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ADAPTIVE WEB-BASED QUOTATION GENERIC MODULE FOR SME'S

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Abstract: *Current trends in manufacturing engineering activities show the direction spreading from system-level to multiple-system-level design, for instance, from product-level optimality to optimality for the portfolio of products, from one SME to a network of cooperating SMEs, etc.*
The objective of the current study is to analyze the product lifecycle and quotation generation processes in different enterprises as well as to find out their weaknesses and strengths in different processes. There will be created a concept of web based module for collecting the client's data and requests enabling to classify the product BOM and manufacturing route. Finally it allows calculation of the product's optimal price levels and making the automatic offers through the web. The proposed module increases the cooperative enterprises effectiveness, sales volumes and profitability. *Keywords: Product lifecycle management, ERP, SCEM, product development, e-manufacturing*

1. INTRODUCTION

The increasing competitiveness in global market highlights the importance of design, quality, productivity, multi-company collaboration, optimal price levels and production process predictability. The manufacturers are now under increasing pressure to keep their places in the market. To improve their ability to innovate, bring products to market faster, and reduce manufacturing bottlenecks, the manufacturers have been improving their product development and management abilities. In the recent years has been seen growing investments in the area of product lifecycle management (PLM) [1,2].
Product lifecycle management helps enterprises to achieve their objectives of reducing costs, improving product quality and minimizing time-to-market by directing the various business functions toward the common goal of controlling and managing product data throughout the product lifecycle. For small and medium sized enterprises (SME), selecting the right solution can be even greater challenge due to limited resources available for the evaluation process [3,4].
Product structure management represents one of the most important aspects of PLM. It evolves according to the different requirements through-out the product lifecycle, product structure management aims to integrate these heterogeneous points of view on product data and product structure. The BOM is the technical document on describing the product's structure, it is used to depict the structure and relationships between the final product, sub-assemblies, outsourced parts or materials (produced outside), as well as the corresponding quantities of the sub-parts and materials of each assembly [4,5].
In one hand our proposed adaptive web-based quotation generic module is tightly integrated with the product structure management and BOM as after defining the product and its structure we can calculate the product's price. From the other hand it is closely integrated with the enterprise resource planning system (ERP). The most important modules that an ERP systems supports are: sales,

marketing and distribution, enterprise solution, production planning, quality management, assets accounting, materials management, cost control, HR, project management, financials, and plant maintenance [6,7].

From the ERP system we can get the input information data to the calculation of product's price (material cost, purchase product cost, labor cost, overhead, special conditions dependent cost etc.).

2. BACKGROUND OF THE QUOTATION PROCESS

The cost of a product can be roughly divided into engineering costs, actual production costs, and cost of materials when focusing modeling on how the product is configured and a price determined (the quotation process). It is also necessary to make a rough dimensioning and classification of the product before a price estimation can be made. Complex products require a fast amount of engineering before the request can be answered with a quotation. If that engineering process is automated then it lower the final end product's cost. In the other hand, if the quotation-to-order ratio is low, an opportunity exists for raising of efficiency either by improving the ratio or by reducing the costs associated with developing the quotations.

The initial specification of the product during the quotation process has a major impact on the optimization of the product and disposing a large part of the total cost. It is crucial that the specification and/or classification would be correct and valid. Web-based product configuration systems can be used to optimize and streamline the tasks to be carried out in the quotation process [8,9,10].

The quotation generic module consists of three different modules, which are shown in Fig.1. Those modules are: quotation and customer relationship management (QCRM); resource management (RM) (in a manage production plan the output is available delivery time); product data management and product classification (PDMC) (the output is product price from the classified product structure and BOM). These are tightly integrated with each other and we can get the effective results only when they collaborate.

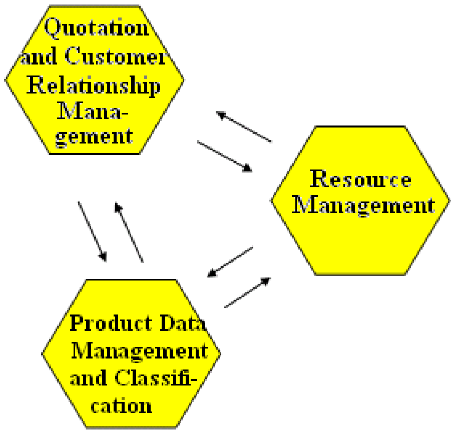

Fig. 1. Collaboration between modules

3. WEB-BASED QUOTATION GENERIC MODULE

The quotation generic module is also divided into three different levels: client, system and enterprise level. From the enterprise level (see Fig. 2) the system gets the necessary input data either automatically (from the enterprise ERP system) or manually (typed from the enterprise user). The collected data include material, labor, product purchase, overhead and special costs.

In the client level customer can input query data. Client level is brought out in Fig.3. In the system level is generated the quotation depending on the data from the client and enterprise level. Quotation data is saved in quotation database. The system level communicates automatically with the RM module to get the data for the product price and possible delivery time.

If customer confirms the quotation the system automatically generates an order, saved in order database and sent to enterprise via e-mail or web-page. The concept of the quotation generic module is brought out in Fig.3.

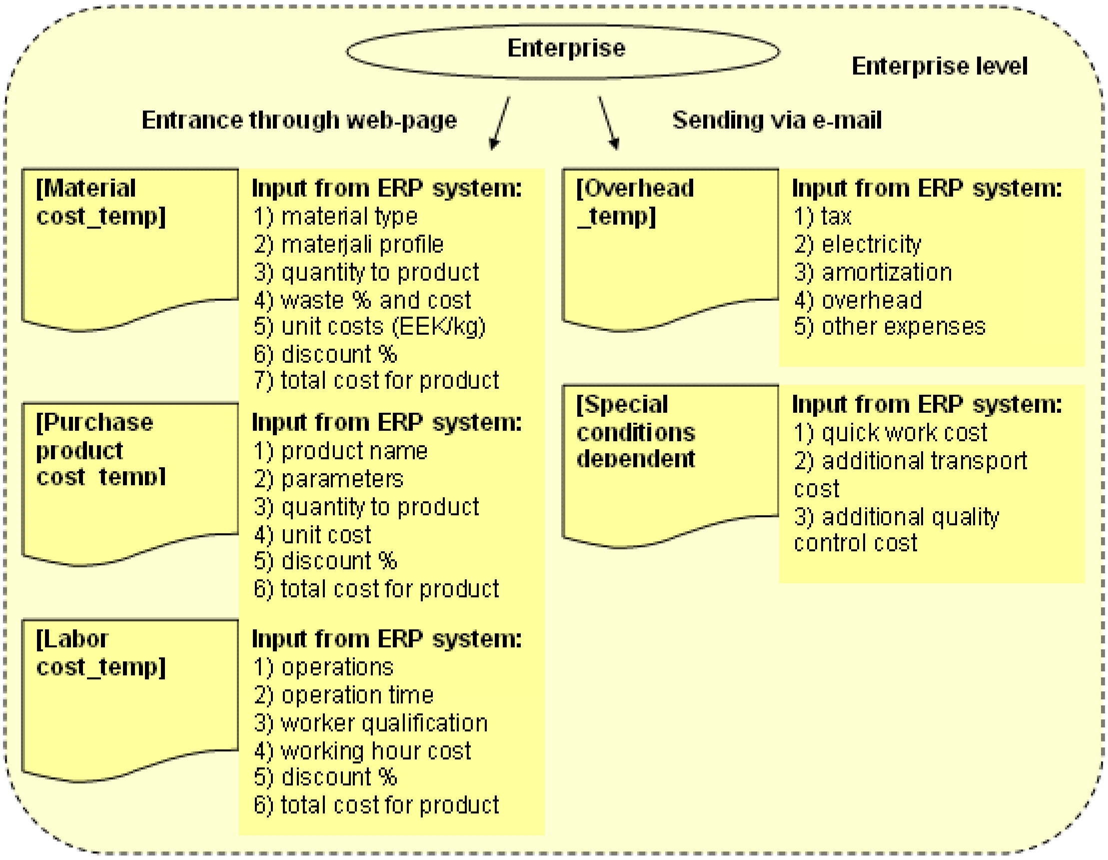

Fig. 2. Enterprise level description

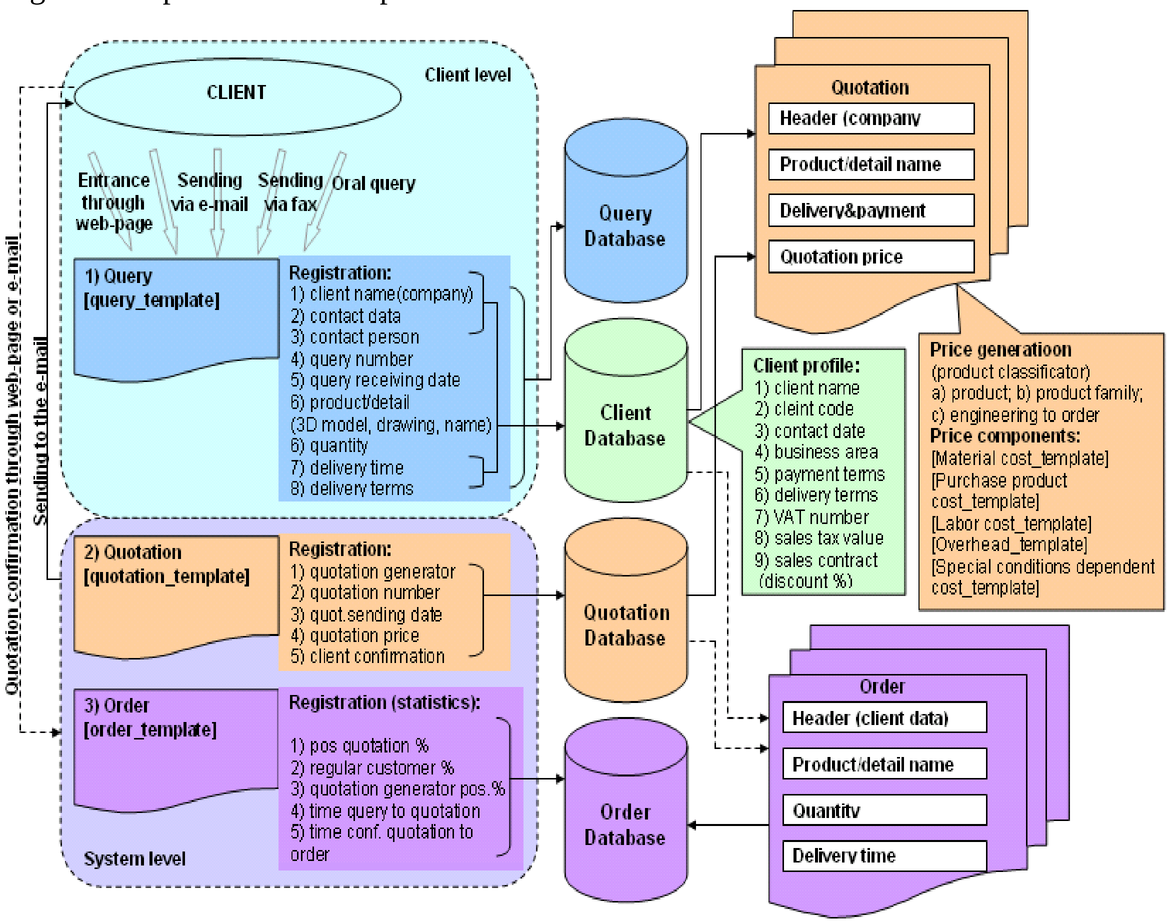

Fig. 3. Quotation generic module concept

Beside the general concept of the adaptive web-based quotation generic module it is important to understand and describe the quotation generation and order receiving process. Depending on the company structure and size the described process can be different, but the general parameters are same and can be easily varied.

In Fig.4 is brought out the quotation generation and order receiving process in general enterprises with the users' involvement.

Depending on the enterprise either the sales manager, project manager or general manager receives the query and enters it into the system. It is their first choice – accept or reject the query.

After that system classifies the requested product and generates the quotation using the data from the product classificatory module and resource management module. Sales manager, production manager, development manager, project manager, store manager or general manager checks the generated quotation and confirms it. Confirmed quotation will be sent to the customer. All modification and confirmation data will be saved in the quotation database.

During the communication between enterprise and client the quotation can be manually modified and re-sent to the customer if needed.

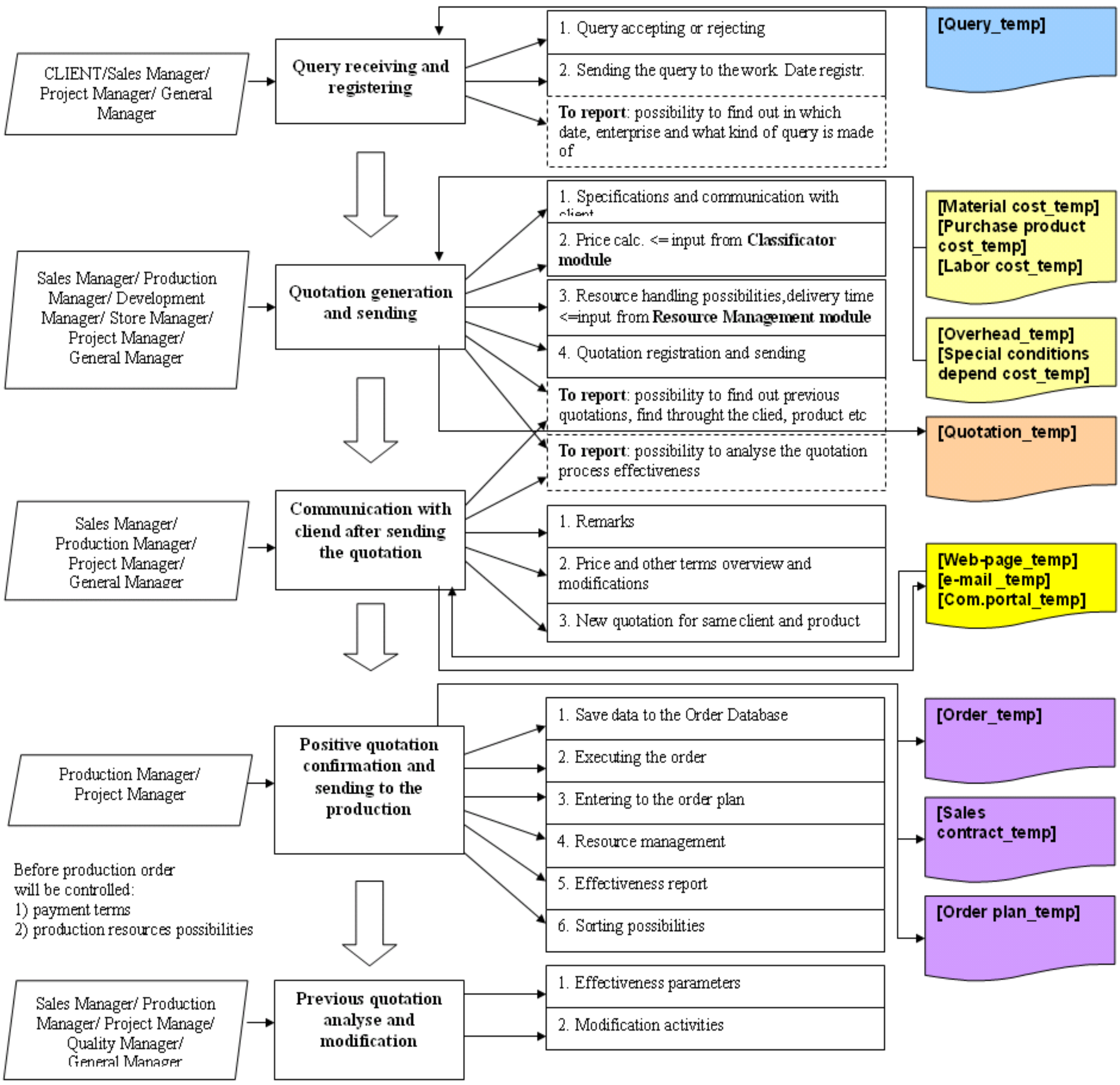

Fig.4. Quotation generation and order receiving process

If the client confirms the quotation it will be automatically updated to the order. System checks payment terms and production resources availability, in some cases the bookkeeper or general manager can manually confirm it, and after that the order will be sent to the production. The necessary data is saved in the query, client, quotation and order database. All data will be available through the internet.

4. CASE-STUDY OF ESTIMATING PRODUCT PRICE

To give an example of calculating the estimated product price in an automatic quotation module, manufacturing a casing of an autonomous robotic device with a comparatively new technology - Selective Laser Sintering (SLS) - will be analyzed.

Rapid prototyping is mostly based on slicing a three-dimensional model and producing a part layer by layer using that information. In the sintering-process the plastic powder is heated with a laser beam over its melting point and as the material cools down solidified layer is formed. The unsintered material has the supportive function. As the parts cannot be sintered directly to the building platform, a powdered is needed. In addition several layers of material are spread onto the produced parts. Both the powdered and top-layers carry the function to smoothen the cooling process.

The first expenditure by manufacturing parts by SLS is the plastic powder. The sample part is brought out in Fig.5 where dimensions are 105x100x52 mm and volume 74 775 mm^3.

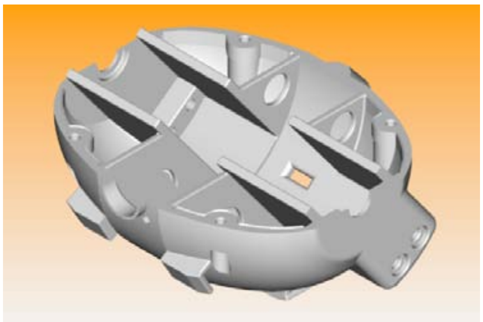

Fig.5. One side of the casing

The material is directly spent to the manufactured parts, but as the process chamber is heated near to the material melting point, the rest of the supporting material is also affected and as it has to be „refreshed“ with new powder additional powder is spent. Depending from the machine, SLS-machines mostly consume electricity and compressed air, hence these costs and in addition the amortization of the machine are taken into account. The total product cost is calculated with equation 1.

$$C_T = C_{pf} + C_{build} \quad (1)$$

Where: C_{pf} - preparation and finishing costs; C_{build} - part(-s) building costs;

Preparation, finishing and building costs comes from the equation 2 and 3.

$$C_{pf} = C_{mpf} + C_e + C_{cair} + A_{pf} \quad (2)$$

$$C_{build} = C_{mbuild} + A_{build} + C_e + C_{cair} \quad (3)$$

Where: C_{mpf} - material costs in preparative and finishing steps (powder bed and upper layers); C_e-cost of electricity; C_{cair}-cost of compressed air; A_{pf}-amortization of machine for preparative and finishing steps; C_{mbuild}-material costs in building; A_{build}-amortization in building a part.

Material costs in preparative, finishing steps and building is calculated with equations 4 and 5.

$$C_{mpf} = V_l * \rho_p * C_w \quad (4)$$

$$C_{mbuild} = (V_p * \rho_{smat} + V_{dmat} * \rho_p) * C_w \quad (5)$$

Where: V_l-volume of lower and upper material-layers; ρ_p-density of powder; C_w -cost per unit of weight;V_p-part(-s) volume; $\rho_{smat.}$-density of sintered material; $V_{dmat.}$-damaged material volume(powder).

Amortization of machine for preparative and finishing steps and building part is calculated with equation 6 and 7.

$$A_{pf} = (t_h + t_{lo} + t_{up}) * C_{tunit} \quad (6)$$

$$A_{build} = l * t_{la} * C_{tunit} \quad (7)$$

Where: t_h–heating time; t_{lo}–time to spread the lower material layer; t_{up}–time to spread the upper material layer; C_{tunit}–cost per time-unit. l–number of layers; t_{la}-layer building time. The parts are made layer-wise. If the volume of the part, layer thickness and approximate layer building time is known, it is possible to calculate approximate part self-costs to each part. The layer sintering time depends from the amount of the material to be sintered on actual cross-section, the quantity of layers has the main affect to the time altogether.

5. CONCLUSIONS

In the current study the product lifecycle and quotation generation processes in different enterprises were analyzed to find out their weaknesses and strengths in business chain. There was created a concept of web based module collecting clients' data and requests, whereas classifying the product BOM and manufacturing route. The proposed solution enables calculation of the product optimal price levels and automated offer generation for web-based applications. The module increases the cooperation enterprises effectiveness, sales volumes and profitability.

6. ACKNOWLEDGEMENTS

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