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The integration of activity based costing and enterprise modeling for reengineering purposes

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Abstract

This paper describes an approach to integrate the Activity Based Costing (ABC) technique within the framework of GRAI Integrated Methodology (GIM) in order to assist business process reengineering justification and evaluation. The first step of integration is to have ABC adopt cost pools and lists of activities derived from GIM process modeling. Further on ABC is involved in two stages of the methodology: (a) ABC adds to the ECOGRAI method of performance modeling by supporting the determination of the right performance indicators that are responsible for business process costs. (b) ABC is a sound approach to translate operational performance indicators not found in accounting ledgers into financial terms and the company's profit bottom line. The approach has been developed during the Esprit research project REALMS and implementation results from two industrial partners are presented.

Keywords: Reengineering; Benchmarking; Activity based costing; Enterprise modeling

1. Introduction

The 1990s can be characterized as the decade of change. The struggle to gain or even sustain competitive advantage in a global market, in most of times, has led many companies to alter the complexion of many businesses. As a result, the direct cost of products and services become shorter and shorter. All the above affect critically the cost structure of the enterprises. The increase of overheads in comparison to direct costs is outstanding in the manufacturing sector [1] and a need for an allocation in a more equitable manner among dissimilar products and customers is identified [2,12,24]. It is worth saying that the extremely demanding market calls for products of higher quality and lower prices. The slogan "the customer pays for only the services he gets" clearly depicts the market pressure [3]. The new economic and competitive realities, as businesses evolve into the 1990s affect the management as well. The organization must adapt to the changing environment in order to survive and the role of management information is fundamental to a more long-term development of management capability [4].

Management information must reflect reality, be predictive, embody strategy, explain cause and effect, reflect the customer's perspective, determine the relative profitability of both products and

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customers, relate to the business processes, be in the language of management.

Enterprise modeling and Activity Based Costing (ABC) try to satisfy the above needs, having the objective of improving business performance and sustaining this improvement in the future. A lot of success stories have been reported [5,6] trying to define the most appropriate implementation in a company. Information Technology (IT) has definitely been an enabler of ABC [7] and has helped its extensive use in Business Process Reengineering (BPR) projects [8].

It is well recognized in the literature that one of the most difficult tasks in the development of an activity-based cost system is the identification and design of the activities that should be included in the processes. Many modeling tools are available nowadays, whether for incremental (TQM) or radical enterprise system analysis, redesign and improvement (BPR). Enterprise modeling is an important prerequisite for a successful BPR project [9]. Many different methodologies exist, such as SADT, NIAM [10] or ARIS [11], all of them having the same purposes:

- to handle the complexity of the real world,
- to precisely model the business processes with sophisticated mapping techniques,
- to be understandable, flexible and descriptive.

The integration of enterprise modeling with an activity-based cost system is recently been studied, the most popular approach being this of IDEF-0 modeling with ABC. Many different software programs, such as Activa, EasyABC, TRM/ACM, Profit Manager, DaCapo Process Manager [12–14] combine modeling techniques, activity based costing and/or simulation. However, this kind of integration has not always been successful.

ABC was treated as an accounting approach in the context of strategic management accounting that can help the company in planning, control, decision measuring and performance evaluation. No systematic search for the activities to reengineer or for the appropriate performance indicators and related cost drivers is included in the above software products.

In the following paragraphs, an account of work done within the ESPRIT project REALMS (REengineering AppLication using Modeling & Simulation) will be presented. This project's goal was to prove that the integration of enterprise modeling, activity based costing (ABC) and simulation to support reengineering is feasible and would lead to considerable benefits for the industrial pilot users.

The long-term goal of the project is the development of an integrated methodology and software tool to support business process reengineering and benchmarking in mid-sized European companies. No similar integrated tool existed up to now that combines different scientific disciplines (*Systems Analysis, Simulation, Cost Accounting, Engineering Economics, Management Consulting*).

2. Approach

The methodological steps followed in the REALMS project that combine enterprise modeling and ABC for reengineering purposes are the following (Fig. 1). The main difficulty in this kind of project is to detect the activities that need reengineering.

1. *Model a pilot users' critical business process*. The modeling tools used are those of GRAI Integrated Methodology (GIM) [15], i.e. IDEF-0 for the physical and functional views of the business process, GRAI-grids and GRAI-nets for the decisional views. Those tools are included in the software product IMAGIM.
2. *Develop a performance model for the selected business process*. The performance measurement tool used is the ECOGRAI methodology [16] to define performance drivers (time, quality, cost/productivity) in relation to the objectives and the decision variables of the business process. Activity based costing (ABC) is added here to the ECOGRAI approach in order to support the determination of the right performance indicators that are responsible for the business process costs (cost drivers).
3. *Conduct benchmarking* based on the performance model developed in step 2. Identify examples of best practices, compare to the existing

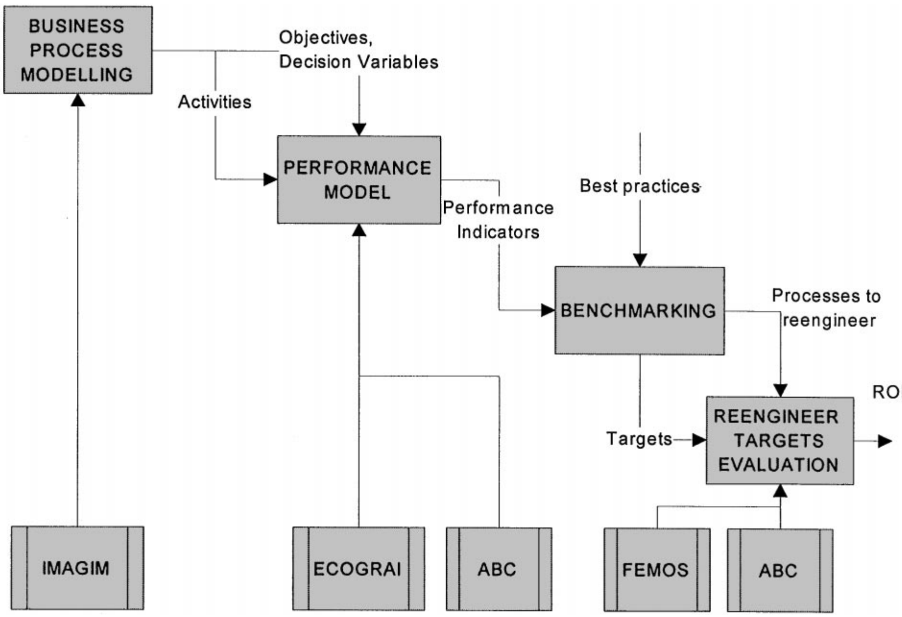


Fig. 1. Overview of the approach.

performance indicators and set targets to be pursued by the reengineering actions.

4. *Evaluate reengineering targets*. Those targets set in step 3 are usually expressed in the form of operational indicators (e.g. lead times, inventory levels, etc.). Those indicators need to be translated in financial terms, a task which is almost impossible to be handled by traditional cost accounting systems. Two different stages are defined at this point: (a) evaluation of the proposed improvement and (b) evaluation during the implementation phase. Activity Based Costing (ABC) seems to be here the ideal approach to calculate Return On Investment (ROI) coming from the improvement of such operational indicators.

A more detailed description of those parts of the above approach that require the integration of Activity Based Costing is presented in the next paragraphs.

2.1. Model a pilot users' critical business process

Among the possible set of processes that represent material/information flows across the logistics chain, the Customer Order Flow [17] has been chosen in this project as being the most critical from the pilot users' point of view, in order to be the subject of business modeling and reengineering.

The customer order flow involves and cuts across the *sales, costing, product development, production planning and shipping/distribution* functions of both pilot industrial users. The two pilots are absolutely complementary across the value chain in the specific user sector of semi-processing of non-ferrous metals. ELVAL (GR) is a producer and supplier of semi-processed aluminum products, while TUBUSMETALL (D) is a wholesaler of non-ferrous products and a producer of components using semi-processed raw materials (Fig. 2). For both of them the customer order flow is of utter importance due to the vast number of product varieties according to customer requirements.

The processing of customer orders considers the logistics chain from the customer's request to the delivery of the product. The first step is to calculate the costs and the delivery date for a customer request concerning the capacity resources, the costs of raw material, etc. Further on, the price which will be proposed to the customer has to be calculated based on the estimated costs.

The price and the date are fixed in the bid to the customer. On this basis the customer will negotiate

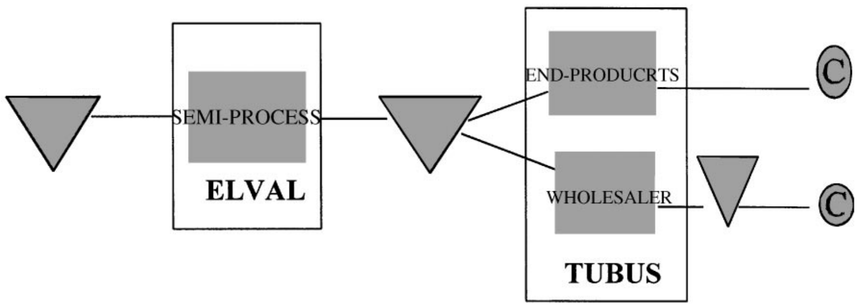


Fig. 2. The logistics chain of the two pilot users.

with the company. If the negotiation was successful, the negotiated delivery date and price will be fixed in the customer order. After the realization of the customer order the company can post-calculate the costs and the final delivery date is known.

2.2. Develop a performance model for the selected business process

The performance model includes a system of key indicators:

1. *Operational indicators* concerning time-based and process quality (reliability) performance measurement. For the business process and its critical activities chosen in this project (customer order flow and delivery date/price assignment decisions) this translates into indicators having to do with *delivery lead times (time-based)* and their *deviations (process quality)*. Another class of quality indicators is the *reliability of cost and price estimations* used to respond to customer requests.
2. *Cost drivers* and their reciprocal cost rates developed using the activity based costing (ABC) technique. The activities of ABC coincide to the activities of the activity model developed with GIM, thus making easier communication and integration of the key indicators model. For the customer order flow process, the ABC technique leads to a more fair distribution of *overhead costs* to customer orders that either require *special products/customers* or *small batch quantities*, compared to whatever is considered a standard product or a normal batch quantity ordered. This permits a better assignment of product prices.
3. *Productivity-driven indices* of the customer order flow process help to evaluate changes in sales output caused by accepted customer orders and changes in productivity caused by the treatment of those customer orders (e.g. manufacturing or outsourcing) using a profitability-based modeling approach. Those indices are based on *variable cost* calculations that help to define product profit contributions and profitable customer orders,and therefore they are complementary to the ABC cost drivers that deal with the distribution of fixed costs in pricing decisions [3,15,18,19,25].

As seen in Fig. 1, the performance model needs the input of activities that have been specified in IDEF-0 diagrams with the help of IMAGIM (Fig. 3). Constraint information for the performance model are the objectives (OBJ) and the decision variables (DV) of the decisional activities shown in the GRAI-nets (Fig. 4). The performance model itself is supported by ECOGRAI and ABC methods to produce a set of performance indicators (PI) that feed the benchmarking activity. The role of ABC is to support the determination of PIs that are drivers of business process costs. The collection of ABC data for the customer order flow process in the two industrial users has been done with the help of the form of Table 1, where the IDEF-0 and GRAI-nets activities coincide to the ABC activities.

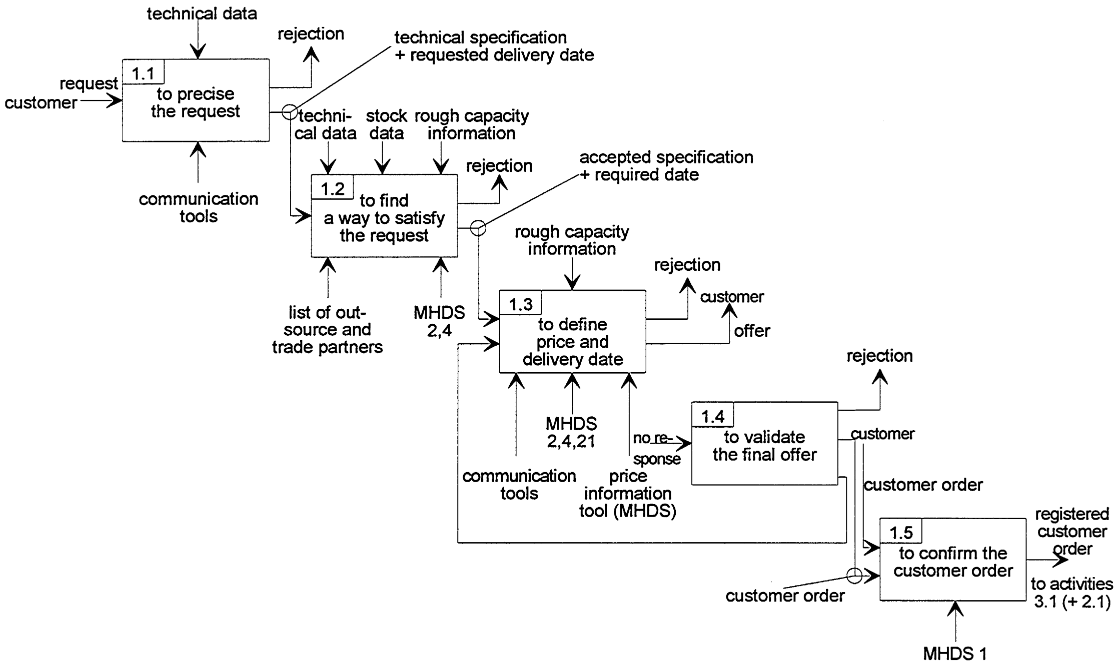


Fig. 3. A1-level, to create a customer order (activity 1). © REALMS Consortium of WP2 [20].

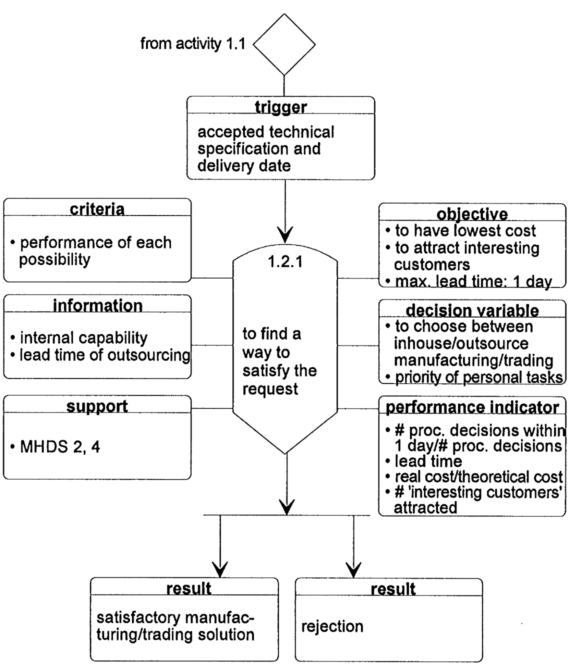


Fig. 4. GRAI net, to find a way to satisfy the request (activity 1.2), © REALMS Consortium of WP3 [3].

2.2.1. *Activity based costing (ABC)*

This method has been proposed as a solution to the overhead cost allocation problems. ABC differs from conventional costing in its treatment of non-volume related overhead costs. Many significant *overheads are related to specific activities* which are relatively independent of production volume. It is the volumes of such activities (not the volume of production) which consume resources and therefore determine the overhead cost. These activities drive the overhead costs and ABC uses such activities for both product costing and process control.

When activities are segregated in this way, a hierarchy emerges. Some activities, like hot-rolling, are performed on individual units. Others – setups, material movements, and first part inspections – allow batches of units to be processed. Still others – engineering product specifications, process engineering, product enhancements, and engineering change notices – provide the overall capability that enables the company to produce the product. And plant management, building and grounds maintenance, and heating and lighting sustain the manufacturing facility.

Table 1
The data collection form for activity based costing

Sales office 1	Personnel cost	Equipment	Total cost	Active volume	Selected cost driver	% Activity consump.
A1. To create a customer order	**1 412 385**	**1 412 38.5**	**1 553 624**	10 827	No of customer orders	34.91
A1.1. To precise the request	70 248.75	7024.875	77 273.625	13 367	No of customer requests	34.91
A1.2. To find a way to satisfy the request	280 995	28 099.5	30 9094.5	12 030	No of offers	34.91
A1.3. To define price and delivery date	**842 985**	**84 298.5**	**927 283.5**	12 030	No of offers	34.91
A1.3.1. To calculate price and delivery date	561 990	56 199	618 189	12 030	No of offers	34.91
A1.3.2. To negotiate with customer	140 497.5	14 049.75	154 547.25	12 030	No of offers	34.91
A1.3.3. To send offer to customer	143 461.5	14 346.15	157 807.65	12 030	No of offers	34.91
A1.4. To validate the final offer	143 461.5	14 346.15	157 807.65	12 030	No of offers	34.91
A1.5. To confirm the customer order	71 730.75	7173.075	78 903.825	10 827	No of customer orders	34.91
Support activities						
Setup					No of setup hours	
Material handling	14 000	1400	15 400	2868	No of operations	20.00
Buying	29 520	2952	32 472	1206	No of supplier orders	23.79
Receiving	10 080	1008	11 088	2446	No of receivings	28.71
Quality control	12 000	1200	13 200	10 827	No of customer orders	34.91
Machine processing					Std labor hours	
Packing	168 000	16 800	184 800		Std labor hours	
Production planning and control	6000	600	6600	8662	No of production orders	34.91
Shipping				13 486	No of invoiced tons	37.03
Maintenance					Std labor hours	
Warehousing	9800	980	10 780		Storage time	
Inventory control	12 000	1200	13 200	8301	No of invent. transactions	20.00

Business process information is enhanced by using a measure of the volume of each activity (or cost driver) to generate a cost rate which could be used not only to cost production but also as a performance measure for the activity concerned.

2.2.2. *Internal cost drivers and induced cost drivers in a manufacturing environment*

The customer order promising process (delivery date and price assignment) includes a mix of executional and decisional activities. Those activities consume *internal process resources*, mainly of administrative nature (salaries and other equipment and operational overhead expenses of the sales dept., costing dept. and engineering dept.).

The allocation of this kind of expenses is done with the help of *internal cost drivers* whose consumption volumes characterize the internal work of the business departments that directly take part in the order promising process.

However, the characteristic of the decisional activities of the order promising process in manufacturing is that they *seriously influence the factory overhead expenses* and the cost drivers of factory *support activities*. For example order promising decisions to accept special products influence the *product sustaining activities*, and decisions to accept small orders influence the *batch level activities*. Consequently, we define the so-called *induced cost drivers* of factory support activities (Table 1).

2.3. Target evaluation

This part of the approach follows benchmarking, where examples of best practices have been detected and compared to the existing performance indicators of the industrial users. The outcome of benchmarking is a set of processes to reengineer with their associated targets expressed in performance values.

The component productivity measures that evaluate the performance of a single activity or a relatively small organizational unit (*indicators*) assist first-line managers in improving productivity. Goals are established for the productive use of resources, and actual performance is compared to the predetermined objectives. New thoughts on this subject in relation to advanced manufacturing environments [21] claim that traditional summary measures of local performance – purchase price variances, direct labor and machine efficiencies, ratios of indirect to direct labor, volume variances – are harmful and probably should be eliminated, since they conflict with attempts to improve quality, reduce inventories, and increase flexibility. Moreover, direct measurement is needed for quality, process times, delivery performance, and any other operating performance criterion that companies want to improve [22].

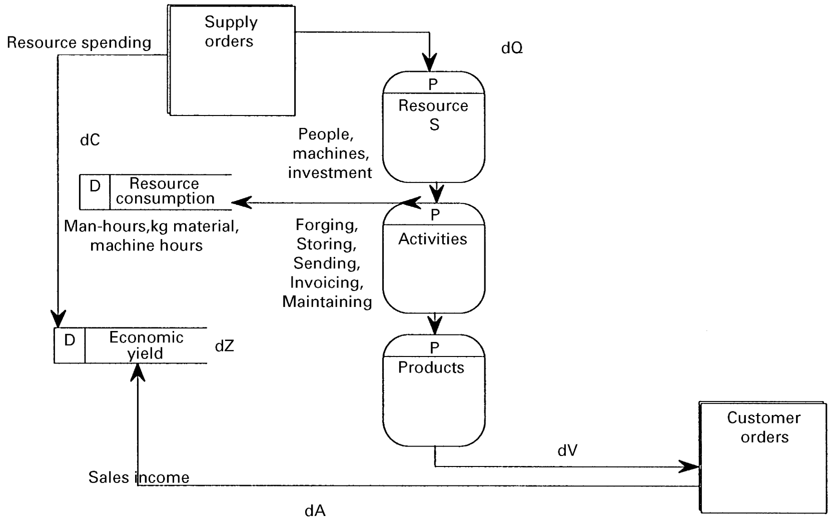
However, these operational measurements have somehow to show ability to integrate with financial measurements in order to support the improvement of the company's bottom line. What is needed is a *translator* of operational (or logistics) performance indicators into financial terms having to do with the profits bottom line of the company. The role of this translator is played in our approach by ABC. The sequence of reengineering targets evaluation during the REALMS project is as follows:

- Performance evaluation compares the documented targets expressed in the form of performance indicators to the actual performance of the two pilot users during the project. The improvement of performance indicators is measured at the pre-implementation phases by simulation using the FEMOS system [22] and during actual implementation in specific time-phased data collection steps. The performance indicators include logistics measures as well as cost/productivity measures.
- Activity based costing is used to translate logistics measures into financial measures. It is the only accounting method to measure and evaluate inventory and lead time policy costs usually not present in the formal cost accounting ledgers.
- Economic evaluation will provide financial measures at the enterprise level that influence the financial results of the pilot users' companies. This is the ROI (Return on Investment) of the solutions implemented during the REALMS project.

2.3.1. Profitability modeling based on overhead costs (ABC)

Fig. 5 shows the basic profitability model used. The main difference from traditional engineering economics models is that products do not consume resources (production factors) directly (at the unit level). Instead, they consume resources through activities [26]. In our example the Customer Order promising process (*A1. to create a Customer Order (C.O.), A12. to find ways to satisfy the request, A13. to define delivery date & price* according to the GIM activity model) should guide the company *to accept customer orders that increase profitability*.

The use of activity based costing avoids the pitfalls of traditional costing practices, where standard products (in terms of product specifications, lot sizes and delivery conditions) subsidize special products [23]. A more fair distribution of overhead costs using activity based cost driver volumes results in better pricing decisions: "Raise prices for customer orders that make heavy demands on



dV=Change of customer orders mix, dA=Change of sales economic value, dQ = Change of resources, dC=Change of costs, dZ=Change of profits

Fig. 5. Profitability model.

overhead resources and lower prices to more competitive levels for high-volume standard products. With this repricing strategy the company should arrive at a new customer order mix that either makes fewer demands on its resources or generates more revenues for the same consumption of resources".

3. Sample analysis and results

A sample analysis was carried out in a six month period for the two pilot users of the REALMS project. In both companies, ELVAL (GR) and TUBUSMETALL (D), the five most important product families were identified and information was attained for all of them. For these product groups, the internal and induced cost drivers have been determined. Their volume as well as the relative consumption and costs of the activities have been calculated. These costs are necessary in a future stage of the project in order to evaluate the following reengineering actions:

- calculate the financial impact changing performance indicators' values,

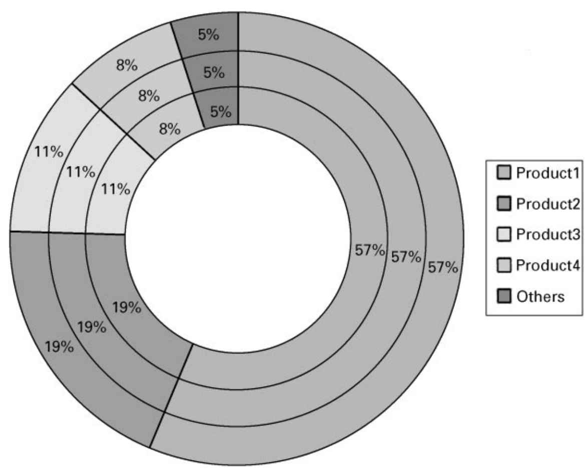


Fig. 6. Percentage activity consumption for ELVAL (GR) in activity A1, to create a customer order.

- reduce the number of activities of the business process (effectiveness),
- reduce resource consumption per activity of the business process (efficiency),
- make better decisions (e.g. price and due date assignment, inventory policy).

3.1. Collection of relevant information

With the use of GIM (GRAI Integrated Methodology), all the customer order flow activities were identified. Based on the results of the above methodology, we generated a questionnaire form which was suitable for both companies. Questionnaires were given to employees, they were filled with data and then were returned. It was understandable that some of the necessary information was not available in the databases of the companies in the past, so estimations had to be taken into account. As a result, a fine-balance should be found between the filled pre-formatted questionnaires and some face-to-face personal interviews with key employees of the pilot users. Wherever possible, estimations were cross-checked to minimize errors. Conflicting data were not used at all.

3.2. Results

Results are illustrated in the following diagrams, concerning the Activity "to create a customer order" and the most important support activities.

The comparison of the results between the two different enterprises enabled a benchmarking analysis which is depicted in Figs. 6–11.

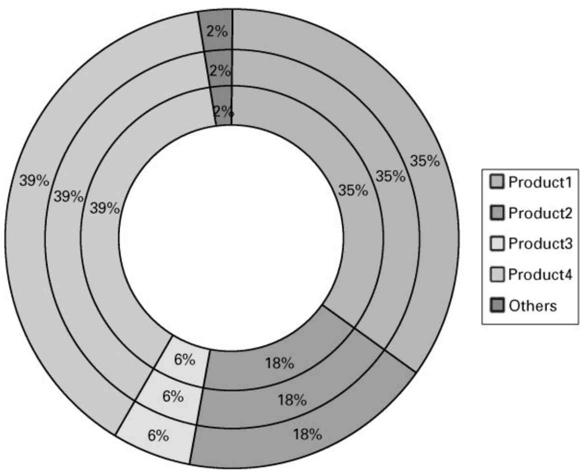


Fig. 7. Percentage activity consumption for TUBUS (D) in activity A1, to create a customer order.

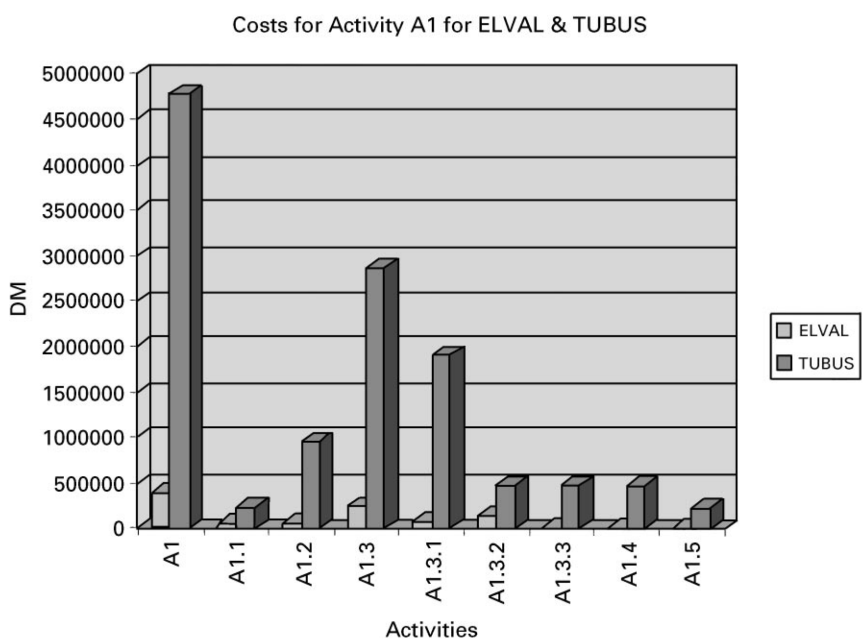


Fig. 8. Comparative results between TUBUS (D) and ELVAL (GR) for the costs in Activity A1: To create a customer order.

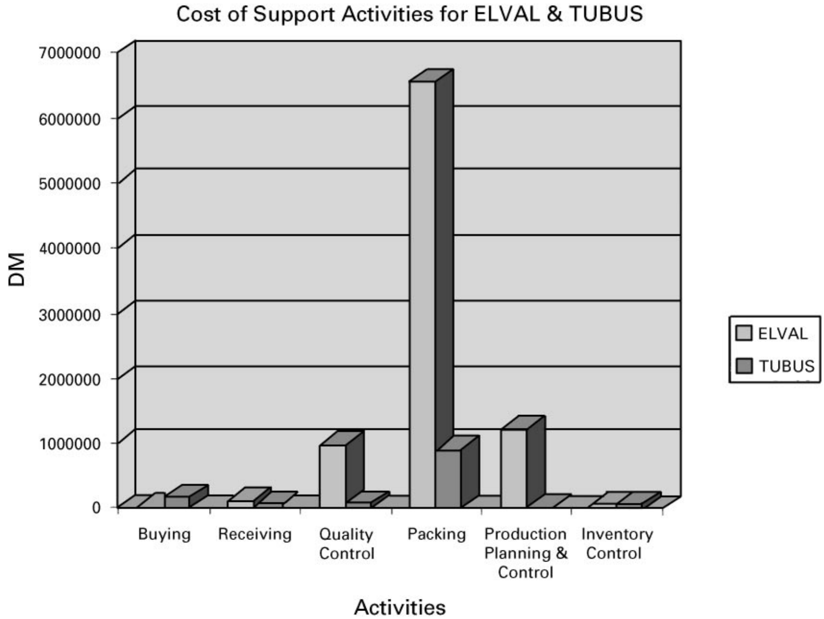


Fig. 9. Comparative results between TUBUS (D) and ELVAL (GR) for the costs in selected support activities.

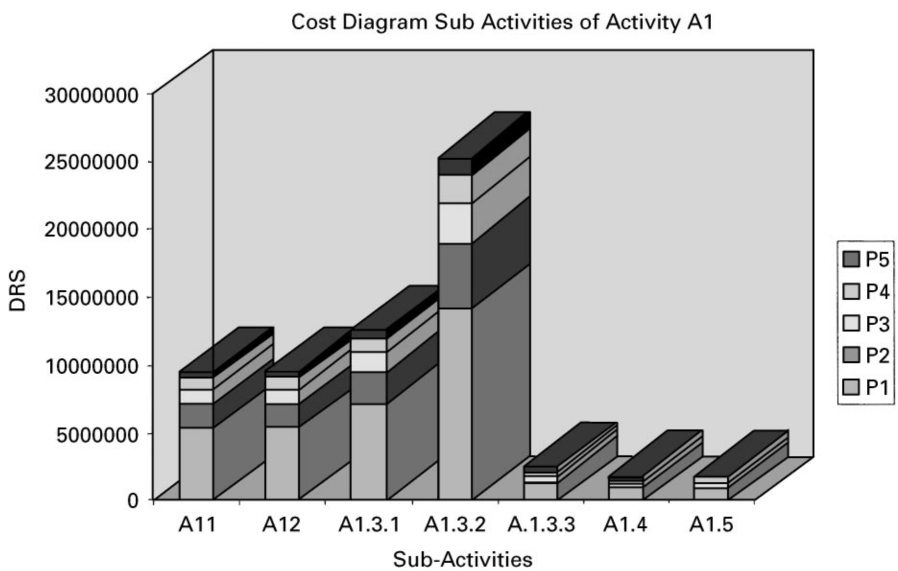


Fig. 10. Costs for sub-activities of activity A1 (to create a customer order) for the 5 different products in ELVAL (GR).

The outcomes of the analysis highlighted many important issues connected with the creation of the customer order for the two companies:

- Firstly, the activities with the largest costs were identified in both cases (Figs. 8–11). This is a basic concept in activity based costing and

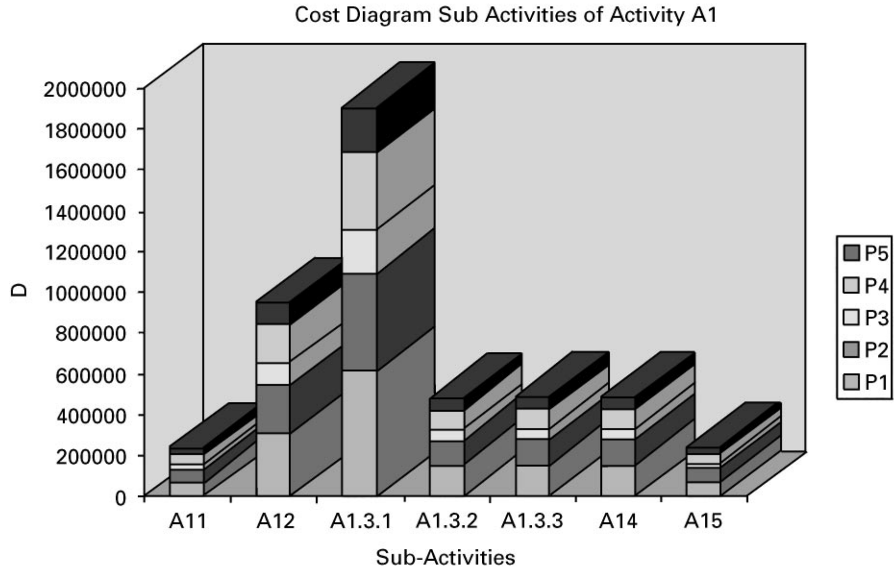


Fig. 11. Costs for sub-activities of activity A1 (to create a customer order) for the 5 different products in TUBUS (D).

activity based management saying that cost can be reduced where cost occurs.

- The cost was allocated to different products and activities. This helped the organization to create a clearer picture of the cost per product sold (Figs. 10 and 11).
- The cost of creation of one customer offer and order could be calculated (using information from Table 1), giving a good productivity indication of the process. This analysis could not be easily carried out with a different approach.
- The cause of cost in each activity was found with the analysis of different cost drivers for every activity and product (Figs. 6 and 7).
- Finally, the differentiation of the two companies could be explained by the generation of benchmarking analyses per product in an activity level, for the creation of the customer order process.

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