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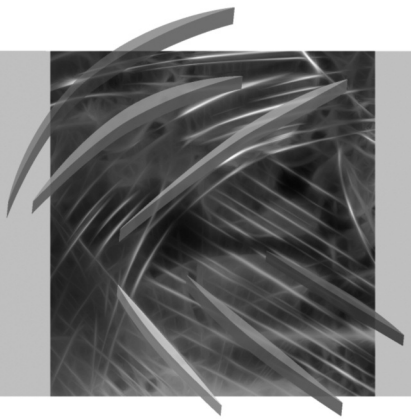

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Information Systems in Business

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COMPUTER-AIDED ECONOMIC EFFECTIVENESS MANAGEMENT IN APPLYING FSM SYSTEMS

Abstract: The paper discusses the use of assessing Return on Investment (ROI) and Total Cost of Ownership (TCO) to manage economic effectiveness of acquiring and using IT systems. The first section introduces methodological framework for estimating ROI and TCO. Possibilities of supporting the process with the so-called ROI/TCO calculators are examined subsequently. The main section of the paper presents a case study of implementing the proposed method of analysis to manage economic effectiveness of deploying an FSM (Field Service Management) system in a hypothetical telecommunication company. The idea of a specialized calculator and its implementation were developed in a thesis supervised by the author of this paper and written as a part of a postgraduate course in "Effective IT Management in a Company".

Keywords: economic effectiveness management, ROI, TCO, ROI/TCO calculator, Field Service Management, FSM system.

1. Introduction

The global financial crisis, which has affected the Polish economy since the second half of 2008 resulted in the deterioration of economic situation in the majority of companies, evidence of which has been provided by current business statistics, economic and social analyses, or by monitoring tendency changes in the economy. Implications of the crisis have been observed in the information technology field as well, with clear signals coming from producers and providers of IT products and services, as well as from their customers. That the situation had grown worse was also acknowledged by nearly all major companies monitoring IT industry, including DiS, Gartner, Forrester Research, IDG, and PMR. According to PMR surveys, in 2009 not only had the IT market not increased for the first time in recent years, but it shrunk by 9.2% (from PLN 26.9 billion to PLN 24.5 billion), and although 2010 saw a year-on-year increase of 5.8% in the market's value, the 2008 level had never been reached (with the market being worth 1.0 billion less than in 2008). The forecasts for 2011 prove more optimistic with a predicted double-digit growth (10.9%)

to PLN 28.7 billion, i.e. 1.8 billion more than in a record 2008. Nonetheless, it is not certain whether the trend change will be lasting as neither the Polish nor the world economy has overcome the financial crisis yet. The PMR numbers are shown in Figure 1.

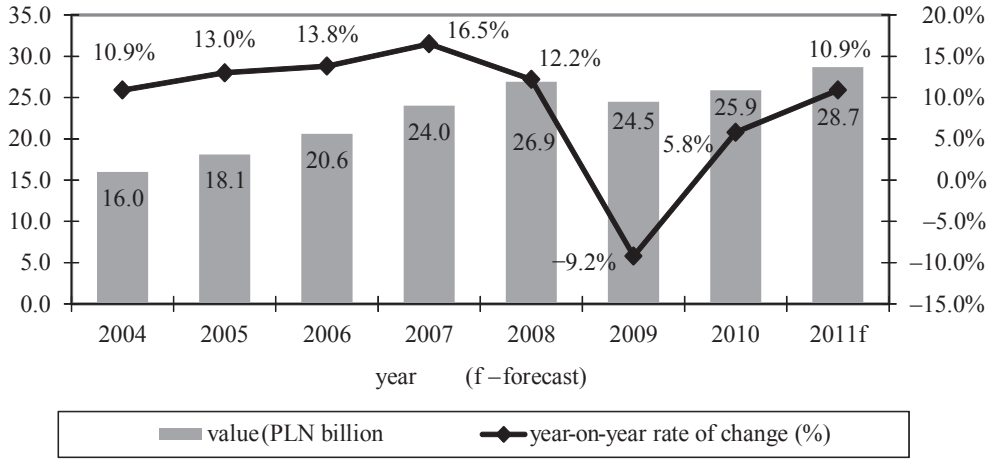

Figure 1. Value and year-on-year rate of change for IT market in Poland according to PMR data and forecasts from August 2011

Source: own presentation based on [Olszynka 2011, p. 2].

This situation has affected the functioning and informatization programs of a large percentage of companies and institutions. The author's surveys from 2009 and 2010 on the impact of the global crisis on IT initiatives and systems in 248 companies and institutions showed that many of these had modified their informatization strategies. Apart from cuts in IT seminars and training expenses, the respondents most frequently indicated the following as visible symptoms of the change: postponed IT investments, reduced IT investment spending, and reduced IT departments' budgets (see, e.g., [Dyczkowski 2010a, pp. 231–232], [Dyczkowski 2010b, pp. 110–113], and [Dyczkowski 2011, pp. 294–295]).

With shrinking IT budgets the interest in calculating effectiveness of IT solutions has been growing, as the previously mentioned author's surveys,[1] as well as other analyses (see, e.g., [Syska 2009]), demonstrated. To assess the effectiveness of IT investments, apart from implementing CBA-based (Cost-Benefits Analysis) methods, well-known in the literature of the subject and tested in the practice of evaluating

[1] These saw a vast number, considerably increasing from a year-on-year perspective, of companies and institutions declaring to optimize IT costs, e.g., through TCO. 15.83% of all respondents in 2009 and as much as 22.94% in 2010 mentioned such concern, the percentages being respectively 25% and 31.25% for those respondents who declared to change their strategy. See [Dyczkowski 2010b, pp. 110–111], and [Dyczkowski 2011, pp. 294].

investment effectiveness, we may also examine return on investment or optimize the cost of IT use. In the first case, we base the analysis on such indices as ROI (Return on Investment) or CFROI (CashFlow ROI), in the second, on different versions of TCO method (Total Cost of Ownership).[2]

The aim of the present study is to discuss possibilities of computer-aided economic effectiveness management in acquiring and using IT systems. The successive sections synthetically present methodological framework for TCO and ROI analysis before examining possibilities of supporting the process with the so-called ROI/TCO calculators. The main section focuses on a case study of implementing the proposed method of analysis to manage economic effectiveness of deploying an FSM (Field Service Management) system in a hypothetical telecommunication company. A specialized calculator ROI/TCO has been created and implemented in the MS Excel environment in order to support the process effectively. Its parameterization allows it to be used with every IT system optimizing mobile service chain management. The idea of the calculator and its implementation were developed in a thesis supervised by the author of this study and written as a part of a postgraduate course in "Effective IT Management in a Company" [Sinkiewicz 2010]. The tool is being used and developed in successive implementation projects. Its interactive version, available on Comarch FSM system webpage, allows to estimate the savings possible through the implementation of the system (see Figure 4).

2. A methodological framework for IT effectiveness management

In the literature on the subject we may find descriptions of various approaches to calculating and evaluating economic effectiveness of IT projects and products, with examples of their application.[3] Likewise, through their websites and specialized portals, consulting and training companies and IT solutions providers give access to corporation methods of effectiveness analysis, specialized encyclopedias, educational materials, case studies of IT projects' effectiveness, and present the best practices in the field.[4]

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[2] Comprehensive descriptions of the listed methods of effectiveness evaluation and of problems in their application may be found in: [Cypryjański 2007], [Drobniak 2008], [Dudycz, Dyczkowski 2007], and [Rogowski 2008].

[3] See monographic studies dedicated to IT effectiveness analysis, such as [Cypryjański 2007], [Dudycz, Dyczkowski 2007], [Dudycz, Dyczkowski, Nowak (Eds.) 2006], and [Lech 2007].

[4] See such websites and portals as: http://ceo.cxo.pl, http://decyzje-it.pl, http://erp-portal.pl, http://gazeta-it.pl/pl/roitco, http://it-consulting.pl, http://roitco.vmware.com/vmw, http://tco.pl, http://www.alinean.com, http://www.computereconomics.com/page.cfm?name=ROI%20and%20TCO, http://www.enterpriseefficiency.com, http://www.ey.com/PL/pl/Services/Advisory/IT-Risk-and-Assurance/IT-Enterprise-wide-Governance--Risk-and-Compliance, http://www.idg.pl, http://www.itstandard.pl, http://www.mspstandard.pl, http://www.pwc.com/pl/pl/konsulting/efektywnosc-funkcji-it.jhtml.

In the present analysis, as we said earlier, we will focus on two classes of scenarios for IT effectiveness management, i.e.:

1) ROI-oriented, i.e., oriented to increase the return on IT investments through growing benefits attributable to a positive impact of IT on company's results,

2) TCO-oriented, i.e., oriented to reduce total investment expenses and costs of IT while maintaining or even increasing business benefits.

When we come to examine ROI-oriented scenarios, the question arises of whether the ROI metric can be applied to IT investments, a question discussed by some authors who point at the static character of the former, which disregards the change in the value of money over time, and at the methodology lacking in precision and uniformity, with no single calculation formula generally accepted (cf., e.g., [Chabik 2005, p. 30], [Dudycz, Dyczkowski 2007, p. 85], and [Rogowski 2008, pp. 131–133]). This is why a generalized model concept of ROI proposed by A. Wargin [2003, p. 61] to evaluate the effectiveness of IT initiatives is worthy of notice. In this interpretation, ROI is calculated as follows:

ROI = change in revenue + change in costs + intangible benefits – spending on system,

where:

- change in revenue is a difference between the revenue before and after the implementation of an IT solution,
- change in costs is a difference between the costs before and after the implementation of an IT solution,
- intangible benefits are evaluation, usually subjective, of qualitative parameters,
- spending on system comprises the total investment and operating expenses (those of system maintenance).

Despite the weaknesses mentioned above, a fair share of subjectivity with regard to the values used in calculation, and whatever calculation formula we apply, we may regard ROI as a simple and synthetic metric of IT investment effectiveness. The most important advantages of ROI are it being comprehensible to managers and easy to calculate, since the data required may be found in basic financial reports (balance sheet, income statement).

As for TCO-oriented scenarios, the following two considerations must be kept in mind:

1) approaches proposed by various companies and institutions carrying out such analyses differ from structural and procedural perspectives,

2) the TCO method has been evolving in recent years.

As regards different approaches, the Gartner Group model of classifying and estimating costs continues to prevail in practice (see, e.g., [Cypryjański 2007, pp. 180–188], [Dudycz, Dyczkowski 2007, pp. 99–104], and [*TCO Analyst*... 1997]). Nonetheless, consulting companies, such as Forrester, Meta Group, or RM Consulting, use their own methods of analysis which yield more precise results in certain

points (see, e.g., [Greenbaum 2005], and [Reichman, Staten 2008]). Likewise, producers and providers of IT solutions adapt expense and cost structures and estimation formulas to their own products and/or services, as it is the case of, for instance, the SAP TCO model (see, e.g., [Cypryjański 2006, pp. 503–510], and [Cypryjański 2007, pp. 188–193]).

The evolution of the TCO method, referred to in the second place, is closely connected with a rapid development of information technologies and their applications, which makes problematic drawing on data relating to former projects to compare and estimate changes in expenses and costs. This is especially true of new technologies and innovative applications. For that reason, in order to estimate expenses and costs, especially from an *ex ante* perspective (i.e., for the so-called "to-be" situation), we use models of expected changes in productivity after the implementation of new IT solutions which allow to estimate predicted reductions in TCO components more precisely than historical data.

A close correlation between the two groups of effectiveness management scenarios has to be mentioned next. Obviously, it would be the best to minimize TCO while maximizing benefits (including ROI), which argues in favour of such approaches to effectiveness management that allow to examine the two classes of scenarios jointly. One of such is the Value IT method promoted by E. Syska [2003], which uses formulas with which we can calculate ROI (or CFROI), as well as TCO components. In this approach, in order to determine IT effectiveness, we first have to calculate a so-called IT net effect (E_0) for a company at a given time. To do so, we apply the following formula:

$$E_0 = benefits - business\ process\ costs - IT\ costs.$$

Using the same formula, we then calculate the IT net effect (E_1) after an IT project/system has been implemented. The effectiveness is $E_1 - E_0$. Some typical situations are the following:

– an initiative has aimed at reducing IT costs (e.g., by means of their optimization based on the TCO method) while maintaining business process costs and benefits:

$$E_1 = benefits - business\ processes\ costs - \downarrow IT\ costs,$$

– although the implementation of a project has caused IT costs to increase (through higher investment expenses), at the same time it resulted in a much more considerable reduction in business process costs (mainly because of so-called automation effects), with no change in benefits:

$$E_1 = benefits - \downarrow\downarrow business\ process\ costs - \uparrow IT\ costs,$$

– the implementation of a project has again raised IT costs but at the same time benefits have increased in a much more significant way (mainly as a result of so-

called information and transformation effects), and business process costs have not changed:

$$E_1 = \uparrow\uparrow \textit{benefits} - \textit{business process costs} - \uparrow \textit{IT costs}.$$

The cost-expense side of the account is transparent and relatively easy to identify and quantify. It is much more complicated to identify and quantify benefits derived from IT projects. If the estimation of predicted benefits and/or opportunity costs is to be reliable, it should be based on effectiveness data provided by similar implementations. Additionally, we should use the reference values of KPI (Key Performance Indicators) characterizing business processes being supported and their changes. This will allow to identify and quantify benefits and/or opportunity costs with much greater precision and reliability, and, thus, to calculate ROI.

3. Supporting effectiveness management: ROI/TCO calculators

After presenting some methodological bases of IT effectiveness management, we may pass to instruments that can help the analysis. According to the author of the paper, only when appropriately supported with comprehensible and easily available tools, will calculation and evaluation of effectiveness become a common practice in IT investments. As the paper focuses on TCO and ROI analyses, we will devote the following sections mainly to so-called ROI/TCO calculators. However, the question of creating an appropriate supporting environment concerns the other effectiveness management methods as well. The starting point for our description of ROI/TCO calculators will be a generalized scheme of TCO/ROI analysis process, shown in Figure 2. The scheme presented in the figure requires a brief comment.

Firstly, it is based on the Value IT approach discussed earlier, in which, as we have seen, the cost-expense side of the account is transparent and relatively easy to identify and quantify. It is so for *ex ante* analyses only if a TCO structure being used matches a project's characteristics, and we can obtain the necessary comparative data. This is why it is useful to gather such data. It should also be required of IT solution providers that they develop project budgets in keeping with the structure of direct, indirect and deferred costs/expenses used in an analysis.

Secondly, we have also seen that it is more complicated to identify and quantify benefits derived from IT investments, and estimates differ more considerably here. Therefore, apart from collecting relevant historical and comparative data on tangible benefits and/or opportunity costs of implemented projects,[5] as we do for costs/

[5] Theoretically, the best way to determine historical and/or comparative benefits is to generate appropriate reports from the accounting system of a company where a solution under consideration (here being an FSM system) has been implemented. Such reports should cover all cost objects the implementation bore directly or indirectly upon. They should be produced for the period before the implementation ("as-was"/"as-is" situation) and then at least three months up to a year after the end

expenses, it is important to extend the analysis so that it includes examination of KPI characterizing business processes being supported. By modelling predicted KPI values on the basis of comparative data, we are able to estimate a possible increase in productivity (cost reductions and changes in productivity indices) in an indirect way with reliability, as we will see in Section 4.2. on the example of FSM systems. If, additionally, over the implementation period, and then during the post-implementation audit, we have access to actual productivity data of the solution being implemented, we may assume that the changes in KPI reflect the quality and effectiveness of the system. It is then relatively easy to translate the rates of change in KPI into financial terms, as each of the indicators relates to particular cost objects and/or income. In order to improve the results of KPI modelling, we may include an analysis of sensitivity (what-if) and of OBP (optimist, basic and pessimist) scenarios, thus allowing for variability and risk factors inseparable from IT initiatives.

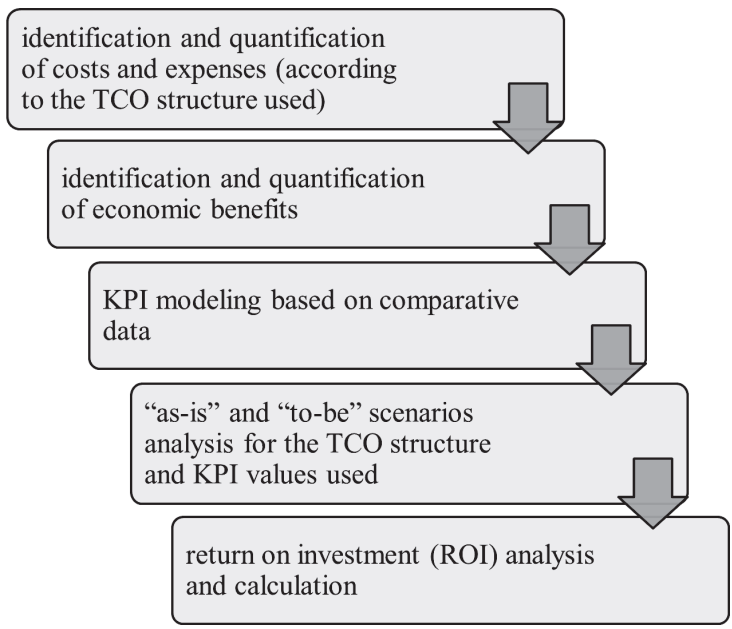

Figure 2. Generalized scheme of economic effectiveness analysis using the TCO and ROI methods

Thirdly, having the necessary data, we can automatize the analysis, at least partly, by creating appropriate support tools. So-called ROI/TCO calculators are an example of these. The idea of how they work is simple, and follows the scheme in Figure 2. One of such calculators was described in the already mentioned thesis writ-

of the stabilization period (“as-is”/“to-be” situation). Unfortunately, very often companies do not store appropriate cross-sectional data, or are unwilling to give access to them for various reasons.

ten by T. Sinkiewicz as a part of a postgraduate course in "Effective IT Management in a Company" and supervised by the author of the present study. In the next section we will have a closer look at the calculator and its uses.

4. Case study: analyzing economic effectiveness of an FSM system with a ROI/TCO calculator

4.1. FSM as a set of tools for optimizing the service chain

Before proceeding to the case study, for the completeness' sake we should present FSM systems and their environment, i.e., field services. One of the characteristics of modern economies is their highly developed service sector, which includes the so-called modern services,[6] more and more delocalized, i.e., services being provided off the provider's site in a mobile fashion. This structure prevails in, for instance, telecommunications, network maintenance outsourcing, insurance, public media, home services, and public safety in a broad sense, including crisis management. With a growing number of delocalized services and greater and greater pressure for quality put on their providers, the need arises for effective IT support for field service management in order to deal with such problems as:

– improving effectiveness and productivity, reducing unnecessary costs via good task scheduling,
– improving quality of customer service by means of shortening response and/or service completion time and through an attempt to complete the service on the first visit in order to increase customer satisfaction and prevent customer loss,
– optimizing operating costs, including travel expenses, which, in addition, serves environmental concerns (vehicle emission reduction, etc.),
– complying with operating norms, standards, regulations and procedures.

Field Service Management (FSM), or Field Force Automation (FFA), is a complete set of methods and tools for optimizing processes and information exchange in companies carrying out their main tasks through specialist staff in the field. In other words, FSM is optimizing the service chain, i.e., managing a company's resources efficiently in time in order to provide services of high quality at the lowest costs.

An FSM system may also be defined, after Gartner Consulting [Maoz, Clark 2010], as essentially meant to support all stages of the service life cycle. Those stages vary according to the sector/branch, but, generally speaking, are the following:

– a work order is placed and registered,
– resources are assigned to the task based on the order's parameters,
– a schedule is developed and optimized,
– a technician is sent into the field in order to complete the task,

[6] The term refers to, e.g., banking, finance, insurance, telecommunications, IT, media, research and development, administration, and management.

– the task is completed,
– task completion information is registered,
– additional services and/or products are sold,
– an invoice for services and/or products sold is issued.

The FSM system market is dynamic, diverse, and with no dominant products. It is also characterized by that apart from buying ready-made applications from external providers, such as Oracle/Siebel, SAP, ClickSoftware, Astea, Service Power, Vertical, IFS, Ventyx, Clevest, Microsoft Business Solutions, or Servigistics, service companies very often use solutions developed by their own IT department or custom-made ones (see [Maoz, Clark 2010], and [Ragsdale 2010]).

Figure 3 shows the functional scheme of one of FSM systems, i.e., Field Service Management produced by the Polish Comarch.

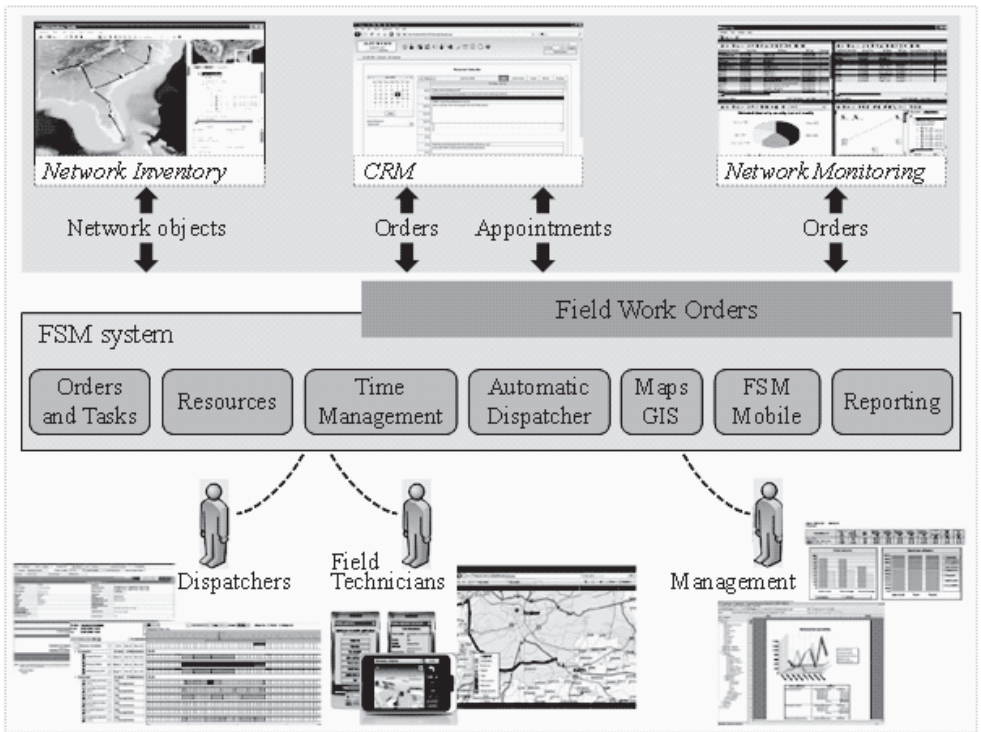

Figure 3. Functional scheme of the Comarch FSM system

Source: own presentation based on [*Comarch Field Service Management* 2011].

Comarch FSM is a complete, multi-module solution designed to support planning, scheduling, distribution and field work. It enables a more effective use of company resources with work orders assigned to technicians best qualified to complete a task, but at the same time allowing for technicians' availability and geographical

location. Advanced automation techniques and built-in algorithms enable to optimize field work for costs as well as productivity. With technicians having mobile remote access to relevant information about the task, dynamic management in real time is possible. Dispatchers are provided with tools needed to locate and visualize technicians on a digital map. As the system is based on SOA (Service Oriented Architecture), it can be integrated with other applications used in a company and/or web-based (cloud computing). For detailed description of the Comarch FSM system, see the producer's website (see [*Comarch Field Service Management*... 2011], and [Uczciwek 2011]).

4.2. Selected aspects of economic effectiveness management in applying FSM

As we could see in Section 2 and, particularly, in Section 3, what is most difficult and most likely to provide data of insufficient reliability in managing effectiveness is identifying and quantifying economic benefits. This is also true when we try to determine economic benefits indirectly by way of KPI modelling, since the core of this method is the existence of repositories containing effectiveness data from similar implementations along with generalized and statistically verified comparative values of those KPI that characterize business processes being supported.

In the case of FSM systems, the most comprehensive and reliable analyses in the field of services management are available through the Association for Services Management International (AFSMI). According to AFSMI, the following are the most important KPI for calculating the effectiveness of Field Service Operations management and, what follows, for comparing benefits derived from optimizing mobile service delivery chains through the implementation of different FSM systems [Israel 2010]:

– number of technicians per dispatcher,
– average number of daily work orders per technician,
– annual cost per dispatcher/scheduler,
– annual cost per technician,
– rate of field work orders compliant with SLA (Service Level Agreement),
– first time/visit fix rate.

Table 1 shows the average KPI values from an AFSMI survey (or, more precisely, that of TSIA, or the Technology Services Industry Association, independent of AFSMI since 2009) carried out in 2010 on a group of more than five hundred AFSMI members, all supporting their business processes with various FSM systems. The results obtained in the survey may well serve as reference data for estimating predicted increase in productivity following the implementation of an FSM system. As such systems differ functionally and technologically, while investigating the effectiveness of an individual producer's solutions, we should supplement the average KPI values with data relating to former implementations of their products.

Table 1. Average Key Performance Indicators values according to a AFSMI/TSIA survey

KPI description	KPI value
Number of technicians per dispatcher	15.1
Average number of daily work orders per technician	4.1
Rate of field work orders compliant with SLA	90%
First time/visit fix rate	85%
Annual cost per technician	USD 128,000
Annual cost per dispatcher/scheduler	USD 75,100

Source: [Israel 2010].

The same indicators served to analyze economic effectiveness of implementing the FSM Comarch system in a hypothetical telecommunications company. All changes in KPI values following the implementation of the system were assumed to be due to its functionality. The analysis used data on the increase registered in the values of the selected KPI in five telecommunications companies providing field services where the Comarch FSM system had been deployed. The results of the analysis are presented in Table 2.

Table 2. Increase in Key Performance Indicators values after deploying the Comarch FSM system (percentage)

KPI description	Comarch FSM system versions		
	basic	extend	full
Number of technicians per dispatcher	52	68	73
Average number of daily work orders per technician	11	21	28
Rate of field work orders compliant with SLA	15	25	29
First time/visit fix rate	10	15	25

Source: own presentation based on [Sinkiewicz 2010, p. 41].

4.3. Analysis with a ROI/TCO calculator: assumptions and results

A full description of the hypothetical company being the object of an analysis using a ROI/TCO calculator designed and implemented in the Excel spreadsheet environment is to be found in [Sinkiewicz 2010, chap. 4.2]. For the effectiveness analysis' sake, we will concentrate on KPI values important from the perspective of deploying an FSM system, i.e.:

– there are, on average, 1000 work orders a day, 10% being emergency work orders,
– SLA applies to emergency work orders only, 74% of which are completed on time, the average delay time is 45 minutes, and the average damages for an hour's delay are PLN 200,
– 70% of work orders are completed on the first visit, so that there are 300 extra work orders a day as a result of bad service,

– a technician completes an average of 4 work orders a day, the average work order completion time is an hour, it ensures that the number of work orders per technician per day can be increased providing schedule and travel time optimization,
– because technicians are assigned to work orders "manually", a dispatcher manages an average of 8 technicians,
– the average annual cost is PLN 72,000 per technician and PLN 84,000 per dispatcher.

Those KPI values served as the initial data to estimate predicted benefits from implementing an FSM system. It was assumed that individual values would increase in the way that they had in the case of similar implementations (see data in Table 2). As regards the components of the project's total investment expenses and costs and their distribution over time for three versions of the system, they were estimated on the basis of prices and estimates available relating to similar projects. Finally a ROI/TCO calculator[7] was used to calculate the ROI value. Table 3 compiles costs and expenses, predicted benefits and ROI.

Table 3. Effectiveness of deploying the Comarch FSM system

Description	Comarch FSM system versions		
	basic	extended	full
Costs and expenses (TCO) in PLN	1,857,700	2,942,600	5,498,200
Predicted benefits on a year basis in PLN	5,667,269	9,653,348	10,794,339
Return on investment (ROI) over 3 years	610%	682%	393%

Source: own presentation based on [Sinkiewicz 2010].

5. Conclusions

The example of FSM systems has shown that the analytic approach presented in the paper may be successfully adopted for the evaluation of economic effectiveness of IT projects, and so its wide use is recommendable. Effectiveness management will be still more efficient if supported with ROI/TCO calculators, those available on IT solution producers' and providers' websites or branch portals, or those being unique solutions implemented, for instance, in a spreadsheet environment, and which, over time, may be made widely available. This was the case of the ROI/TCO calculator discussed in the paper, whose interactive version, available on Comarch FSM system

[7] A full description of the calculator is found in [Sinkiewicz 2010, chap. 4.3 and 4.4]. A supplement to the work contains a ROI/TCO calculator implementation in Excel. The calculator consists of two spreadsheets: TCO, for calculating the total cost of ownership for the Comarch FSM system over a three-year period, and ROI, for calculating, first, the benefits from implementing the system on the basis of predicted changes in KPI values, and, second, the rate of return on investment (with two algorithms). See also [*Comarch Field Service Management. ROI Calculator* 2011].

webpage (see Figure 4), allows a prospective buyer to estimate savings they will make thanks to the implementation of the Comarch FSM system.

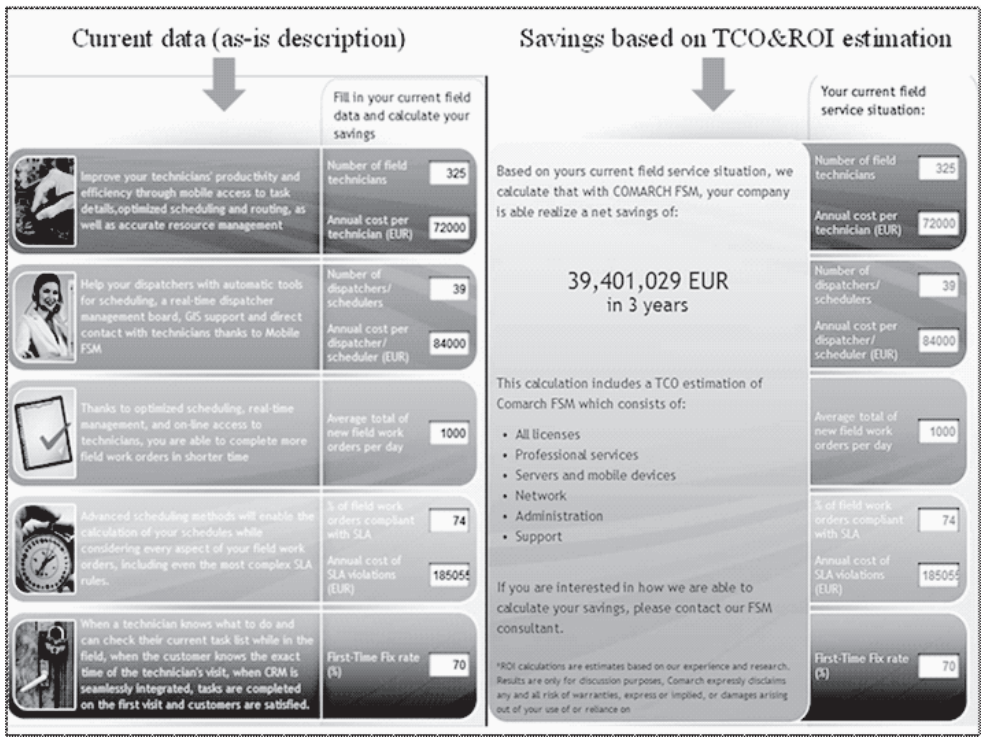

Figure 4. Interactive ROI/TCO calculator for the Comarch FSM system

Source: own presentation based on [*Comarch Field Service Management. ROI Calculator* 2011], and [Uczciwek 2011].

The author hopes that these points will help to popularize the knowledge on the subject as well as encourage the use of tools for supporting effectiveness management, such as the ROI/TCO calculator that we have seen, in everyday practice. This seems to be of a particular interest at the time when the economic crisis has caused so many companies to limit spending on informatization.

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KOMPUTEROWE WSPOMAGANIE ZARZĄDZANIA EFEKTYWNOŚCIĄ EKONOMICZNĄ ZASTOSOWAŃ SYSTEMÓW FSM

Streszczenie: Opracowanie przedstawia możliwości zastosowania pomiaru stopy zwrotu z inwestycji (ROI) oraz metody TCO (Total Cost of Ownership) do zarządzania efektywnością ekonomiczną pozyskiwania i użytkowania systemów informatycznych. W części początkowej syntetycznie omówiono podstawy metodyczne badania TCO i ROI. Następnie zaprezentowano możliwości wspomagania tego procesu za pomocą tzw. kalkulatorów ROI/TCO. Główna część pracy zawiera studium przypadku użycia prezentowanego podejścia do zarządzania efektywnością ekonomiczną zastosowań systemów FSM (Field Service Management), na przykładzie wdrożenia w hipotetycznej firmie telekomunikacyjnej. Koncepcja specjalizowanego kalkulatora oraz jego implementacja została wykonana w ramach pracy dyplomowej przygotowanej na Studium Podyplomowym „Efektywne Zarządzanie IT w Przedsiębiorstwie", której autor był promotorem.