internet or web. They are not made familiar to the interface modes between users and available ICT tools. They do not have, in general, training on efficient use of ICT applied to construction management. There are also significant changes in communication infrastructures that, in certain cases, result in the substitution of a vertical organizational structure, typical in a traditional construction company, by a structure of horizontal and informal management. This new form has a matrix characteristic in terms of communication and of information management.

Taking into account of the need to train and to prepare the involved human resources in construction management it was created a partnership between institutions of higher education and construction companies. This partnership took into account the complementarity of experiences and the respective knowledge. The research and education institutions have more experience in the use of ICT and the construction companies know the necessities of improvements and can identify the chances to transfer these results of the experiments to be undertaken.

2. PILOT PROJECT USING ICT - ATELCOMA

The partnership elaborated a proposal of the project that was presented to the European Commission in the scope of the program Leonardo. The project was called Atelcoma (Application of Teleworking in Construction Management). It had duration of two years between September 1999 and June 2001. The project was approved for financing by the European Union and had eleven partners of the Finland, Holland, Ireland, Portugal and the United Kingdom. The total cost of the project was approximately of 185000 Euros with a public financing of about 60%. The website of the project is www.fe.up.pt/atelcoma.

The initial objectives of the project intended to approach some needs:
a) Sharing experiences on using ICT in construction management;
b) Finding tools to decrease mobility costs of technical staff;
c) Internationalising construction management practices in the European Union;
d) Generating a set of training courses about the use of ICT at European level;
e) Increasing the use of ICT in construction.

During the two years some applications of the use of ICT in construction management have been tested. Four of these attempts, indicated in the chapter conclusions, are described as two case studies. The simpler of the cases consisted on the

definition of testing the need for training of each technician, involved in the construction management, for using the basic tools of ICT. The joint solution was the production of a CD-ROM with information on the basic tools as the electronic mail, the programs of web navigation and programs for using file transfer protocols (ftp). These tools, essential for the use of ICT, were designed for middle and high level technicians. The content was organized based on the current profiles of the users and was pedagogically in accordance with the examples presented and with application to concrete cases for resolution.

Another one of the applications consisted of the use of video-conference for management of drawings to use in the construction site. The users had been the technician placed in charge of the construction site and the design technician based in headquarters. The equipment used had low cost and software programs used to view the drawings were public domain and free to use. A short training of the involved technician was done on how to use video-conference equipment and on how to manage programs of visualization. Once the procedure was tested in one construction site the system showed that saved time and displacement for all participants.

A third application consisted of the elaboration of a system of heavy equipment control of a contractor using a program based on a web page. The intention of the elaboration of this program was to concentrate in only one application the leasing and purchase orders, the deliveries records, the dismissals data, the replacements, the repairs and the termination of equipment. The program was tested during six months having been adopted by the company as a fundamental element of construction management.

The fourth attempt of use of the TIC consisted on the definition of protocols for management of subcontracts of reinforced concrete. The main objective was to make the planning of the use of construction formwork between a contractor and a subcontractor companies working about 400 km apart. The goal was to avoid meetings and staff displacements. The experience was carried through on a housing construction site during a period of three months.

As main result of project implementation and conclusion a final conference was held in Eindhoven, Holland in May of 2001. The participants of the conference were the project partners, representative elements of the local industry of construction and Dutch university staff. For this event, taking into account the dissemination of project results, a CDRom with the main results and another documentation of support was produced. These main materials have been the support for a course given in the College of Engineering of the University of Port (Computer Science in Construction) for future civil engineers. This was a voluntary course for those who wanted to learn the use of ICT in construction management.

3. COURSE IN CIVIL ENGINEERING

The course was, in part, a spin off effect of the project Atelcoma. The first phase of the course consisted of the identification of the operations of construction management where it was possible and advantageous to use ICT. This phase was composed over all for a debate between the students and the professor, having in consideration the habits of operating and the intrinsic conditions of construction management. The following stage was the implementation of these improving modifications, caused by ICT use, in current operations. The third step consisted in the evaluation of benefits due to the changes proposals. This was done through individual work of analysis and through collective discussion using project documentation and other existing materials in the library or in the web.

The last phase of the course consisted in the presentation of the students final projects, that they had chosen, that were produced based on the documents that they had analyzed, in some pages of the web related with the subject of the course and in personal preferences. The most relevant final projects had diverse extension and depth. The respective subjects oscillated between the definition of minimum training and of educational requirements for future construction managers and the proposal for management of sub-contractors using ICT. Other examples of the student projects were the definition of a protocol for communication between the engineers and architects and a model based on ICT for control of progress during the construction process. All the projects had been placed in the course page web allowing discussion and exchange of experiences between the students in a proper forum.

4. MAIN RECOMMENDATIONS

Some conclusions of partners of the project Atelcoma were chosen to illustrate the respective experiences. The first set of recommendations mentions the use of ICT to produce and manage a data base with all documents for the construction management of a hospital. Another example dealt with the coordination implied in the management of construction of a large building using sophisticated programs of construction management. These two examples are presented with some comments and drawbacks that illustrate the project conclusions about these experiences.

Partner A: The first impression was that the draftsmen were not prepared for this use of ICT in project design. One of the examples was that the technician continued bringing the paper drawings for the meetings instead of using the computer screen. The draftsman invoked that the scale in the monitor was too small to view the details. As a result, in the following meetings, a computer associated with a data show projector was used to allow the analysis of the drawings in a larger scale.

Another one of the negative results was the fact that construction contractors did not have enough or adequate CAD programs, especially the sub-contractors. The solution was to provide the equipment by the companies of coordination and management of the construction site. There were also some misfortunes due to bad previous experiences of the technical staff with the use of the TIC in other construction sites. It was then necessary to insist in using ICT in the project. One of the methods was to compel the competitors to use the data base for retraction and delivery of documents when bidding the diverse contraction proposals.

After investigating the use of the programs of construction management one concludes that the use of these tools creates dramatical changes in internal control of the information within the construction. The consequences for users will be that the

tools can update available information in the system and the errors, due existing misadjusted or outdated information, diminishes significantly. This improvement of the information flows, with a better distribution and more quality given to the participants of the construction management process, leads to a better decision process. In summary, when adjusting the behaviour in function of the information this can improve the performance in terms of duration, of costs and of quality.

One of the challenges is that the construction management has to improve the administration of the complete information in order to benefit the communication process. Another challenge is the adequate structuring of the archive of the project information. In the long run, the challenge is to transform and change the technician's attitudes in construction management such as designers, site managers, technical support staff, engineers, coordinators and directors. The final issue is to find the way to make the transformation of operations in a different way to match the electronic environment.

5. STUDENT EXPERIENCES

This text reflects, in a summarized way, the proposals elaborated by students of senior year in the course of Computer Science in the Construction throughout the last years. This summary is not exhausting and it does not present any judgment of value in terms of quality of the elaborated works. It intends, over all, to present the perspectives developed during a semester in view of investigating the possibilities of ICT in construction management.

Document Management in a Construction Site
This was a proposal aiming at making a bridge between the construction and the technologies of information. It analyzed the type of documentation in the construction site in order to be able to study the adequate forms of management that involved ICT use. The adopted method analyzed existing cases and presented possible alternatives to traditional techniques using ICT. It considered the use of digital tools to manage the information that circulates in each construction site ranging from mail to invoices.

The project proposal considered the digitalization of the information when the electronic source was not available. It defined the stages to improve the management including storage, indexation of information, search techniques and access procedures. It presented some solutions of dedicated platforms to the management of the information and the communication in construction presenting existing solutions in the market. It still made recommendations to optimize this change with a friendly interface, a performance of the adjusted net of communication, the guarantee of security of digital documents and the flexibility of the considered system.

Protocol of ICT in Construction
This work presented an analysis of the type of information used for each specialty of a building design. It considered a protocol to be able to allow a flow of information that is efficient and efficient. The utility of this protocol is to establish a set of rules that regulate the way the information exchange will be processed. This protocol, to be signed by diverse actors, is binding for the agreed tasks and during the established stated periods. The first step consisted in the definition of the communication channels between the project participants. Since this protocol includes the definition of the information to circulate it will indicate the main topics of the design.

In this definition the necessary details and formats must be enclosed so that these prevent deficient interpretations of the data. The occasions must be presented where the information exchange must elapse throughout the process. The following phase defined the procedures of exchange of information with inclusion of the control processes. The last step consisted in the implementation of the commitment to use the different recommendations of the protocol for the different actors. A possible index for a protocol of this nature could be objectives, definitions, description of the process of information exchange, prerequisite and conditions, responsibilities, questions of control, check-lists and definition of the content that constitutes the exchanged information.

Database for Subcontractors Management
This work was based on obtaining a method that allowed the definition of concrete criteria to choose subcontractors besides the price and the duration. Having in consideration that the choice of the subcontractors is based on the need to find who performs defined tasks with quality and low cost it becomes necessary to choose who offers other guarantees. The considered method suggests that a database is created that includes information on the performances of some subcontractors. This information had to be stored and to be structuralized within some characteristics. This data was grouped by the agreed prices and final prices, by delays, by data about quality of the work, by information on paid invoices and by safety rates.

This information would be obtained by the contractor supplied by the subcontractors in previous subcontracts or by exchange with other construction companies who have used the services of the subcontractors. Some of this data could be also being attached to the bid proposals. The use of the ICT would allow elaborating prospective information about the future performance for each one of the subcontractors. This would allow evaluating the different bids in a more complete manner and could produce different simulated scenarios. The proposal included, for this last effect, the adoption of methods of balance of the different criteria using multi-criteria functions to compare these different aspects of each subcontractor.
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6. CONCLUSIONS

The attitudes and results of the participants in the project and in course related with the use of ICT in construction management had evidenced some of the possibilities that these presented. The knowledge on the possibilities of use of ICT showed, in certain cases, advanced solutions. These were based on imagination, analysis, reflection and simulation efforts. It was also surprising the devotion to the subject and the contribution for the quality of the results gotten in the end of project and of the course.

The great benefits of the project have been based on the spirit of openness and innovation revealed by the participants, both from the educational institutions and from the professionals in construction management. The cooperation at the international level in this area allowed underlining some differences in the

construction management habits throughout Europe. It also allowed showing the possibilities for potential improvement of the activity. While referring to the course it was evident that the role and the tasks of the professor were modified significantly when comparing with actual education. The motivation of the pupils had been concentrated in the results of the individual projects taking into account the experiences of the project Atelcoma in the professional area and leaving space for the teacher to become a tutor and an advisor.

The important conclusion is that ICT can represent a tool of great value in the construction management practice and education. This use presents diverse options like shown in the examples presented in the CDRom of project Atelcoma. This diversity assumes different aspects in what it respects over all to the content to the format but in the immense possibilities for testing and for implementation. The specific trainings and the formation for using ICT in construction must also be promoted and be implemented as essential way for the modernization and improvement of the sector.

6. REFERENCES

[1] Donald Macdonald, **Audio and Audiographic Learning - The Cornerstone of the Information Highway**, Chenelière McGraw-Hill, Toronto, Canada, 1998.
[2] **Quality Guide of Open and Distance Learning - Procedures and Practices**, Socrates Project, Szamalk College, Budapest, Hungary, 1999.
[3] Margaret Haughey and Terry Anderson, **Networked Learning - The Pedagogy of the Internet**, Chenelière McGraw-Hill, Toronto, Canada, 1998.
[4] A. W: Bates, **Technology, Open Learning and Distance Education**, Routledge, London, 1995.
[5] R. Flowers, **Computing for Construction Managers**, R. Flowers, Pergamon Press, London, United Kingdom, 1998.
[6] **Atelcoma - Application of Teleworking in Construction Management - Proceedings**, Technical University of Eindhoven, Eindhoven, The Netherlands, 2001.