Integration of bidding and procurement systems with e-marketplaces: case study of an Austrian tile layer

Jörg Zabel*, Olaf Peters and Frithjof Weber

Department of Computer Aided Design, Planning and Production, Bremen Institute of Industrial Technology and Applied Work Science at the University of Bremen (BIBA), Hochschulring 20, D-28359 Bremen, Germany
E-mail: zab@biba.uni-bremen.de  E-mail: olf@biba.uni-bremen.de  E-mail: web@biba.uni-bremen.de
*Corresponding author

Viktoria Steinlechner

Swietelsky Bauges.m.b.H., Valiergasse 34, A-6020 Innsbruck, Austria
E-mail: v.steinlechner@aon.at

Abstract: This paper describes the efforts to develop a modular bidding and procurement application and to integrate the system with a broker service for tiles and related products in the supply chain of the tile industry by means of the case study of an Austrian tile layer. The main drawbacks of the as-is situation as well as the requirements and envisaged to-be processes are briefly outlined. Furthermore, the chosen architecture and the envisaged functionality of the electronic marketplace and the supportive tools are introduced. The work has been carried out within the scope of the European project e.bip (IST-999-0710; start date: 1 March 2000; duration: 30 months; total efforts: >18 man-years), which aims to innovate the bidding and procurement processes in the tile supply chain.

Keywords: electronic marketplace; broker service; bid preparation; procurement; supply chain; building industry; tile sector; process analysis; process reengineering.


Biographical notes: Jörg Zabel studied Computer Sciences at the University of Bremen. After his studies, he joined the Bremen Institute of Industrial Technology and Applied Work Science (BIBA) in 1998 as a Research Scientist in the Department of Computer-Aided Design, Planning and Production. He has several experiences in European R&D projects (e.g., EP22298 DECIDE – Decision Support for Optimal Bidding in a Competitive Business Environment, EP26956 OnTour – Open Network for Tourism). He is currently involved in the e.bip project (IST-1999–10710 Efficient Bidding and Procurement in the Tile Industry). His research interests are in the areas of e-business and e-commerce. His special interests are in the areas of bid preparation, e-procurement, e-brokering and e-marketplace systems.

Copyright © 2004 Inderscience Enterprises Ltd.
Olaf Peters studied Computer Sciences at the University of Bremen. After his studies, he joined the Bremen Institute of Industrial Technology and Applied Work Science (BIBA) in 1999 as a Research Scientist in the Department of Computer Aided Design, Planning and Production. He has several experiences in European R&D projects (e.g., EP 22828 CSCCM – Computer Supported Cooperative Construction Management). He is currently involved in the e.bip project (IST-1999–10710 Efficient Bidding and Procurement in the Tile Industry) and the regional project AAI (ESF/AuT 405–53–2082 Bidding and Offering in the internet–designing ergonomic information and communication technologies meant to increase efficiency in bid preparation in the construction industry). His research interests are in the areas of e-business and e-commerce. His special interests are in the areas of bid preparation, e-procurement, and e-marketplace systems and usability.

Frithjof Weber studied Production Engineering at the University of Bremen. Before starting his studies, he gained several years of experience as Electro-Mechanic at shop-floor level. After his studies, he joined BIBA in 1995 as a Research Scientist in the Department of Computer-Aided Design, Planning and Manufacturing. He has headed the department since 1998. He has been involved in various European projects in the area of concurrent engineering, information, and knowledge management. His current research interests are in the areas of CE, availability of information and knowledge, bid preparation, process design, and problem solving in product development.

Viktoria Steinlechner is Project Manager in the Swietelsky Bauges.m.b.H, the mother company of Baldauf Fliesen & Baustoffe GmbH. After studying Business Administration, specialising in empirical studies and marketing, she worked in the textile industry. Mrs. Steinlechner is experienced in EC projects leading task forces in the CSCCM and e.bip project where Baldauf was involved as an industrial user. Mrs. Steinlechner has special expertise in analyzing business processes in various departments of the enterprises and supports the operational staff in implementing new methods and tools in everyday business.

1 Introduction

The tile industry continues to use a traditional procurement process, which is both slow and expensive [1]. While there are emerging internet services and technologies to handle bidding and procurement processes (cf. [2–3]), none of them are specifically focused on meeting the needs of the tile industry. The e.bip project aims to develop an electronic brokerage system, which is, in contrast to existing e-commerce platforms, focused on the specific business-to-business cooperation and procurement activities in the supply chain of the tile industry.

Small- and medium-sized enterprises (SMEs) are reluctant to being bound to mainly one retailer or wholesaler and want to cooperate with a small set of them instead. The objective of the e.bip project is to overcome the drawbacks of the traditional bid preparation and procurement processes of SMEs by providing quick access to up-to-date product information, improved product characteristics including:
• colour information and common product identifiers to support the selection of the ‘right’ product
• advanced price requests for negotiation support
• direct and ICT-based ordering of product components defined in the bidding process.

The paper aims to summarise the findings of the business process analysis in the context of a case study of an Austrian tile-laying company. Against this background, the e.bip system architecture is introduced by focusing on the bidding and procurement application for tile layers. Special attention has been paid to support the workflow by integrating the electronic marketplace with the local application for tile layers for easier data exchange and a higher acceptance of the solution.

The following section outlines the approach applied for reengineering the business processes of the e.bip industrial partners and for specifying the e.bip system architecture. Section 3 introduces the actors, relations, and goods of the tile supply chain. The as-is model as well as the to-be processes of a tile layer are exemplarily described in Section 4. Section 5 presents the chosen architecture for the electronic marketplace and its supportive tools. The bidding and procurement application for tile layers is detailed within Sections 6 and 7. Section 8 summarises the technical aspects of the overall system architecture. Section 9 also highlights the expected benefits of the envisaged e.bip system.

2 Approach

The e.bip project applied a classical process reengineering approach. Starting point was the analysis of the current business processes at all end user’s sites. The current as-is processes were captured and modelled in order to obtain a detailed mutual understanding of the business activities of the different actors in the tile value chain. By analysing the drawbacks and capturing the user requirements, a model of the to-be processes was developed defining the target within the e.bip project. Simultaneously, broker architectures and case studies of existing e-business solutions have been evaluated. The synthesis of to-be models and study results represented the basis for the specification of the overall e.bip architecture.

An important principle in the e.bip project is the use of iterative and participatory development approaches in all project phases. The as-is processes and their drawbacks have been captured by carrying out interviews with the e.bip industrial partners and distributing questionnaires. With regard to the user participation, a very easy modelling method had to be selected. Therefore, the models of the as-is and to-be processes were defined using the IDEF0 approach (cf. [4–5]). The methodology of the Unified Modelling Language (cf. [6]) was applied during the specification of the software system.
3 Tile value chain

3.1 Actors

The value chain in the tile industry consists of different players, namely manufacturers, stone traders, retailers, wholesalers, building contracts and customers. We defined their roles as follows:

- **Manufacturers** are the producers of ceramic or natural stone tiles and act as sellers only.
- **Stone traders** sell complete solutions to their customers. The material needed is either bought from manufacturers or produced by the stone traders themselves.
- **Retailers** sell the products obtained from wholesalers to customers or tile layers.
- **Wholesalers** act as business intermediaries between manufacturers/stone traders and building contractors/ceramic retailers. The main added value provided by the wholesalers is the provision of logistics.
- **Building contractors** buy tiles from the wholesalers and retailers and sell these together with their services to customers. Building constructors comprise tile layers, architects, building companies, and engineering companies.
- **Customers** are the final consumers of tiles or tile products.

Companies from all the above-mentioned roles – with the exception of customers – are present in the e.bip consortium. Consorzio per la Zona Industriale Apuana (CZIA) is a consortium of stone traders and natural stone tile manufacturers in the Massa and Carrara region of Tuscany (Italy). TIBA is a Portuguese wholesaler and retailer of products and materials for the construction sector. Beinkofer is one of Austria’s leading wholesalers and retailers of building material, tiles, and Do-It-Yourself-cater. Baldauf (Austria) deals in tiles and stones and has its own purchase department and independent work force of stone layers thus acting as a tile layer and building contractor. Additionally, a Pilot User Group has been established covering ten ceramic tile manufacturers in the area of Castellón (Spain).

3.2 Relations

The relations between the members of the value chain are typically 1:1 relations (e.g., a wholesaler buys tiles from a manufacturer) or n:1 relations (e.g., a building contractor sends an invitation to tender to some wholesalers). By establishing the electronic e.bip marketplace in the tile value chain, the business transactions carried out by applying the e.bip tools will turn into brokered 1:1 and brokered n:1 relations. The operator of the e.bip marketplace will act as a business intermediary providing its users with additional services and business opportunities. Auctions (1:n relations) and stock market scenarios (n:m relations) are unusual in the tile value chain and thus will not be supported by the e.bip solution.

The e.bip project focuses on the business-to-business relations between manufacturers, wholesalers/retailers/traders and building contractors. The business-to-consumer sector is not addressed.
3.3 Goods and their characteristics

In the tile industry, many different types of tiles can be distinguished. The two most important categories are:

1. ceramic
2. natural stone tiles.

Their characteristics can be summarised as follows:

- The specific value (price per unit of weight) of the product justifies long transport routes across several borders.
- Tiles are fashionable articles with short life cycles. This forces companies to either hold a very small stock (leaving little choice to consumers) or to take the risk of devaluation of the merchandise when these go out of fashion.
- Tile production processes cannot be standardised. Both the varying qualities of the raw material (for stone and marble tiles) or the specifics of each firing process (for ceramic tiles) lead to variations in colour, dimensions, and quality, making it impossible to guarantee a large quantity of an exactly similar product.
- Different product identifiers for similar or identical items and the missing standardisation for construction material characteristics in Europe often leads to communication problems within the supply chain.

After this general introduction to the tile value chain, the following section details the processes, drawbacks, and requirements of tile layers through a case study of an Austrian SME.

4 Process analysis and reengineering

4.1 Company profile

Baldauf Fliesen & Baustoffe GmbH (Baldauf Tiles & Building Materials Ltd.) is a small Austrian enterprise whose key activity is the trade and laying of tiles and natural stones within the regional market. Its customers are public institutions, commercial and industrial enterprises as well as private households. All tiles and natural stones are obtained either directly from the producer or manufacturer or from wholesale companies in Italy, Austria, or Germany.

Baldauf has an annual turnover of about 6.5 million ECU and about 30 employees. Baldauf is a 100% subsidiary of Swietelsky Bauges.m.b.H., Linz (Swietelsky Builders Ltd.), one of the biggest building companies in Austria. Baldauf has two branches in Tyrol and Vienna. The Tyrolean branch, where the e.bip system will be implemented, is organised as an independent profit centre directly reporting to Swietelsky. The profit centre idea is so much part of the company’s strategy (of both Baldauf and Swietelsky) that it is carried down even to the work force at the construction site.

Marketing its products, Baldauf is confronted with the problems of rising competitive pressure of an expanding market and the customers’ increasing expectations. To meet
these challenges successfully, solutions have to be found to safeguard competitiveness, to reduce costs inside the company and thus increase a successful commercial activity.

4.2 As-is situation

This section introduces the top-level processes of Baldauf (cf. Figure 1) and highlights the major drawbacks and bottlenecks by focusing on bid preparation and procurement.

Figure 1  IDEF0 node tree of Baldauf’s as-is processes

Generally, it was identified that many business processes are still predominately based on paperwork. Fax, phone, and face-to-face communication are the major means of interaction. Electronic data exchange is used scarcely and much information has to be retyped, which is time-consuming and a possible source of error. Except for bid preparation, the activities at Baldauf are not well supported by the applied software systems.

For the whole bidding process, the e.bid application is used (cf. [7–8]). This system also contains databases of customers and suppliers. Two additional applications are applied for order processing stock keeping and invoicing as well as for the cost calculation of invitations to tender. The three software systems are not integrated. As a consequence, data have to be manually re-entered and the current status of an order cannot be easily retrieved.

The bid preparation process (A1) starts with the processing of a customer inquiry, followed by the development of a technical solution, cost calculation as well as the compilation and distribution of the bid documents. Finally, the bid-pursuing activities are carried out. At Baldauf, efforts have already been undertaken to increasingly include the supplier into the bidding process to minimise costs and handling time by introducing the
Integration of bidding and procurement systems with e-marketplaces

389

e.bid system. However, the as-is analysis revealed that the entire bidding process is efficiently supported, but hindered by missing access to up-to-date product information (cf. A3 Procuring material). Price comparisons as well as the search for specific tiles are currently very difficult due to the lack of product number standardisation and the difficult identification of tiles with a specific tonality (cf. Section 3.3).

When an order is received (A2), the bid data of the e.bid system are taken over and adapted to the client’s modification requests. Currently, the bidding data cannot be transferred electronically into the order processing system. In general the customer immediately gets an order confirmation as soon as he places the order. This confirmation is based on a bid or on sales negotiations and is archived as paper document.

After sending the order confirmation, the procurement process (A3) is triggered. Baldauf keeps a permanent stock of ceramic tiles and natural stones, borders, bars, bindings, and oven materials for the sales department as well as for the processing of laying work. In this context, the following problems have been identified.

The access to information about adequate product ranges (e.g., new products, their characteristics, prices, and manufacturers) is one of Baldauf’s main problems. Today, Baldauf’s tile assortment is restricted to the products of a few Austrian and Italian manufacturers/wholesalers who regularly present new collections at Baldauf and provide their information material (catalogues, brochures, price lists). All standard products are captured in a local repository of the e.bid system. Due to the lack of access to up-to-date product data, the stored information often becomes obsolete. Currently, the master data (i.e., supplier, customer, and product data) are only manually updated once a year.

The negotiation and ordering processes with manufacturers/wholesalers are protracted since traditional communication means are predominantly used. Furthermore, Baldauf has limited possibilities to distribute by itself invitations to tender to a broad range of manufacturers and wholesalers.

For software reasons, different procurement activities have to be carried out twice, e.g., data of an order confirmation cannot be copied into the procurement software. The data of delivered goods are currently repeatedly captured in three different forms. The procurement system insufficiently supports this task.

Additionally, promotional material that could facilitate customers’ decision making is missing, (e.g., product samples for Baldauf’s showroom and professional design proposals about the combination of different products and colours [tiles and borders/wall and floor]).

Baldauf’s chief engineer prepares, coordinates, and supervises the processing of orders (A4), including:

- all technical details
- schedule
- personnel planning.

Accounting of the piece-wages for the tile-layers is performed manually based on periodical reports about the laying work. These report forms do not contain all necessary information and cause problems in subsequent tasks.

The invoicing activities (A5) include:

- collecting
- compiling
• sending
• archiving of invoices.

The preparation of the overall invoice is complicated and time-consuming because the partly hand-written delivery notes of goods and reports about laying work have to be manually collected and summarised. Furthermore, the sales invoices for material are sometimes prepared without a corresponding delivery note. Then the stock has to be corrected when the invoice is prepared.

Occasionally the bid prices are compared with the data of the corresponding invoice for analysis of any deviations. Post-calculations (A6) are often carried out when the expected success is missing. In the same manner, the collection and evaluation of the different information, forms, and reports are very time-consuming and insufficiently supported by the applied IT system.

4.3 Requirements and to-be processes

Figure 2 shows Baldauf’s system requirements in the context of their top-level to-be processes. Planning the ideal solution, it was noticed, that the ‘What’ remained mainly the same at this level, but the ‘How’ changed significantly.

Figure 2  Simplistic model of Baldauf’s to-be processes in IDEF0 notation

Since the as-is analysis revealed that the applied IT systems for procurement, order processing, stock keeping and invoicing do not support the corresponding processes efficiently and are additionally not well integrated, the to-be situation has been modelled assuming an optimal software support. The requirements toward the IT infrastructure are indicated in the IDEF0 diagram by the supporting means or mechanisms arrows entering the bottom of the process boxes.
Process-spanning, it was noticed that Baldauf requires an integrated system supporting:

- entire bidding
- procurement
- invoicing
- warehousing processes.

Additionally, electronic communications for negotiation, ordering, invoicing, etc. need to be introduced to increase the efficiency of the communication processes. The internal report forms should be partly substituted by electronic replacements.

Concerning the bidding and procurement processes (A1, A3), it turned out that Baldauf as SME is unable to spend the personal resources necessary to maintain a tile repository with up-to-date properties and price information. Thus, the idea to outsource such a service came about. The required broker service should give access to a large amount of product information and allow Baldauf and other buyers of tile products to search for specific tiles. Additionally, the broker service should notify the buyers about additional products of certain series as well as provide additional information on suitable combinations of tiles (design proposals).

Furthermore, the broker service should have e-commerce functionality to allow online ordering and negotiations. Also price comparisons, announcements of special offers, and the possibility of giving out invitations to tender to the subscribed sellers of tile products should be supported. From the increased market transparency, the enhanced information access, and accelerated electronic transactions, Baldauf expects a considerable qualitative and quantitative improvement for all bidding and procurement activities.

For the process ‘Receiving Order’ (A2), it is expected that the bidding data is transferred electronically to the procurement system and can be easily accessed to generate order confirmation. Order confirmation data should be directly used for ordering merchandise within the procurement process (A3) as well as for checking the stock, i.e., the system has to support identifying and commissioning of the available stock material and ordering of the required components.

To process an order (A4), improved IT-supported project planning and coordination is needed. Since these aspects are not addressed by e.bip, the specific requirements are not detailed in this paper. However, IT support for capturing returned material from sites and customers should be covered by the warehousing system.

Moving from as-is to to-be, the most significant organisational change concerns invoicing and post-calculation. Since the processes comprise similar activities for collecting order data, both as-is processes have been merged to one to-be process (A5).

For all orders with an order value of more than a defined threshold, the efforts required for the post-calculation will be captured directly with the invoice data to streamline the post-calculation activities. The data collection and entering process should be supported by the invoicing module. This activity can be facilitated if manufacturers/wholesalers provide electronic reports and invoices instead of paper documents. The invoicing system should provide advanced statistical functions to determine for instance a project-related list of piece wages, which is currently not possible.
5 The e.bip system architecture

The synthesis of the to-be scenarios from the different members of the tile value chain participating in the e.bip project led to the overall concept of the system architecture which is briefly introduced in this section. The e.bip system architecture (cf. Figure 3) consists mainly of three different functional components:

1 Master Broker System – a central, stand-alone online broker service.
2 Seller and Buyer Clients – local clients connecting the Master Broker System with existing back-office solutions.
3 e.bip/e.bid application – a local application supporting bidding and procurement of building contractors like tile layers.

A more detailed overview of the functionality is provided in the section below.

Figure 3 e.bip system architecture

5.1 Master Broker System

The Master Broker System is a virtual business-to-business spot marketplace for commodity items and will be run as an ASP (Application Service Provider) service maintained by one or more of the e.bip partners. It may additionally be sold to interested third party operators.

The e.bip broker service primarily covers stone and ceramic tiles, but is dynamically extendable to other products and materials. The provider of the Master Broker System will control and administer the product classification scheme as well as the tile product definition. However, to handle the continuously changing and developing products and
product classes, all users of the Master Broker System will be able to make proposals (e.g., to introduce new product categories, product attributes, etc).

One of the main tasks of the Master Broker System is to unify product information by providing a mapping mechanism to handle the problem of managing several product identifiers for similar articles. It also, advanced search features for tiles, including colour-matching mechanisms to find tiles of certain colour or colour range.

For distributing new or updated product information, special offers, invitations to tender, bids, etc. among connected manufacturers, wholesalers/retailers, and building contractors, the potential buyers/sellers can use the notification services of the virtual market-place. Negotiations between buyers and sellers take place through negotiation agents. After specifying the conditions and negotiation margins of a bid/request, the broker agents can autonomously negotiate for the best price and thus considerably accelerate the overall negotiation process.

Ordering, invoicing, and payment transactions will not be addressed by the first prototype of the Master Broker System developed within the e.bip project, but supported by the client modules that was optionally added during the commercialisation phase.

Interested manufacturers, wholesalers/traders, and building contractors can subscribe to the e.bip virtual marketplace (see [9] for more details) and use it by accessing the web front-end through a normal web browser without installing local software. However, in order to interface the broker system with existing back-office solutions (ERP, accounting, etc.), a Seller Client and a Buyer Client application will be offered.

5.2 *Seller and buyer client modules*

The Client Modules have been introduced in the e.bip architecture to integrate the Master Broker System with IT systems already used by:

- building contractor
- retailer
- stone trader
- wholesaler.

The Seller Client provides functions to transfer product information generated and stored at the seller’s IT system to the Master Broker System. The Buyer Client can be used to integrate product or bidding/procurement data retrieved from the Master Broker System into the existing IT systems, respectively the e.bip/e.bid application (see Section 5.3). Additionally, both modules offer functions for retrieving supplier/customer data and archiving services.

5.3 *E.bip/e.bid application*

The e.bip/e.bid application software represents a local application for building contractors (especially tile layers) of the tile supply chain. The e.bip/e.bid application aims to support contractors during the bidding, procuring, order processing and invoicing processes with their clients (e.g., households). While the Master Broker and the Client applications are focused on the trading of tiles in the business-to-business sector, the e.bip system is
completed by the e.bip/e.bid application with tools for handling customised tiling projects with final customers.

The application is developed by extending the bidding application ‘e.bid’ in the project CSCCM (cf. [7,10]). The e.bid application currently includes the generation of segregated project calculations that consider services and material. In e.bip, procurement and invoicing functionality as well as the interconnection with the Master Broker System will be added to take full advantage of the new broker service. This increases access to more product information and a greater number of suppliers, and more up-to-date product information. The e.bip/e.bid application will support the information and workflow for all bidding and procurement activities by substituting paper documents, interfacing the Broker System, and integrating communication systems such as email. The functionality and architecture of the e.bid/e.bip application are discussed in the following sections.

6 Use cases of the e.bip/e.bid application

Figure 4 shows the core functions of the e.bip/e.bid application for bidding and procurement by using the use case methodology that is part of the UML. A use case diagram depicts the relationships between use cases and actors (people, organisations or systems involved). The e.bip/e.bid application interacts with the building contractor (e.g. tile layer), the Buyer Client, and the contractor’s local stock-keeping system. The different use cases are defined as follows:

Synchronise Local Product Repository: The building contractor can synchronise and extend the local product data repository with up-to-date information obtained from the Master Broker System. The e.bip/e.bid application initiates and controls the data synchronisation process (through the Buyer Client) and updates the data of the local repository.

Prepare Bid: The ‘Prepare Bid’ use case comprises functions for:

- capturing and assessing customers’ inquiries
- managing bid projects
- specifying hierarchical technical solutions (product and/or service)
- calculating its prices
- generating bills-of-material/labor and the final bid documents (cf. ‘Provide Text Templates’ use case).

The functions provided by the existing e.bid application are used by building contractors. The e.bid application also manages the information and message exchange between the company and its suppliers by sending electronic price requests to suppliers and receiving their electronic answers.

In addition, the combined e.bip/e.bid application will allow the contractors to transfer inquiries via the Buyer Client to the Master Broker and download the received bids from the Broker to the e.bip/e.bid application in order to incorporate the prices into the bids that will be sent (electronically) to the building contractor’s customers. Building contractors will further benefit from the bid preparation process by accessing a larger and
more up-to-date product repository managed by using the synchronisation mechanism provided by Master Broker (see above).

**Procure Material:** In case of a successful bid (i.e., the customer has placed the order), the building contractor can directly adapt the bidding data and indicate the new status of the project. As the customer may want to modify the order, (e.g., by selecting another kind of tile) the application still supports the sending of inquiries to the contractor’s supplier as well as the receiving and incorporating of the supplier’s bids. Moreover, the e.bip/e.bid application supports the contractor by generating the order confirmation for the customer and sending it electronically or conventionally to the customer.

The data on the order confirmation will be used to check the stock (i.e., the system will support the identification and commissioning of available stock materials) for required merchandise and support the ordering of unavailable materials for the customer. The building contractor can generate the order documents by using predefined text templates and sending them, either electronically or conventionally, to the sellers who made the most favourable bids for the ordered items.

**Transfer Inquiry:** The use case triggers the Buyer Client to transfer an inquiry to the Master Broker. Inquiries are sent out during the bid preparation or procuring process and can be semi-automatically generated by the e.bip/e.bid application.

**Receive Bids:** The use case triggers the Buyer Client to download received bids (answers to inquiries) from the Master Broker. The function is called during the bid preparation and procuring process to capture, compare, or confirm the conditions of bid/order items and to incorporate the conditions into the bid and order documents of the building contractor.

**Check Stocks:** The use case interfaces with the stock management system or the Stock-Keeping Module of the e.bip/e.bid application (cf. Section 7) to check for existing and unavailable materials and to commission required material for an order.

**Prepare Invoice:** The building contractor can capture relevant information on the order processing phase (see corresponding use case) and can access the existing project data for generating (pro forma) invoices for a customer’s order. Furthermore, the application will allow computation of project-related list of piece wages as well as sending of invoices by electronic means (email) to customers.

**Provide Text Templates:** The e.bip/e.bid application will provide a library of text blocks from which the user can select the elements needed for generating a technical description of bid components, the final bid document, as well as order, order confirmation, and invoicing documents.

**Compute Statistics:** Statistics about bids, orders, invoices, and their deviations are also provided to help building contractors in the post-calculation process. To capture required user input, the use case ‘Capture Actual Values’ is triggered (data captured during the invoicing procedure can be re-used).

**Capture Actual Values:** By entering the actual required resources (manpower, material, machine-hours) for an order, the e.bip/e.bid application will support the contractor in computing statistics and preparing invoices.
7 Architecture of the e.bip/e.bid application

The e.bip/e.bid application is based upon the results of the CSCCM project, which consists of several modules, namely:

- supervisor
- civil work manager
- text module.

Figure 5 shows how these modules are embedded in the e.bip environment and extended by the new e.bip modules:

- material manager
- order-processing
- invoicing and statistics
- stock-keeping module.

The following sections detail the functionality of the different e.bid and e.bip modules.
Integration of bidding and procurement systems with e-marketplaces

Figure 5  Architecture of the e.bip/e.bid application

### Local Installation at Tile Layer

#### e.bid Modules (CSCCM)

- **Supervisor**
  - Capturing and Assessing Inquiries, Managing and Monitoring Bids and Orders
- **Civil Work Modeller**
  - Specifying Technical Solution (Material/Labour/Services), Calculation of Bid Price
- **Text Module**
  - Preparing Bid Documents, Invoices, Printing Lists

#### e.bip Modules

- **Order Processing Module**
  - Order Monitoring/Tracking, Capturing of As-Is Data
- **Invoicing and Statistics Module**
  - To-Be/As-Is Comparisons, Global Statistics, etc.
- **Stock-Keeping Module**
  - Capture Transactions, Support Commissioning
- **Material Manager**
  - Master Data Repository, Price Requests, Material Ordering

---

7.1 **Supervisor (SV)**

The Supervisor enables its user to organise, manage and monitor bid projects. Each inquiry from a customer is captured and assessed by this module. The module provides an interface to the overall project data enabling easy and fast access to current project information. In e.bip, the SV will be extended not only to monitor bids, but also to provide the necessary information about orders and ongoing building projects. The overall functionality of the module includes:

- capturing of customer requirements
7.2 Civil Work Modeller (CWM)

The Civil Work Modeller allows the project engineer to specify the product (or service) and to calculate its price. By selecting components from the company-specific product programme contained in a database, a bill-of-material-and-labor is generated and a technical description of the components is prepared for the text module. After the technical solution has been specified, its costs are calculated and a realistic bid price is determined.

The CWM addresses companies that are selling material and labor modelled through craftsmanship and civil work activities. This applies to main contractors like Baldauf. The major part of order processing takes place in the construction site. The CWM provides the following functions:

- selection and configuration of bid components (materials, processes, labor rates, surcharges)
- management and reuse of existing product descriptions
- calculation of internal costs (material and labour costs, overheads)
- calculation of the final price.

7.3 Text Module (TM)

The Text Module supports the preparation of the final bid document and the creation of an attractive layout. It accesses the other modules and extracts the relevant data to be configured by the user for an appropriate and attractive sequence. It also provides lists with data from other modules (product lists, customer lists, prepared bids, etc.) and make them available in the necessary formats. In e.bip, it will be extended to provide invoice documents, statistics, etc. The functions of the TM can be summarised as follows:

- preparation of attractive text documents
- selection of components to be presented in the bid document
- application of predefined document templates
- management and selection of predefined text blocks
- exporting all of the above into different file formats.

7.4 Material Manager Module (MMM)

The Material Manager is the central repository for material data within the e.bip bidding and procurement system. It can be used to communicate with the e.bip Broker Network
Integration of bidding and procurement systems with e-marketplaces

by means of the Buyer Client for submitting price requests, ordering material, import of material information and synchronisation of the master data repository. Also, its API is used by the other modules to obtain lists of material, navigate through the available material information, etc. The Material Manager (cf. Figure 6) offers the following functions:

- Maintain a master data repository of material and suppliers.
- Initiate price requests and handle the results obtained from the master broker service.
- Initiate the ordering process for bid-related materials.
- Retrieve hot list data (i.e., products or suppliers selected on the website) from the Master Broker Service and import the collected items into the data repository.
- Synchronise the data repository with the Master Broker Service (e.g., retrieve new prices for standard materials, supplier data updates, information on added/removed materials in the subscription lists, etc.).

Figure 6  Sample screen shots of the MMM

7.5  Order-Processing Module (OPM)

The Order Processing Module is responsible for managing and capturing order-relevant information, administering an order history, ordering materials and commissioning stock
materials. The module captures all order-relevant bidding data when a bid becomes an order, and allows monitoring of the progress of a customer’s order. The main functions supported by the Order-Processing Module can be summarised as follows:

- manage and capture order-relevant data (e.g. as-is material consumption, as-is work volume, etc.)
- compare the as-is and to-be order/bid data
- administer an order history
- check and commission required stock materials for an order
- generate and manage supplier orders
- support comparison of ordered versus delivered/returned materials.

7.6 Invoicing and Statistics Module (ISM)

The Invoicing and Statistics Module provides an overview of the actual costs of an order for invoice preparation and post-calculations. Also, it provides global statistics about bids and orders from a selected time range. This module can be used when an order has been served so it does not monitor an order’s progress (this is done in the Order Processing Module). The Invoicing and Statistics Module provides the following functions:

- overview of all order related data
- collection of all data about material withdrawal, subcontractor expenses, etc. from the OPM
- calculation of internal staff costs, overheads, and general costs for vehicles, transport, or tools
- comparison of the data with the calculated costs in the bid and provide a deviations report
- performance of miscellaneous global statistics.

7.7 Stock-Keeping Module (SKM)

The Stock-Keeping Module provides basic stock-keeping functions for the tile layers. The module allows:

- management of stock materials
- generation of stock material orders
- creation of inventory lists for the stock.

The module is an optional part of the e.bip/e.bid application that can be replaced by other commercial MS-Windows and ODBC compatible warehousing systems. The main functions of the module includes:

- management of information on stock items
- provision of search functions for stock items
• checking of stock for items to be ordered and generation/management of orders for stock materials
• capturing of incoming stock materials and delivery data
• supporting comparison of ordered versus delivered stock materials
• capturing of information on returned materials from a building site
• supporting of stock inventory by generating inventory lists, capture forms, and deviation reports.

8 Technical overview

The Master Broker System will reside on a server allowing users to access e.bip services on the internet, either through a standard browser or a Java Client Application (like the Client Modules which uses Java). The web layer provides the interface to the Master Broker system. Due to its dynamic model, the web interface will be provided using JSP (Java Server Pages) technology accessing the Java components residing on the Master Broker System server.

XML will be used for the data exchange between the Master Broker System and the Client Modules. The catalogue information exchange will be based on the Electronic Catalogue XML (eCX) data type definition (DTD), as it provides a method for electronic catalogue interoperability. The e.bip consortium also cooperates with standardisation authorities like ASCER (cf. [11]) and the C-ECOM project (cf. [12]) to facilitate the establishment of a standard for the formal description of tile attributes and tile identification. The transfer of the XML files will be accomplished by using the Simple Object Access Protocol (SOAP) – a light, http-based protocol.

The Buyer and Seller Modules will reside on the clients’ computers to support the communication between the e.bip Master Broker System and the existing IT systems of clients. Clients can use the Client Modules by downloading the applications, installing them on their computer, and configuring the wrapper for their existing IT system. To provide the most flexible and platform-independent solution, Java will be used to implement these modules.

The Procurement Module will be an extension of the existing CSCCM/e.bid software system and will be implemented using Visual Basic with a Microsoft SQL-Server. The communication between Buyer Module (Java) and Procurement Module (DCOM) will be done by using a DCOM-Java Bridge software like JCom (OpenSource). Figure 7 shows the main technical decisions regarding the e.bip architecture.
9 Expected benefits

Baldauf’s investments in new technologies and related organisational changes are expected to result in an increase of productivity and quality of the bidding, procuring, and invoicing activities by facilitating transactions. The direct impact will be the reduction of time and cost of the processes. Using modern communication technologies will lead to a higher degree of information on new products—their characteristics, prices, and availability as well as potential suppliers of the merchandise.

These goals can hardly be ascertained by a measuring system because the volume/time of business processes vary according to the volume of orders. Nevertheless, Baldauf quantified the following productivity goals (cf. Table 1). The as-is values have been taken from year 2000 and the target values will be evaluated after the implementation of the e.bip solution.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>As-is</th>
<th>To-be</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of suppliers per price inquiry</td>
<td>2-3</td>
<td>4-6</td>
<td>100%</td>
</tr>
<tr>
<td>Average bid prep time / man hours</td>
<td>3</td>
<td>2</td>
<td>33%</td>
</tr>
<tr>
<td>Average bidding cost</td>
<td>180 €</td>
<td>120 €</td>
<td>33%</td>
</tr>
<tr>
<td>Bid success rate</td>
<td>72%</td>
<td>80%</td>
<td>11%</td>
</tr>
<tr>
<td>Average bill prep time (man hours)</td>
<td>4</td>
<td>1</td>
<td>75%</td>
</tr>
</tbody>
</table>
Table 1  Baldauf’s expected benefits (continued)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>As-is</th>
<th>To-be</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average billing cost</td>
<td>240 €</td>
<td>60 €</td>
<td>75%</td>
</tr>
<tr>
<td>Average post-calculation time per order</td>
<td>3 hours</td>
<td>1 hour</td>
<td>67%</td>
</tr>
<tr>
<td>Average post-calculation cost per order</td>
<td>180 €</td>
<td>60 €</td>
<td>67%</td>
</tr>
</tbody>
</table>

10 Conclusions

The paper has presented the e.bip approach as an innovation in the bidding and procurement processes of tile layers by developing a new broker service in the supply chain of the tile industry and by integrating the electronic marketplace with a local application for tile layers.

The Baldauf case study revealed that the efficiency of the bidding and procurement processes of tile layers could be considerably increased. The developed model of an optimal to-be situation has been generalised and used as a basis for specifying the e.bip/e.bid application as well as the overall e.bip system architecture. It is expected that the e.bip solution will lead to a higher acceptance of electronic brokerage systems by emphasising on integration with existing systems and workflow support without neglecting the usual ‘internet way’ of doing business on an online marketplace. Due to the generic nature of the architecture, the e.bip solution is also expected to apply to other branches of the building industry and sectors characterised by a similar supply chain management. Since the tile business is a very dynamic area in the construction business with respect to the life cycle of product information, a successful implementation of the broker service in this sector represents an excellent test bed of the broker concept to prove the transferability into other sectors.

At the time of writing this paper, the specification of the software components of the project has been done and the development of the system has started. The first prototype of the systems was available in December 2001. Following the implementation phase, pilot projects will be established for all roles of the tile supply chain to evaluation, test, and refine the software. Future findings and results will be made available on the e.bip homepage on the World Wide Web (cf. [13]).

Acknowledgment

This work is partly funded by the European Commission through IST-1999–10710 project e.bip ‘Efficient Bidding and Procurement in the Tile Industry – Practical Trading Tools and Broker Services for the Exchange of Product Characteristics.’ The authors wish to acknowledge the European Commission for their support. We also wish to extend our gratitude and appreciation to all e.bip partners for their strong support and valuable contribution during the various stages of the activities presented in this paper.
References


