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ECONOMIC EFFECTIVENESS EVALUATION IN A PROJECT OF INFORMATION TECHNOLOGY CHANGE ON THE EXAMPLE OF ORDER PROCESSING SYSTEM

Abstract: One of the most common groups of IT projects comprise undertakings which nature lies in change of used technologies. Such initiatives aim at substituting existing systems for solutions characterised by better technical parameters, higher utility or technological compatibility with other applications in a business environment. These projects, as all the other undertakings in informatisation field, must be economically effective. Therefore a profitability analysis is required, before they are initiated. This paper presents methodological grounds for such an analysis and introduces a procedure of effectiveness evaluation which is consistent with requirements of the so-called European projects. The main part of the work includes an example of economic effectiveness evaluation for a project which involved an improvement of an order processing system. The project was carried out by one of the main food articles suppliers for major retail chains, and aimed at substituting existing business document exchange technology for solutions based on e-EDI.

1. Introduction

Information technology plays more and more important role in business organisations. Many companies perceive it as one of key factors for building their competitive advantage and a stimulus for their development. Implementation of information and communication technologies (ICT) radically transforms ways in which companies operate, open new business areas and change rules of running a business. It should be considered, though, that a relatively short life-cycle, resulting in constant changeability, is the inherent feature of ICT. Improvements of IT solutions which are used by business entities often require technological changes.

The majority of assessments of newly implemented technologies are based on technical and qualitative criteria, including usefulness[1]. Economic effectiveness evaluation plays supporting role only in this case. It increases in importance though, when a technological change is a part of an ICT undertaking which is financed (or co-financed) with external resources, including European funds. In such a case the aforementioned assessment based on effectiveness calculation, including cost-benefit analysis (CBA), is obligatory and acts as a point of reference for financial viability appraisal and recommendations for decisions on project launch or continuation. This paper discusses how such assessments should be conducted, referring to the example of improving order processing system by substituting an existing platform for solutions based on electronic data interchange (EDI) technology. The following part brings forward a general overview of this technology.

2. General characteristics of EDI and e-EDI technologies

Electronic Data Interchange (EDI) is one of the major input/output and communication IT technologies, playing an important role in modern economy. The National Institute of Standards and Technology defines EDI[2] as "the computer-to-computer interchange of strictly formatted messages that represent documents other than monetary instruments. EDI implies a sequence of messages between two parties, either of whom may serve as originator or recipient. The formatted data representing the documents may be transmitted from originator to recipient via telecommunications or physically transported on electronic storage media." Wikipedia in turn includes the following definition[3]: "An inter-company, application-to-application communication of data in standard format for business transactions, Electronic Data Interchange (EDI) is a set of standards for structuring information[4] that is to be electronically exchanged between and within businesses, organizations, government entities and other groups. The standards describe structures that emulate documents, for example purchase orders to automate purchasing".

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[1] The exhaustive review of quality and usefulness assessment concepts for IT products, as well as a presentation of methods, techniques and detailed assessment criteria and metrics can be found in [Kobyliński 2005; Sikorski 2000].

[2] Quoted after the document: *Announcing the Standard for Electronic Data Interchange (EDI)* 1996 April 29, http://www.itl.nist.gov/fipspubs/fip161-2.htm.

[3] 'Electronic Data Interchange' entry quoted after http://en.wikipedia.org/wiki/Electronic_Data_Interchange.

[4] There exist two major sets of EDI standards now: the UN recommended UN/EDIFACT is the only international standard and is predominant outside of North America, and the US standard ANSI X12 (X12) is predominant in North America. The others are: the TRADACOMS standard is predominant in the UK retail industry and the ODETTE standard used within the European automotive industry. All these standards are still updated (for more details see: http://en.wikipedia.org/wiki/Electronic_Data_Interchange).

The example mentioned in Wikipedia is depicted by Figure 1 (flow model of EDI messages). It should be explained that the schema presents these types of trade transactions only, which underwent automation within the project of technological change analysed in a further part of this paper (see section 4) with respect to its economic effectiveness. The dashed lines have been used to distinguish transactions and/or EDI message groups which were not implemented at the current stage of the project.

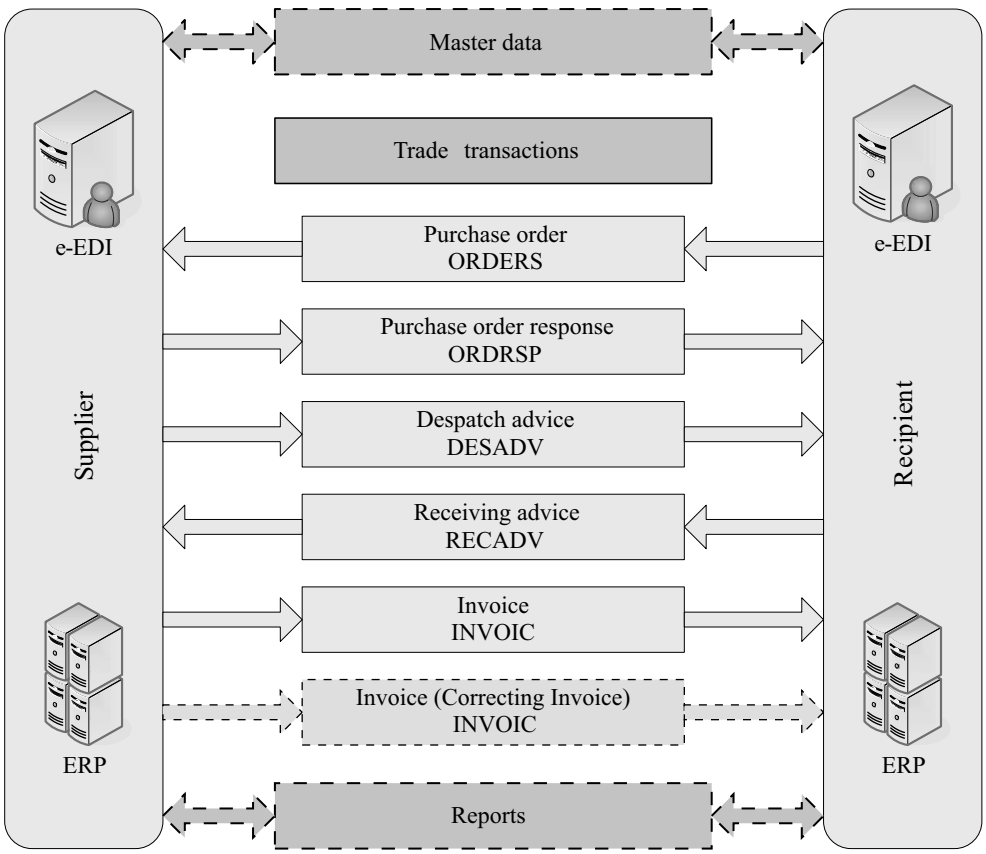

Figure 1. Flow model of EDI messages
Source: own presentation based on [*Dobre praktyki EDI* 2004, pp. 16-17].

Despite being relatively unheralded, in the era of technologies such as XML web services, the Internet and the World Wide Web, EDI is still the data format and/or data interchange technology used by the vast majority of electronic commerce transactions in the world. It happens so, since the EDI standards were designed to be independent of communication and software technologies. The EDI messages can be transmitted using any method agreed to by a sender and a recipient. From the

technological perspective two types of solutions are predominant in business communication practice. The past one was the usage of a Value Added Network (VAN) to B2B and/or in B communication mainly for companies which engage in dozens or more transactions with their – usually regular – business partners every day. The dynamic development of the Internet as a business communication medium as well as the globalisation of the world economy contributed to the growth of EDI users community. This created the necessity to adapt EDI to the transformed, heterogenic network environment. This need was satisfied, above all, by the standards for embedding EDI documents into XML – therefore in reference to such a version of EDI the term "XML-EDI" is sometimes applied. The entire range of solutions used by the EDI version which relays on contemporary Internet technologies and services is in turn often referred to as e-EDI (by analogy with such terms as: "e-business" or "e-commerce"). Many organizations are migrating to the new technologies and protocols in order to reduce costs. For example, Wal-Mart requires now of its trading partners to switch to the AS2 protocol[5]. In order to increase accessibility to EDI and/or e-EDI technologies not only for large companies, but also for smaller entities (especially small and medium-sized ones), acting in their surrounding, companies providing complete EDI-related service packages – acting as EDI operators – came into being. There are currently four such providers operating at the Polish market[6].

Considering problems to be discussed later in this paper, including effectiveness evaluation on a basis of cost-benefit analysis, the brief description of EDI and e-EDI technologies should be concluded with a list of main expenditure/cost and benefit categories related to such technologies.

The cost of implementing EDI and/or e-EDI refers to the following issues[7]:

- determining a strategy of an enterprise development (cost of time spent on planning activities in the field of EDI/e-EDI and cost of remodelling business processes and/or procedures),
- developing and implementing the ICT environment (cost of acquiring EDI/e-EDI software and its integration with existing systems, cost of trainings for own personnel and trade partners, cost of testing EDI application for trade document exchange, etc.),
- operating a system (cost of sending and receiving data/messages, line rental and network access fees, cost of outsourced services such as EDI/e-EDI platforms, etc.).

[5] AS2 (Applicability Statement 2) is the draft specification standard by which vendor applications communicate EDI or other B2B data (such as XML) over the Internet using HTTP/HTTPS, a standard used by WWW.

[6] The major Polish EDI operators include: Comarch (ECOD platform – Electronic Document Processing Centre), EDISON (EWA platform – EDIson Web Access), INFINITE (EDINET platform) and XTRADE (Xtrade platform). See [*Pakiet informacyjny dla dostawców stosujących EDI* 2007, pp. 9-12] and the operators' web-sites mentioned there.

[7] For more information see [*Dobre praktyki EDI* 2004, pp. 8-9 and 32-34].

It must be stressed that implementation of EDI/e-EDI technologies generates cost for both (or more) partners, and each of them should cover their own total cost of EDI/e-EDI ownership (TCO).

The use of EDI/e-EDI solutions brings numerous benefits, which can be divided into two basic categories[8]:

1. Direct benefits derived from automation of business and/or operational procedures:
– reducing cost of preparing and exchanging documents or transaction processing,
– eliminating mistakes at data input,
– increasing considerably transmission and processing speed,
– shortening the sale → invoicing → payment cycle;

2. Long-term benefits achieved by remodelling and redesigning information flows as well as by adjusting a strategy to opportunities offered by the new technology:
– optimising organisation and circulation of information,
– strengthening ties between business partners,
– rationalising a logistics cycle (reducing stock, just-in-time procedures, etc.),
– building competitive advantage (efficient customer service consistent with ECR reference model),
– multiplying effects of ICT investments.

The knowledge of expenditures, costs and potential benefits will be used in the example of economic effectiveness evaluation for the project of changing technology into e-EDI, which will be presented in section 4 of the paper. Before the example is discussed, however, methodological grounds for such evaluation should be introduced.

3. Methodological grounds of economic effectiveness evaluation for ICT

Both literature and commercial white papers abound in descriptions of effectiveness evaluation methods for IT undertakings[9]. The practice of ICT projects shows a limitation of their use and an inclination to choose simple absolute and/or relative profitability assessments, with use of static financial metrics (Payback Period – PB, and Accounting Rate of Return – ARR) or the dynamic ones (Net Present Value – NPV, Internal Rate of Return – IRR, Profitability Index – PI, Discount Payback

[8] See [*Dobre praktyki EDI* 2004, pp. 8-11]. See also information on EDI benefits published on the web portal of Polish EDI/e-EDI users community, at http://www.edipol.com.pl/EDIEC.html.

[9] The exhaustive review of effectiveness evaluation methods for ICT projects and common typologies of them can be found e.g. in the works [Cypryjański 2007; Dudycz, Dyczkowski 2006a]. It should be considered that the vast majority of them derives from methods of investment effectiveness calculation or economic and financial analysis; see e.g. [Rogowski 2004; 2007].

Period – DPP and Modified Internal Rate of Return – MIRR). Far less frequently economic effectiveness evaluation is extended to assessments which take into account changeability of project assumptions and risk factors, including: sensitivity, scenario or simulation analyses. Among dedicated approaches developed for a purpose of examining IT and/or innovative projects, the biggest attention is paid to such methods as: Total Cost of Ownership (TCO), Total Economic Impact (TEI), Real Options Valuation (ROV), Information Economics (IE) and Applied Information Economics (AIE)[10].

Despite having multitude of methodological approaches and specific measures available, it is still difficult to appoint the best ones objectively. The selection of a method, beside quantification of immeasurable effects and inputs, is therefore considered to be one of the most difficult issues by examining effectiveness of ICT projects. The difficulties result from such reasons as: a variety of ICT projects, problems with complete identification of effects and expenditures/costs, shortcomings in quantification of some categories of effects and expenditures/costs as well as from rapid development and short life-cycle of information and communication technologies [Dudycz, Dyczkowski 2007, p. 288].

Table 1. Effectiveness evaluation pillars for European projects

Philosophy	Cost-benefit Analysis (CBA)
Principles	Incrementality, universality, comparability, complexity, uniqueness, objectivity, coherence
Methods for effectiveness (profitability) assessment	Net Present Value (NPV) in commercial/financial (FNPV) or in social (ENPV) meaning Internal Rate of Return (IRR) in commercial/financial (FRR with respect to project or own capital) or in social (ERR) meaning
Analytical algorithm	$PVC=\sum_{t=0}^{n}\frac{C_t}{(1+k)^t}<PVB=\sum_{t=0}^{n}\frac{B_t}{(1+k)^t}$ where: *PVC* – Present Value of Costs, *PVB* – Present Value of Benefits, t – time scope (e.g. assumed life-cycle of an IT project), k – discount rate
Decision-making criterion	Absolute profitability criterion: If $CBA=PVB-PVC$ a project is profitable, provided that $CBA>0$, what means that $NPV\geq 0$ and that $IRR\geq k_l$ where: *PVC* – Present Value of Costs, *PVB* – Present Value of Benefits, k_l – limiting (accepted) discount rate
Methods for risk analysis	Sensitivity analysis, scenario analysis, simulation analysis

Source: own presentation based on [Rogowski 2007, pp. 192-201].

[10] Detailed descriptions of these methods and procedures for their application are presented e.g. in [Dudycz, Dyczkowski 2006a, pp. 99-118; 2006b; *Informatyka – ocena efektywności* 2006].

In case of technological change projects, which are discussed in this paper, a uniform methodology for effectiveness evaluation has not been developed either. Therefore, for a purpose of selecting adequate methods, the author chose a criterion of their applicability in effectiveness evaluation systems used for European projects, which are oriented at innovations, including ICT ones. Such a pragmatic attitude stems from the assumption that opportunities for practical application of methods which could allow wider group of Polish beneficiaries to use European funds, reserved for supporting ICT investments in the widest sense, should be demonstrated and propagated. Besides, innovative projects – including such that involve technological change, and which are focused on in this paper – are clearly preferred in European programmes.

If the so-called evaluation pillars for European projects, presented in Table 1, are carefully analysed, it becomes clear that these criteria are met (see [Rogowski 2007, chapter 7]) by analytical methods based on CBA-type algorithms, which are not only popular and exhaustively described in economic publications (see [Rogowski 2004, chapter 2] and works quoted therein), but which have also been verified in investment calculations and frequently applied in ICT area recently (see [Dudycz, Dyczkowski 2006a, chapters 4 and 5]).

The following section will present an exemplary application of CBA-type analysis in economic effectiveness evaluation for a project which involved improvement of order processing system aiming at substituting existing solutions for those based on e-EDI.

4. Example of economic effectiveness evaluation in a technological change project

4.1. General characteristics of the project

The project carried out by a major food articles producer and supplier aimed at implementation of electronic order processing system, based on e-EDI applications, which could effectively deal with orders placed by chain customers, and supermarket chains in particular (see the description in [Różański 2007] and information in [Dyczkowski 2008]). The project assumed substitution of existing communication channels (fax and telephone) for a systems that could exchange such electronic documents as:

- Purchase Order (EDI message ORDERS),
- Purchase Order Response (EDI message ORDRSP),
- Shipping Notices (EDI message DESADV),
- Receiving Advice (EDI message RECADV),
- Invoice (EDI message INVOIC)[11].

[11] The complete description of the said EDI documents/messages is included in freely available Central Repository of Electronic Document Templates, at http://www.crwde.pl.

All this required activation of functionalities supporting EDI mechanisms included in the distribution module of the ERP-class system used by the company (JDEdwards, currently Oracle – EnterpriseOne[12]), and their integration with ECOD electronic platform by Comarch[13]. Figure 2 shows the electronic order processing scheme for chain customers. The analysis of it helps to identify major benefits expected after implementation of such an application. The benefits involve the so-called automation effects[14] which stem from electronic transaction processing (see section 2), and result in: shortening of processes, elimination of mistakes typical for manual operations and reduction in amount of paper documents (of nearly 200 thousand A4 pages). The aforementioned benefits imply decrease in cost of distribution activities processing. In addition, the introduction of the electronic document exchange (in particular of the RECADV message – advice on shipment reception by customers) enables to issue invoices for goods shipped 2 days earlier.

4.2. Assumptions for effectiveness evaluation

According to the principles of incremental analysis only those items of expenditures, costs and effects were considered, which would change in effect of project realisation. The minimum expected 4-year life-cycle period was assumed for the system. The investment expenditure was estimated at 118 000 złoty (software licence – 12 300 złoty, implementation services – 105 700 złoty), whereas total annual operational costs were predicted at the level of 11 712 złoty.

In order to identify and quantify effects achieved by implementing electronic order processing system, it was assumed that they would equal the total cost of carrying out distribution processes to be automated. The analysis of the workload required to proceed with a single purchase order acceptance, its registration in the system, recording a receiving advice, making out and sending an invoice (see Figure 2) proved that the entire process should be shortened by 16 minutes on average. At 35 thousand transactions per year this would mean over 9333 work hours saved, what was the equivalent of 5 full time jobs. The further calculations assumed liquidation of 3 work posts, what should bring a reduction in labour cost of the customer service department equal to 108 000 złoty (5% rate of increase was adopted for subsequent years herein). A decrease in cost of office materials (paper, toner) was

[12] The specification is available at Oracle corporate site, at http://www.oracle.com/applications/jdedwards-enterprise-one.html.

[13] The broad description of this platform can be found at ECOD portal, at http://portal.ecod.pl/pl.

[14] The automation effects are achieved by using ICT in two manners: (1) as a factor that substitutes labour, (2) as a factor that improves efficiency and productivity parameters of information processes. The effectiveness is positively affected in both cases, due to reduction in cost of operational activities and management processes at most. The benefits refer to these business processes only which are modified within informatisation project. Apart from automation effects, informative (informative and decision-making) and transformative ones may be considered. See e.g. [Cypryjański 2007, pp.140-141; Dudycz, Dyczkowski 2006a, pp. 63-64].

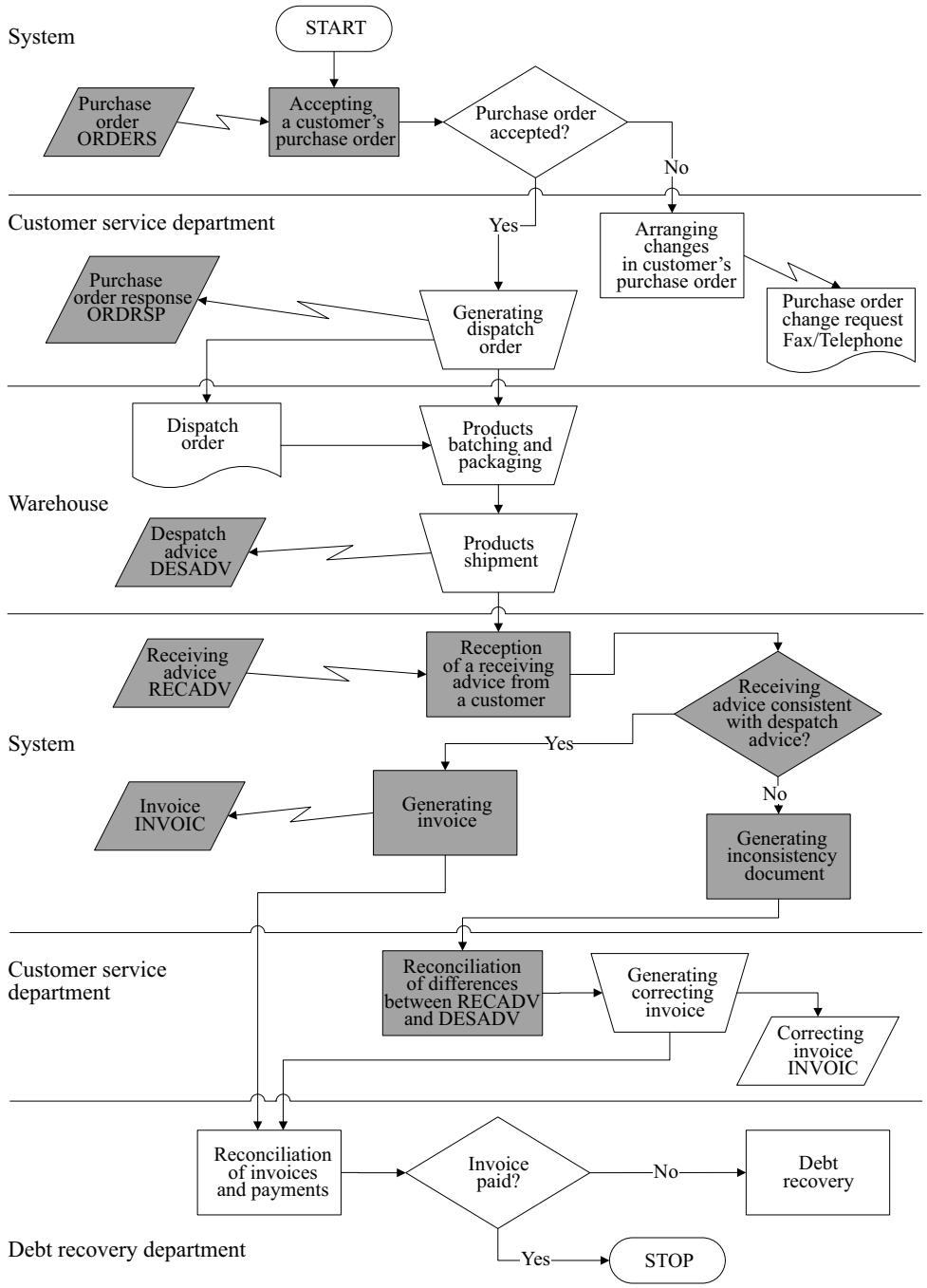

Figure 2. Electronic order processing scheme for chain customers
Source: own presentation based on [Różański 2007].

estimated at 15 680 złoty. It was also predicted that the introduction of electronic document exchange (in particular of the RECADV messages) would accelerate the process of issuing invoices for goods shipped. The analysis of time necessary to deliver this document to the company headquarters proved that after the completion of the technological change project 2 workdays should be gained. In addition, the introduction of the invoice variance document and the possibility to make out invoices for agreed partial shipments (this refers to conformity of transactions included in DESADV and RECADV documents) should enable to shorten payment collection time. In order to assess additional income related to faster payment collection, a solution based on automatic overnight deposit order was assumed in further analysis. Considering the interest rate equal to 0.8 * WIBID ON, agreed with the bank, the additional interest income was estimated at 19 793 złoty a year.

The limiting discount rate k_1 was assumed at WACC (weighted average cost of capital) level, which was equal to 7% in that case.

4.3. Cash flow and calculated NPV and IRR values

Table 2 presents a breakdown of cash flow related to the considered project. It served as input data for Excel built-in financial functions that were used to calculate fundamental measures of absolute profitability assessment for this IT investment, namely *NPV* and *IRR*. Their values equalled to 229 823.49 złoty and 76.26% respectively.

Table 2. Cash flow breakdown in złoty – supporting calculation for *NPV* and *IRR*

Item	Years of use of the implemented system			
	base year	base year + 1	base year + 2	base year + 3
Capital outlay and costs	129 712	11 712	11 712	11 712
Saving (cost reduction) and financial effects (deposit)	0	143 473	148 873	154 543
Net cash flow (*NCF*)	–129 712	131 761	137 761	142 831
Discounting factor (*CO*)	1.000	0.9346	0.8734	0.8163
Discounted cash flow (*NCF* × *CO*)	–129 712	123 141	119 802	116 593

Source: own presentation based on data from [Różański 2007].

4.4. Effectiveness evaluation for the project

The results of the above-presented analysis and the computed values of $NPV = 229\,823.49$ złoty > 0 and $IRR = 76.26\% > k_1 = 7\%$ entitles to say that the implementation project of the electronic order processing system for chain customers, based on the new e-EDI technology, met absolute profitability criterion, and thus, as economically effective, deserved positive recommendation for its launch.

5. Conclusions

The analytical methods presented in the paper, based on CBA methodology – adopted in European projects – which employs absolute decision-making criteria relaying on estimated NPV and IRR values, as well as the example of their application in profitability examination for the project of changing existing technology to e-EDI, demonstrated usefulness of such an approach in economic effectiveness evaluation of similar projects. It is particularly important, since it can be noticed that too often a fascination with technological innovations dominates over a realistic analysis of needs and possibilities in such projects. Therefore a thorough evaluation of economic effectiveness is indispensable. It is a prerequisite for such an allocation of material and financial resources that would enable to sustain dynamic development of ICT applications in companies and institutions, and guarantee financial support from European programmes for implementation of new technologies. If Polish companies are to effectively benefit from support of European funds, they have to learn how to apply effectiveness calculation methodology required by fund managing institutions. The author believes that both the discussion initiated in this paper and the example presented herein will help to disseminate knowledge on this vital issue.

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