

# A MODEL FOR ASSESSING THE IMPACT OF ELECTRONIC PROCUREMENT FORMS

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## **Abstract**

This paper aims to contribute to the development of a model for assessing the direct and indirect impact of various forms of electronic procurement (EP) on a firm's integral purchasing (-related) costs. The model builds on existing classifications of purchasing costs and benefits and is illustrated by means of a number of empirical cases.

**Keywords:** electronic purchasing, purchasing related costs and benefits

## **Introduction**

Fundamentally, Internet technology provides ways of drastically reducing different categories of transaction- and communication costs. In that respect, the potential merit of various electronic procurement (EP) forms, such as electronic catalog systems, electronic auctions, intelligent agent applications, electronic market places seems largely undisputed (Smelzer and Ruzicka 2000, Croom 2000). However, the wide range of solutions available faces organisations with the challenge of assessing the suitability of the different solutions for their specific commodities and portfolio of purchasing requirements. Many organisations seem to struggle with this. Although a fastgrowing body of literature emerges on various specific EP forms like electronic ordering systems (Harink, 2000), electronic reverse auctions (Teich et al, 1999), intelligent agents (Liang and Huang 2000) and so on, there still does not seem to be a clear (theoretical) basis for specifying conditions under which different EP forms appear appropriate in different purchasing and organisational settings (see e.g. Emiliani, 2000).

This paper aims to contribute to the development of such a basis. More specifically, we present the first outline of a formal model which gives the impact of EP forms on categories of purchasing costs and benefits based on company specific criteria and conditions. First we define six EP forms that actually exist nowadays in practice and their general impact on organisations. Second, we present the results of a literature study regarding existing conceptual models of purchasing costs and benefits. Next, we qualitatively assess the impact of the different EP forms on the different purchasing costs and benefits. The underlying criteria for this assessment will be indicated. The validity of this model is supported with the analysis of empirical evidence gathered in the course of several research and consultancy projects in which the authors were involved. Finally the results are discussed with ideas for further research.

## Electronic procurement encompasses several forms

Electronic procurement (EP) can be defined as using Internet technology in the purchasing process. It is important to note that this definition is tight in the sense that it excludes old applications like ordering by telephone or by fax. On the other hand, this definition is relatively wide, because it not only encompasses the use of Internet applications in the purchasing process, but it also includes the use of intranet and extranet applications<sup>1</sup>. For example, ordering office supplies by using a supplier catalog on a website is a form of EP.

Based on the definition of EP a large number of forms of EP can be distinguished. Some of these forms have received a lot of attention already, which has led to a situation that these forms are quite well-defined and relatively well-developed. Other forms of EP are still quite young and immature. Some of them will mature, others will never reach that state. In this paper we will focus on the forms of EP that are quite well-defined and relatively well-developed. Each of these forms has received a name in daily practice, namely:

- e-MRO
- web-based ERP
- e-sourcing
- e-tendering
- e-reverse auctioning
- e-informing

The various forms of EP will be described as processes: a collection of activities that have to be executed by one or more employees. The Internet technology that is needed in these processes can be offered to the employees in several ways:

- via market places: market places are specific websites on the Internet (aimed at e.g. an industry or an commodity) that bring buyers and sellers together to facilitate employees of organisations in applying forms of EP and more in general e-commerce.
- via intranets: intranets can be seen as a number of websites with information that can only be accessed by employees of one organisation.
- via extranets: extranets can be seen as a number of websites that can only be accessed by employees of a number of known organisations. One of these websites may be a market place.

In the following we shall briefly define these six forms of EP.

e-MRO as well as web-based ERP is the process of creating and approving purchasing requisitions, placing purchase orders and receiving goods and services ordered, by using a software system based on Internet technology. In the case of e-MRO the goods and services ordered are maintenance, repair and operation (MRO) supplies (i.e., non-product related). The supporting software system (an ordering catalog system) is used by all employees of an organisation. In the case of web-based ERP the goods and services ordered are product-related. Usually only the employees of the purchasing department (or the planning

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<sup>1</sup> One of the most characteristic elements of Internet technology is the TCP/IP-protocol. The Internet as well as intranets and extranets are based on this protocol.

department) are using the supporting software system (a web-based ERP-system (Enterprise Resource Planning)).

E-sourcing is the process that identifies new suppliers for a specific purchasing category, using Internet technology (usually the Internet itself). By identifying new suppliers a purchaser can increase the competitiveness during the tendering process for this purchasing category. E-sourcing is also a way of decreasing the supply risk associated with this purchasing category (Kraljic, 1983).

E-tendering is the process of sending RFI's and RFP's to suppliers and receiving the responses of suppliers, using Internet technology. Sometimes within e-tendering the analysis and comparison of responses is also supported. E-tendering does not include closing the deal with a supplier. As a matter of fact, e-tendering smoothens a large part of the tactical purchasing process (according to (van Weele, 1988)), without focusing on the content of that process.

In daily practice an auction enables a supplier to sell (surplus) goods and services to a number of (known or unknown) buying organisations. During a relatively short time frame the buying organisations involved generate bids for the goods and services that are auctioned. The auction has an increasing (an English auction with several bids) or decreasing price mechanism (a Dutch auction with one bid only). A reversed (English) auction is the opposite: it enables purchasers to buy goods and services needed from a number of (known or unknown) suppliers. E-reverse auctioning is the Internet technology based equivalent of reverse auction. Usually e-reverse auctioning focuses on the price of the goods and services auctioned. Other criteria are in most cases neglected during the reverse auction. Of course, other criteria can be used in a previous phase in order to determine which suppliers are invited to join the e-reverse auction. E-reverse auctioning does really close a deal between a buying organisation and a supplier, if parties agree on the price.

E-informing is a form of EP that is not directly associated with a contract or a transaction, whereas the others are. E-informing is the process of gathering and distributing purchasing information both from and to internal and external parties, using Internet technology. For example, publishing purchasing management information on an extranet that can be accessed by internal clients and suppliers is a way of e-informing.

## **Impact of forms of EP on organisations**

Organisations are confronted with EP and all the forms it encompasses. The question arises whether an organisation should do something with EP and if so, which form(s) of EP should be chosen. In order to answer these two questions it is necessary to know what the impact of each form of EP is, when it is implemented. In general the impact of implementing a form of EP in a company may relate to four areas:

1. organisation;
2. IT;
3. cultural;
4. financial.

The organisational impact has to do with changes in functions. By implementing a form of EP, processes change. As a consequence, activities that need to be executed change. Some activities may diminish, other activities may need more or less time and new activities may emerge. Because functions are based on activities that have to be executed, this will cause functions to change.

The IT impact has to do with changes in the collection of networks and systems an organisation uses. By implementing a form of EP, (a specific tool based on) Internet technology usually has to be introduced in the organisation and has to fit in with all other networks and systems. For example, an ordering catalog system has to be bought and installed. This ordering catalog system must probably interface with the financial system and the HR system that are already in use.

The cultural impact has a direct relation with the organisational impact and deals with the norms and values of an organisation. If there are no significant changes in functions, everything will more or less remain the same and there is no real cultural impact. If functions significantly change (e.g. within every function it is now allowed to order non-product related goods and services), employees may have to execute some new activities or may have to let go of some old activities. Norms and values may change drastically.

In general the organisational, IT and cultural impact of an EP form can not be neglected. However within the scope of this article we restricted ourselves only looking to the financial impact.

The financial impact deals with the costs and savings associated with the implementation of a form of EP. Based on the current, 'stable' integral purchasing costs, the organisation has to create a clear picture with respect to:

- the integral purchasing costs that will be realized after the implementation of a specific form of EP (the new, stable situation);
- the costs that have to be made in order to reach that new, stable situation.

Of course, from a financial perspective solely, there is no need to implement a specific form of EP if the integral purchasing costs that will be realized in the new, stable situation are higher than in the current, stable situation. Only if the integral purchasing costs in the new, stable situation are less than in the current, stable situation, it may be sensible to implement that specific form of EP, see figure 1.

insert figure 1 here

Based on the costs that have to be made in order to reach that new, stable situation compared with the difference in integral purchasing costs (i.e., the structural savings), the pay back time can be estimated and a (preliminary) decision can be made. In this article we will only focus on the impact of the forms of EP on the integral purchasing costs and benefits. Therefore we need a structure by which these integral purchasing costs and benefits can be described well.

## Purchasing costs and benefits

In this section, we present the results of a literature study regarding existing conceptual models of purchasing costs and benefits. Traditional purchasing and supply literature defines purchasing costs as the equivalent of the actual spending. In other words: the price paid to the supplier. Writers on TCO (Ellram 1994) have indicated the importance of also including (a) the actual costs of carrying out a particular purchasing transaction and (b) the longer term consequences of owning or using the product or service purchased (e.g. the cost of actually installing, maintaining and salvaging a machine). Following the TCO approach, formal economic models of supply strategies have been developed, see e.g. Homburg (1995). An interesting feature of Homburg's model is his modelling of supply risk, where the risk refers to the (opportunity) cost of currently not paying the (theoretically) lowest price and suffering interrupts in supply from the supplier. Taking a higher level of analysis, writers on buyer-supplier relationships and business networks (see e.g. Gadde Snehota 1998) primarily consider the costs and benefits of doing business with a supplier beyond the level of individual transactions. More specifically, they distinguish the categories of economic consequences of supplier relationships as can be seen in Table 1.

insert table 1 here

Obviously, the classification by Gadde and Snehota seems to incorporate all of the cost categories identified in the traditional and TCO literature. Taking their level of analysis will enable us to consider all possible consequences of implementing and using one or more EP forms, whether it concerns the use of such forms within the same relationship or using it to change or break-off the relationship. However, while we still take into account the different categories of supply costs and benefits we suggest a slightly more compact – and disjunct – grouping of the purchasing costs. In the following analysis we will use the following categories:

- The expenditures on purchased items and services directly related to a firm's primary operations. We will refer to these expenditures as DIR – as in *direct* – . Note that DIR also includes the costs of investing in the supplier's primary operations, e.g. investments in machinery or the costs of training the supplier's workforce;
- The expenditures on purchased items and services which are not directly used in the firm's primary operations. We will refer to these expenditures as NPR – as in non-product related - . Note that NPR may also include expenditures intended for and/or used by the supplier.
- The costs of executing operational purchasing activities, i.e. ordering and expediting. We will refer to these costs as OPC;
- The costs of executing tactical purchasing activities, i.e. setting specifications, selecting suppliers, negotiating and contracting etc. We will refer to these costs as TPC;
- The costs of executing strategic purchasing activities, e.g. conducting spend analysis, managing suppliers etc. We will refer to these costs as SPC;

Note that DIR and NPR comprise actual expenditures while OPC, TPC and SPC are the costs accruing from time spent by the firm's employees and management. The relevant purchasing benefits are categorized as follows: CB for cost-benefits and RB for revenue-benefits. In the

following sections we will attempt to formulate hypotheses about how implementation of various EP-forms may impact on DIR, NPR, OPC, TPC, SPC, CB and RB.

## **Direct implications of EP forms on the purchasing costs**

Having defined the various EP forms and the categorization of relevant purchasing costs and benefits, hypotheses can be formulated about the implications of implementing an EP form on each category. In this section we first specifically consider the immediate impact of implementing different EP-forms on DIR, NPR, OPC, TPC and SPC. These implications can be seen in Table 2. Indirect impact of implementing EP on these costs as well as impact on CB and RB will be discussed in section 5.

insert table 2 here

The arrows in table 2 represent the impact on the respective cost categories. They either go up or down (indicating an increase or a decrease). In addition, a distinction is made by double arrows implying a strong impact and an arrow between brackets for a slight impact. As several effects might occur with each EP form in each cell more than one arrow (and in different directions) may appear. The overall effect will be a "summation" of several effects. For determining the actual size of each arrow for a specific company we need to take a closer look at the underlying conditions and criteria. When for a company most of these criteria do not apply the size of an arrow may decrease that much that no effect may be expected. Below we will indicate which criteria are important for each cell in Table 2, where an impact is expected.

For e-MRO the NPR purchasing volume can be considerably lowered. This savings will intuitively be larger if the total NPR volume (or as a percentage of total spend) is high, especially when the situation with respect to contracts in NPR is not optimal at the moment. This means that, when contract coverage and/or concern leverage is low and/or maverick buying is high there is a lot of room for improvement. Furthermore the 'clickability' of the NPR volume has to be taken into account. Here 'clickability' of a purchase is defined as whether the purchase can be done with a few simple mouseclicks or not. As an example office supplies are in general clickable, whereas ordering a company for moving office equipment (when an employee gets another room) is not. For e-MRO only savings can be made on clickable purchases. Thus the higher the clickability the better. Although there are a lot of factors that will give rise to a huge decrease in the NPR spend, there is also an increase: when using a third party for implementing an e-MRO system, service contracts (updates) will be necessary. Reducing the OPC with e-MRO is most effective when the number of purchase orders is high as well as the number of the internal customers (employees). Also when the convenience of ordering is low for the internal customer substantial improvements can be made. The TPC will increase as more time as the conditions with respect to e-MRO need to be discussed with the MRO suppliers (a discussion that was not necessary in the old situation). When the experience with Internet technology of suppliers and purchasers is high these costs may not increase that much. If the availability of purchasing management information is low at the moment, e-MRO gives the possibility to obtain this information more efficiently and more reliably and therefore lowering the SPC.

For web-based ERP solutions only the OPC can be lowered assuming an ERP system is already available. As the ERP system should already have made the ordering process of direct purchases very efficient, a web application can only give added value being a better user interface. Therefore when the number of internal customers, that order direct goods is high and the convenience of making these orders is not so high in the current situation, the most cost savings can be made. Note that the NPR costs may increase because of possible maintenance contracts for this web application.

For e-sourcing only a direct impact is expected on the TPC. E-sourcing can be a very useful tool for locating possible new suppliers, getting information and contacting them. This will be most useful for the commodities in the leverage and bottleneck kwadrant of the Kraljic matrix (these can be both direct and indirect commodities). As e-sourcing facilitates tactical purchasing the TPC will decrease.

Introducing e-tendering is done to lower the TPC. Especially when in the current situation the so-called tendering bureaucracy is high, meaning the amount of paperwork involved with the whole tendering process and also the way the process is organised itself. Having a far from optimal situation with respect to contracts may also give a larger impact. Having a low concern leverage and/or a low contract coverage (like with e-MRO, see above) in the old situation leaves a lot of room for improvement on tactical purchasing. As with the web-based ERP system and e-MRO here also the NPR costs may increase because of possible service contracts.

For e-reversed auctioning a company needs to have a high number of possible suppliers as the idea of an auction is to obtain lower prices by using the market mechanism. Therefore the impact of introducing this process will be higher when the leverage (or even routine) purchasing volume is high (the volume can consist of direct and indirect purchases). Another condition to be able to hold a reversed auction is to have the commodity well specified. The larger the number of commodities that can be well specified, the more an e-reversed auction can be applicable, thus the larger the possible effect. Having a third party actually execute the e-reversed auction or having third party software increases the NPR spend. On one hand, if often time consuming and unclear (price) negotiations occur currently, e-reversed auctions can replace that, lowering the TPC substantially. On the other hand the preparation of an e-reversed auction takes considerable time making a good specification of the commodity and setting up the whole process with all suppliers involved, giving rise to an increase of the TPC.

E-informing can be implemented to have better and more efficient access to strategic purchasing information (that is more reliable also) and in that way lowering the SPC. The effect of introducing this will be larger if the experience with Internet technology of both suppliers and purchasers is higher, like with e-MRO. Similar to e-MRO as well, the impact will be bigger when at the moment the availability of purchasing management information is low. Also a high strategic (and to a lesser extent bottleneck) purchasing volume makes this tool more useful. For the usage of e-informing IT support will be needed though, as the actual implementation involves coupling different information systems together, giving rise to higher OPC. The actual amount of that will depend on whether a company already has a good IT-support infrastructure or not.

## Indirect purchasing costs and benefits of implementing an EP form

In the previous section, we considered the expected immediate impact of various EP-forms on OPC, TPC, SPC, DIR and NPR. The underlying assumption in that exercise was that the frequency and depth of the different steps in the purchasing process remained unchanged. In terms of a firm's Loss and Profit statement, the expected net reduction in the sum of OPC, TPC, SPC, DIR and NPR directly contributes to a higher profit, see figure 2.

insert figure 2 here

Naturally, it may be expected that as a result of the direct impact of EP, certain changes in the frequency and/or depth of one or more steps in the purchasing process will be considered. In that respect it is particularly interesting to consider changes in the frequency and/or depth in the tactical purchasing steps: specification, selection and contracting. Let us for example consider the possible consequences of ET on the frequency of supplier selection. As the direct costs of selecting suppliers drops (TPC fall), it seems to make sense to consider a higher frequency of tendering. The general rationale behind this would be that in this way, the firm would benefit from better deals, resulting in a lower DIR (or NPR) and or more benefits (CB and RB). However, changing suppliers more often will create additional costs in terms of (re-) investing in more suppliers, managing more suppliers and possibly losing certain cost-and/or revenue benefits. Table 3 aims to capture some of the possible consequences.

insert table 3 here

Therefore, when the implementation of EP leads to changes in the frequency and/or depth of the tactical purchasing steps, these indirect effects on purchasing costs and benefits must be taken into account as well. The possible indirect effects of EP implementation in terms of the firm's Loss and Profit statement are shown in figure 3.

## Some empirical illustrations

In order to roughly evaluate our theoretical model, we briefly consider two empirical cases.

A large Dutch transportation company decided in 2000 to implement e-MRO. Based on a clickable NPR purchasing spend of about Euro 50,000, a thorough and detailed business case was developed. Savings are mentioned for three areas: the biggest saving will be realized by reducing maverick buying (about Euro 5 million per year). Other savings will be realized by increasing process efficiency (Euro 2 million once only) and improving purchasing control (Euro 4 million per year, once enough data is captured in the system). The organisation has chosen not to cash the savings based on increased process efficiency (no jobs will be lost). This means that NPR will reduce dramatically, OPC will remain the same as a consequence of the organisational choice mentioned and SPC will decrease (on the longer term). At this moment a part of the organisation works with e-MRO, but realised savings are not yet available. However, the feeling is that the savings mentioned in the business case will be realized easily. This organisation had chosen to buy a software solution (initial license fee of about Euro 1.5 million). As a consequence, this organisation will pay about 20% of the initial license fee per year (so, NPR slightly increases).

A European vendor of e-reverse auctioning services, that has already served several clients, provided the following data (based on about 200 auctions). The preparation of an e-reverse auction takes about 4 to 6 weeks for several people (from the buying organisation). This means that TPC increases. The actual auction will reduce prices significantly by 10 to 15% (so, NPR or DIR decreases). The volume of the purchasing category auctioned varies from Euro 50,000 to Euro 2.5 million. The buying organisation using an e-reverse auction service has to pay Euro 2500 - 8000 plus a part of the savings accomplished (so, in that way NPR increases slightly).

## Conclusions

Developing a simple qualitative model of the possible impact of various forms of EP underlines the danger of treating EP as one 'solution'. Trying to assess the direct impact of the various forms is hardly straightforward, let alone the possible indirect impact. Opposing effects may occur within one and the same category of purchasing costs. In addition, the dramatic reduction in search and communication costs makes it worthwhile to consider drastically different frequencies and/or choice-sets in the purchasing process, e.g. supplier selection. Doing so may have a range of indirect effects, not only on the purchasing costs but also on costs of internal processes other than purchasing. Still, the basic structure of our model seems to offer a useful starting point for better understanding the complexity and challenges of EP.

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Table 1: categories of supply costs and benefits (based on Gadde and Snehota 1998)

Costs of supplier relationships	Benefits of supplier relationships
<ul style="list-style-type: none"> <li>- Direct procurement costs (purchasing spend)</li> <li>- Direct transaction costs (costs of specifying, selecting, negotiating, contracting, ordering etc)</li> <li>- Relationship handling costs (investments at supplier, transaction independent communication)</li> <li>- Supply handling costs (supply risk investigations)</li> </ul>	<ul style="list-style-type: none"> <li>- Cost-benefits (possibility to keep costs of internal processes at a low level, e.g. inventory)</li> <li>- Revenue-benefits (improving product quality, innovation etc)</li> </ul>

Table 2: Direct impact of EP forms on the purchasing costs

	DIR	NPR	OPC	TPC	SPC
<b>e-MRO</b>	-	↑↓↓↓	↓↓	↑	(↓)
<b>web based ERP<sup>1</sup></b>	-	(↑)	↓	-	-
<b>e-sourcing</b>	-	-	-	↓	-
<b>e-tendering</b>	-	(↑)	-	↓	-
<b>e-reversed auctions</b>	↓	↓(↑)	-	↑↓	-
<b>e-informing</b>	-	-	(↑)	-	↓

<sup>1</sup> assuming in the starting situation an ERP system is present

Table 3: Possible indirect impact of some EP forms

	Effect on DIR / NPR	Effect on TPC	Effect on SPC	Effect on CB / RB
<b>Changing supplier (s) more often</b>	Likely to fall as more alternatives can be considered	Assumed constant (more selections but costs per selections are lower)		Can go either way: a new supplier may lead to a significant fall in DIR but replacing the old supplier may result losing valuable CB or RB. It may also lead to a drop in DIR and improved CB and RB
	May rise as investments are necessary in (more) suppliers over time		May rise as more suppliers must be managed (over time)	

Figure 1: structural savings through implementing EP

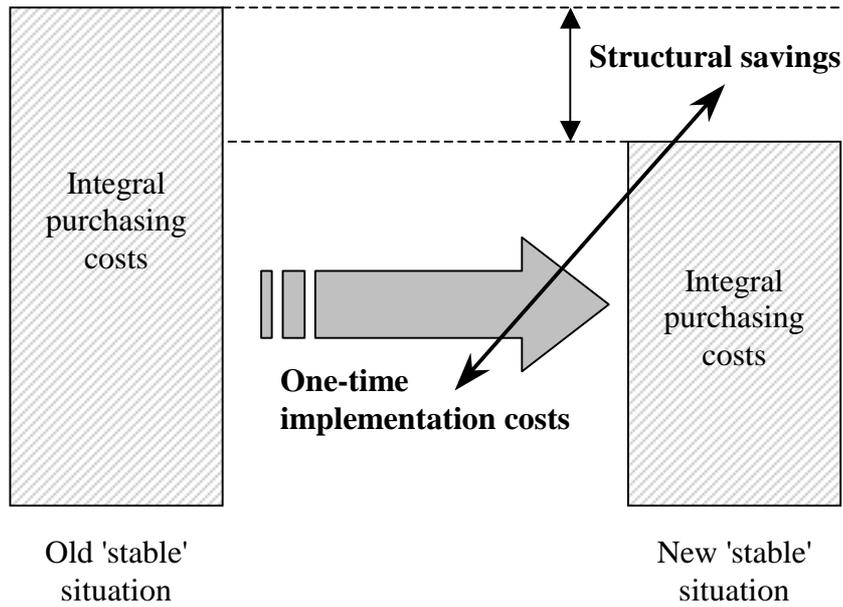


Figure 2: direct impact of EP assuming no change in purchasing strategy

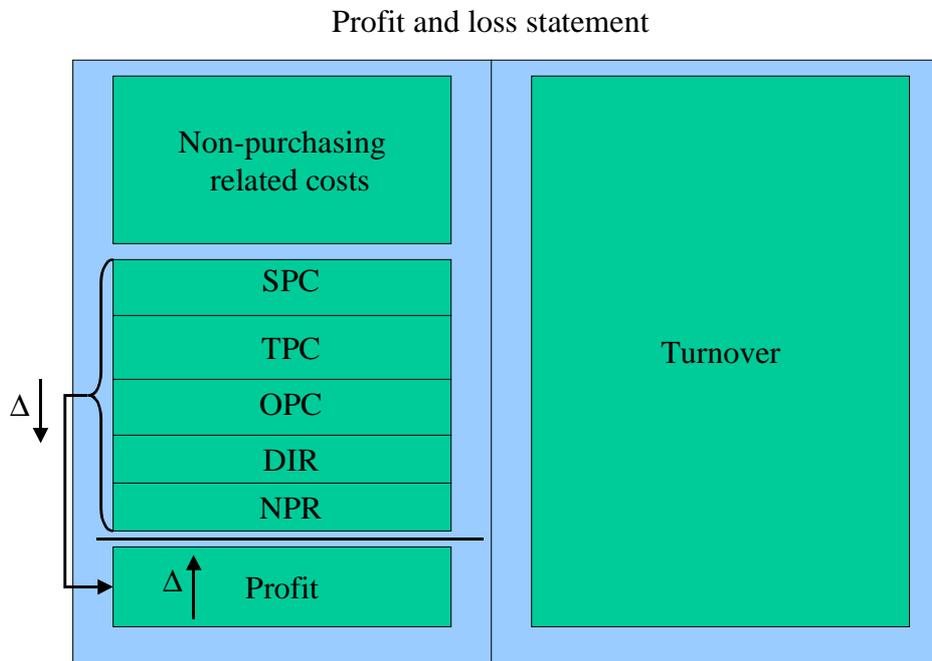
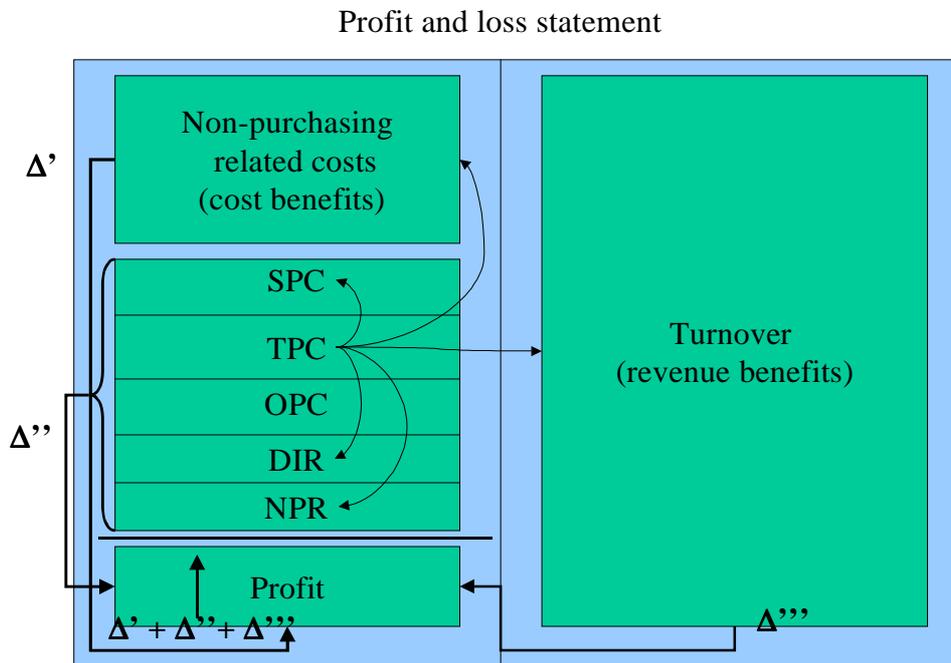


Figure 3: possible indirect impact of EP forms



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