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EVALUATION OF ERP SYSTEMS IMPLEMENTATION PROJECTS

Abstract: The paper presents results of the author's research, intended to recognise the state of art practices in conducting Enterprise Resource Planning (ERP) systems implementation projects in Polish enterprises. The research was done from the perspective of companies in which the systems were implemented. Collected data, presented partially in this article, show a relatively positive picture of the projects, as in most cases time and cost limits were not overrun and functional objectives were met.

1. Introduction

Information technology plays more and more important role in business entities. It is perceived by numerous enterprises as a fundamental factor for their development. The implementation of information and communication technologies (ICT) radically changes the way organisations operate, opens new areas and redefines rules of making business. These are the reasons why companies reserve increasing funds for such purposes. This is, in brief, how the “bright side” of information technology looks. On the other hand there exist opinions that escalating expenditure on ICT do not generate expected results. Some studies point out that technological advance does not go hand in hand with effective and efficient implementation of ICT solutions in business entities. Despite significant improvement observed in recent years¹, the share of unsuccessful undertakings, in which business objectives of implementing ICT systems as well as functional and qualitative requirements were not met, and at the same time budgets and timeframes were exceeded, remains too high.

¹ Facts supporting this statement can be found, among others, in „The Chaos Chronicles” published in 1994, 2000 and 2002/2003. The subject is widely discussed in [Czarnacka-Chrobot, 2004, pp. 209-238]. The positive shift in results of ICT projects carried out in Polish companies was identified also in a comparative study of nearly 400 such undertakings conducted by the author in the period of 2004-2007. The conclusions are presented in [Dyczkowski 2006b, 2007a and 2007b].

The author of this paper has been examining various aspects of organising and running ICT projects for several years, and identification of critical success factors has become the major focus of the research since 2004. In order to verify and assess these factors a broad range of data related to effectiveness and efficiency of ICT projects – reflecting time, budget and functionality compliance as well as a level of meeting end-users' requirements – has been collected².

This article aims at introducing the above-mentioned database. The presentation will be limited, however, to ERP systems implementation projects only, due to the following reasons:

- their strategic character and, consequently, high requirements with respect to achieving goals of ICT investments,
- high importance of organisational, structural or procedural changes in business entities and their information and decision-making systems – instead of technology itself – to successful implementation of ERP solutions,
- role of these projects in improving operations of Polish companies – since their requirements include, among others, introducing processes-based management standards corresponding with best business practices and operational reference models,
- and complexity of these undertakings resulting in common difficulties with defining, planning, realising and achieving their objectives.

2. Basic Facts About the Study and Its Context

As stated in the introduction, the selection of the research problem stemmed from observed divergence in views on effectiveness assessment in implementing integrated systems (including ERP) in companies as well as on benefits they actually generate. On the one hand, there still exist opinions that such systems are very expensive, while results of their operation are insufficient (refer to evaluation presented in “The Chaos Chronicles” mentioned before). On the other hand, numerous conferences, discussion with end-users or published case studies (cf. [Nowarska 2004]) tell a different story of both applying information and communication technologies for business purposes and running implementation projects. These undertakings are perceived as consistent with business strategies, thoroughly planned, efficiently conducted, and their effects are meaningful and appreciated by end-users. This situation implies two questions: what is the reality, and which judgement – optimistic or pessimistic – is closer to the truth?

In order to collect empirical data a survey was conducted. The questioners – recruiting from participants of different forms and types of studies at Wrocław

² This approach is consistent with proposals of other research teams examining ERP systems. See [Allen, Kern and Havenhand 2002; Bhatti 2005; Plant and Willcocks 2006; Ugwu and Kumaraswamy 2007].

University of Economics – were contacting respondents directly at face-to-face meetings. The survey was organised in two cycles – the first: between October 2004 and June 2005, and the other: from April 2006 to March 2007 – both times providing the author with sets of characteristics of more than 500 ICT projects, 190 and 203 of which were positively verified and qualified to further analysis. The whole procedure led to creating a repository which comprises 393 project descriptions and metrics, consisting in each case of 50 quantitative and qualitative parameters of ICT projects, 9 descriptive and typological characteristics of companies, where projects were implemented as well as 4 attributes validating acquired data. The database is stored and processed in two file formats: the primary are spreadsheets of STATISTICA (*.sta), the secondary MS EXCEL workbooks (*.xls). A subset selected for the purposes of analysis presented in this paper comprises data referring to the implementation of ERP solutions (less frequently an entire system, more often particular modules and/or components of it), including characteristics of 91 companies and ICT projects, conducted in these entities (the spreadsheet of STATISTICA had in its initial form the size of 91 cases and 63 variables).

Table 1. Structure of Analysed Companies with Respect to their Business Areas and Sizes

Composition of the group		Sector (basic area of operation)									
		Industry		Trade		Finance		Other		Total	
		No.	[%]	No.	[%]	No.	[%]	No.	[%]	No.	[%]
Total (by sectors)		35	38.46	22	24.18	14	15.38	20	21.98	91	100.00
Size of a company	Small (1-49)	0	0.00	6	27.27	2	14.29	2	10.00	10	10.99
	Medium (50-249)	14	40.00	9	40.91	1	7.14	7	35.00	31	34.07
	Big (250-1999)	17	48.57	4	18.18	2	14.29	5	25.00	28	30.77
	Very big (≥ 2000)	4	11.43	3	13.64	9	64.29	6	30.00	22	24.18
Structural complexity	One plant, one location	18	51.43	10	45.45	4	28.57	5	25.00	37	40.66
	Multiple plants, one location	4	11.43	1	4.55	1	7.14	3	15.00	9	9.89
	Multiple plants, numerous locations	13	37.14	11	50.00	9	64.29	12	60.00	45	49.45
Scope of activity	Local	0	0.00	4	18.18	1	7.14	4	20.00	9	9.89
	Regional	3	8.57	6	27.27	2	14.29	3	15.00	14	15.38
	National	4	11.43	5	22.73	9	64.29	12	60.00	30	32.97
	International	28	80.00	7	31.82	2	14.29	1	5.00	38	41.76

Source: own presentation based on results of the survey.

Table 1 presents the most important facts on structures of companies, where examined projects were run. It can be noticed that the composition of the analysed

group is complex with respect to sizes of companies³, their organisational and geographic structures, as well as areas of business activity. It should be mentioned, in addition, that the identified structure is inconsistent with the overall profile of business activity in Poland. The author is aware of this circumstance, however, for the research carried out with “available resources”, meeting representativity conditions would have been difficult to achieve. Furthermore, most of examined companies have their seats in Lower Silesia region, what might have influenced results of the study. For these reasons the contents of table 1 ought to be treated exclusively as information on the profile of the analysed group of organisations.

3. Characteristics of the Analysed ERP Projects

By analogy with organisations presented in the previous part, examined ICT projects were diverse, what becomes apparent when analysing their budgets, durations and other synthetic descriptions of scope, brought forward hereafter.

Table 2 contains data on sizes of budgets and table 3 about timeframes, which constitute main dimensions of the considered projects. While analysing the database, it becomes evident that there appeared projects of limited, as for ERP terms, budgets (in 39.56% of cases they amounted to less than 100,000 PLN), nevertheless a share of medium-sized budgets (100,000 to 1,000,000 PLN) is comparable. A certain number of undertakings involve significant expenditure (20.88% of projects had budgets exceeding 1M PLN and 14,29% of all considered undertakings required investments of more than 5M). The last group comprises almost exclusively implementations carried out in financial institutions (mostly banks and leasing funds) or by telecommunication operators. When the duration of projects is taken into consideration, it should be stated that the majority of questionnaires refer

Table 2. Budget Sizes of the Analysed ERP Projects

Budget size [in PLN]	Number of projects	Cumulated number of projects	Share [%]	Cumulated share [%]
below 20,000	11	11	12.09	12.09
below 100,000	25	36	27.47	39.56
below 500,000	21	57	23.08	62.64
below 1,000,000	15	72	16.48	79.12
below 5,000,000	6	78	6.59	85.71
over 5,000,000	13	91	14.29	100.00

Source: own presentation based on results of the survey.

³ Company size was established in a simplified way, and reflected a number of employees only. However, classification criteria were in this respect consistent with guidelines of the Polish Central Statistical Office and Eurostat.

Table 3. Timeframe of Analysed ERP Projects

Timeframe of a project	Number of projects	Cumulated number of projects	Share [%]	Cumulated share [%]
less than a week	1	1	1.10	1.10
less than a month	14	15	15.38	16.48
less than 3 months	18	33	19.78	36.26
less than 6 months	12	45	13.19	49.45
less than one year	23	68	25.27	74.73
more than one year	23	91	25.27	100.00

Source: own presentation based on results of the survey.

to long-range projects (those lasting more than half a year account for 50.55% of the total size of the sample). The group of long-term undertakings (timeframe exceeding six months) was dominated by implementations conducted in such sectors as: “*industry*”, “*finance*” and “*other*” (most of all by telecommunication operators mentioned before).

Figure 1 presents in addition the distribution of project classes for considered ERP implementations. There were several definitions of this term, and consequently different algorithms of its estimation, used by the author throughout the analysis. The distribution demonstrated in the picture is based on normalised categories representing budget and timeframe of particular projects using a six-point Likert scale (where “1” is attributed to the projects of the lowest budget – here below 20,000 PLN – or those of the shortest period reserved for their realisation – here less than a week etc.). The value of the project classes was calculated as the arithmetic mean of normalised budget and duration of an undertaking⁴.

Budget and timeframe are closely related to the third dimension of projects i.e. their scope. Although this characteristic was exhaustively described in attachments to questionnaires, it will not be presented in details within the confines of this paper. For methodological sake it should be mentioned, however, that besides typical implementations of selected modules of ERP systems, there appeared numerous projects extending their functionality (CRM, SCM, Business Intelligence, corporate portals, EDI etc.). The survey comprised both roll-outs and projects intended to modernise and rationalise systems already operated. There was also a certain number of undertakings – particularly dedicated to streamlining logistic chains – which involved networking and internet technologies, including the implementation of solutions based on mobile technologies or the systems of automatic identification and localisation of objects. In addition – as a comment to the

⁴ In the course of data analysis values of project classes were calculated also as the square root of the product of normalised budget and timeframe related to particular undertakings or as the integral part of that value. Due to similarity of distributions, regardless algorithms used, and a limited scope of this paper only one method of calculation will be presented.

project scope characterised by tables 1-3 and figure 1 – it should be mentioned, that implemented solutions were based as well on software developed by leading global providers of ERP systems, such as, for example: R/3, mySAP ERP and Business One (SAP), MFG/PRO (QAD), IFS Applications (IFS), Oracle Finance and E-Business Suite (ORACLE), Navision and Dynamics/Great Planes (MBS), MAPICS (Mapics/Infor), Exact Globe Enterprise and e-Synergy (Exact) or TETRA CS3 (Sage/TETRA), as on Polish applications, such as, for instance: TETA 2000 and Biznes Partner (Teta), Symfonia (Sage Symfonia/Matrix), Impuls (BPSC) or CDN XL (Comarch CDN).

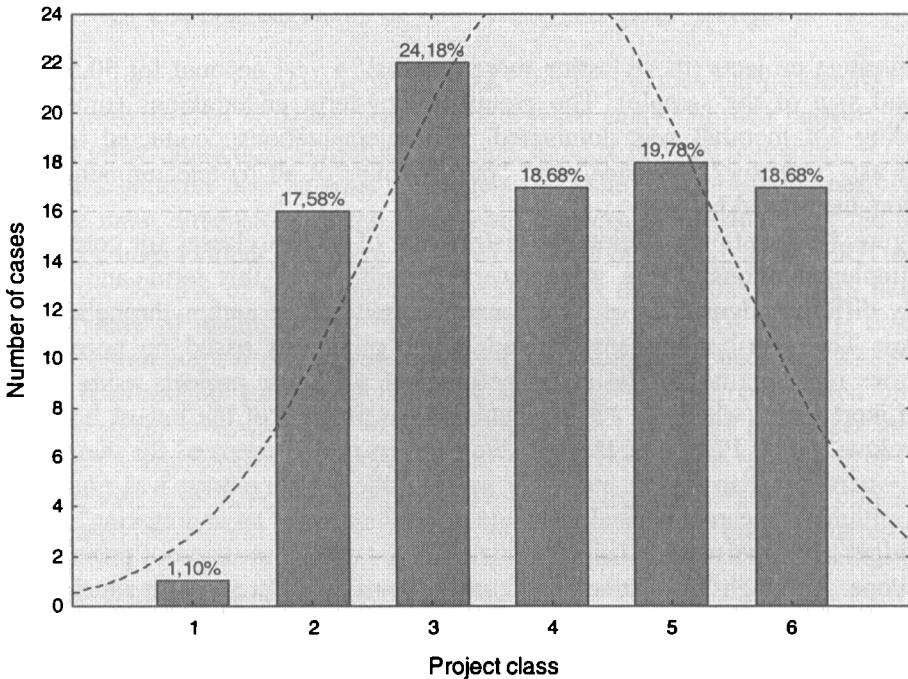


Figure 1. Distribution of Project Classes in the Analysed Group of ERP projects

Source: own presentation based on results of the survey.

To conclude the concise general description of the examined projects – and before proceeding to a presentation of selected specifications and detailed analysis, in particular referring to implementation effectiveness and end-users' satisfaction – it should be emphasised that the empirical material was collected from the perspective of companies which ordered the realisation of projects or conducted them on their own. The customer's point of view (i.e. of external clients or internal ones, in case of own projects) was one of the assumptions of the described research project.

4. Selected Performance Measures in the Analysed ERP Projects

Evaluation of realisation and outcomes of ERP projects implementations comprises both the quantitative assessments of compliance and qualitative measures. The first group refers to budget and time compliance⁵. Due to the limitations of the paper a detailed presentation of values and their distributions for both metrics will be left out and replaced with a discussion on the performance measure called contractual compliance⁶. The value of this metric is calculated similarly to the project class – that is as the arithmetic mean of normalised values of budget and time compliance (where “1” is attributed to the projects of the lowest degree of consistency, whereas “6” is applied to those where this level is the highest).

Figure 2 presents the distribution of contractual compliance for analysed ERP projects, calculated according to the formula mentioned before. It becomes evident that, according to the majority of respondents, the considered projects were characterised by high and/or very high contractual compliance (in 67.03% of cases values of that metric equalled 5 or 6, what meant that budgets and deadlines were met or that costs were lower than planned and/or projects were completed earlier than expected). The average level of contractual compliance was 4.67, what in the “school grading system” means “more than good”. The overall positive picture is shadowed by the considerable share of undertakings characterised by worse assessments of contractual compliance. The projects classified to categories 2-4 (overrun time and/or budget) account for 32.97% of the total. This results from the occurrence among analysed ERP projects of 10 cases (10.99%) in which budgets were exceeded by 25-50% and another 7 (7.69%) where they were overrun by 50-100% as well as 8 situations (8.79%) in which the time/deadline of realisation was exceeded by 25-50% and another 6 (6.59%) where delays reached 50-100%.

Qualitative compliance assessment took into consideration two aspects: initial and final compliance. The initial compliance was evaluated by comparing features and functionalities of products – i.e. ultimate outcomes of implementation projects – with original requirements specified by end-users. The final compliance took into account project dynamics, reflecting all alterations introduced in a course of project

⁵ Budget compliance was measured as a relation of actual project cost to its initial budget, whereas time compliance was calculated as a quotient of actual project duration and realisation time originally planned or as a relation of actual and projected closing date of an undertaking. For both characteristics there were six compliance classes used in the questionnaire. With respect to budget they were defined as follows: (1) cost exceeding budget by over 100%, (2) cost exceeding budget by less than 100%, (3) cost exceeding budget by less than 50%, (4) cost exceeding budget by less than 25%, (5) cost comparable to budget and (6) cost below budget. The time compliance classes were defined similarly.

⁶ The proposed metric name refers to the fact that implementation budget and duration constitute, beside scope, basic parameters of ICT projects included in contractual documentation – starting from the terms of reference and finishing with final versions of agreements.

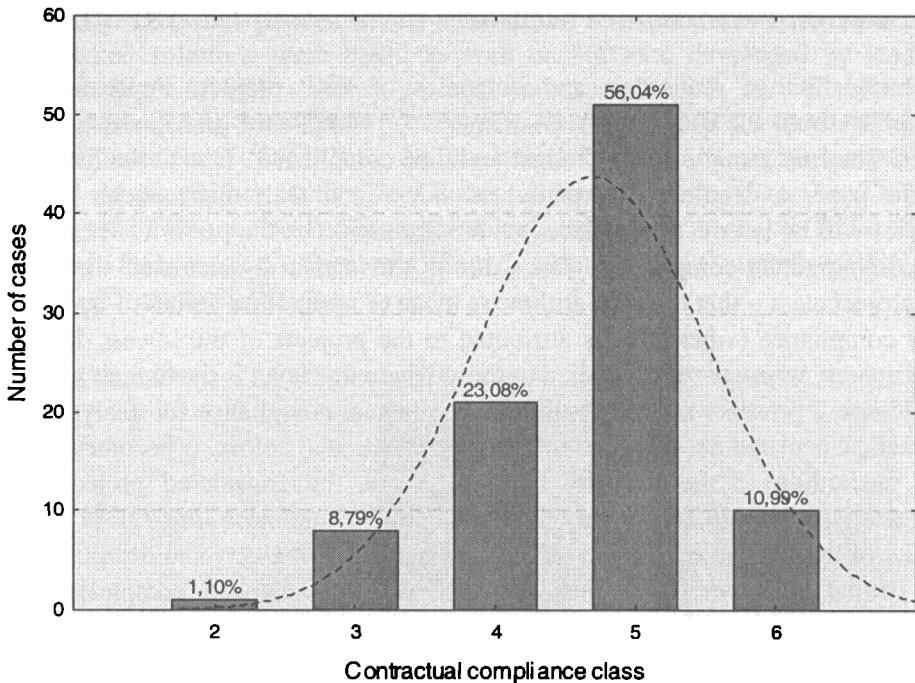


Figure 2. Distribution of Contractual Compliance Classes for the Analyses ERP Projects
Source: own presentation based on results of the survey.

realisation⁷. The detailed presentations of values and distributions for both characteristics cannot be made within the confines of the paper. It will be substituted, however, with a discussion on the functional compliance measure⁸. Value of that metric is calculated similarly to the contractual compliance – that is as the arithmetic mean of normalised values of the initial and final compliances (where “1” is attributed to projects of insufficient consistency, whereas “8” – as 8-point scale is used – is applied to undertakings characterised with the full consistency).

Figure 3 presents the functional compliance distribution for the analysed ERP projects, calculated according to the previously described procedure. It becomes apparent that the majority of assessments (40.66% of all indications) qualified to the category “very high”. If this result is added to the share of projects characterised by “high” or “full” functional compliance, the combined category – repre-

⁷ For both initial and final compliance there were eight classes used in the questionnaire, defined as follows: (1) insufficient (compliance level below 40%), (2) very low (over 40%), (3) low (over 50%), (4) partial (over 60%), (5) medium (over 70%), (6) high (over 80%), (7) very high (over 90%) and full ($\cong 100\%$).

⁸ The proposed metric name refers to the fact that assessments of initial and final compliance focus on utility (functional characteristics) of ICT products and/or services.

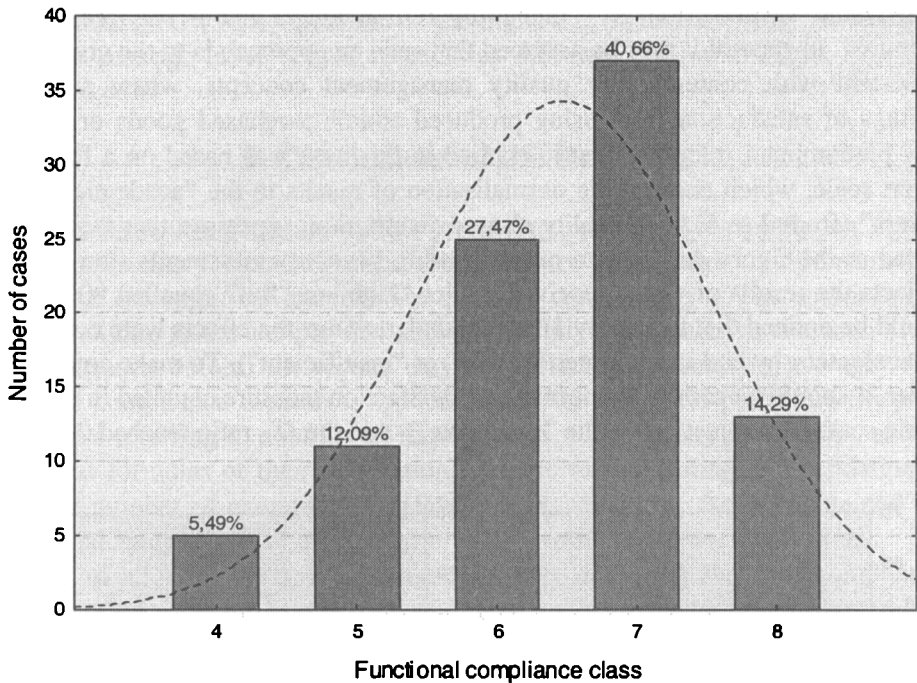


Figure 3. Distribution of Functional Compliance Classes for the Analyses ERP Projects
Source: own presentation based on results of the survey.

senting undertakings where products or services met functional requirements at least in 80% (classes 6 to 8) – accounts for 82.42% of the total number of projects. The average value of functional compliance for the assessed group equalled 6.46. In order to achieve comparability of assessments for contractual and functional compliance – as different scales were used – an IT benchmark index (IT_{bi}), proposed in 2004 by Love and Irani (cf. [Ugwu and Kumaraswamy 2007, p. 236]), will be applied. The ratio is calculated using the following formula:

$$IT_{bi} = \frac{\sum w}{A * N}, (0 \leq IT_{bi} \leq 1)$$

where w represents a weight/value of an assessment, A corresponds the highest possible weight/value and N is a total number of assessments (respondents).

Functional compliance, calculated according to the algorithm presented above, equals 0.808, and is higher than the contractual compliance estimated using the similar method, which amounts to 0.778.

In addition, information on general qualitative assessments of outcomes for analysed ERP projects were collected. This issue was evaluated based on measures characterising satisfaction of end-users' needs, requirements and expectations by

final results of undertakings – that is by ICT products and/or services put into operation. In general it may be assumed that such an approach is to the great extent consistent with contemporary quality management concepts, where subjective feelings of satisfaction from using produced and/or purchased goods or services play predominant role. The metric applied in this case was based on a four-point Likert scale, which enabled the normalisation of results to the “academic grading system” (from 2 to 5). The quality classes distribution, expressed that way, is presented at the figure 4a. Despite overwhelming positive assessments (the share of projects the results of which received grades “high” or “full” equalled 80.22%), it should be noticed that for nearly 1/5 of all undertakings the effects were considered unsatisfactory by end-users (notes “partial” or “insufficient”). To make comparison easier, it should be added that normalised satisfaction measure equalled in the “academic scale” 3.93 (just below the “good note”), and the IT_{bi} ratio reached 0.787.

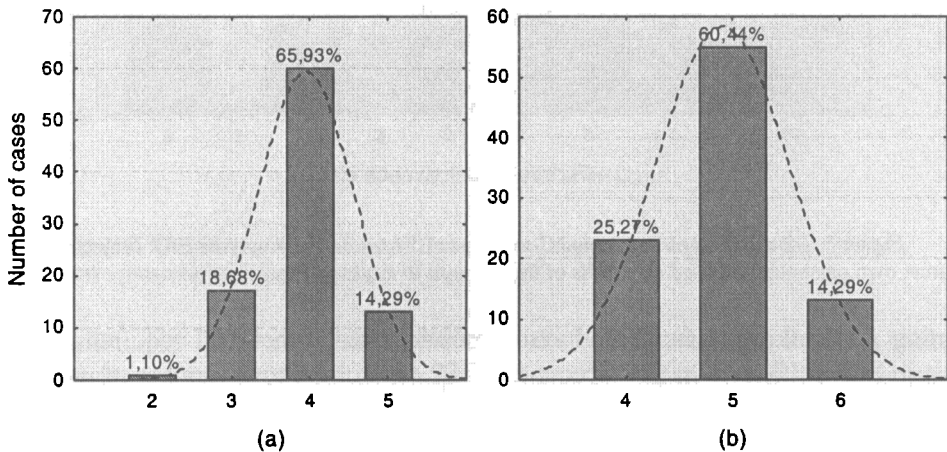


Figure 4. Distribution of Classes Regarding (a) Normalised Quality and (b) Results for the Analysed ERP Projects

Source: own presentation based on results of the survey.

The evaluation of the analysed ERP projects was supplemented with a distribution of classes with respect to achieved results, which is presented at figure 4b. For the purpose of this assessment project results were defined by the author as a function of four normalised parameters: contractual and functional compliance, quality of outcomes and a project category, thus taking into account the influence of ICT projects complexity on results achieved⁹. It can be observed that nearly 3/4

⁹ Within the analytical procedure project result classes were established using several methods transforming the values of particular characteristics, included in each set of data, into a single parameter. The algorithms comprised: the arithmetic mean, the square root of the product, the integral

of undertakings (74.73%) qualified to the highest two classes – what is a positive sign. The average level of this metric was 4.89 and the value of the IT_{bi} ratio equalled 0.815.

5. Conclusions of the Research

The information presented in this paper requires a brief recapitulation. It may have a preliminary character only, though, since a thorough, multidimensional analysis of the empirical material has not been completed yet. The author is also aware, that due to the sample size and its not fully representative character (what was mentioned before) the results may not reflect the “country’s average”. The proposed compliance measures, applied within the analytical procedure (in particular those referring to contractual requirements, functionality and results, as well as various formulas of their calculation), require further testing and validation on a greater number of exemplary projects, too. Nevertheless, the data obtained and their initial analysis justify an attempt to draw several important conclusions.

First of all, positive quantitative assessments of budget and time compliance, which resulted in high average level of contractual compliance for considered ERP projects, should be emphasised again. It is a proof that providers of such solutions, as well as companies which deliver implementation services, have already learned how to thoroughly estimate sizes of the two most critical resources types required to carry out these projects in an effective and efficient way. This could also be a sign of retreat from practises, far too common in the past, of estimating budgets and timeframes considering an optimistic scenario only, which lead to considerable overruns. This may well be a suggestion that customers (companies, for which ERP projects are developed) have already acquired knowledge and skills, based on previous experience, how these parameters of a contract should be set¹⁰. All the signals confirm growing maturity of the market for ERP systems and related implementation services. It should be mentioned, however, that the assessment of contractual compliance for the group of ERP projects, calculated according to the IT benchmark index formula (0.778), was lower than that for all undertakings analysed by the author (0.791). This fact may be explained with higher complexity of the first category of projects.

Secondly, extremely important are – what should be repeatedly emphasised – high qualitative assessments of results of the analysed ERP projects (this refers to

part of that value or the IT_{bi} ratio. Due to similar results, regardless algorithms used, and the constraints of this paper, only one distribution, based on the arithmetic mean, will be presented.

¹⁰ Besides own experience, helpful information can be found in materials available at home pages of ICT systems providers or companies delivering implementation services (refer, for example, to the Academy of Knowledge (Akademia Wiedzy) of the Business Consulting Center – a company from Poznań which is one of the key partners of SAP at the Polish market; <http://bcc.com.pl>) or in business vortals (visit, for example, the web-page of IDG at erpstandard.pl).

respondents' opinions on initial and final compliance, the subjective quality measure as well as metrics calculated on that basis, such as: functional compliance and project results compliance). In fact, an ultimate goal for implementing information and communication technologies is *not* the most efficient realisation of projects, but providing end-users with solutions meeting their needs, requirements and expectations, and supporting them in the most satisfactory way. It should be added, that assessments of ERP projects (values of IT_{bi} ratio amounted to: 0.808 for the functional compliance, 0.787 for the satisfaction measure and 0.815 for the project results compliance) are similar or higher than in case of all the undertakings examined by the author (for which the IT benchmark index reached: 0.798, 0.790 and 0.792 respectively).

Thirdly, an analysis of factors¹¹ which lead to the positive evaluation of effectiveness of implementing ERP systems shows that this situation results from:

- considerable improvement with regard to management and realisation procedures within considered projects, what is demonstrated by high ranks of such factors as: precise business objectives, efficient requirements formulation process (needs, expectations) or reliable estimation of project parameters (time-frame, budget),
- paying attention to the fundamental role of a human factor as a carrier of knowledge and competencies required for the proper organisation and management in ICT projects – what is demonstrated clearly by high positions in hierarchy of such issues as: involvement of future users, well qualified and properly assembled project teams or experienced project managers,
- better adjustment of information and communication technologies to end-users' requirements, needs and expectations (solutions characterised by considerable structural and functional flexibility, with predefined parameters and oriented at certain business areas etc.).

Closing the list of initial conclusions, it should be stressed, that the research is being continued, and results from next cycles, including the multidimensional comparative analysis and the examination of critical success factors, will be successively processed and published.

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¹¹ Broader analysis of critical success factors for ICT projects can be found, among others, in [Dyczkowski 2006a and 2007c].

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