ASSESSMENT AND SELECTION MODEL
FOR MANAGEMENT SYSTEM SUPPORTING SMALL
AND MEDIUM-SIZED ENTERPRISES

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Abstract: The article presents analysis of selected ERP (Enterprise Resource Planning) systems in term of the application of the "Production" module in a manufacturing enterprise. Conditions for system evaluation and selection have been expressed in classes of criteria. In each class several practical criteria were considered and rated with great detail. The final results are presented on a point scale allowing the comparison of same class systems.

Keywords: assessment ERP systems, ERP system selection criteria, ERP evaluation model

SO IS USUALLY IS!

Taking part in a dozen or so of ERP systems implementation projects, from my observations, the method to choose an appropriate system by customers frequently consists in comparing functionality of selected primary a couple of systems. According to them, the best system is the one that has better functionality and a wider scope, fits to all company departments, has a nice interface, easy to implement, is reliable, etc. To avoid partiality suspicions during the system selection, customers compare them on their own responsibility. In this case, they often invite producers and their representatives to present their solutions, they ask for testing different tasks and sometimes they make reference visits in order to achieve users opinions about offered systems. From the statements of individuals taking parts when system selection, follows that the more facts they know about systems, then the less difference between them they note. Finally they feel confused. This shows that comparative method raises problems that are often difficult to deal. This happens because comparative methods assumes, that one

should be familiar with presented systems because only in this way they can be objectively compared. So the question is whether there is an alternative solution to the comparative method? and how to choose the simplest and better?

The main method that can be helpful when choosing an ERP system is to carry out an exact technical analysis based on a mathematical model, in which detailed selection criteria will be evaluated by individual users. Each of the criteria is given an indicator rating based on survey results (Table 1). The resulting indicators are corrected by other factors such as individual user preferences, risk or timeout of the project. On the basis of partial results, total assessment indicator for each considered system will be determined. Obtained result will not be definitive or incontestable because it depends on company type , its size and the preferences of groups taking part in the selection of the new system.

MODEL ASSESSMENT AND SELECTION OF INFORMATION SYSTEM

Consider i $\in$ (1..n) - baseline information system evaluation criteria. Basic rating indicator system selection (R) for adopted criteria can be defined as:

$$R = \sum_{i=1}^{n} x_i \tag{1}$$

Where:

x_i - assessing indicator for i-th selected criterion.

Considering that any single criterion consists of m particular criteria j $\in$ (1..m), then the sum of indicators at a given assessment level gives the evaluation indicator system selection:

$$R_{SI} = \sum_{i=1}^{n} \sum_{j=1}^{m} x_{ij} \tag{2}$$

x_{ij} - assessing indicator for n considered criteria.

The system selection indicator usually should be supplemented by individual user factors such as: the effect of personal preference arising from operated system attribute, the weight of each evaluation criteria, project timeout and/or budget exceeding ect.

Let consider the following - a_1 ,b_1…….. z_m individual user factor, then the evaluation indicator system selection after correction will take the form,

$$R_{SI} = \sum_{i=1}^{n} ((a_1 b_1 \ldots z_1) x_{i1} + (a_2 b_2 \ldots z_2) x_{i2} + \ldots + (a_m b_m \ldots z_m) x_{im}) \tag{3}$$

One of the main criteria when selecting a new ERP system remains the price and system implementation cost. On the other hand, most of companies are also interested in the greatest functionality of the system. To ensure a balance between financial indicator criteria (Table 2 shows that users assign fewer points to the more expensive system) and the rest indicator criteria, the model should be optimized to meet Pareto-optimal point.

$$Max\sum_{j=1}^{k}(x_{ij}) \quad Min\sum_{j=k+1}^{m}(x_{ij}) \tag{4}$$

$\sum_{j=1}^{k}(x_{ij})$ – financial criteria indicators

$\sum_{j=k+1}^{m}(x_{ij})$ – rest of criteria indicators.

Such objective function approach allows the calculation of Pareto-optimal point [Dixit, Nalebuff 2008], by maximizing financial indicators criteria relative to the rest of criteria indicators.

MODEL APPLICATION FOR EVALUATION ERP SYSTEM FOR SMALL AND MEDIUM-SIZED MANUFACTURING ENTERPRISES

Browsing the statement available on the Polish market of ERP systems [Computerworld 2010], we can see how much competition is in this class solutions and how wide range of options are available to potential users. Tables [Computerworld 2010] show that, ERP market leaders belong to three leading brands. One of the leading suppliers of this class of systems include companies such: BPSP, SAP and Microsoft, then there is a middle class group with quite variable composition over time including TETA, IFS, COMARCH and others. The last group serves niche market segments. ERP systems ranking is a very virtual product sets and their suppliers. Data for these rankings are given frequently by stakeholders themselves that's why in this paper I used a subjective criterion when choosing ERP systems to investigate in the study: about whom the most it is said and heard among system users. The analysis concerns three selected ERP systems in management Small and Medium-Sized manufacturing enterprises (SME): Comarch ERP XL (shortly Comarch), Sage ERP X3 (Sage) and SAP Business One (SBO). The presented analysis has a task, rather, to be aware of aspects that one should pay attention during the selection process and system evaluation, than to specify absolutely the best system or confirm these ratings because these ratings look like they want those responsible for PR and advertising from suppliers.

To start the creation of the analysis firstable we should think about the main criteria to evaluate and appropriate ordering them according to the degree of importance [Grudzewski, Hejduk 2004]. Both the price and the software implementation value still remain as the main selection criteria. Sectorial companies opt for more expensive systems, more scalable and better suited to their industry. Financial companies or those acting in the regulated markets expect a system that is in accordance with the legislation in given sector. Regardless of any business specifics, system functionalities, which must have the system will provide the basis for the selection. Right from the start it is necessary to find answers to questions such as: what is the probability of system failure and data loss? The time required to restore the software? How data loss can be prevented in case of server damage or virus attack?

Besides the problem of choosing the suitable system, SME are faced with the problem of choosing the appropriate company that will supply, implement and provide the necessary level of technical support. Keeping in mind that ERP system usually is a project for many years, then from the selection step, it is necessary to check out the system upgrade features and the possibilities of making change in the system. At such moments, it becomes very important the scalability of the system and its integrity. The validation of specified criteria in the literature [Doradcy-IT 2014] are the result of the survey presented in Table 1 where companies show a high value of functionality, fault tolerance and cost of the system.

Table 1. System selection criteria according to respondents

1 – least important 5 – most important	1	2	3	4	5	Number of respondent
System functionality	0	0	0	8	22	30
System failure	1	0	4	5	20	30
Software price and implementation cost	0	3	6	4	17	30
Software implementation duration	2	2	5	9	12	30
Ability to add new modules	2	1	2	18	7	30
System flexibility	0	2	4	16	8	30
Technical support after implementation	0	2	5	8	15	30
System technology	1	1	10	16	2	30
Hardware requirement	2	6	6	12	4	30
Others	8	3	12	5	2	30

Source: [Doradcy-IT 2014]

For each criterion weight is determined on the basis of respondents answers. At the beginning we define for each criterion the weight of importance.

$$p_i = \frac{i}{\sum_{i=1}^{n}(i)} \tag{5}$$

p_i – i-th weight criterion validity, i $\in$ (1,2,3,4,5), n = 5

$$\sum_{i=1}^{n}(p_i) = 1$$

Then weights are determined for each criterion separately (single criterion consists of m particular criteria).

$$p_k = \sum_{i=1}^{m} p_i * l_i \tag{6}$$

l_i – number of respondents.

The weight of criterion can be used to determine the coefficient of respondents preferences. In this case, and to differentiate the systems relative to each other, it can be necessary to allocate additional points, e.g. 0,25 point to each investigated attribute over the standard feature [Chmielarz 2003]. The evaluation and selection of ERP system supporting production in SME's is going to be carried

out according to the following criteria: financial, production attributes functionality, vendor support, system implementation and training, system integrity, scalability, and technological environment. Each of the criteria will be prescribed an evaluation of five-point scale. Points are designed for the existence or lack of particular features (lack = 0, exist but highly insufficient = 1, function partially complied = 2, fully satisfied = 3, exceeding the basic functionality = 4).

Financial criterion

One of the main criteria for the selection of a new ERP system is the software price and implementation cost [Grudzewski, Hejduk 2004]. The ERP Total Cost of Ownership (TCO) goes beyond these two components. The majority of SME companies, incorrectly interpret system value evaluating the software value on the basis of its standard functionality. It should, however, take into account other additional costs including installation, implementation and employees training costs. If the company does not have appropriate hardware infrastructure may also occur replacement computers, network equipment and other related services. In the investigated sector, SAP AG, a big provider of business software, proposes license (Standard/Start) depending on the enterprise needs. SAP AG together with its partners offer a special package with fixed price including 5 licenses with implementation service for 25 000 PLN [VisaCom 2015]. Comarch SA, a Polish business software supplier, provides a license package for 10 posts, including production feature for a price of 2000 PLN per module. Sage (The Sage Group, plc) is a general ERP solution provider for distributors and manufacturers, in accordance with the analysis "Sage ERP X3 vs Epicor", Sage costs for 10 users – including but not limited to, manufacturing: around $45,000 1 year (perpetual license).

Table 2. Financial criterion evaluation

Investigated criteria	SAP BO	Sage	Comarch
License cost	2	1	3
Implementation cost	2	2	3
Training cost	1	2	3
Technical Support cost	2	3	3
Client opinion	2	3	3
Total	9	11	15

Source: own based on survey result

Functional criterion

Each of the three analyzed systems have a built-in tools with similar functionality. SAP BO includes products tree and trees assembling products that serve as production routing. In the other hand it is not possible to indicate the work centers and machine responsible for a given stage production. The situation looks different in Comarch, where by defining the production routing, the workstations, machines

and individual time operations are taken into consideration. Sage, relative to Comarch is enriched with service cooperation routing. The system has also weight station interface so that one can manage weighing materials during the manufacturing process. Material management in all considered systems covers the functionality required to purchase goods and services, manage inventory, and inspect incoming materials. Inventory Management includes issuing and transferring inventory, inventory restocking, and the inventory count and adjustment processes. Planning control functions for series-type production, make-to-order, single-item production and planning to warehouse are a fundamental part of production and control components of SAP BO. Comarch supports in addition variant production process, including mixed planning form (simplified, detailed or roughing). Sage supports finite and infinite capacity requirements planning. Both Sage and Comarch provide for Material Planners an interactive drag-and-drop scheduling tool in GANTT format for manual viewing, simulation, and updating of outstanding work orders and routing operations.

Table 3. Production module functionality evaluation

Investigated criteria	SAP BO	Sage	Comarch
Production management	3	4	3
Production planning	2	3	4
Production scheduling	2	3	4
Customer satisfaction	3	3	3
Total	10	13	14

Source: own based on survey result

Support system criterion

The most transparent and functional support features given by ERP system suppliers is to help client on-line. SAP AG provides a full description of the functionality of all modules of the system often supported by practical examples. On-line service is available in 26 languages. The supplier website provides an interactive guide, demonstration videos and tutorials. SAP Consultant can be contacted by phone and chat from 8 am to 4 pm. The Sage website contains information on different system modules and solutions which have been applied. There are brochures and documents describing the system functionalities. Sage inserted a hyperlink to its channel on YouTube platform, where there are instructional videos. Help and support is available directly from the system, but it is necessary to buy a subscription. Phone support is available 24 hours a day. On the Comarch SA website general description of individual system modules and their functionalities are presented. Detailed information about the system and benefits that arise from their use are well described in the documentation. Selected issues are illustrated and explained. The website has a database of instructional videos, tutorials for users, discussion forum and advices. In order to use these helps

you have to be logged on the "Individual customer site". Phone support operate from 9 am to 5 pm.

Table 4. Support system criterion evaluation

Investigated criteria	SAP BO	Sage	Comarch
On-line	4	2	2
Documentation access	3	3	3
Instructional videos	3	3	4
Technical phone support	2	4	2
Client opinion	4	3	3
Total	16	15	14

Source: own based on survey result

System implementation and training criterion

To standardize the ERP systems implementation, several methods were created. Almost every large supplier has developed its own methodology. SAP AG and its Partners have developed: GoForWard, STI (Short Time of Implementation), MASAP and others. These methods are usually developed during numerous implementation, carried out in various organizations adapting them to industries specificities. System deployment lasts between 2 and 8 weeks. Implementation costs depend on the number of purchased licenses. In addition to traditional on-site installation, SAP AG offers cloud solution and mobile deployment. Comarch SA employees have created a tool that assists and synthesizes the work of group involved in the realization of both partner and client implementation. It is an action plan, on the basis of which the implementation is proceeding smoothly. System deployment lasts from 2 to 8 weeks and depends on company size and business processes complexity. SIGMA (Sage Implementation Global Methodology Approach) by means of which Sage carries out implementation projects. The methodology includes project life cycle, adapted each time to the specificities of organization. The SIGMA technique developed over thousands of implementations carried out in different organizational cultures in many countries. Sage deployment may take about 3 months and depends on the number of purchased modules. The last Sage ERP X3 version 7 may be sold as cloud-based business software.

Table 5. Implementation and training criterion

Investigated criteria	SAP BO	Sage	Comarch
Implementation - Quickness	4	4	3
System fitting to customer need	4	3	3
Training access	4	2	3
Client opinion	4	3	3
Total	16	12	12

Source: own based on survey result

Integrity and system scalability criterion

SAP BO has an open architecture and uses Microsoft SQL Server, which became the standard, especially for SME. Main processes enabling the functioning of any company are fully integrated thanks to user and data interfaces. Data can be exported into Microsoft Excel or Word document. There is a standard interface for CAD (Computer Aided Design) applications and PDA (Personal Digital Design) applications to collect production data and then their storage. Data synchronization , contacts, tasks and e-mail between SAP BO and Microsoft Outlook improves system performance. Comarch is characterized by its flexible modular structure, thanks to which System can be enlarged for new users, new fields, modules and functionalities. Thanks to Comarch EDI service (Electronic Data Interchange), data exchange with any business partner becomes automatically and transparency. A characteristic feature of Comarch in term of logistic and production processes is the electronic exchange of different types of documents during customer orders execution including: storage state report, transshipment of consignment or goods, order status, etc.). The integration of Sage technology and Microsoft environment enables IT (Information Technology) sharing process, resources and increase company business effectiveness. Electronic Document Management (EDM) solution, ensures information exchange across the enterprise. Within the production scope, where supply chain is a very important process for effective planning, Sage and Preactor have conclude cooperation, which resulted in a global and fully integrated solutions for planning and scheduling production.

Table 6. System integrity and scalability evaluation

Investigated criteria	SAP BO	Sage	Comarch
Scalability	3	4	4
Integrity	1	3	4
Client opinion	2	4	4
Total	7	11	12

Source: own based on survey result

Systems technology criterion

SAP BO is based on a single server integrated with Windows NT network. It uses, based on Win 32 bilayer architecture client-server. Custom development (called Add-ons) are done using the SAP BO SDK (Software Development Kit). SDK is a"toolbox" that contains interfaces, sample code, documentation and development tools. It provides application programming interfaces (APIs) that allow developers to enhance SAP BO. The system uses the following databases: MS SQL Server 2008 or 2012, Sybase Adaptive Server Enterprise and IBM Universal Database Express Edition. Sage in turn is built on SAFE X3 (Sage Application Framework for Enterprise) platform. This platform provides users with best-in-class collaboration capabilities in either client/server or web mode, as well as

an integrated business. Thanks to this solution, the system is available on the following Operation Systems (OS): Microsoft Windows, Linux Red Hat and Unix. Data can be stored and processed in both MS SQL Server or Oracle technologies. Comarch operates in a client-server mode. Thanks to its modern technology - Microsoft SQL Server - provides efficient, reliable work, data security and application integration with Microsoft Office. The system uses Microsoft SQL Server 2008 / 2008R2 / 2012 / databases.

Table 7. System technology evaluation

Investigated criteria	SAP BO	Sage	Comarch
Modularity	3	3	3
Openness	3	3	3
OS technology	4	4	2
Data Base	4	3	2
User opinion	3	2	2
Total	17	15	12

Source: own based on survey result

Systems overall rating

Considered system analysis is not intended to identify the best system but rather to pay attention to the main features that can be adopted during ERP systems selection. After summing main criteria total points and in order to calculate the final indicator system selection rating, only individual user preference factor is added in this case. Other measures such risk coefficient, budget overruns or project time exceeding factors and others may also be used.

Table 8. Total weighted evaluation criteria

System selection criteria	User reference	SAP BO	Sage	Comarch
Financial criterion	1.06	9	11	15
Functionality	1.21	10	13	14
System support	1.07	16	15	14
Implementation and training	1.06	16	12	12
Integrity and system scalability	1	6	11	12
System technology	0.91	17	15	12
Total		74	77	79
Indicator system rating		77.19	80.8	83.46

Source: own calculations

After determining the coefficient of respondents preferences basis on Table 1 and (6), and after summing all individual given points for basic and associated criteria, the analysis result shows that the described in this paper systems are almost on the same level. SAP BO scored the fewest points due to the weaker production management and system integrity. It makes however up for effective

implementation, training and support system. Sage took second place. It differs from its predecessor a higher level of production management feature and greater number of built-in tools. Thanks to good production management support and, above all, a greater number of integrated tools that translate into large functionality, Comarch ERP scored the highest number of points. This result explains the higher license sales of the software on the Polish market.

SUMMARY

As follows from experts experience, the comparative method gives raise to various problems that are often difficult to resist. It assumes a good knowledge of examined systems, because only then they can be objectively compared. A casual systems knowledge will not lead to a reasonable evaluation and system selection. It seems that the presented in this paper method can avoid the subjective features of the comparative method as better functionality, greater flexibility, etc. and provides measurable indicators that can be used to evaluate and compare selected criteria for choosing an ERP system for SME's. The simplicity of the methods is that scores are assigned to each criterion according to user own discretion, which was included in the evaluation systems model. The presented model can be modified and used to evaluate other systems class in accordance with the needs of the company.

REFERENCES

Chmielarz W. (2003) Teoria i praktyka oceny informatycznych systemów finansowo-księgowych, Wydawnictwo Naukowe Wydziału Zarządzania UW.

Comarch (2015) Comarch ERP XL Light, downloaded April 30th, 2015 from http://www.comarch.pl/files-pl/file_64/Comarch-ERP-XL-Light-10.pdf

Computerworld (2010) Przegląd systemów do wspomagania zarządzania.

Dixit A. K, Nalebuff B. J. (2008) Sztuka Strategii, MT Biznes 2008.

Doradcy-IT (2014) Metody i kryteria wyboru systemu ERP, downloaded April 30th, 2015.

Hejduk I. K., Grudzewski, W. M. (2004) Metody Projektowania systemów zarządzania. Difin S.A.

Sage (2015) Sage vs Epicor, downloaded April 30th, 2015 from http://www.rklesolutions.com/sage-x3-vs-epicor/

SAP (2014) downloaded 30th March, 2015 from demo systemu ERP | Business One | SAP: sap.com/poland/solution/sme/ software/erp/small-business-management/demos.html

Visacom released (2014) and downloaded April 08th, 2015. sap.visacom.pl/index.php?option=com_content&view=article&id=223&Itemid=1,