

BENCHMARKING METHODOLOGY BASED ON ERP SYSTEM EVALUATION: CASE STUDY

Sławomir Kłos, Justyna Patalas-Maliszewska

Abstract:

Enterprise resource planning (ERP) is a computer-based information system for enterprise integration. ERP integrates information from all functional areas of enterprise to support management processes. The implementation of ERP is an expensive and time-consuming process but for contemporary enterprises it is a necessity. The effective enterprise management is impossible without on-line information about business processes executed in all functional areas. The ERP implementation involves a strategic decision that influences enterprise development for many years. Thus, ERP systems should evolve together with enterprises. The paper proposes a benchmarking methodology that enables evaluating the implementation of an ERP system in three manufacturing companies focused on make-to-order production. The enterprises make small series or single prototype production. The research is based on benchmarking of the enterprises that implemented ERP systems in the past years. It involves comparison of the most important financial ratios and statistical data extracted from the ERP system. Results of data analysis are a basis for a proposed procedure of ERP evaluation. The procedure enables not only evaluating the ERP system implementation but also determining functional areas that require support, changing business processes or functionality of ERP. The proposed benchmarking methodology presents how much the ERP system is adapted to enterprise requirements. Examples presented are based on a case study of Polish enterprises.

Keywords: *enterprise resource planning, benchmarking, evaluation methodology, case study.*

1. Introduction

The process of implementing the ERP system is often a shock therapy for most enterprises and especially for manufacturing companies that focus on prototype and variable production. Approximately 90 percent of enterprise resource planning (ERP) implementations is late or over the budget [5] and 70 percent of ERP implementations fail to deliver anticipated benefits [1]. The crucial impact on the implementation complexity has the size of the enterprise [4], type of production and a scope of ERP implementation (included functional areas into the ERP project) [McGinnis]. Because the ERP systems are complex and expensive, there are many researches in ERP success measurement [Jen, Wang]. Some researchers investigate organizational adoption of ERP [Basoglu], [Wang], methodology of ERP selection [Wei, Wang] and cultural issues in ERP [Xue, Liang]. Many researchers investigated

critical factors (e.g., top management support, sufficient training, proper project management, communication, etc.) to the success of ERP implementation [Motwani].

The evaluation of ERP systems is not a trivial process because of the implementation impact on all functional areas of an enterprise. On the one hand, it is difficult to measure benefits of ERP system implementation because the measurement requires a lot of ratios and, on the other; the evaluation of the ERP system requires determining implementation scope and time. The ERP implementation is a strategic decision for an enterprise, which means it cannot be evaluated on the basis of ratios, collected a year after a productive start of the system. At least two or more periods should be taken into consideration.

The paper proposes a methodology of ERM system evaluation based on a benchmarking technique. The methodology is used to evaluate real enterprises. The investigated enterprises belong to the same branch and all of them implemented the same ERP system. Firstly, the similarity of the enterprises was checked in terms of economic ratios. The proposed methodology requires data to be collected from several periods of time after ERP implementation to evaluate the ERP long-term impact on the enterprise. Examples presented in the paper are based on real data extracted from ERP systems, balance sheets and profit and loss accounts. The issue discussed in the paper is formulated as follows: "Given is a number of similar enterprises that implemented ERP systems and a set of economic and technical data from at least three periods of time of ERP system operation. How to evaluate the ERP system implementation on the basis of a benchmarking methodology?"

Next chapter presents characteristics of three companies. The companies are compared as regards economic ratios and data rates extracted from ERP systems that enable to evaluate repeatability of business processes supported by ERP.

2. Benchmarking of companies X, Y and Z

Benchmarking is a continuous search for and adaptation of significantly better practices that lead to superior performance by investigating the performance and practices of other organizations (benchmark partners). In addition, it can create a crisis to facilitate a process of change. Benchmarking (also "best practice benchmarking" or "process benchmarking") is a process used in management, in particular strategic management, in which organizations evaluate various aspects of their processes in relation to best practice, usually within their own sector. This then allows organizations to develop

Table 1. Income of companies X, Y, Z - ratio INCOME.

Net income	2002	2003	2004	2005	2006
Company X	16 122 247	20 146 185	24 722 777	26 620 102	37 595 665
Company Y	15 214 843	16 328 299	23 111 416	23 516 703	30 075 340
Company Z	57 535 039	70 321 448	86 688 575	87 189 582	104 712 076

Table 2. Profit of companies X, Y, Z - ratio PROFIT.

Profit	2002	2003	2004	2005	2006
Firm X	775 544	781 398	2 581 251	2 827 501	8 327 078
Firm Y	1 674 952	2 013 436	2 665 157	1 270 123	2 483 880
Firm Z	8 768 851	15 110 390	14 570 127	6 148 159	16 067 266

Table 3. Inventory of companies X, Y, Z - ratio INVENT.

Inventory	2002	2003	2004	2005	2006
Firm X	4 984 301	4 850 111	5 595 899	7 164 281	8 899 214
Firm Y	2 149 269	3 963 364	3 286 486	2 877 036	3 416 115
Firm Z	14 914 622	17 149 945	18 543 308	16 673 952	12 477 788

Table 4. Cost of companies X, Y, Z - ratio COST.

Cost	2002	2003	2004	2005	2006
Firm X	8 927 782	12 825 880	14 153 834	14 861 173	18 998 440
Firm Y	12 636 602	13 935 076	20 122 227	19 750 557	24 635 191
Firm Z	40 636 458	44 612 068	60 098 533	69 003 845	73 612 411

Table 5. Productivity of companies X, Y, Z - ratio PRODUCTIVITY.

Productivity	2002	2003	2004	2005	2006
Firm X	1.81	1.57	1.75	1.79	1.98
Firm Y	1.20	1.17	1.15	1.19	1.22
Firm Z	1.42	1.58	1.44	1.26	1.42

plans on how to adopt such a best practice, usually with the aim of increasing some aspects of performance. Benchmarking may be a one-off action, but it is often treated as a continuous process in which organizations continually seek to challenge their practices [Camp], [Miller], [Watson]. There are several types of benchmarking [Camp]:

- product benchmarking,
- process benchmarking,
- functional benchmarking,
- financial benchmarking,
- performance benchmarking
- strategic benchmarking.

Authors are expected to mind the margins diligently. Conference papers need to be stamped with conference data and paginated for inclusion in the proceedings. If your manuscript bleeds into margins, you will be required to resubmit and delay the proceedings preparation in the process. The paper uses financial and strategic benchmarking to evaluate the ERP system implementation in manufacturing companies. The benchmarking is done for three Polish enterprises X, Y and Z, which have implemented the same ERP systems. All the enterprises complete engineer-to-order production. Companies X and Z manufacture machine tools and technological lines and company Y manufactures details for machine tool com-

panies. All three companies manufacture prototype products where mechanical engineering work in area of construction and technology is critical. Table 1 presents net income of the companies in 2002-2006. All the companies started exploring the ERP system in 2003. It means that since 2004 all the firms have explored ERP systems. Therefore, data will be analyzed for the period 2002-2006 but the benchmarking will be done only for the period 2004-2006.

Income structures of the enterprises presented in Fig. 1 are quite similar. Enterprises X and Y have almost the same net income, whereas enterprise Z achieves about three time better results.

The profit of the enterprises in 2002-2006 is given in Table 2 and in Fig. 2. Enterprises X and Y have similar level of profit (about PLN 2 billion) and company Z has made profit four or eight times higher (PLN 6-16 billion). It is difficult to conclude from Figures 1 and 2 that the implementation of ERP has impact on income or profit of the companies but two or three years after the implementation all the companies increase their net income and profit.

Next analysis shows changes of inventories in the enterprises after ERP implementation. Table 3 and Figure 3 present the inventories of the enterprises. Figure 1 shows that production of the three enterprises steadily increased in the period concerned. Production growth

means that the companies have to order more materials and it results in inventory increase. Company X illustrates the typical situation where the inventory increases together with the production volume.

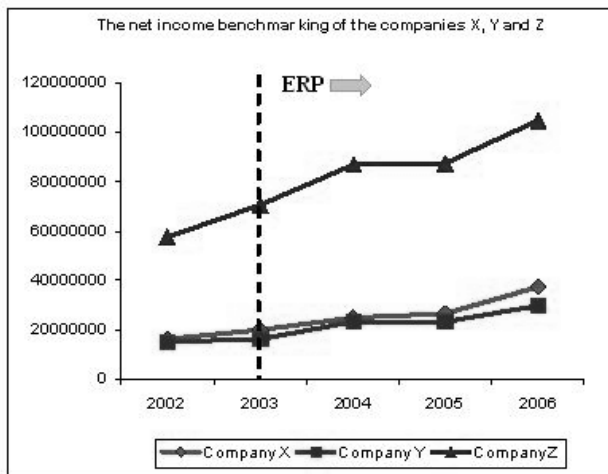


Fig. 1. Net income benchmarking of companies X, Y and Z.

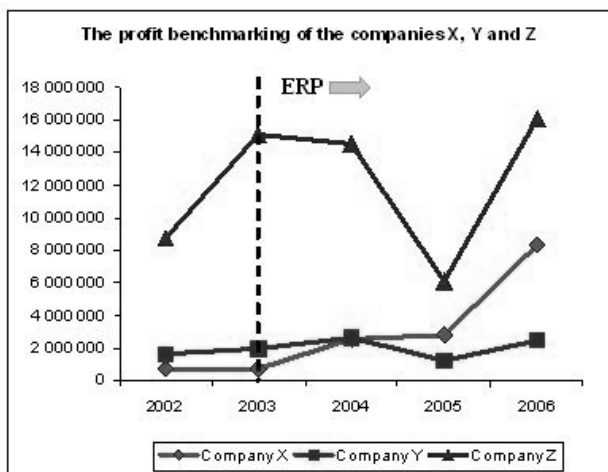


Fig. 2. Profit benchmarking of companies X, Y and Z.

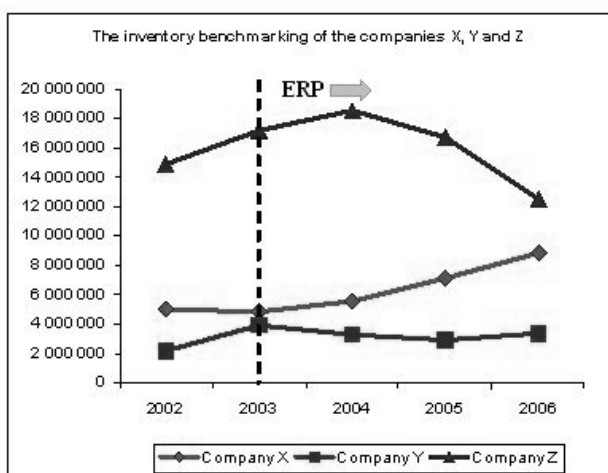


Fig. 3 Inventory benchmarking of companies X, Y and Z.

Better inventory management is executed in company Y. Beside production growing, the inventory stays on the same level (about PLN 3.2 billion). The best inventory

management is in company Z. Beside rapid production development, the inventory value in 2004-2006 dropped significantly. Cost reduction is very important for every production enterprise. Figure 4 shows cost incurred by the firms.

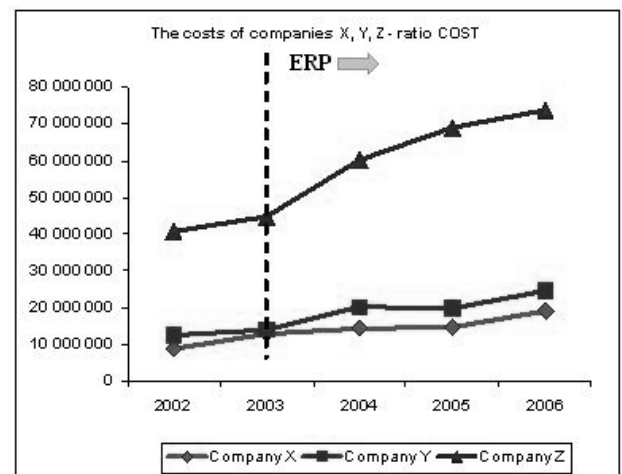


Fig. 4. Cost of companies X, Y, Z - ratio COST.

Beside similar values of income in enterprises X and Y, company X incurs lower cost. Income of company Z in 2004 and 2005 stays relatively on the same level of PLN 87 billion but the cost in the same period grows about PLN 10 billion. The best method to find the relation between net income and cost of enterprise is to analyze enterprise's productivity (see Figure 4).

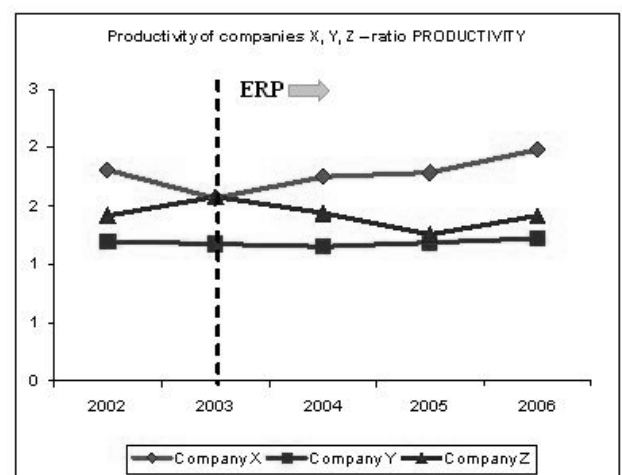


Fig. 5. Productivity of companies X, Y, Z - ratio PRODUCTIVITY.

Figure 5 shows that after ERP implementation the productivity of enterprise X increases, in enterprise Y it stays at the same level and in enterprise Z decreases (in 2006 the same productivity as before ERP implementation).

Next chapter proposes the methodology of ERP system evaluation based on benchmarking. The methodology enables evaluating the improvement of the financial ratios of an enterprise after ERP system implementation.

3. The evaluation methodology of ERP system implementation

To evaluate real impact of the ERP implementation on financial ratios in a company, relative values of the ratios should be taken into consideration. If for example α_0 is a value of a financial ratio before ERP implementation (a reference value) and $\alpha_1, \alpha_2, \dots, \alpha_N$, values of the ratio in the succeeding periods the simple evaluation index can be calculated as follows:

$$A = 1 - \frac{\sum_{k=1}^N \alpha_k}{\alpha_0 \cdot N} \cdot 100\%$$

If the value from the last year before ERP implementation is not acceptable, the reference value can be calculated as average value from several periods before ERP implementation. The five investigated ratios presented in the previous chapter are evaluated in Table 6. Upward arrows in the heads of columns mean that the greatest value is the best and downward arrows mean that the lowest value is the best.

Table 6 shows that beside high absolute value of net income of the company Z, relatively the company has the worst results of ERP implementation. Relatively, company X makes the best profit and the worst by Y. The best inventory management is in company Z and the worst in Y. Cost is significantly reduced in company Z and the same company achieves the best relative productivity. The comparison of the average productivity ratio shows that the implementation of ERP in companies X and Y has not improved their status. The summary evaluation depends on priorities of ERP implementation determined by every enterprise individually. If, for example, the critical goal of ERP implementation for all the enterprises was inventory reduction, the best result is achieved by company Z, etc. Of course, besides average values of different ratios, trend analysis is very important.

Objective evaluation of ERP systems requires taking not only results into consideration but also the labour intensity referred to as the utilization of the system and annual repetitiveness of business processes. Average values that describe a number of data introduced annually into ERP by companies X, Y and Z are presented in Table 7 and in Fig. 6.

Table 7 shows that company Z generates the greatest number of indexes annually (high charge of ERP). Company Y generates the greatest number of sales offers and orders in ERP but have the worst profit of the three companies analyzed. The number of inventory documents in the companies is approximately 10000 but company Z achieves better results by inventory reduction than other two firms. The investigated factors depend on an individual enterprise strategy. Data presented in Table 7 represent labour intensity related to the ERP system in different areas of enterprises. To compare labour input in ERP and results for an enterprise, the relation between different ratios should be calculated. For example, to compare how the business process of preparing sales offers influences the enterprise profit, it can be calculated as an average profit in 2003-2006 divided by number of sales offers:

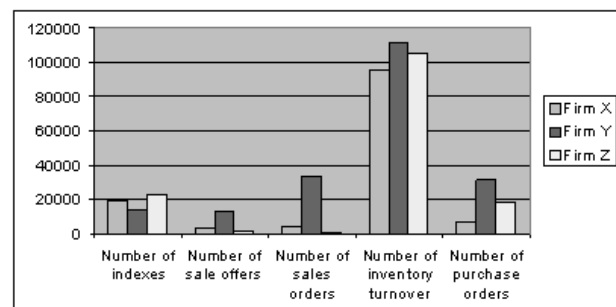


Fig. 6. Average values of data quantity extracted from ERP for 2003-2006.

- Firm X: PLN3,629,307 / 3,103 = PLN1170
- Firm Y: PLN2,108,149 / 12,624 = PLN167
- Firm Z: PLN12,973,986 / 942 = PLN13,773

It means that enterprise Z makes the highest profit on one sale offer. The calculation can be repeated to evaluate the inventory cost related to the number of inventory turnover, cost of a purchase order, etc. The data presented in Figure 6 are extracted from ERP systems of the companies. Consequently, Table 8 shows the average profit on a specific data set.

Table 6. Evaluation and benchmarking of ERP implementation in companies X, Y, Z.

%/FIRM	Net income ↑ Relative ratio RRINC	Profit ↑ Relative ratio RRPRO	Inventory ↓ Relative ratio RRINV	Cost ↓ Relative ratio RRCOS	Productivity ↑ Relative ratio RRPRO
X	69	368	33	70	-1,88
Y	53	26	58	55	-1,75
Z	52	48	9	52	0,73

Table 7. Average values of data quantity introduced into ERP in 2003-2006.

%/FIRM	Number of indexes INDEX	Number of sales offers SALEOF	Number of sale orders SALEOR	Number of inventory turnover INVTUR	Number of purchase orders PURORD
X	18886	3103	4557	95381	6926
Y	14228	12624	33254	111129	31486
Z	22441	942	543	105329	18357

Table 8. Profit per data quantity in enterprises X, Y, Z.

%/FIRM	Profit per number of indexes PPINX	Profit per number of sales offers PPSAOF	Profit per number of sale orders PPSAOR	Profit per number of inventory turnover PPINTU	Profit per number of purchase orders PPPUOR
X	192	1170	796	38	524
Y	148	167	63	19	67
Z	578	13773	23904	123	707

Table 9. Number of employers and ERP users in enterprises X, Y, Z - USRRAT.

FIRM	2004		2005		2006	
	Employer	ERP user	Employer	ERP user	Employer	ERP user
X	216	18	218	60	237	65
Y	100	34	130	67	133	102
Z	201	146	244	172	251	191

Table 10. Average values of data quantity per ERP users.

%/FIRM	Number of indexes per ERP user INXUSR	Number of sales offers per ERP user SOFUSR	Number of sale orders per ERP user SORUSR	Number of inventory turnover per ERP user INVUSR	Number of purchase orders per ERP user PUOUSR
X	540	73	140	2832	254
Y	270	239	618	2025	602
Z	168	6	3	625	124

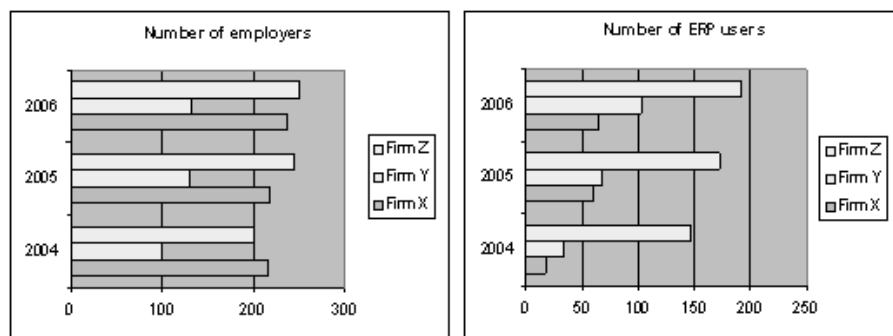


Fig. 7. Number of employees 2004-2006.

Table 8 shows that enterprise Z reaches the best profit per selected data sets extracted from the ERP system. Business processes of firm Y generate the lowest profit from the three companies. To evaluate intensity of ERP charge the values should be related to the number of users. The number of employers and ERP users in the enterprises (data available were from the period of 2003-2006 only) is presented in Table 9 and Figure 7.

Enterprises X and Z employ approximately the same number of workers and enterprise Y about 50% less. In the investigated period all enterprises increase their number of employers. The number of ERP users is increased in all enterprises too. In 2006, the ratio between ERP users and the total number of employees in the enterprises is 27% for the firm X, 77% for the firm Y and 76% for firm Z. The fastest increase in ERP users is in firm Y (about 100% new ERP user every year). The largest number of ERP users (191) has firm Z. It means that the highest costs of ERP licenses are borne by Firm F. The highest value of the ratio between the total number of employees and ERP users shows wide range of ERP system implementation in the

enterprises.

Absolute ratios presented in Table 7 can be regarded as the number of ERP users and recalculated as relative ratios (Table 9 and Figure 8). The average number of data generated by an ERP user represents labour intensity and charge of ERP exploitation of the firms concerned. For example, firm X is the most charged in functional area of construction and technology (number of indexes per ERP user).

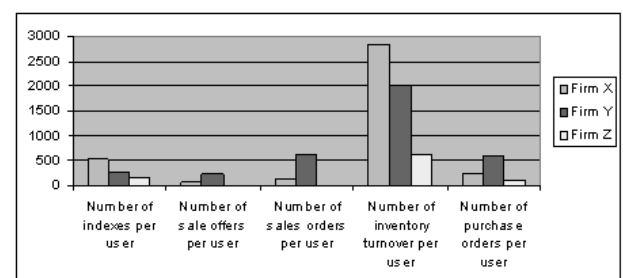


Fig. 8. Average values of data quantity extracted from ERP per user for 2003-2006.

The discussion shows that the evaluation of the ERP system implementation requires defining priorities and critical business goals. Figure 9 presents the enterprise benchmarking methodology based on ERP systems evaluation. The first step is that every enterprise has to prepare itself before selecting and implementing of ERP. The next step results from the first one and it requires only a proper determination of measurements to business goals.

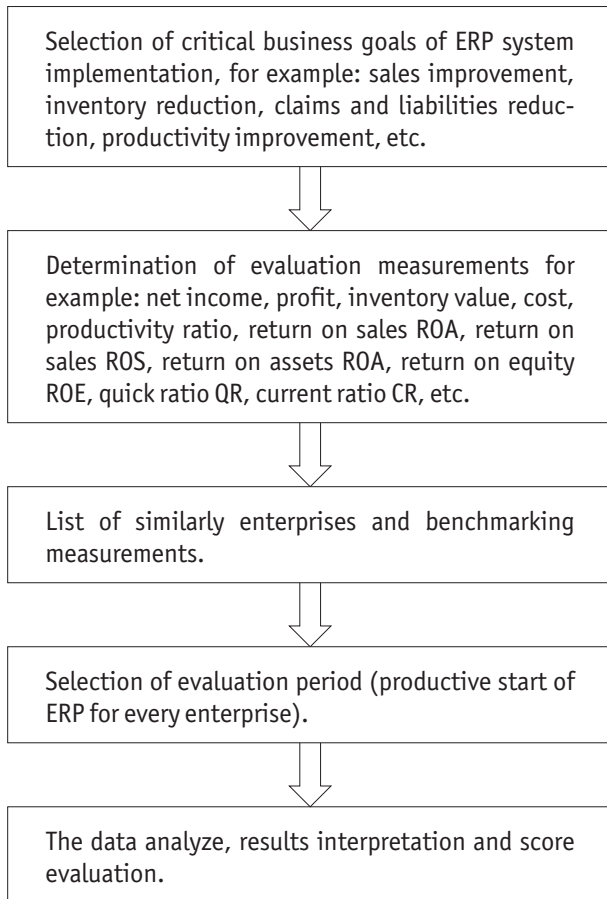


Fig. 9. Methodology of enterprise benchmarking based on ERP system evaluation.

Table 11 presents the score evaluation for Firms X, Y and Z. Values of the ratios belong to set 0, 1, and 2 (the best value being 2 and the worst 0).

Table 11. Score evaluation of Firms X, Y and Z.

Ratio	Firm X	Firm Y	Firm Z
INCOME	1	1	2
PROFIT	2	0	1
INVENT	0	1	2
COST	1	1	0
PRODUC	2	1	1
RRINC	2	1	1
RRPRO	2	0	1
RRINV	1	0	2
RRCOS	0	1	1
RRPRO	0	0	2
INDEX	1	0	2
SALEOF	1	2	0
SALEOR	1	2	0

INVTUR	1	1	1
PURORD	0	2	1
PPINX	1	0	2
PPSAOF	1	0	2
PPSAOR	1	0	2
PPINTU	1	0	2
PPPUOR	1	0	2
USRRAT	2	0	2
INXUSR	2	1	0
SOFUSR	2	1	0
SORUSR	1	2	0
INVUSR	2	1	0
PUOUSR	1	2	0
Total	30	20	29

4. Conclusions

The paper proposes a benchmarking methodology based on ERP system evaluation. The research is based on the case study of three enterprises X, Y and Z that have implemented the same ERP system in 2003. The benchmarking is based on financial ratios and data extracted from the ERP system. The enterprises are investigated against 26 different ratios. The selection of ratios depends on critical goals for the ERP system implementation (inventory reduction, sales increasing, etc.). The result of the benchmarking shows that the implementation of ERP in enterprises X and Z was very good and almost at the same level (about 30 points). The implementation of ERP in enterprise Y has not produced those good effects. Benchmarking can be repeated only for selected functional areas of an enterprise such as sales, production and logistic. Next research will provide benchmarking for other ratios and a larger number of enterprises.

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