

## Choosing a Business Software Systems Development and Enhancement Project Variant on the basis of Benchmarking Data – Case Study

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**Abstract**—Execution of Business Software Systems (BSS) Development and Enhancement Projects (D&EP) is characterised by the exceptionally low effectiveness, leading to the considerable financial losses. Thus it is necessary to rationalize investment decisions made with regard to the projects of this type. Each rational investment decision should meet two measurable criteria: of effectiveness and of economic efficiency. In order to make *ex ante* evaluation of these criteria, being key to the decision-making process, one may successfully use ever richer resources of benchmarking data, having been collected in special repositories that were created with improvement of software processes in mind. The goal of this paper is to present possibilities of rationalization of investment decision concerning the choice of BSS D&EP execution variant with the use of benchmarking data on the basis of a case study. These issues classify into economics problems of software engineering.

**Keywords**-business software systems development and enhancement projects variants; rational investment decision; benchmarking data repositories; software engineering economics

### I. INTRODUCTION

In practice, execution of Business Software Systems (BSS) Development and Enhancement Projects (D&EP) is characterised by the exceptionally low effectiveness, leading to the considerable financial losses. This may be proved by numerous analyses. As indicated by the results of the Standish Group studies success rate for application software D&EP has never gone beyond 35%, while currently products delivered as a result of nearly 45% of them lack on average 32% of the required functions and features, the estimated project budget is exceeded by approx. 55% on average and the planned project time – by nearly 80% on average [1] (for more details see [2]). Analyses by T.C. Jones plainly indicate that those software D&EP, which are aimed at delivery of business software systems, have the lowest chance to succeed [3]. The Panorama Consulting Group, when investigating in their 2008 study the effectiveness of ERP (Enterprise Resource Planning) systems projects being accomplished worldwide revealed that 93% of them were completed after the scheduled time while as many as 68% among them were considerably delayed comparing to the expected completion time [4]. Merely 7% of the surveyed ERP projects were accomplished as planned. Comparison of actual versus

planned expenses has revealed that as many as 65% of such projects overran the planned budget. Only 13% of the respondents expressed high satisfaction with the functionality implemented in final product while in merely every fifth company at least 50% of the expected benefits from its implementation were said to be achieved. Meanwhile (see also [2]):

- BSS are one of the fundamental IT application areas.
- BSS development or enhancement often constitutes serious investment undertaking.
- In practice, COTS (Commercial-Off-The-Shelf) BSS rarely happen to be fully tailored to the particular client business requirements therefore their customization appears vital.

Low effectiveness of BSS D&EP execution leads to the substantial financial losses, on a worldwide scale estimated to be hundreds of billions of dollars yearly, sometimes making even more than half the funds being invested in such projects. The Standish Group estimates that these losses – excluding losses caused by business opportunities lost by clients, providers losing credibility or legal repercussions – range, depending on the year considered, from approx. 20% to even 55% of the costs assigned for the execution of the analysed projects types (see e.g., [5][6]). On the other hand, analyses of The Economist Intelligence Unit, which studied the consequences of BSS D&EP delay indicate that there is strong correlation between delays in delivery of software products and services and decrease in profitability of a company therefore failures of BSS D&EP, resulting in delays in making new product and services available and in decreasing the expected income represent threat also to the company's business activity [7].

The above studies unequivocally indicate there is a significant need to rationalize investment decisions made with regard to BSS D&EP. To do so, one may successfully use ever richer resources of benchmarking data, having been collected with the intention to support improvement of various IT projects, including BSS D&EP. The goal of this paper is to present possibilities of BSS D&EP investment decision rationalization with the use of benchmarking data, illustrated with an example taken from development practice. This decision concerns choosing variant of BSS D&EP execution – since each project of this type may be executed using one of the three variants, namely: (1)

developing new BSS from scratch, (2) customization of COTS BSS, and (3) modernization of BSS being currently used.

The paper is structured as follows: in Section 2 the author presents the criteria of rational investment decision in the context of BSS D&EP along with the selected results of studies concerning *ex ante* evaluation of these criteria. Section 3 is devoted to the presentation of the considered case study problem. In Section 4 the main conclusions coming from the benchmarking data analysis are pointed out, while in Section 5 the effectiveness and efficiency factors for the recommended BSS D&EP variant are analysed. Finally, in Section 6 the author draws conclusions and some open lines about future work on the rationalization of BSS D&EP investment decision with the use of benchmarking data.

## II. RATIONAL INVESTMENT DECISION CRITERIA FOR BUSINESS SOFTWARE SYSTEMS DEVELOPMENT AND ENHANCEMENT PROJECTS

Each rational investment decision should meet three criteria, which in the context of BSS D&EP should be interpreted as follows (for more details see [8]):

- Criterion of consistency, which means that the project undertaken should comply with the environment (economic, organizational, legal and cultural) – unlike the other two criteria, this criterion is not subject to quantitative assessment therefore it is skipped in this paper.
- Criterion of economic efficiency, meaning that the decision should benefit to the maximisation of the relationship between the effects to be gained as a result of project execution and the costs being estimated for the project.
- Criterion of effectiveness, meaning that such decision should contribute to achieving the assumed result, in the case of BSS D&EP usually being considered as delivering product meeting client's requirements with regard to functions and features without budget and time overruns.

Generally speaking, in the case of economic efficiency evaluation, effects are compared against costs necessary to achieve these effects while in the case of effectiveness evaluation these are only the results that are of significance. Thus, economic efficiency is measured by relating total effects to total costs. Meanwhile, effectiveness is measured by the ratio of the achieved result to the assumed result, which is being conveniently expressed as a percentage.

Both economic efficiency criterion as well as effectiveness criterion are based on the obvious assumption that the effects, costs and results are measurable. However, in the case of BSS D&EP this assumption is often treated as controversial. Numerous studies indicate that evaluation of BSS D&EP economic efficiency is made relatively rarely while fundamental reason for this *status quo* are difficulties related to identification, and most of all quantitative expression, of benefits resulting from the execution of such projects (see e.g., [9][10][11][12][13]). These studies reveal

that difficulties related to identification and quantitative expression of BSS D&EP costs too are of significance, which also is of importance to the evaluation of their effectiveness.

Key conclusions coming from the above mentioned studies have also been confirmed by the results of studies carried out by the author of this paper in two research cycles among Polish dedicated BSS providers (for more details see [14]). They revealed that at the turn of the years 2005/2006 the results obtained with the use of the effort estimation methods, employed only by approx. 45% of the respondents, were designed for estimating BSS D&EP costs and time frame while relatively rarely they were used to estimate economic efficiency – such use of these methods was indicated by only 25% of those using effort estimation methods. Heads of IT departments in Polish companies, for which BSS D&EP are executed, still explain the sporadically required calculation of this type of investments efficiency mostly by the necessity to undertake them – most often due to the fact that without such solutions they lack possibility to match competition from foreign companies, as well as to match foreign business partners requirements. While Polish public administration institutions in practice still do not see the need for the BSS D&EP economic efficiency evaluation, in most cases as an argument giving the non-economic purposes of systems being implemented in this type of organizations. On the other hand, at the turn of the years 2008/2009 the results obtained with the use of the BSS D&EP effort estimation methods (approx. 53% of BSS providers surveyed in this cycle declared they commonly employed such methods) were more often used to estimate efficiency: there was an increase to approx. 36% of those using effort estimation methods. This applies to internal IT departments of Polish companies yet still it does not comprise public administration institutions. This increase may be explained first of all by stronger care about financial means in the times of recession, however it still leaves a lot to be desired. Meanwhile, to rationalize various BSS D&EP investment decisions, one may successfully use benchmarking data, having been collected in special repositories with intention to support effective and efficient execution of such projects.

## III. CASE STUDY: DESCRIPTION OF THE PROBLEM

A company that was facing the need to choose an appropriate variant of BSS D&EP execution collects and processes, as a part of its basic activity, orders for certain goods from all over the world in a 24-hour mode, 7 days a week through: website, client service centres, fax and electronic mail (description of the case study taken from [15]). All those channels cooperate with the application, having been functioning in the company for a dozen or so years already, that is designed for orders processing and which no longer is able to satisfy present requirements since:

- Large part of processes is not automated, which requires additional work for registering orders and that generates losses.

- Current status of orders is not known therefore they are being lost, as a result of this other losses are also borne, which together with earlier mentioned losses are estimated to be approx. USD 5000 a day.
- System is expensive and difficult to maintain, with frequent malfunctions as it employs obsolete technology.
- System extends the time of delivering new products to the market, increases the risk of losing clients and lack of compliance with their requirements, slows down the growth of competitive advantage.

Thus the company has faced a decision on choosing variant of BSS D&EP execution that would:

- Eliminate the above mentioned drawbacks of the existing solution.
- Contribute to short- and long-term profits – that’s why the costs and duration of project are of great significance.
- Reduce the costs of functioning of both company and technology.
- Contribute to the reduction of risk, both in terms of business and technology.

Offers for each BSS D&EP variant were submitted, having approximate average values as shown in Table I.

TABLE I. PARAMETERS OF OFFERS CONCERNING EXECUTION OF PARTICULAR VARIANTS OF BSS D&EP CONSIDERED

Variant	BSS D&EP variant	Execution cost offered	Execution time offered
1	Development of new BSS from scratch using modern technologies	USD 10 million	3 years
2	Customization of BSS purchased	USD 5 million	2 years
3	Modernization of BSS used currently	USD 3,5 million	1,5 years

Source: Author’s analysis based on [15, p. 2].

Since each variant was backed by certain part of the board and key users, an analysis aimed at supporting decision-making process was carried out.

IV. CONCLUSIONS FROM THE BENCHMARKING DATA ANALYSIS

The analysis used benchmarking data for BSS D&EP having been collected in the following repositories:

- Standish Group, featuring data about over 70 thousands of the accomplished application software D&EP, which were analysed using the tool called *VirtualADVISOR* [15].
- Software Productivity Research (SPR), containing data from approx. 15 thousands of the accomplished application software D&EP, which were used to verify conclusions coming from Standish Group repository analysis with the use of *SPR Knowledge Plan* tool [16].
- International Software Benchmarking Standards Group (ISBSG), having collected data from approx. 5 thousands of the accomplished application

software D&EP [17], also used to verify findings coming from Standish Group repository analysis and also with the use of *SPR Knowledge Plan* tool, which at its present version offers possibility to import data from the ISBSG repository.

Priority was given to the Standish Group data and this being not only due to the size of this repository, objectivity of data (they come solely from clients) or the fact of IT branch appreciating its practical value [5] but also because they take into account an appropriate kind of client (in terms of branch and size of a company), appropriate kinds and size of BSS D&EP as well as appropriate type and size of application. Thus using the Standish Group repository made it possible to match all three kinds of BSS D&EP against the profile, with 90% match of the 120 attributes of more than 100 projects [15].

What’s also important, in their analyses the Standish Group employs clearly defined criteria of project classification, dividing projects into the following three groups (see e.g., [1][6][18]):

- Successful projects – that is projects completed with delivery of product having functions and features being in accordance with client requirements specification and within the estimated time and budget.
- Challenged projects – that is projects completed with delivery of product that is operating yet has fewer vital functions/features comparing to the client requirements specification and/or with overrun of the planned budget and/or duration.
- Failed projects – that is projects that were abandoned (cancelled) at some point of their life cycle or were completed with delivery of product that had never been used.

In the analysis of the Standish Group data, the following criteria were employed as equivalent for particular variants of the BSS D&EP considered:

- 1) Criterion of expected BSS D&EP effectiveness, including:
  - a) chance to succeed
  - b) level of planned costs overrun
  - c) level of planned duration overrun.
- 2) Criterion of expected BSS D&EP efficiency, including:
  - a) return on investment (ROI)
  - b) payback period.

Data presented in Table II clearly indicate that in the case being considered the highest chance to succeed is held by modernization variant, for which success coefficient is several times higher than that characteristic of variant consisting in development of new application, being only 4% (sic!), and significantly higher than that of COTS customization variant. Also in case of variant 3 the lowest percentage of projects ends with being abandoned – it is several times lower than in case of variant 1 and two times lower than in case of variant 2. What seems interesting, the highest percentage of projects that ended in partial failure (challenged projects) occurs in case of the customization of

COTS application. What’s more, the average expected overrun of both costs (see Table III) and project duration (see Table IV) is also the highest in case of this project variant.

TABLE II. EXPECTED CHANCE TO SUCCEED FOR PARTICULAR VARIANTS OF BSS D&EP CONSIDERED

Resolution	Variant 1	Variant 2	Variant 3
Successful	4%	30%	53%
Challenged	47%	54%	39%
Failed	49%	16%	8%

Source: [15, p. 4].

Moreover, data in Table III clearly indicate that the average expected overrun of the planned costs for projects that ended in partial failure too is the lowest in case of variant 3. Also the lowest percentage of such projects overruns the costs by more than 50%. If offered costs and average expected overrun of these costs are taken into consideration when calculating the expected cost then it appears evident that the lowest expected cost of project execution applies to modernization variant.

TABLE III. EXPECTED LEVEL OF PLANNED COST OVERRUN FOR PARTICULAR VARIANTS OF BSS D&EP CONSIDERED (CHALLENGED PROJECTS)

Cost overrun	Variant 1	Variant 2	Variant 3
0% to 50%	64%	58%	75%
51% to 50%	36%	42%	25%
Average	44%	47%	34%
Offered cost	USD 10 million	USD 5 million	USD 3,5 million
Estimated cost	USD 14,4 million	USD 7,35 million	USD 4,7 million

Source: Author’s analysis based on [15, p. 4].

Analogous conclusions may be drawn on the basis of the analysis of data presented in Table IV. Again, the average expected overrun of the planned duration for projects that ended in partial failure proves being the lowest for variant 3. Also the lowest percentage of such projects overruns the duration by more than 50%. If we take into account the offered duration and average expected overrun of this duration then we can see that the lowest expected duration of project execution applies to modernization variant too.

TABLE IV. EXPECTED LEVEL OF PLANNED DURATION OVERRUN FOR PARTICULAR VARIANTS OF BSS D&EP CONSIDERED (CHALLENGED PROJECTS)

Duration overrun	Variant 1	Variant 2	Variant 3
0% to 50%	57%	59%	80%
51% to 50%	43%	41%	20%
Average	44%	45%	29%
Offered duration	36 months	24 months	18 months
Estimated duration	52 months	35 months	23,5 months

Source: Author’s analysis based on [15, p. 4].

Data shown in Table V clearly indicate that the highest percentage of projects characterised by the highest ROI can be found in case of variant 3 again. On the other hand, what’s interesting is that projects with average ROI most often are projects consisting in developing new application from scratch while the lowest percentage of projects characterised by the lowest ROI can be found in case of customization variant.

TABLE V. EXPECTED ROI FOR PARTICULAR VARIANTS OF BSS D&EP CONSIDERED

ROI	Variant 1	Variant 2	Variant 3
High	11%	34%	52%
Average	66%	57%	37%
Low	23%	9%	11%

Source: [15, p. 5].

In Table VI both ROI and payback period for particular variants of the considered project were estimated in optimistic and pessimistic version. In the optimistic version it was assumed that the costs were identical with the offered costs while in the pessimistic version - that the costs were exceeded by the average values being expected for each variant analysed (see Table III). Based on these assumptions, both in optimistic and in pessimistic version, the highest 5-year gain applies to the modernization variant; also in case of that variant the payback period proves the shortest. It is worth noting that project in variant consisting in developing the new application would pay off after nearly 5 and half years in the optimistic version and after nearly 7 and half years in the pessimistic version.

TABLE VI. EXPECTED ROI AND PAYBACK PERIOD FOR PARTICULAR VARIANTS OF BSS D&EP CONSIDERED

Variant	Optimistic version			Pessimistic version		
	Costs (in \$ millions)	5-year gain (in \$ millions)	Payback period (in years)	Costs (in \$ millions)	5-year gain (in \$ millions)	Payback period (in years)
1	10	0	5,4	14,4	0	7,3
2	5	7,25	3,2	7,35	2,8	4,4
3	<b>3,5</b>	<b>10,6</b>	<b>2,4</b>	<b>4,69</b>	<b>7,9</b>	<b>3,1</b>

Source: Author’s analysis based on [15, p. 5].

The above analysis clearly indicates that what in the considered case would be the best of the three BSS D&EP variants both from the perspective of the expected effectiveness and from the perspective of the expected efficiency is variant consisting in modernization of the application being used (variant 3).

V. THE EFFECTIVENESS AND EFFICIENCY FACTORS FOR THE RECOMMENDED VARIANT

In the analysed case, BSS D&EP consisting in modernization of application being used proves the most effective as well as the most efficient, what results, among others, from (see also [15]):

- Undertaking of such projects as a rule is a result of clearly defined needs of users therefore their goals are comprehensible, what undoubtedly promotes

users' engagement in the project and the board's support for the project, which, according to the list of success factors having been developed by the Standish Group since 1995, are still the two most important success factors [18].

- The fact that modernization projects do not require extensive analysis of requirements, numerous agreements, long-time training, changes of processes that would be destabilizing the work.
- Commonness of such projects thus the skills of executing them are high; what's more, projects of this type do not require additional skills in terms of project management, they rather require technical, the so called „hard”, skills.
- Present structure of project costs in terms of development activities, which due to the increased complexity of projects and ever more developed tools has changed and is now in inverse proportion to the structure as it was 25 years ago: now programming costs make up approx. 20% while other development works make up approx. 80% of the total cost.
- The fact that modernization projects are characterised by the lowest hidden cost (mainly user's time), estimated to be 15% of project costs versus 55% for variant 2 and versus 35% for variant 1.
- The discussed projects may be successfully carried out using agile approach, which also ranks high (sixth position) in the current list of success factors [18].
- Products smaller than those in case of developing application from scratch are developed as a result of the modernization projects and this is what increases their chance to succeed.
- The discussed projects do not have redundant requirements – as this is the case of the COTS customization where, according to the Standish Group data, less than 5% (sic!) of the features and functions get used [15], and of the development of new products (see Figure 1).

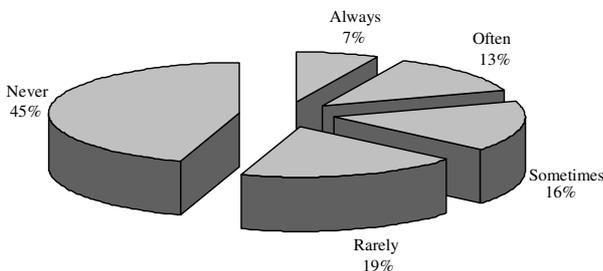


Figure 1. Average use of functions and features in the implemented software systems - custom development applications

Source: Author's analysis based on [15, p. 15].

However, variant recommended in the discussed case is not devoid of drawbacks though. Most of all, it evidently is not suitable for organizations where BSS have not functioned so far (in Poland approx. 95% of small companies do not use BSS – comparing to 50% in developed countries), for new organizations, new departments, and in case of fusion the modernization often ends in failure too. Moreover in modernization variant there are limited possibilities to implement fundamental business changes. What's more, the use of obsolete technologies is being continued, what makes cooperation with modern applications difficult, reduces usability, portability and maintainability of the modified application; performance is usually lower too. It is worth stressing that these attributes are the software product quality attributes of the ISO/IEC 9126 norm [19]. Thus what appears to be open to doubt is reduction of costs and difficulties in maintaining the system as well as technological risk - this being one of the major goals of the solution variant to be chosen (see Section 2). It is also worth mentioning that the ISBSG data indicate lower productivity of such projects: in case of BSS D&EP consisting in developing new BSS from scratch it ranges on average from 9 (for 4GL) to 24.5 (for 3GL) work hours for developing 1 function point (for more details about function points see [20]) whereas in case of modernization projects it takes approx. 27 work hours on average to develop 1 function point [21].

## VI. CONCLUSION AND FUTURE WORK

Based on the analysis of benchmarking data coming from the Standish Group repository, having been carried out with the use of *VirtualADVISOR* tool, it was concluded that what proves the best among the three BSS D&EP variants *in the discussed case* is variant consisting in modernization of application being used. Data analysis indicates that choosing the above mentioned variant is rational due to the criterion of both expected effectiveness and expected efficiency of project. This conclusion has been confirmed by the verification based on the repository of the SPR and ISBSG data, having been carried out with the use of *SPR Knowledge Plan* tool.

From the point of view of effectiveness and efficiency, modernization variant has many advantages yet it is not devoid of drawbacks though. What's more, this does not have to be the best solution in other cases, e.g., for real time systems, for small software product development/enhancement projects, or for organizations that specialise in developing specific kind of new software systems where there is possibility to use the already written code. It should be also mentioned that projects of higher risk, i.e., those having lower chance to succeed, often happen to be more efficient.

As indicated by the study results discussed in this paper, in view of exceptionally low effectiveness of BSS D&EP it is necessary to rationalize investment decisions being made with regard to such projects. To do so one may successfully use ever richer resources of benchmarking data having been collected in repositories with intention to support effective and efficient BSS D&EP execution. In the opinion of T.C.

Jones: "For many years the lack of readily available benchmark data blinded software developers and managers to the real economics of software. Now (...) it is becoming possible to make solid business decisions about software development practices and their results (...). [Benchmarking – B.C.C.] data is a valuable asset for the software industry and for all companies that produce software" [22]. This paper presented the possibility of rationalization of investment decision concerning the choice of the BSS D&EP variant execution with the use of such data, illustrated on the basis of a case study.

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