Target setting for indirect processes: a new hybrid method for continuous improvement of indirect processes

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ABSTRACT

Indirect processes are increasingly contributing to the total cost of production in highly competitive and technology-intensive industries. Unfortunately, they are less assessable than direct processes due to the complex organizational management structure. Therefore, companies seeking to make improvements in indirect areas need decision support methods to indicate which indirect process needs to be improved and to what extent. To facilitate this task, the target setting for indirect processes (TSIP) method has been developed following the constructive research approach. TSIP is a combination of process modelling, the analytic network process, activity-based management from managerial accounting research, and the value control chart from target costing research in a kaizen budgeting framework. This new hybrid method is developed and validated in cooperation with a global first-tier automotive supplier.

Keywords: analytic network process; constructive research approach; continuous improvement; indirect processes; activity-based management

1. Introduction

The pressure of globalization, competition, reduced cycle times and increasing product complexity requires companies to improve their business processes. As potential improvements in direct areas are getting exhausted, indirect processes are the next frontier to tackle (Becker et al. 2007; Deiwiks et al. 2008; Fehr et al. 2011). Internal indirect business processes are not directly generating value. Instead, they are required to keep the direct value-generating processes running. In the literature, they are also called support or non-productive processes, in contrast with core or productive processes. They are often less structured and sequential than direct processes. Moreover, they contain high levels of interdependencies, causing difficulty in easily identifying potential improvements (Schuh et al. 2013; Magenheimer, Reinhart, and Schutte 2014). In practice, the selection of indirect processes that need improvement, in the sense that they become more cost-efficient, is often based on unstructured, intuitive and unmonitored decisions, or even on indiscriminate cost-cutting strategies (Hambrick and Schecter 1983; Lee and Covell 2008; Schuh et al. 2010, 2012). The indiscriminate cost-cutting approach, asking for the same reduction to all indirect processes in order to achieve a cost-reduction goal, may have negative implications for the company. The satisfaction of the customer may be jeopardized following such a reduction strategy in indirect processes, because essential processes may no longer work properly. For example, if the indirect process of cleaning offices is reduced, customers may no longer buy from this company because they do not trust their conscientiousness, even if cleaning is not the core process of the shop. Consequently, cost-reduction exercises may even lead to the paradox of increasing costs in the future, or to the need for other processes to compensate for this weakness (Roach 1991; King 1993). In our example, we could see staff members cleaning the offices in order to compensate for the reduction in cleaning staff, or rehiring cleaning staff. The continuous improvement planning in indirect processes, especially from a financial perspective, is therefore a delicate issue. Despite its importance, it has barely been examined in recent research (Wald et al. 2013). The ensuing question is how to identify indirect processes which have improvement potential.

To answer this question, a method is needed to evaluate the importance of each indirect process, its incurred costs and its capacity to improve. Then, an efficiency measure needs to indicate which process needs improvement. Moreover, we need to take into account that indirect processes are dependent. There is not a single method that can solve all these requirements; therefore we need to use a combination of methods.

This new hybrid method is called target setting for indirect processes (TSIP). It integrates four methods. Each component of the problem is represented by a process modelling method. Evaluating the importance of an indirect process is a multi-criteria problem. The analytic network process (ANP) is the only method that can take interdependencies into account; therefore it is adopted for this task.

For the same reason, ANP is also used to evaluate the capacity of improvement of each indirect process. The measurement of the costs is done with activity-based management (ABM), a managerial accounting method. Finally, the efficiency measure is done with a value control chart (VCC), adapted for the purpose of this research.

The TSIP method was developed by following the constructive research approach (CRA) (Kasanen, Lukka, and Siitonen 1993), in cooperation with a first-tier automotive supplier. The CRA facilitates the development of a new construct that enables scholars to solve practical problems while ensuring objectivity, autonomy and critical stance regarding the research process, as well as gaining insights not available using traditional research methods (Lukka 2000, 2002; Malmi 2010). The CRA reduces the gap between research and practice (Lukka 2000) and is generic enough to be applied to any area (Kasanen, Lukka, and Siitonen 1993). The original six steps, introduced by Kasanen, Lukka, and Siitonen (1993) to perform constructive research, have been extended to seven steps by Lukka (2000), which have been used in studies by Mendibil and MacBryde (2005) and Lindholm (2008), among others. The seven steps are interwoven in the structure of this paper. Section 1 covers steps 1 and 2, finding a practical relevant problem that has research implications and examining the possibility of long-term research cooperation. Section 2 looks at step 3 by obtaining both a general and comprehensive understanding of the topic, while Section 3 describes the proposed approach and outlines step 4 by constructing a theoretically grounded solution. Section 4 presents the case examination ranging over a period of two years, as well as covering step 5 by implementing the solution and testing it in practice. Section 5 discusses the scope of the solution’s applicability and section 6 presents the managerial implications, corresponding to step 6. Finally, the conclusion presents the theoretical contribution of the solution, relative to step 7.

2. Continuous improvement

Continuous improvement is a cycle, a constant activity, where all members of an organization and even its suppliers should contribute (Panwar et al. 2015). Waste should be eliminated and new areas for improvement identified. A large literature has been published on the subject (Albright and Lam 2006; Sanchez and Blanco 2014).

Continuous improvement first requires a picture of the current state of the production system so that areas for efficiency improvement can be identified. Value stream mapping (VSM) can depict the entire current system on a single page using symbolic icons (Lasa, De Castro, and Laburu 2009). It is then easier to identify operational bottlenecks and waste (Henrique et al. 2016), which helps the analyst in creating proposals for improvements (Parthanadee and Buddhakulsomsiri 2014). In order to achieve competitiveness, managers must remove wasted effort, i.e. non-value activities. Delay and excess limit a company in its competitiveness.

Unfortunately VSM does not prioritize non-values activities (Darlington et al. 2016) and does not include costs and economic indicators (Dinis-Carvalho et al. 2015). Therefore, other complementary techniques need to be used to provide this lack of information, as described in the next two sub-sections.

Different improvements have different costs and they need to be evaluated. For this purpose, the price a customer is willing to pay and the profit margin are first identified. Then the target cost can be derived and process can be implemented to achieve this target. A popular way to calculate product or service costs is by use of activity based costing (ABC) (Stefano and Filho 2013), which was designed to correct the deficiencies of traditional costing systems in allocating the indirect costs. The main idea behind ABC is that products consume activities, activities consume resources and resources have a cost (Lutilsky and Dragija 2012). Therefore, direct and indirect costs are allocated to activities instead of departments, as in the traditional systems. The next step is to assign activity costs to products. This task is more difficult for indirect than for direct processes, as they do not trace directly back to products. A common resource can be used differently for different products and therefore a sort of cost factor or cost driver needs to be used to change the cost of the work. For example, if the activity is a working machine on a production line, the cost driver multiplies the machine operating hours to calculate the indirect costs of electricity or maintenance (Cooper 1988a, 1988b). Clearly, the cost drivers need to show the correct relationship between a certain activity and the cost object, otherwise it can lead to severe distortions.

However, achieving profitability only by managing costs may be misleading, as customers are not necessarily satisfied. Activities also need to be managed (Johnson 1988). Businesses need to be flexible to respond rapidly to changes. They need to offer quality. These factors can be achieved only at greater costs. Table **1** summaries the different criteria used to evaluate activities.

Table 1. Importance criteria from the literature

	Flexibility	Delivery	Quality	Cycle time	Excess	Availability
Ramkumar, Subramanian, and Rajmohan 2009	x	x				
Behrouzi and Wong 2011	x	x	x			
Öztayşi and Sari 2012	x	x	x	x		x
Schoenherr et al. 2012	x	x	x			
Wong and Wong 2007	x	x		x		
Johnson 1988	x	x	x	x	x	

Multi-criteria methods have been used to calculate the importance and leanness of activities. Mohammadzadeh et al. (2011) use Fuzzy AHP-TOPSIS to evaluate activities under the criteria of quality, efficiency, completion and set-up time. Wong and Wong (2007) use DEA to evaluate internal supply chain efficiency. Wong, Ignatius, and Soh (2014) use ANP without interactions to calculate the leanness of activities.

In our work, we are extending ABC by integrating ANP in order to calculate the importance of each activity and its capacity to improve. In both cases, as indirect processes are influencing a large number of direct and indirect processes, ANP will take into account these dependencies, as explained in the next section.

3. Methodology

The methodology is based on activity-based cost and ANP data, which are input to the developed target costing approach. The TSIP proceeding is composed of several steps, as shown in Figure 1 (with the output of each step written on the outgoing arrow). Once the problem is defined, the processes are modelled in step I. Modelling processes are often described as the first and most important step towards making a rational decision. The modelling exercise transforms ill-defined processes into a set of well-defined elements, relations and operations (Ishizaka and Labib 2014). The result of this structuring methodology is a better understanding of the process. This, in turn, acts as a prerequisite, or input, for subsequent methodologies used in the proposed integrated approach. In step II, the attached costs of each process are identified, while in step III, ANP is used to determine the contribution level of each alternative in order to reach the main goals of the direct core process, as well as determining the ability level of each alternative to realize improvements. In step IV, a VCC, adapted for the purpose of the method, is then used to derive concrete cost improvement goals based on activity-based costs. By combining these methods, the limitations of each single method, listed in Table 2, are counterbalanced by the strengths of others in respect of the research target.

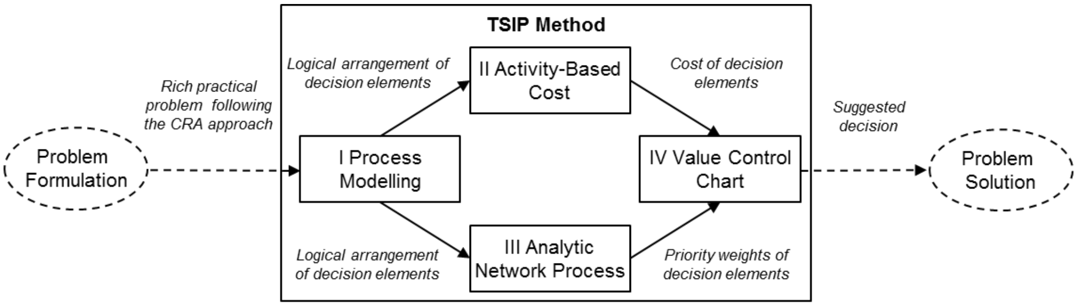


Figure 1. Schematic method development

Table 2. Core strengths and limitations of the methods used

	Strengths	*Limitations*
Processes modelling	The problem and its structure are modelled with a systematic and complete method.	The method is descriptive and not prescriptive.
Activity-based cost	Efficiency gains can be tracked over time.	Sheer costs do not allow an indication of efficiency potentials.
ANP	Qualitative and quantitative elements are prioritized with the consideration of interdependencies between them.	Generated priorities do not allow target derivations.
VCC	Possible derivation of targets and consideration of subsidization, as well as capacity for improvement by the flexible extension of a primary visual method.	The underlying approach is a simplified value to cost efficiency determination, blanking out other factors.

I. Processes modelling

The main goal of process modelling is to develop a formal representation of the contributory factors to the decision problem, including the views, opinions and values of multiple decision-makers. Process modelling is not a solution-oriented approach, but an approach to finding the constituents of the process (Ishizaka and Labib 2014). A popular way to structure the process is the component-based approach, which leads to more manageable activities in the TSIP method. This step has five phases.

I.I. Identification of direct core process. A direct core process generates value to the external customer; however, the improvement possibility will not be analysed. The listing is only necessary to identify the relevant indirect processes in the following.

I.II. Identification of indirect processes. All indirect processes $I = \{1, \ldots, i, \ldots, n\}$ that increase the internal—and, indirectly, as a result, the external—customer value are identified.

I.III. Indirect processes structuring. Each indirect process i can be broken down into activities $J_i = \{1, \ldots j, \ldots, m\}$. When the number of indirect processes or respective activities is high, which is often the case, it is advisable to group them into clusters to facilitate the analysis—for example, forming main processes based on specific process characteristics.

I.IV. Identification of the evaluation criteria. The indirect processes are evaluated on criteria (and possible sub-criteria), based on the characteristics of the core process and the customer requirements. The criteria have to express the value contribution to the direct core process and the capacity to improve.

I.V. Identification of interdependencies. As indirect processes may not add value only to the direct process but to other indirect processes and vice versa, all interdependencies must be identified.

II. Activity-based cost

The idea of ABC is to manage activities and processes by allocating costs to those consuming resources based on their corresponding cost drivers. These are determined by the frequency of the execution of the activities and processes (Johnson 1988). Activities, irrespective of the department, are aggregated to processes with a defined output valued by the customer (Davenport 1993). The clustering is generally done on activity-based data—i.e. all activities with the same cost driver are aggregated. After having identified the cost $c_{i,j}$ of each activity j, it is multiplied by the cost driver d_i of process i to find the drifting cost $DC_{i,j}$ for a given period.

$$DC_{i,j} = c_{i,j} \cdot d_i \tag{1}$$

The drifting cost information is then used in an adapted VCC, as discussed in step IV.

III. Analytic network process

The execution of ANP can be done in parallel to step II as it relies on the output of step I. ANP is the general form of the analytic hierarchy process (AHP), both of which were introduced by Saaty (2001). In the following, a short description of ANP is given based on Ishizaka and Nemery (2014). The main difference between the two methods is that AHP has a hierarchical structure and ANP is based on a network structure (Ishizaka and Pereira 2016). The adopted structure depends on the modelling of the problem: for example, a hierarchical structure is a linear top-down relationship with no feedback from a lower to a higher level, while the network structure is composed of different elements and clusters (groups of elements) that are connected to one another. The network structure can have connections between any factors in the decision problem. These connections represent the different relationships that exist between the clusters and the elements in the decision problem. Different relationships exist between the clusters and their elements:

- Inner dependence: this is a dependency in the same cluster—e.g. between two criteria or two alternatives.
- Outer dependence: this is a dependency between two clusters—e.g. between the cluster of alternatives and the cluster of criteria, or vice versa.

The directions of the connections in the network structure are important because they represent the relationship between two clusters. The goal of the decision problem is to find, based on the network structure designed by us, the processes and activities that are the most appropriate for improvement. For this purpose, pairwise comparisons between the different clusters and elements are performed to derive the priorities of all activities and processes under each criterion. Two key measures are the value contribution $x_{i,j}$ of the activity j to the process i and its capacity to be improved $y_{i,j}$. These two values are not directly combined as they have different scales and will be processed in step IV in an adapted VCC.

IV. Value control chart

The outputs of steps II and III become the inputs for the adapted VCC. A VCC is used to identify processes that need improvement in order to reach the superior target cost level (Glaser 2002). The fundamental assumption is that the maximum affordable cost of an element is determined by its value contribution. Within the VCC, the degree of importance is plotted on the x-axis and the percentage share of cost on the y-axis. The angle bisector is considered as the ideal line where the value contribution of each indirect process matches its costs (Tanaka 1989). Elements above the angle bisector can be considered too expensive, indicating a need for cost reduction. Elements below the angle bisector could be considered too simple, indicating a need for improvement in functionality (Wildemann 2012). It is important to note that the absolute value needs to be used and not the relative value as in the initial VCC proposition, because reduction targets can otherwise be distorted (Brühl 2010).

As most firms start improvement projects triggered from outside competition, the question is, how are these improvements reached with minimum effort? To address this question, the VCC is adapted and further developed by us in the following step, which has two phases. In order to determine the target cost level of each activity and process, the aspired superior cost reduction goal *G* is defined by the market competition.

IV.I. Subsidization effect. It is assumed that production is already efficient in its value stream but not in its costs. This means that there is no redundant indirect process and the value contribution towards the direct process is already optimal. Therefore, the processes and activities below the angle bisector shall indirectly subsidize those above, which are more expensive. As a result, only activities and processes above the angle bisector need to be considered for improvement, but in a reduced capacity because they are partially subsidized by the ones below the angle bisector. The exact cost reduction required is calculated as follows. The allowable costs $AC_{i,j}$ for each activity *j* belonging to the process *i* are proportional to the value contribution $x_{i,j}$ calculated with ANP (step III).

Therefore, $AC_{i,j}$ is given by the total drifting costs of all activities minus the reduction goal *r* multiplied by the normalized value contribution $x_{i,j}$:

$$AC_{i,j} = x_{i,j} \cdot \left[\left(\sum_{i \in I} \sum_{j \in J_i} DC_{i,j} \right) - r \right] \tag{2}$$

The difference between the drifting cost and allowable cost gives the target cost reduction $t_{i,j}$:

$$t_{i,j} = \begin{cases} DC_{i,j} - AC_{i,j} \ \ if \ \frac{DC_{i,j}}{AC_{i,j}} > 1 \\ 0 \ \ otherwise \end{cases} \tag{3}$$

As the costs of the activities and processes below the angle bisector will not be increased, this partially compensates for the allowable costs above the diagonal (i.e. they can be higher). The subsidizing factor s indicates the degree to which the efficient activities below the angle bisector will contribute to reduce the reduction need of those above and is given by:

$$s = \frac{r}{\Sigma_{i \in I} \Sigma_{j \in J_i} t_{i,j}} \tag{4}$$

The subsidized target cost reduction $s_{i,j}$ is given by:

$$s_{i,j} = \begin{cases} s \cdot t_{i,j} \ \ if \ \ \frac{DC_{i,j}}{AC_{i,j}} > 1 \\ 0 \ \ otherwise \end{cases} \tag{5}$$

The subsidized allowable cost s$AC_{i,j}$ of activity j is given by:

$$sAC_{i,j} = DC_{i,j} - s_{i,j} \tag{6}$$

In the case where all drifting costs are larger than their allowable costs, all elements require cost reduction and the s$AC_{i,j}$ is equal to the $AC_{i,j}$. By consequence, the subsequent consideration of capacity described below is relevant.

IV.II. Capacity consideration. Cost reduction is not always a straightforward task and not all processes and activities have the same ability to adapt. It is therefore necessary to incorporate the capacity of the activity to improve $y_{i,j}$ calculated with ANP (step III) in the target cost reduction. To determine the target cost reduction $p_{i,j}$ considering the capacity for improvement, some pre-calculations are required. In particular, it is necessary to ensure that the target cost reduction is not shifting the allowable costs with capacity consideration above the current drifting costs or below the allowable costs.

For this purpose, the minimum distance $lu_{i,j}$ between these two thresholds for each activity needs to be calculated:

$$lu_{i,j} = min\left\{(sAC_{i,j} - AC_{i,j}); (DC_{i,j} - sAC_{i,j})\right\} \tag{7}$$

As only the activities above the angle bisector are considered, the priority values $y_{i,j}$ of the considered activities need to be normalized:

$$z_{i,j} = \frac{y_{i,j}}{\sum_{i \in I} \sum_{j \in J_i} y_j} \tag{8}$$

The consideration of the capacity of the activities should neither increase nor decrease the total reduction requirements. To ensure this, the extent to which each activity should be adapted has to be levelled. This is done with the help of q, $\gamma_{i,j}$ and $\delta_{i,j}$:

$$q = \begin{cases} \frac{\sum_{i \in I} \sum_{j \in J_i} \alpha_{i,j}}{\sum_{i \in I} \sum_{j \in J_i} |\beta_{i,j}|} \ \ if \ \ \sum_{i \in I} \sum_{j \in J_i} \alpha_{i,j} \leq \sum_{i \in I} \sum_{j \in J_i} |\beta_{i,j}| \\ \frac{\sum_{i \in I} \sum_{j \in J_i} |\beta_{i,j}|}{\sum_{i \in I} \sum_{j \in J_i} \alpha_{i,j}} \ \ otherwise \end{cases} \tag{9}$$

$$\gamma_{i,j} = \begin{cases} \frac{\alpha_{i,j} \cdot q}{lu_{i,j}} & if \ \sum_{i \in I} \sum_{j \in J_i} \alpha_{i,j} \leq \sum_{i \in I} \sum_{j \in J_i} \left|\beta_{i,j}\right| \\ \frac{\alpha_{i,j}}{lu_{i,j}} & otherwise \end{cases} \tag{10}$$

$$\delta_{i,j} = \begin{cases} \frac{\left|\beta_{i,j}\right| \cdot q}{lu_{i,j}} & if \ \sum_{i \in I} \sum_{j \in J_i} \alpha_{i,j} \leq \sum_{i \in I} \sum_{j \in J_i} \left|\beta_{i,j}\right| \\ \frac{\left|\beta_{i,j}\right|}{lu_{i,j}} & otherwise \end{cases} \tag{11}$$

where

$$\alpha_{i,j} = \begin{cases} (z_{i,j} - \overline{z_{i,j}}) \cdot lu_j & if \ (z_{i,j} - \overline{z_{i,j}}) > 0 \\ 1 & if \ (z_{i,j} - \overline{z_{i,j}}) = 0 \\ 0 & if \ (z_{i,j} - \overline{z_{i,j}}) < 0 \end{cases} \tag{12}$$

$$\beta_{i,j} = \begin{cases} (z_{i,j} - \overline{z_{i,j}}) \cdot lu_j & if \ (z_{i,j} - \overline{z_{i,j}}) < 0 \\ 1 & if \ (z_{i,j} - \overline{z_{i,j}}) = 0 \\ 0 & if \ (z_{i,j} - \overline{z_{i,j}}) > 0 \end{cases} \tag{13}$$

The highest value from the $\gamma_{i,j}$ and $\delta_{i,j}$ (14) is then used to calculate the costs reduction considering the capacity of the activity (15).

$$k = max\{\gamma_{i,j}; \delta_{i,j}\} \text{ for all } j \text{ where } DC_{i,j}/AC_{i,j} > 1 \tag{14}$$

$$p_{i,j} = \begin{cases} s_{i,j} + \frac{\gamma_{i,j} - \delta_{i,j}}{k} \cdot \ lu_{i,j} & if \ \frac{DC_{i,j}}{AC_{i,j}} > 1 \\ 0 & otherwise \end{cases} \tag{15}$$

Finally, the allowable cost considering capacity $pAC_{i,j}$ of activity j is given by:

$$pAC_{i,j} = DC_{i,j} - p_{i,j} \tag{16}$$

Each activity j has its own target cost level $pAC_{i,j}$ calculated. For those activities initially located above the angle bisector, this represents a higher value-/cost-efficient level, taking into account the capacity of these activities to reach such improvements. If all activities achieve this target, the total reduction goal r is achieved.

VCC is best represented in a graph due to its visual representability. Figure 2 shows an adapted SC-VCC (subsidization and capacity considering VCC) based on example data in Table **3**. As already pointed out, not all activities change their value contribution as they are already assumed to be optimal on this axis; therefore the shifting will be only on the vertical axis. $A_{2,1}$ is below the angle bisector; therefore it is already cost efficient and does not need any cost improvements. As a result this activity subsidizes the cost reduction of all other activities above the angle bisector. This effect is shown in Figure 2 by movement *A* (the distance of all activities above the angle bisector between the $DC_{i,j}$ and the $sAC_{i,j}$ is smaller than between the $DC_{i,j}$ and the $AC_{i,j}$ positioned on the angle bisector). $A_{1,1}$ is the activity that has the highest cost reduction need ($t_{i,j}$ and $s_{i,j}$), which is even increased ($p_{i,j}$) due to its high capacity to implement this cost reduction compared to the capacity of all other activities above the angle bisector. This effect is visualized in Figure 2 by movement *B*. The SC-VCC allows the derivation of the reduction need, which represents distance *d*.

Table 3. Example of calculations for the SC-VCC

Activity	*Value contribution*	*Capacity for improvement*	*Drifting cost*	*Allowable cost*	*Target cost reduction*	*Subsidized target cost reduction*	*Subsidized allowable cost*	*Target cost reduction considering capacity*	*Allowable cost considering capacity*
i,j	$x_{i,j}$	$y_{i,j}$	$DC_{i,j}$	$AC_{i,j}$	$t_{i,j}$	$s_{i,j}$	$sAC_{i,j}$	$p_{i,j}$	$pAC_{i,j}$
$A_{1,1}$	0.05	0.40	28.00	3.50	24.50	16.90	11.10	20.10	7.90
$A_{1,2}$	0.20	0.35	21.00	14.00	7.00	4.83	16.17	5.35	15.65
$A_{2,1}$	0.35	0.15	11.00	24.50	0.00	0.00	11.00	0.00	11.00
$A_{2,2}$	0.40	0.10	40.00	28.00	12.00	8.28	31.72	4.55	35.45
$\sum$	1.00	1.00	100	70	45.25	30	70	30	70

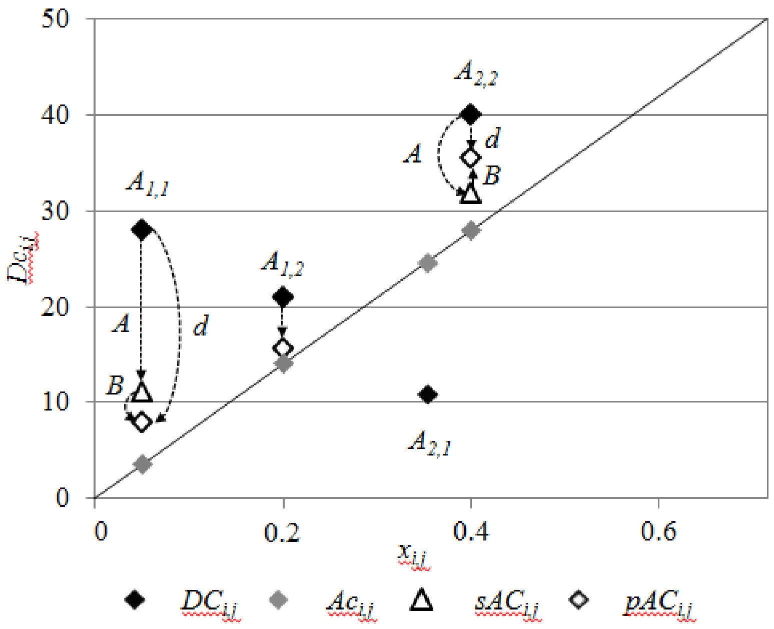


Figure 2. Adapted SC-VCC with data from Table 3

4. Case study

The implementation of the TSIP approach proposed in section 1.3 is an important step within the CRA, because it validates the analytic model building (Lukka 2000, 2002; Labro and Tuomela 2003). The aim is to examine whether the method works technically and smoothly (Lukka 2000). The cooperating organization is a global first-tier automotive supplier. The automotive industry is regarded as a pioneer in many fields and is driven by a large share of indirect processes as well as significant cost pressure (Moritz and Heiss 2012; Stolz and Berking 2013; Roland Berger 2014). The unit in focus is a national EFQM award-winning plant, certificated by ISO/TS 16949 (based on ISO 9001, including continuous improvement). The cooperating organization, and specifically the studied site, have already gained experience in process improvements in indirect areas: tools such as value stream mapping, analysis and design or 5/6S are used on a regular basis to improve indirect processes. They are, however, struggling to identify areas for improvement within budgeting processes from a management perspective and, as a result, the company asked the authors of this paper to develop a method for better identifying indirect processes to improve and to what degree.

The implementation of the TSIP method was realized in a three-stage approach, as shown in Figure 3. In the first implementation stage, the four steps of the TSIP method were implemented. At the end of the first stage, the indicated processes for improvement were presented to senior management, where continuation of the project was approved. Steps II and IV were rerun with the updated cost information and, following another presentation with the possible improvement indications, the senior management and board of management decided that the use of this method should be pursued and should become an integral part of the yearly tactical planning process (3a). Furthermore, the TSIP method has recently been used for planning and management actions to identify improvement potential, with the ultimate goal of maintaining the competitiveness of the cooperating plant over the course of the year (3b). For this reason, the TSIP method can be interpreted within kaizen budgeting as a method of enhancing continuous improvement on a regular budgeting basis. Kaizen budgeting has to be distinguished from budget cuts as it not only follows external triggers, but anticipates and encourages efficiency gains ex-ante (Blocher, Stout, and Cokins 2010). The TSIP method is now used regularly within the yearly rolling tactical planning process at the cooperating organization, replacing previously used budget allocation methods.

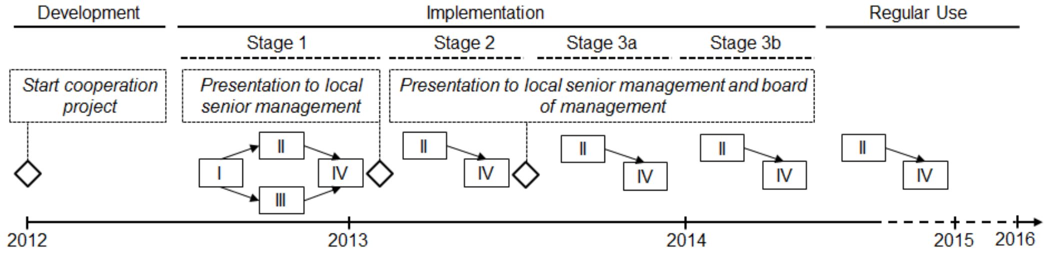


Figure 3. Implementation stages

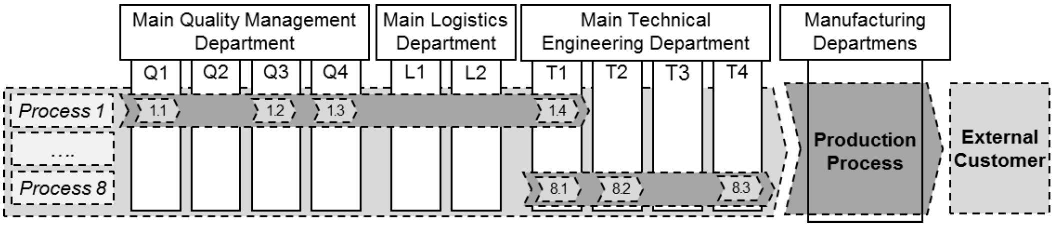
The following describes in detail how each step of the TSIP method was performed at the case organization.

I. Processes modelling

I.I. Identification of direct core process. The production process was defined as the direct core process. The manufacturing departments were retained as the internal customer.

I.II. Identification of indirect processes. Eleven indirect processes operated by ten departments clustered into three main departments (quality management, logistics and technical engineering) were identified as internal service suppliers. The definition of the internal customer-supplier relationship was communicated in the context of an already existing consumption-based production strategy and, as a result, the concept was readily accepted by the managers involved, who were signed off as evaluating experts in ANP.

I.III. Indirect processes structuring. The eleven indirect processes were deconstructed into 88 activities. The schema of the process model and activities is shown in Figure 4.



Q1: Department for product quality securing
Q2: Department of customer management
Q3: Department for quality and method management
Q4: Department of material analysis
L1: Department of production planning and control
L2: Department of physical logistics
T1: Department of manufacturing methods and tooling technology
T2: Maintenance department
T3: Industrial engineering department
T4: Resource management department

Figure 4. Schema of the process and activity model

I.IV. Identification of the evaluation criteria. First, a literature review (Table 1) was conducted on the factors used to evaluate the performance of business processes in the cooperation case context.

The senior managers of the cooperating company then proposed the criteria quality, delivery, ability to change (flexibility), failure cost reduction (availability and excess) and cycle time reduction, as they are applied on a regular basis in the cooperating plant. These criteria confirm the findings from the literature review, even if other terminology has been used.

I.V. Identification of interdependencies. All department managers in charge of at least one activity assigned to a process had to identify the inner dependency of all activities of such processes under each criterion in a brainstorming session. As several interdependencies have been identified by different managers, the need for ANP, which takes them into account, was demonstrated.

II. Activity-based cost

In the first two stages of the development of the TSIP method, the indirect departments were actively supported in order to determine the activity-based costs ex-post with the support of management from the accounting department. From stage 3a onwards, the departments were allocating their resources to the performed activities and processes themselves, based on the information provided by the accounting department.

III. Analytic network process

The ANP network (Figure 5) was designed in SuperDecisions.

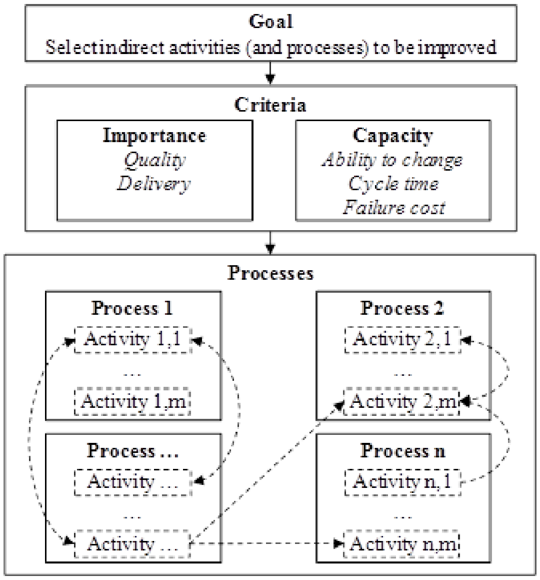


Figure 5. Network design

The evaluation is as follows. The processes were evaluated by five senior manufacturing main department managers and five senior plant managers, because they had a macro view of all processes. The evaluation of activity level was carried out by the respective department managers (quality management, logistics and technical engineering) in charge of at least one activity clustered under one process and the respective interdependencies. Each manager gave their evaluation independently and was briefed in a 30-minute meeting on understanding the evaluation of the pairwise comparisons questionnaire. The questionnaire was then sent to each manager requesting a timely response (average response rate of two weeks, with some individual delays requiring a further request).

If the consistency ration (CR) was larger than 0.1 on the activity level, the evaluating managers were asked to revise their judgements until consistency was reached. Evaluations can be aggregated at a judgement level with a geometric mean or at a priority level with an arithmetic mean. Aggregating at judgement level means that the contribution of each participant to the final priority cannot be found and therefore anonymity is preserved. As managers wanted to preserve their anonymity, aggregation at judgement level has been selected.

If we consider that the expertise or implication of the decision–makers is different, then weights can be given. There are several ways to provide weights (Chakhar et al. 2016):

a) Weights are explicitly defined by a mediator or an external independent person.
b) Weights are implicitly given according to the hierarchical level or (financial) implication of the decision-makers.
c) Weights are inferred from the input data.

The first method depends on the availability of a mediator, which was not the case in our case study. The second method was not liked by the decision-makers as it is very subjective to give weights according to the hierarchy. Therefore the third option was preferred.

On the process level, the organization decided that the senior managers were not to receive a revision request if the consistency ratio was larger than 0.1, due to the limited time available. We applied the Cho and Cho (2008) method, where a high inconsistency ratio is interpreted as an indicator of a lack of coherent understanding (expertise) of the evaluated processes. The weights w were assigned as follows: $CR < 0.1$: $w = 3$; $0.1 < CR < 0.2$: $w = 2$; $0.2 < CR < 0.3$: $w = 1$; $CR > 0.4$: $w = 0$. In total, 163 matrices with 4578 pairwise comparisons were completed by the 20 managers.

IV. Value control chart

An SC-VCC was designed for all stages, as the cost data changed over time.

IV.I. Subsidization effect and IV.II. Capacity consideration. An extract of real case data from stage 3a of the implementation process at the cooperating plant is shown in Table 4. The planned drifting costs of 56.6 million EUR shall be reduced by five per cent (r = 2.8 million EUR).

The drawing of the VCC is shown in Figure 6 and the SC-VCC with cost measures on both axes in Figure 7 (which facilitates the direct derivation of the required reduction targets of each activity from the chart). Activities allocated below the angle bisector (for example, $A_{11,2}$) help to subsidize the reduction need of all activities allocated above the angle bisector in the first step of subsidization (shown as data point *A* in Figure 7, representing $sAC_{6,8}$ = 3.328 kEUR). In the next step, the potential of $A_{6,8}$ and all other activities above the angle bisector is considered. The reduction need of activity $A_{6,8}$ is $p_{6,8}$ = 453 kEUR (read from Table 4), which is the vertical distance between $pAC_{6,8}$ = 3.208 kEUR (point *B* in figure 7) and the angle bisector. As $A_{6,8}$ has a higher capacity to improve its cost position ($y_{6,8}$ = 0.0146) than the average of all activities above the angle bisector ($\overline{z_{i,j}}$ = 0.0118), $pAC_{6,8}$ is smaller (positioned closer to the y-axis) than $sAC_{6,8}$ (causing a larger distance to the angle bisector).

Table 4. Extract of calculations for the SC-VCC of stage 3a for processes 5, 6 and 11

Activity	*Value contribution*	*Capacity for improvement*	*Drifting cost*	*Allowable cost*	*Target cost reduction*	*Subsidized target cost reduction*	*Subsidized allowable cost*	*Target cost reduction considering capacity*	*Allowable cost considering capacity*
i,j	$x_{i,j}$	$y_{i,j}$	$DC_{i,j}$	$AC_{i,j}$	$t_{i,j}$	$s_{i,j}$	$sAC_{i,j}$	$p_{i,j}$	$pAC_{i,j}$
…	…	…	…	…	…	…	…	…	…
$A_{5,1}$	.0045	.0130	545	239	306	32	513	37	508
$A_{5,2}$	.0065	.0134	2.052	349	1.702	179	1.872	216	1.836
$A_{5,3}$	.0018	.0132	444	97	347	37	407	43	401
$A_{6,1}$	.0009	.0146	1.443	46	1.397	147	1.296	200	1.243
$A_{6,2}$	.0032	.0146	665	169	496	52	613	71	594
$A_{6,3}$	.0048	.0146	2.660	258	2.402	253	2.407	344	2.317
$A_{6,4}$	.0007	.0146	591	35	556	59	532	79	511
$A_{6,5}$	.0008	.0146	369	43	326	34	335	47	322
$A_{6,6}$	.0008	.0146	484	40	444	47	437	63	421
$A_{6,7}$	.0008	.0146	419	40	378	40	379	54	364
$A_{6,8}$	.0092	.0146	3.662	492	3.170	334	3.328	453	3.208
$A_{6,9}$	.0092	.0146	407	492	0	0	407	0	407
…	…	…	…	…	…	…	…	…	…
$A_{11,1}$	.0217	.0069	1.088	1.163	0	0	1.088	0	1.088
$A_{11,2}$	.0335	.0083	1.340	1.798	0	0	1.340	0	1.340
$A_{11,3}$	.0319	.0099	665	1.714	0	0	665	0	665
$\sum$	1.00	1.00	56.567	53.738		2.800	53.738	2.800	53.738

[Costs in kEUR]

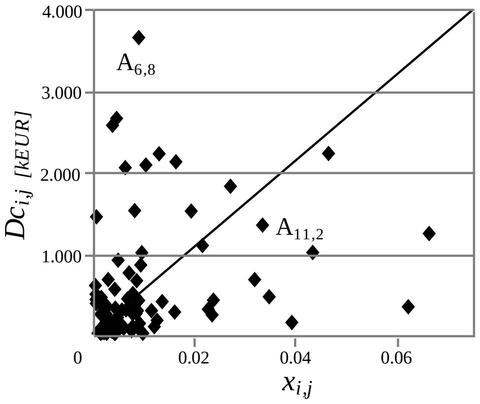


Figure 6. VCC of implementation, stage 3a

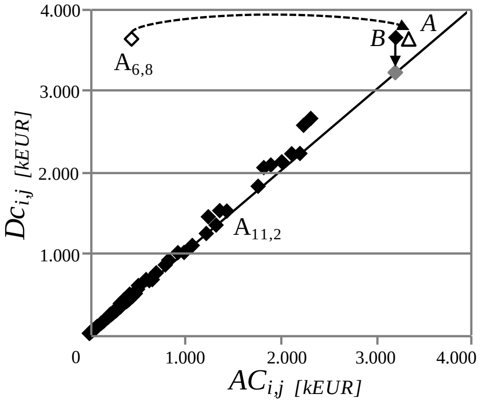


Figure 7. SC-VCC with cost measures on both axes of implementation, stage 3a

The display of the results in a management cockpit, which allows the management of the cooperating plant to process the data individually as demanded, is of specific interest.

Based on the cockpit, it is possible to derive reduction goals for:

- Each senior manager in charge of one main department.
- Each manager in charge of a department.
- Each process covering different departments.
- Each activity complemented by the information on how to reach the reduction goals.

Different variants for reaching the reduction goal may be considered: reduction of the cost driver to match the cost of the activity, reduction of the cost of the activity to match the cost driver, or a combination of the two.

With respect to the usage of the TSIP method in the budgeting process, the target derivation found specific attention to be paid to the department level because budgets are allocated on this level in the cooperating organization. Nevertheless, detailed discussions based on the outcomes of the TSIP method were also observed on a process and activity level between the managers of the indirect processes and their colleagues from the manufacturing departments.

5. Discussion

To examine the applicability scope of the developed method and to ensure the validity of the research, a differentiated market test was applied (Lukka 2000; Labro and Tuomela 2003). The market test gets stronger if a construct moves towards the upper right-hand corner of the market test evaluation table shown in Figure 8. The X in Figure 8 illustrates the unequivocal weak market test status that the TSIP method at the cooperating plant reached, because it is positioned above the dotted market test border. The dotted X demonstrates the desired usage of the TSIP method in additional plants and possibly the whole corporate group. The intention to further roll out the method, which is thought to be a chance to break up the recent ‘black box’ character of indirect processes, was announced by another plant manager along with a member of the management board. The foremost expectation of rolling out the TSIP method is to strengthen the market competitiveness of the corporate group, as market powers require reduced sale prices and high levels of quality and delivery at the same time.

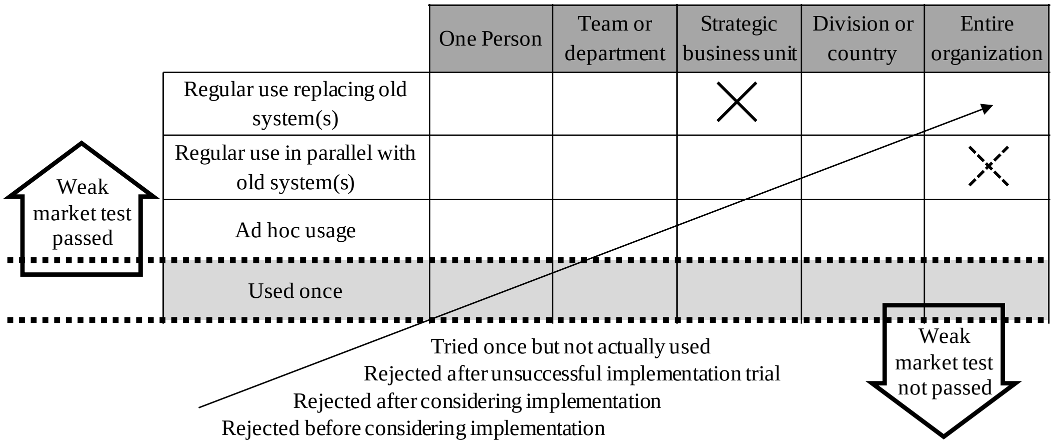


Figure 8. Dimensions of weak market test (based on Labro and Tuomela 2003)

In addition to passing the market test confirming the relevance of TSIP, the universal characteristic of the method should be pointed out, facilitating an application of the method in alternative settings. Additionally, it can be assumed that the management of the cooperating plant has comprehensive knowledge of the possibilities and drawbacks of tools to manage continuous improvements in indirect processes: besides being a national EFQM award winner and ISO/TS 16949 certified first-tier automotive supplier plant, they set up benchmarking activities with competitors, customers and consulting firms on a regular basis. The perception among the benchmarking partners is that the operative realization of improvements in indirect processes is not so difficult (even some less experienced organizations might not be able to do so); rather, the identification of areas for improvement from an aggregated management perspective is the crucial challenge. However, declared approaches lack the incorporation of planning functionalities (e.g. value stream mapping), oversimplify the selection process (Pareto analysis: focusing on the largest cost causing processes) or do not allow concrete derivations (for example, if benchmarking figures are available, they are commonly aggregated on a high-level—e.g. average share of logistic costs of total product costs in an industry). Therefore the positive evaluation of the TSIP method from the case study company shall be highlighted and the method enhanced and diffused in academia and in practice.

6. Managerial implications

The practical implications of this research are multiple. It has been proved through the practical validation that managers will benefit from better decision-making performance. Indirect processes often have a high level of interdependencies and a low level of transparency, insights and tangible information. Therefore, waste is difficult to detect and decisions hard to make. Continuous improvement should be seen as a set of achievable and non-harming targets. Therefore the decision relies on the collective decisions on ranking of all managers and not simply on the actual number of performance indicators.

Although there was initially some minor resistance from some managers as they perceived the framework to be very complex, the recommendations produced were adopted without problem. The main reason is that the process is structured, consistent, transparent and retraceable. In particular, the managers reported that it is much clearer to the employee on what they need to focus and there are fewer conflicts than before when uniform targets for all processes were set. This conducive working environment helps further to implement and sustain the continuous improvement strategy.

The process also had some weaknesses that need to be carefully handled. Problem structuring is performed by the managers and therefore relies on their accuracy and fairness. Interdependencies of a process were mapped by the manager in charge of that process. In order to increase artificially the importance of his process, more interdependencies could have been added. However, as the interdependencies were identified by multiple managers, they were cross-checked and the process modelling was found to be robust.

It is also necessary to note that the priority values of the alternatives are only valid in the context of continuous improvement. This means that radical cost reductions might require a redesign of the processes, making the process structure and evaluations obsolete. In such a situation, a new examination with the TSIP method would be required.

A limitation inherent to the ANP method is that the number of required pairwise comparisons may be high, as in our case study. To overcome this problem, further cluster levels have been set up and evaluated by different experts to reduce the comparison effort required by a single expert.

For the gathering of the cost information, the classic activity-based costs have shown their suitability at the cooperating plant. Depending on the specific organizational circumstances of potential further users of the TSIP method, recently discussed approaches such as time-driven ABC (e.g. Kaplan and Anderson 2004; Hoozée and Bruggeman 2010) might help to overcome potential challenges in collecting cost information, caused, for example, by the absence of respective calculation elements in the reporting structure of an organization.

The definition of cost efficient when the value-to-cost ratio is 1 within the VCC is derived from the idea that the customer pays only for what they really need. However, it leaves aside other possible improvements. The activities and processes below the angle bisector may also contribute to reaching subordinate target cost levels. In this case, their contribution would go against the philosophy of the VCC, where elements below the angle bisector should actually increase their costs.

Finally, the aim of the TSIP method is to give managers a tool that enables any organization to reach a desired cost-efficient level in indirect processes, with appropriate efforts. Once the reduction targets are derived, the operational improvements of the business processes have to be initiated. If they were initiated for all examined processes at the same time, significant efforts might be required, potentially leading to resistance within the affected departments. It is therefore important to stagger their implementation and use proven change management techniques.

7. Conclusion

The priority values of all indirect activities and processes calculated by ANP and activity-based costs allow the derivation of concrete reduction goals in an adapted VCC. As a result, the TSIP method goes beyond the simple selection of processes to be improved and, in consequence, goes a step further than previous ANP studies. The TSIP method contributes to the body of research on the use of the ANP in the context of performance measurement, thereby allowing unique insights, representing an advanced decision-making basis for managers to decide how to allocate cost reduction targets in indirect areas. This has not been possible to such an advanced level with any other approach.

This study has demonstrated that ANP can be applied to a very large project. It is true that a high number of activities to compare leads to a high number of pairwise comparisons; however, not all managers were experts in all processes and, as a result, their evaluation was requested solely for their domain of expertise, making the process manageable. The incorporation of several evaluations from different people leads to a group decision process. In this case the participants did not interact, but interaction could be considered in future work in order to incorporate a negotiation stage for contradicting evaluations.

As all managers of the considered indirect processes and the senior managers of the manufacturing departments, as well as further senior managers, were involved in the evaluation process, the derived management implications were given wide approval. Furthermore, due to the transparency insights gained, factual driven negotiations between the managers at the cooperating plant within budgeting processes have been observed. Before the implementation of the TSIP method, negotiations within budgeting processes were often described as driven by internal political preferences and the individual negotiation skills of the respective managers. All these gained insights may open the door for a broader field of application of ANP in organizational research.

In this case, the developed TSIP method was used for cost reduction where the quality and deliverability were assumed to already be at their optimum. The TSIP method could also be used by inverting the variables: the costs are at their optimum and both the quality and the deliverability of the processes need to be improved. The TSIP method was primarily designed to analyse indirect processes; however, applying the method to analyse direct process improvements is also possible.

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