Improving Bid Preparation in Supply Chains in the Construction Industry

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Abstract: Bid preparation is a non profitable process per se and thus offers a high potential for improvement: The costs and time for preparing a bid have to be little and the success rate must be high. This paper presents a case study which demonstrates how a small company in the construction industry can increase its efficiency in the area of bid preparation by redesigning its processes and introducing new information and communication technology. The paper summarises the current problems in bid preparation and outlines the approach which was taken to improve them. A reference model for an ideal bidding process is presented and a corresponding software system is described which provides specific support for co-operative bidding in the supply chain. The benefits which were achieved in a pilot project at a manufacturer of marble and granite are outlined and the findings from the approach are summarised.

Keywords: Bid preparation, construction industry, process design, reference model

1. Introduction

The building industry is one of Europe's most significant industries, representing more than 10% of the gross national product of the Union and producing a turnover of 550 Billion Euro. It occupies more than 9,000,000 employees in 1,900,000 companies, out of which more than 90% have less then 9 employees [1]. Thus, the building industry is mainly composed of small enterprises.

These enterprises face a notable potential for improvement in order to survive in today's turbulent markets with international competition. In general, their current business processes are mainly based on traditional work procedures. Information and communication technology is exploited only to a small degree and if, mostly in isolated solutions. For example, Email is scarcely used as a communication means and only few companies operate networks for data exchange. Thus, these enterprises cannot participate in electronic commerce.

Further, business processes are characterised by intuitive, informal approaches and systematic or methodical approaches are scarcely used. Consequently, decision processes are depending strongly on social factors and individual liking, and the reusability of existing results is low. As a result, building companies feel a strong need for reengineering their business processes.

Being a non profitable process per se, *bid preparation* is a specific area calling for improvement. Bidding is an indispensable process for winning orders but does not bring income on its own. Thus, the time and costs for preparing a bid have to be little and the success rate must be high.

The bid preparation process in the construction industry is influenced by the fact that construction work is typically carried out in a supply chain. Consequently, construction companies have to interact with their suppliers when preparing a bid. The suppliers contribute prices for material or subcontracted labour, i.e. they prepare 'sub-bids' in the frame of the overall bid. However, the integration of the supply chain into the bidding process is merely arbitrary both process wise and electronically – though it covers a significant part in the process and the bid. Fax and telephone are still the major means of communication.

The CSCCM project – Computer Supported Co-operative Construction Management – which was funded by the European Commission's ESPRIT program, aimed to redesign this bid preparation process. The objective was to demonstrate how modern information and communication technologies can be applied in small and medium companies for optimising the key success factors costs, time and quality and thus increasing their competitiveness. Specific emphasis was given to co-operation in the supply chain. The CSCCM consortium comprised three companies from the construction industry (Baldauf: laying and trade of tiles and natural stones; COGEMAR: cutting and trade of marble and granite; Stadlbauer: wholesale of building material), three software houses (TEAM, IBK, ISD), and one research institute (BIBA).

This paper presents a reference model for bid preparation, a corresponding software system and a case study of a pilot at COGEMAR: Chapter 2 explains the pilot approach at COGEMAR and summarises profile, strategy, as-is and to-be situation of the company with respect to bid preparation. Chapter 3 outlines the reference model and the supporting means for its usage. Chapter 4 describes the software system, which has been developed in the project and which has been implemented at the industrial users. Chapter 5 summarises the benefits which were experienced in the pilot at COGEMAR and chapter 7 concludes the paper.

2. The COGEMAR Pilot Project

The following section describes the approach taken in the COGEMAR pilot project. Similar approaches had been taken in parallel at the other two end users in the CSCCM project and their case studies are described in [2]. The three companies represent a typical supply chain in the construction industry (cf. Figure 1), so that it was possible to analyse and experiment the interaction for bid preparation among these companies.

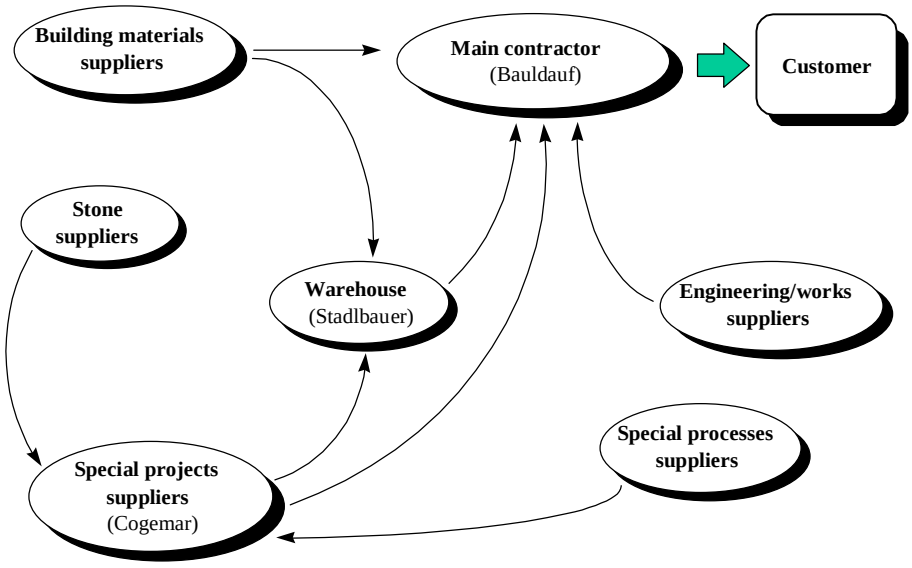

Figure 1: The typical supply chain in the construction industry

2.1 Approach

The pilot project applied a classical approach for process design which was balanced in-between the extremes of radical reengineering and incremental, continuous improvement: Starting point was the analysis of the business processes at COGEMAR. In a first round, the current as-is processes were captured and end user requirements for an optimised solution were identified. These were transferred into to-be processes defining the target that had to be reached within the pilot project. Also, a generic reference model for bid preparation was developed (cf. Chapter 3).

Subsequently, existing business applications used by COGEMAR and software packages available on the market were analysed. They were examined concerning the provided and missing functionality and their usability. After these analysing work packages, the software development started with the specification of the software architecture. The software consists of different modules, each one representing specific key processes in bid preparation. The solution was implemented in pilot projects at COGEMAR who uses the system in their day-to-day business for making bids.

2.2 Company Profile and As-Is Situation

The COGEMAR group is an Italian supplier of finest natural stone material. They buy big marble and granite blocks directly from quarries, cut them and deliver them to building companies in more than 20 countries world-wide. This includes e.g. Japan, China, Hong Kong, America as well as the Arab countries. COGEMAR has 3 main business lines: cut to blocks, cut to slabs, and cut to size. The companies of the group have a specialised and professional direct staff of 80 people and an indirect staff of 20 people.

The cut to size business is a typical one-of-a-kind process. Each project is different and the cutting tasks range from simple semi-standardised tiles up to complex geometrical patterns, for e.g. hotel lobbies or mosques. Consequently, detailed bidding activities are required for receiving orders. The effort for one bid can range from 1 hour up to 10-20 days (i.e. up to 10.000 Euro and more), depending on the complexity of the project and the availability of the bill of materials. In 1996 the company prepared about 1000 offers, of which about 320 were rather complex and were done by the technical department, while the other ones (being not so complex) were prepared directly by the commercial department. The equivalent of two full time employees was dedicated to the bidding process in the technical department. Approximately 10% of the offers prepared by the technical department became orders.

Traditionally, major activities in the bidding process were directly carried out by the owners. These had very high and specific skills for this activity and the bidding process was very much based on their experience. The whole bidding process was essentially a manual process. Computer support was available only for the secretary work (word processing) and for some information on internal standard costs and internal resource availability.

2.3 Company Strategies and Objectives for the To-Be Processes

COGEMAR's business strategy defined the framework under which the objectives for the improvement of the bidding process were defined. Important elements of this strategy were:

- Representing the dynamic area of COGEMAR, the cut to size business line should become stronger as it has the highest potential margins and is less affected by the growing competition of the marble and granite industry
- The structure and the organisation of the company should become a managerial one, less dependent from the owners and from the knowledge of some "guru"; this knowledge should be embedded in COGEMAR's information system and procedures and should be transformed in rules to be applied by the employees
- The relationships with subcontractors (63% of manufacturing costs in the cut to size business line) should change: the number of providers could decrease, but the remaining ones should

operate more like partners than like suppliers, and the co-operation should be structured and become more formalised and less informal

- Customer satisfaction should be a major goal in order to ensure their loyalty over time

Based on these considerations, the company aimed to increase the productivity of the bidding process with respect to time and costs and to increase the bid success rate. Further they aimed to guarantee that an internal group of employees would be able to manage the bidding process autonomously with efficiency and effectiveness. As the bidding process was very much based on the experience of individual persons, a system which supports the sharing of knowledge was needed. Ideally, the owner knowledge should be transferred in an information system, so that bidding personnel could have an "automatic" guideline with respect to customers, suppliers, costs, treatment and processes. Thus, the knowledge would be transformed from a personal asset to a company asset.

Also, the productivity had to be increased with respect to reusability, reliability and filtering of incoming inquiries. The supply chain relationship had to become more efficient in order to reduce the price inquiry lead time and to reduce the effort for making inquiries. Whenever possible, the document exchange with customers and suppliers should be done through electronic media and the exchange should be made directly with the information system. Also, transparency and professionalisation of the supplier relationship was needed.

Moving from the "as is" to the "to be" situation, the basic structure of the bidding process, that is the main "macro"-phases of the process and the organisational units involved, were not changed very much, but the activities in each phase and how they were done had to be changed significantly. At macro-phase level, the main change to be implemented was the introduction of an inquiry filtering phase, which avoids to loose time and resources for not feasible or not interesting inquiries.

3. A Reference Model for Bid Preparation

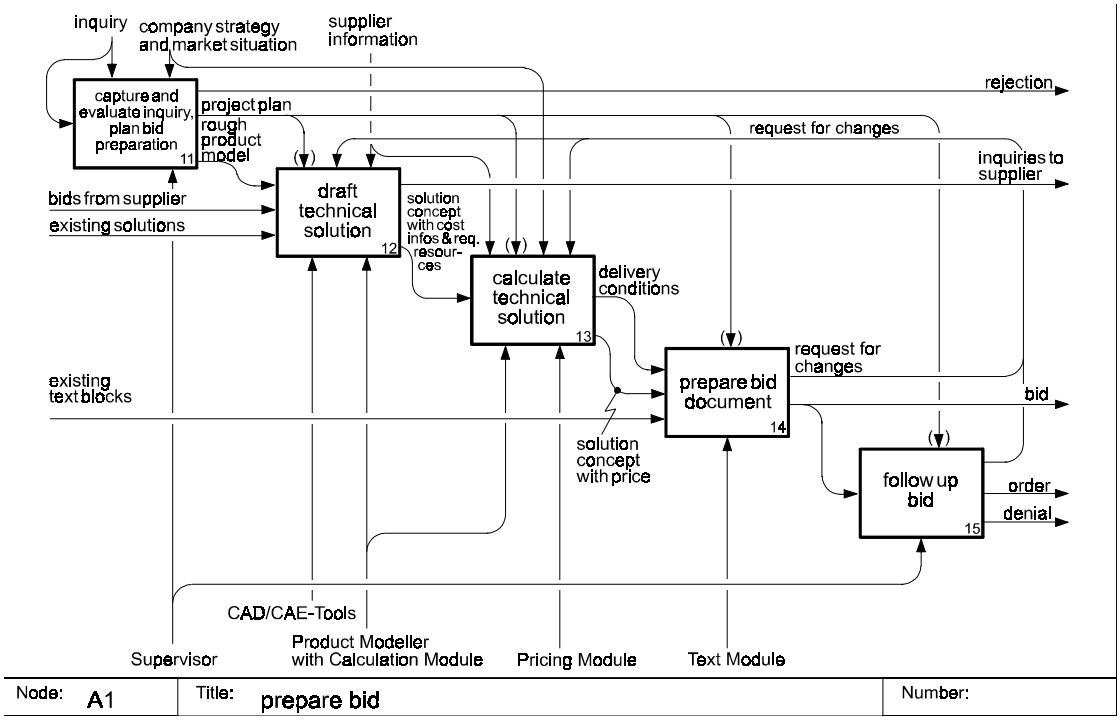

Figure 1: Central diagram of the reference model for bid preparation

During the process analysis at COGEMAR and the other construction companies, it was identified that the bidding process of the different end users was very much the same when describing the main activities. Decomposing the process in activities and sub-activities with the IDEF0 methodology [3], the first three levels showed rather similar activities. Even more: Comparing it with the

bidding process of companies in the manufacturing industry [4], [5], [6], the likeness was high as well.

These similarities were the trigger for developing a reference model for bid preparation. The rationale for its development was the fact that reference models reduce the modelling effort and increase model quality by reusing experience from existing models [7]. Thus, it was aimed to provide this reference model as an aid for companies, consultants, or academics who analyse bidding processes.[1] It can be used

- to reason about the existing process and to redesign it by following the provided examples
- to specify an appropriate software system to be used for bid preparation
- to evaluate existing software systems with respect to their usefulness for the bidding process

The reference model represents the bidding process in eight IDEF0 diagrams and textual descriptions. It names the main activities and their typical inputs and outputs. Also, it lists software functions, which can be used to support the respective activities. Figure 1 shows the central diagram of the model, Table 1 lists the activities of the node tree. The bidding process is decomposed into five typical activities: the capturing of the inquiry, the development of a technical solution (more specific: a draft since the 'real' solution is developed only when the order is won), the calculation of costs and price of the solution, the preparation of the actual bid documents, and finally the follow-up of the bid.

A0 Carry out construction work
A1 Prepare bid
A11 Capture and evaluate inquiry, plan bid prep.
A111 Capture inquiry
A112 Complete inquiry
A113 Translate cust. requirem. in prod. Model
A114 Evaluate inquiry
A115 Plan bid preparation
A12 Draft technical solution
A121 Identify similar solutions
A122 Configure solution concept
A123 Specify missing solution components
A13 Calculate technical solution
A131 Specify delivery conditions
A132 Determine resource specific costs
A133 Add overheads and surcharges
A134 Fix price
A14 Prepare bid document
A141 Compile results into bid document
A142 Write covering letter
A143 Check and authorise bid
A144 Send and present bid
A15 Follow up bid
A151 Archive bid
A152 Check customer reaction
A153 Negotiate contract
A154 Document results of bid preparation
A2 Handle order
A3 Compare 'to-be' and 'as-is'
A31 Compare bid and processed order
A32 Analyse deviations
A33 Feed back analysis and initiate actions

Table 1: Node tree of the reference model

3.1 Supporting Means

The reference model is also intended for self-directed usage by small and medium construction companies. Since these are not familiar with business process redesign, the model is accompanied with some supporting means which aim to assist the companies in applying the model by providing knowledge about process redesign. The supporting means are a collection of various existing and self developed methods and guidelines which have been selected for their simplicity and pragmatism:

- *Change methodology:* A description of 10 steps to perform the change from As-Is to To-Be

[1] The authors are also aware about the acceptance problems of reference models. It has been experienced that firstly, reference models are sometimes prejudiced as 'academic' and not useful for 'real' business, and that secondly, they suffer from the 'not invented here' phenomena which hinders their up-take. However, it was also experienced that an intermediate version of the reference model was well appreciated at Baldauf, one of the other end users in the CSCCM project, and assessed as very valuable for their process modelling activities.

- *Selected methods and tools:* An introduction into 22 methods and tools that can be used with the change methodology
- *IDEF0 introduction:* A short overview about the method and some recommendations for its usage
- *Typical problems:* A list with characteristic problems in bid preparation as stimulation for the analysis of own processes
- *General guidelines:* Some basic best practice recommendations for improving business processes

The model and the supporting means can be downloaded for public usage from the CSCCM WWW site [8].

4. A Software System for Co-operative Bid Preparation

This section outlines the CSCCM software which provides specific support for bid preparation in supply chains in the construction industry. The 'specification' of the system has been derived from the reference model, as this defines all functions needed by the end users during bid preparation. The authors aimed to design the system especially for the needs of small and medium enterprises by concentrating on the essential bidding functions and developing them with utmost carefulness for achieving a high level of usability (in contrast to developing a monolithic bidding system with, say, detailed functionality for specific calculations as they are used by large construction companies). Figure 2 shows the overall architecture of the modular system. The major modules are explained in more detail below.

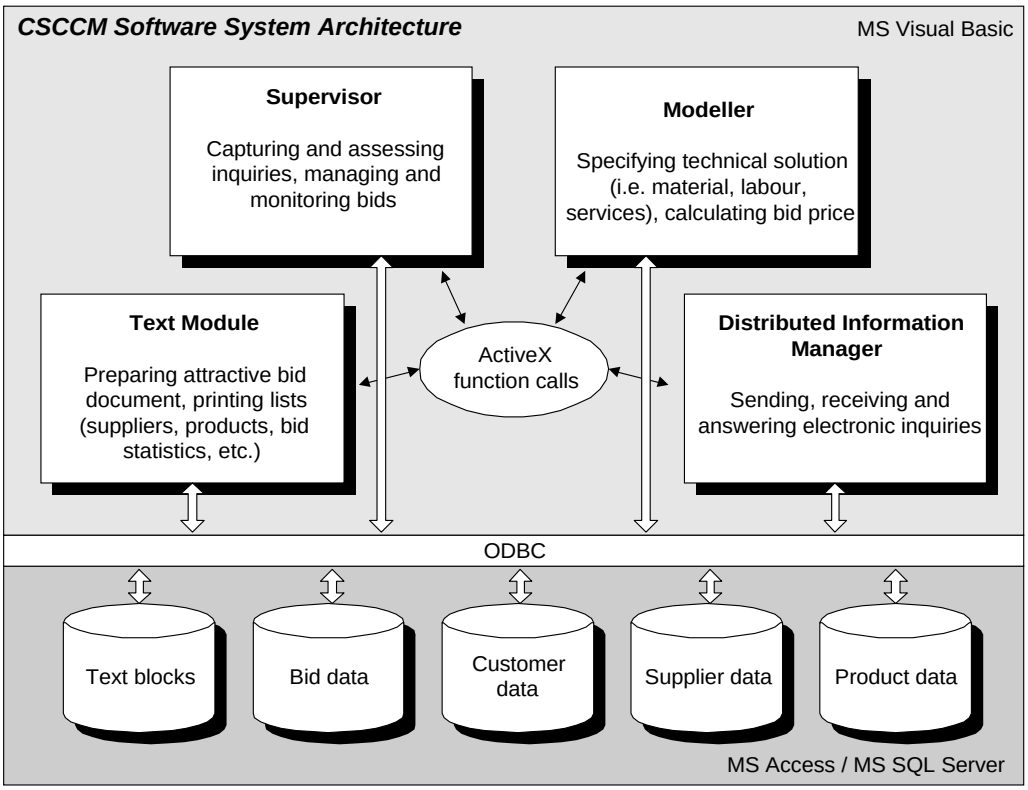

Figure 2: CSCCM Software System Architecture

The Supervisor is responsible for capturing and assessing the customer inquiry and managing the bid projects. In order to collect all relevant information of a customer inquiry, a 'wizard' guides the user systematically through the capturing process. Since the amount of information to be captured for each bid is rather different, the user is free to enter the information or to jump to the next screen.

However, the wizard makes sure that the user is reminded of what to enter. An explorer-type interface to the overall bid data enables easy and fast access to current bid information and the re-use of existing solutions.

The last step of the wizard is the inquiry assessment in which bids are assessed for their likeliness to become an order. Figure 3 shows the inquiry assessment, where values between 1 (inquiry to be rejected) and 5 (bid to be made) are assigned to each criteria (e.g. type of work, risks, customer importance, customer solvency, etc.). From these criteria an assessment factor is calculated for providing decision support. The assessment can also be displayed in a graphical form for providing a quick visual overview. After a decision is made and documented, the bid project is started (or rejected).

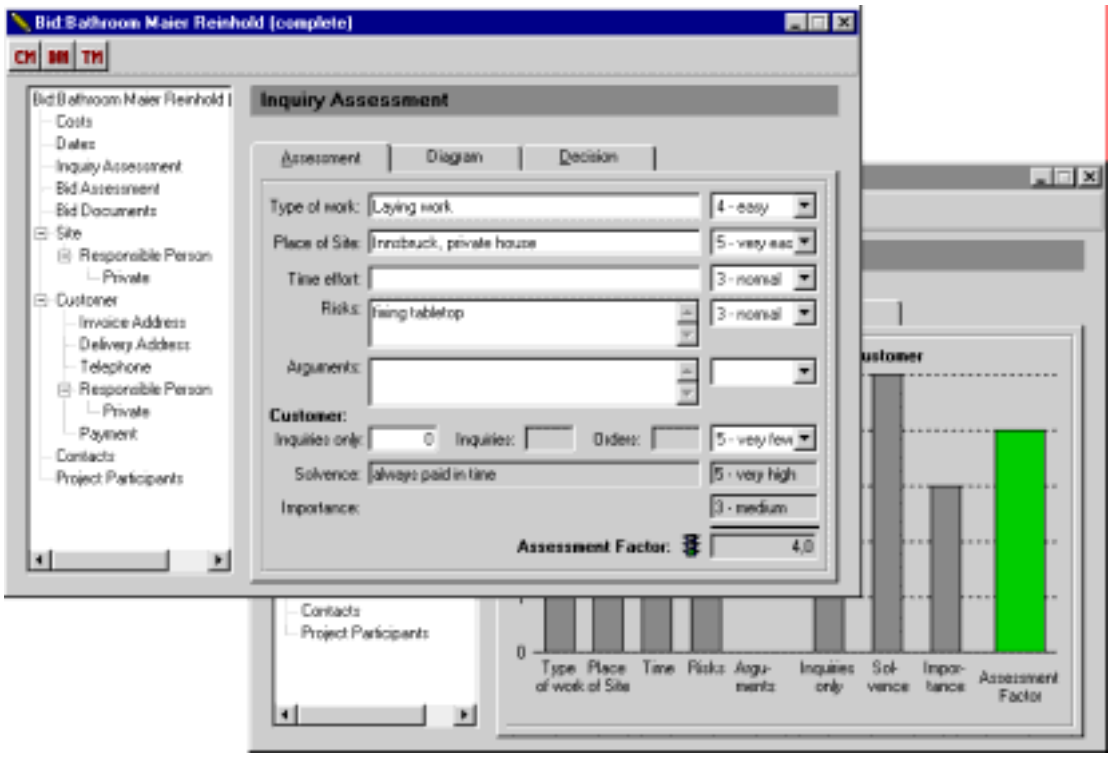

Figure 2: Assessing the inquiry with predefined decision criteria (e.g. difficulty of work, risks, customer importance, etc.)

The Modeller allows the project engineer to specify the product (and/or service) and to calculate its price. By selecting components from the company-specific product programme contained in the CSCCM database, a bill-of-material-and-labour is generated and a technical description of the components is automatically prepared for the Text Module. The technical solution is described with a hierarchical product model which consists of ‘items’ and ‘elements’. After the solution has been specified, its costs are calculated and a realistic bid price is determined. The costs of components, including surcharges for transport, loss, packing, etc. are usually also contained in the product database or can be asked from the suppliers with the help of the Distributed Information Manager. The Modeller exists in two different versions, one for more craftsmen oriented construction work (Civil Work Modeller), and one for more production oriented work, as e.g. at COGEMAR (Production Modeller).

The *Text Module* supports the preparation of the final bid document and the creation of an attractive layout. The module offers different templates for creating different types of bid documents, e.g. for private customers and public call for tenders. From the Supervisor and the Modeller, the Text Module receives all relevant bid data (addresses, technical solution, prices, surcharges, etc.) and, depending on which template is used, decides which of this information will be displayed in the bid document.

The Text Module offers a library of text blocks from which the user can select the needed elements for his bid. The text blocks are, for example, for addressing the customer in a friendly way (e.g. for cover letters), for defining the delivery conditions, or for fixing the legal conditions of the bid. The module also provides functions for preparing lists with the data from the other modules (product lists, customer lists, prepared bids, etc.) and for making them available in attractive formats.

The *Distributed Information Manager (DIM)* manages information and message exchange between the company and its suppliers. Its major purpose is to send electronic price requests to suppliers and to receive their electronic answers (i.e. their bid). Figure 3 shows how a price request is prepared. When the DIM is opened (after the technical solution for a bid has been defined), it accesses the bid data and identifies all components for which the costs have not been defined yet. Also, the DIM checks in its own database by which supplier each of these components could be provided. This information is displayed in the left part of the price request window (see Figure 3). By checking the boxes, the user can then define for which material a price shall be requested from which supplier. When the user knows that a component could be provided by another supplier as well, he can add the supplier by simply dragging & dropping it from the suppliers list onto the component. (Figure 3 shows this event: 'COGEMAR' is just about to be dropped on the component 'Console').

The price request is then sent to the supplier by email. The supplier can open the request with the CSCCM system, prepare his bid and send the answer by email. This email can then be opened with the DIM and the component costs can be transferred automatically into the respective bid and the product database. Thus, the complete process of asking for and receiving price information can be carried out electronically and no data has to be retyped. Also, the communication process is faster, because the email is sent immediately, while conventional fax sending, which is often carried out by the secretary, may take some hours.

Figure 3: Preparing a price request by selecting potential suppliers

The DIM is a central module in the CSCCM solution as it sets the pace to electronic commerce by supporting efficient and practical co-operation in the supply chain with simple means. It has to be emphasised that after a detailed analysis [9], the technical decision was intentionally made for communication via regular email and not via EDI (electronic data interchange), as EDI receives only limited acceptance by small and medium companies due to higher costs involved.

CSCCM^{light} is a downsized version of the CSCCM system and is available for companies who do not want to make use of the complete CSCCM system, but who want to participate in the supply chain by receiving or sending electronic bids and inquiries. CSCCM^{light} provides all functions for reading and answering electronic inquiries.

Computer Based Training: The CSCCM software environment is completed with a multimedia based computer based training (CBT) package. The CBT's purpose is to introduce the CSCCM

system to new users and interested parties. It provides an overview about the software system and the corresponding bidding process. The CBT does not aim to train the users for the system (i.e. it does not replace training sessions on the system), but introduces them into the overall process of preparing a bid and co-operating with suppliers. Also, the CBT provides interested companies with an impression about how they could improve their bidding process with the CSCCM system.

5. Business Benefits

The CSCCM software system as described above is in operation for more than half a year now. After a phase of initial testing and refinement on existing old bids, the system is used today by COGEMAR (and the other end user companies) to prepare their bids. The redesigned bidding process and the software system are assessed as a success.

On the tangible side, a significant increase of the productivity of the bidding process was achieved. The time needed for preparing a bid was reduced by one fourth for simple and complex bids as shown in Table 1. As the bid preparation costs are directly dependant on the time needed, this corresponds to a similar cost reduction. The initial target for very complex bids has not yet been completely achieved but it is expected that the performance will continue to improve when more reusable complex bids are in the system and the bidders are fully familiar with the software.

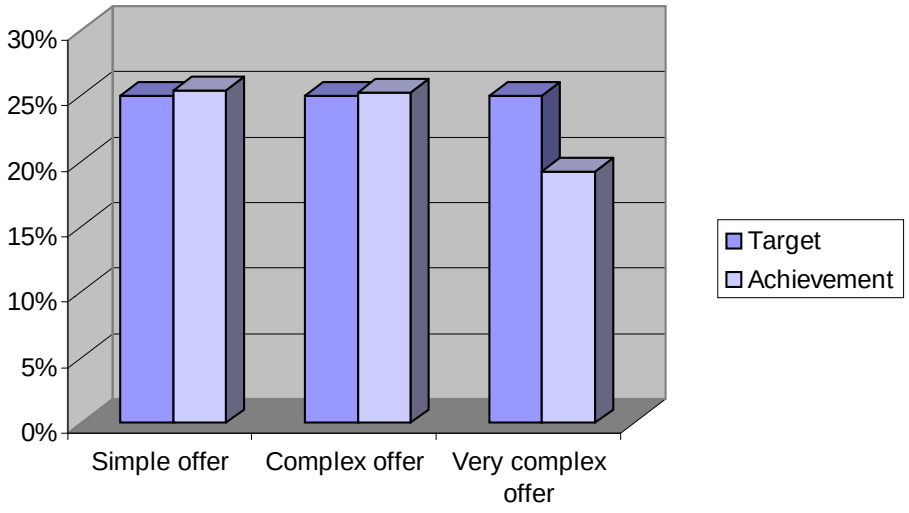

Figure 4: Reduction of bid preparation time and costs at COGEMAR

However, also the intangible side shows clear benefits and the system is well accepted by employees and management due the following main factors:

- Holistic and consistent support of the complete bidding process, from capturing the inquiry up to archiving of the bid
- Good level of usability of the system which is fitted for the small company and not overloaded with unimportant details
- Better availability of information from old bids for reuse among all bidders
- Better transparency of the overall status of bidding projects among all bidders and sensible and synergetic combination of the employees' actual bid preparation process with the management's control process
- Higher independence from "guru" knowledge (indicated by the reduction of time dedicated by the company owners for bid employee assisting and advising)
- Tighter connection to suppliers with electronic communication

Similar benefits were achieved by the other two end user companies [2], [8]. Having reduced the time for preparing bids, COGEMAR is now able to produce more bids and thus gained a better position in the global market for natural stones in which competition has increased significantly in the last two years, especially due to the crisis in Asia.

6. Conclusion

The paper has presented a case study about the improvement of the bid preparation process in the supply chain in the construction industry. It also described a reference model for bid preparation and a corresponding software system.

The analysis of the processes in the industrial companies revealed potentials for optimisation on process and technology level. On one hand, there are activities which can be carried out in a more methodical way. These are, e.g. filtering of inquiries for their likeliness to become an order, or the pursuing and systematic archiving of bids. On the other hand, it was identified that with most activities, it is mainly the 'how' that has to be changed and not the 'what', i.e. that the supporting means (especially information and communication technology) have to be improved. For example, major benefits were achieved by implementing a software module with integrated email functionality for sending and receiving price inquiries and automatically importing them into the bidding system.

The pilot case at COGEMAR was performed successfully, the targets for increasing the bidding productivity have been achieved, and the system is well accepted by management and users. The authors feel that these results are mainly due to the following success factors which have been emphasised throughout the development: careful process design with a high level of employee participation, usage of pragmatic and simple methods and technologies, a well designed software system with a high level of usability, and finally strong management commitment.

The problems and potentials at end user sites were identified to be rather similar. Thus it can be expected that the developed reference model and software system is of significant help for the improvement of the bidding process of small and medium enterprises in the construction industry. Further publications of the project are accessible on the CSCCM homepage [8] and the end results of the project are now commercially available under the product name "e-bid".

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Frithjof Weber studied production engineering at the University of Bremen. Before starting his studies, he gained several years of experience as electro mechanican on shopfloor level. After his studies, he joined BIBA in 1995 as a research scientist in the Department of Computer-Aided Design, Planning and Manufacturing. Since 1998 he is heading the Department. He has been involved in various European projects in the area of Concurrent Engineering. His current research is in the area of CE and information management. His special interests are process design, information logistics, bid preparation and problem solving in product development.

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