The importance of new product development is observed in recent research on dynamic capabilities and target costing (TC). With established concepts from literature on dynamic capabilities and TC, we examine possible path-dependent conflicts in introducing TC to an organization using a traditional western product design approach. This study describes the attempt to add TC to a traditional stage-gate (SG) product development process. Implementing TC as a separate tool in an SG model raises the possibility that the sequential and rigorously “gated” design process would be in conflict with the iterative and multifunctional nature of TC. We find that conflict exists between the SG method and TC. This finding is consistent with criticisms on SG raised in literature. These criticisms include limitations on learning because of the truncation of sub-projects without iterations in TC. Moreover, we support the finding of a previous study that extremely rigorous gate evaluations reduce flexibility in the development system. We connect this previous study’s observations with the concept of dynamic capabilities to make our analysis highly granular and to highlight the aspects of TC that are in conflict with SG-type design processes.

Keywords: cost reduction, target costing, product development, process development, dynamic capability
INTRODUCTION

Increased competition has increased the interest in product design. Several studies (i.e. Dannels, 2002; Marsh & Stock, 2003; Verona & Ravasi, 2003; Prieto, Revilla & Rodriguez-Prado 2009) have explored dynamic capabilities in product development and design. The authors argued that product development is an essential function by which a company can ‘create, integrate, recombine and shed resources and capabilities’ (Prieto, Revilla & Rodriguez-Prado, 2009). Dynamic capabilities comprise a set of variables that shape product development competencies.

A design method that has been gaining increased attention because of increased competition is target costing (TC) (Clifton, Bird, Albano & Townsend, 2004). Given that the performance, quality and costs of a product are believed by many to be determined at the design phase (Ansari, Bell, Cypher, Dears, Dutton, Ferguson, Hallin, Marx, Ross & Zampino, 1997; Dekker & Smidt, 2003; Olhager, 2013), TC development is perceived as a strategic activity that is critical to a company’s survival.

The bulk of our understanding of TC originates from Toyota in Japan, where a method for strategic cost management emerged as a means to control costs during the early part of the product development phase (Kee, 2010; Afonso, Nunes, Paisana & Braga, 2008; Swenson, Ansari, Bell & Kim, 2003; Ansari, Bell, Cypher, Dears, Dutton, Ferguson, Hallin, Marx, Ross & Zampino, 1997; Ellram, 2000; Kato, 1993; Kato, Böer & Chee, 1995). Most variations of TC integrate cost control in the product development process by aligning costs with customer requirements and the cost structure requirements of the company (Ansari, Bell, Cypher, Dears, Dutton, Ferguson, Hallin, Marx, Ross & Zampino, 1997; Ibusuki & Kaminski, 2007). The aim is to control costs constantly during product development, starting from a concept to the finished product, by involving large portions of the value chain in a nonlinear manner (Ansari, Bell, Cypher, Dears, Dutton, Ferguson, Hallin, Marx, Ross & Zampino, 1997; Nicolini, Tomkins, Holti, Oldman & Smalley, 2000; Zengin & Ada, 2010).

The most frequently utilised traditional product development model in western companies is typified by the stage-gate (SG) approach (Cooper, 1990), which does not include cost at any part of the conceptual process.
SG divides the new product development process into stages and meters progress from stage to stage by imposing decision gates. The stages are linear and sequential and based on mid-20th century views of the design process derived from the Taylorist vision of the division between ‘thinking’ and ‘doing’, which was transferred to the product development arena as ‘design versus production’. In this view of product development, design is separated from supplier and production involvement in a series of silos.

Thus, two contrasting approaches to product development exist. These two approaches are recursive and multifunctional TC and linear and siloed SG. The dynamic capabilities required in these two approaches appear to be different and possibly mutually exclusive.

This study describes how TC is utilised in the SG product development process in a company called CEHaul to reveal the role of dynamic capabilities in the two contrasting approaches.

**LITERATURE REVIEW**

Previous studies have revealed the importance of adapting to rapid social change through dynamic capabilities, that is, to integrate, build and reconfigure internal and external skills (Tecce, Pisano & Shuen, 1997). The need to develop the ‘dynamic’ aspect of interactions with the environment has dominated recent research (i.e. Wang & Ahmed, 2007; Prieto, Revilla & Rodriguez-Prado, 2009). Alpenberg and Scarbrough (2013) revealed the significant effect of dynamic capabilities on the performance results of TC implementation and established the validity of the underlying concept that dynamic capabilities are potentially important in understanding TC. In the following sections, we draw upon previous research and present the conceptual pillars that frame this field research.

**Product Development Process**

The process of product development is described differently by different authors. Atkinson, Kaplan, Matsumura and Young (2012) divided the process into three steps, namely, market research, product design and
product development (Ansari, Bell, Cypher, Dears, Dutton, Ferguson, Hallin, Marx, Ross & Zampino, 1997). According to Ibusuki and Kaminski (2007), the product development process also consists of three steps, namely, concept, product and process development, in which each step consists of various measures. This description was supported by Cooper and Kleinschmidt (1987 & 1988) and Cooper, Edgett and Kleinschmidt (2002). These descriptions are derived from the mid-20th century Western understanding of the product design process and contain path-dependent knowledge. Meanwhile, TC is developed with a different understanding of the product development process and embodies a different set of beliefs about the process.

**Stage-gate (SG) Approach**

The dominant approach for product development in the west is SG (Cooper & Kleinschmidt, 1987, 1988; Cooper, Edgett & Kleinschmidt, 2002; Cooper, 1990). Companies that use rigorous SG evaluations enhance their product development efforts by improving performance, reducing new product cycle time, enhancing efficiency and introducing discipline. The SG process is a method of exerting control on product development (Cooper, 1994, 2001; Cooper, Edgett & Kleinschmidt, 2002).

However, the concern that gate controls are unsuitable for all types of products is growing. Specifically, the process of SG is inappropriate for products that require radical innovations (Leifer, McDermott, O’Connor, Peters, Rice & Veryzer, 2000; McDermott & O’Connor, 2002; Veryzer, 1998). Sethi and Iqbal (2008) suggested that rigorous gate control can harm new products that have a high degree of novelty and adversely affects learning in the product development process. The other issues discussed included culture clash in the subject company and the shift from being engineering-driven (internal) to being cost-reduction focused (external) (Everaert, Loosveld, Van Acker, Schollier and Sarens, 2006).
Target Costing (TC) Process

Versions of the TC process have been documented by only a few authors, who have described TC in several ways (i.e. Ax, Greve & Nilsson, 2008; Burrows & Chenhall, 2012; Yazdifar & Askarany, 2012). Our primary in-depth understanding of the process is based on Ansari, Bell, Cypher, Dears, Dutton, Ferguson, Hallin, Marx, Ross and Zampino (1997) and Cooper and Slagmulder (1999). Other authors, such as Ellram (2006), Everaert, Loosveld, Van Acker, Schollier and Sarens (2006), Ibusuki and Kaminski (2007), Loosveld (2003), Hamood, Omar and Sulaiman (2013) and Kobayashi (2014), subsequently focused on several TC characteristics.

An aspect of TC indicates that the cost structure is determined during product development. The total cost in the entire life cycle is considered before the product is manufactured (Ansari, Bell, Cypher, Dears, Dutton, Ferguson, Hallin, Marx, Ross & Zampino, 1997). This consideration is important because approximately 85% of the total life cycle cost is determined by market research, product design and product development (Atkinson, Kaplan, Matsumura & Young, 2012; Cooper & Chew, 1996).

To achieve the ‘target cost’, engineers, marketers and product developers analyse the factors that affect product cost to establish means to reduce cost without reducing product function and quality (Ansari, Bell, Cypher, Dears, Dutton, Ferguson, Hallin, Marx, Ross & Zampino, 1997). This main method is referred to as value engineering (VE). TC and VE complement each other. TC identifies the target cost, and VE with quality function deployment (QFD) identifies opportunities for cost reduction (Akaau & Mazur, 2003; Afonso, Nunes, Paisana & Braga, 2008; Akhbari, Alpenberg, Scarbrough & Wennberg, 2012; Ansari, Bell, Cypher, Dears, Dutton, Ferguson, Hallin, Marx, Ross & Zampino, 1997; Zengin & Ada, 2010).

Furthermore, Cooper and Slagmulder (1999) created a sample process for TC as a three-stage model based on the experience of seven Japanese companies with mature and effective TC processes. The first step, market-driven costing, is about designing new products with specific cost requirements at the concept phase. The second step, product-level TC, describes a detailed design to meet cost requirements. The third step,
Dynamic Capabilities in Target Costing (TC)

We draw from the idea of Tecce, Pisano and Shuen (1997) that dynamic capabilities are the ultimate source of competitive advantage and are elements to enhance the existing resource configuration in a demanding environment (i.e. Tecce, Pisano & Shuen, 1997; Eisenhardt & Martin, 2000; Knight and Collier, 2009). The essence of dynamic capabilities is that they reside in the potential to change resources, routines and competences (Prieto, Revilla & Rodriguez-Prado, 2009). They are defined as ‘the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve and die’ (Tecce, 2007; Eisenhardt & Martin, 2000; Tecce, Pisano & Shuen, 1997). Simplified, dynamic capabilities are a set of specific and identifiable processes, such as product development and strategic decision making (see Eisenhardt & Martin, 2000).

Dynamic capabilities in the product development process can be divided into three parts, namely, knowledge creation, knowledge integration and knowledge re-configuration (Tecce, Pisano & Shuen, 1997, Tecce, 2007; Prieto, Revilla & Rodriguez-Prado, 2009). Knowledge generation (KG) refers to developing specific activities to identify and solve problems and knowledge for the development and launch of new products. Knowledge integration (KI) refers to combining the knowledge and skills of individuals from various departments to design and develop a specific product; knowledge is revealed and shared as part of the product development process. Knowledge re-configuration (KR) is the ability to feel the need for reorganization and combination of knowledge or patterns that are embedded in products and activities by establishing flexible relationships and teams.

According to Collier and Knight (2009), TC can provide useful information for decision making and improve the capacity and resource base of the organization, especially in certain situations. The authors concluded
that managers play a key role because they bring external knowledge about resources and transfer such knowledge to new internal procedures to develop new and sustainable dynamic performances. Easterby-Smith and Prieto (2008) claimed that dynamic capabilities and the firm’s abilities for knowledge management are connected. In a later study, Akhbari, Alpenberg, Scarbrough and Wennberg (2012) and Alpenberg and Scarbrough, (2013) found that the adoption of TC by Swedish listed companies is influenced by dynamic capabilities. The authors also found a partially positive correlation between dynamic capabilities and performance results when TC is used.

RESEARCH PROCESS

In this study, we adopted an individual case study research design, which is desirable when studying social sub-systems, such as institutions and organizations (Scapens, 1990). Case studies should be characterized by a few observation units and many variables to be able to describe, understand and explain what occurs within an organization (Yin, 2007). Interviews were the primary source of information in this study because this method creates the opportunity to follow up with additional questions for clarification (Yin, 2007; Bryman & Bell, 2005). Direct observations of daily activities and project meetings held by the project manager and sub-project leader were also conducted. During these meetings, we observed a large number of the participants in their work setting. Furthermore, we reviewed corporate documents to confirm the issues that emerged during the interviews (Patel & Davidson, 2003; Yin, 2007). We were given access to documents, such as TC training workshop materials, organizational chart, company brochures and the ‘Global Development Process’ (GDP) guide of the parent company.

We interviewed employees with different backgrounds in the area of product development who had actively participated in the introduction of the TC process. The interviewees included the project manager of the steering group who led the operational work. We also interviewed one of the project leaders and two additional individuals according to the areas we wished to investigate comprehensively. Table 1 presents all the individual interviewees.
Table 1: Individual Interviewees at CEHaul

<table>
<thead>
<tr>
<th>Interview</th>
<th>Job title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manager for Business Planning and Product Target (program owners)</td>
</tr>
<tr>
<td>2</td>
<td>Project Leader and Purchasing Coordinator</td>
</tr>
<tr>
<td>3</td>
<td>Project Manager Engineering</td>
</tr>
<tr>
<td>4</td>
<td>Product Manager for “Media Platform” (two machine models)</td>
</tr>
<tr>
<td>5</td>
<td>Director CEHaul Platform and Chairman of the Steering Group for Haulers</td>
</tr>
</tbody>
</table>

We used unstructured and semi-structured interviews. Unstructured interviews were used with the contact person to obtain a thorough understanding of the situation at CEHaul. Semi-structured interviews were used for the rest of the interviewees to obtain deep and detailed information. The interview guide addressed various questions, including each employee’s role in the TC process and the importance of skills and knowledge. All interviews were recorded and transcribed. Between interviews, we conducted direct observation of formal meetings held by two of the project managers. These meetings are usually held every two weeks and handle small sub-projects for cost savings. Each meeting is attended by about six individuals from various departments.

**CASE DESCRIPTION: CEHAUL**

Construction Equipment Group (CEGroup) is one of the world’s leading manufacturers of construction equipment. Manufacturing takes place in Europe, Asia and North and Latin America. The CEHaul division of CEGroup is a world leader in the category of “articulated haulers.” CEHaul was the original developer of this category, which pertains to transporting large volumes of materials in difficult terrains at a cost that is lower than that of alternative methods. Articulated haulers are very large vehicles with an empty weight of over 15,000 kg and a payload of over 20,000 kg. Distribution of the haulers is particularly complex because they are large and heavy and must be transported individually. Hence, detailed plans for the delivery to the final customer are required as part of the sales agreement.
The market for articulated haulers is mature, and products across competitors have become increasingly alike. CEHaul is one of the main players in the global market. It faces tough competition from Caterpillar and Komatsu. CEHaul manufactures all parts of its articulated haulers and performs the final assembly. Additional activities include product development and support for after-sales service, IT, personnel, finance, procurement and communications and global marketing.

For a long time, the competitive strategy of CEHaul has been to have the best product in the market. In the current and much more mature market, this goal is becoming extremely difficult because all competitive products are similar, and the expertise obtained from extensive experience is widely distributed among competitors. This situation results in extreme demands for quality and functionality when pursuing cost reduction. In addition, regulatory requirements change rapidly. This change entails additional costs for changes in products because of safety or environmental regulations. Product development at CEHaul is significantly influenced by regulatory requirements for emissions. New components are required to meet these requirements, which have influenced the company’s competitive strategy. Given the cost effect of these regulatory requirements, the company’s market price has increased without any added customer value. Meanwhile, customers demonstrate increased price sensitivity while demanding for additional functions and improved quality.

CEHaul attempted to implement TC twice. We report mainly on the second attempt. The first attempt of CEHaul to introduce TC to their already established product development process took place in 2011. The initiative came from CEGroup’s CEO, who challenged the entire organization to improve the profit for each product through cost reduction without reducing quality and functionality.

External consultants analysed the products at CEHaul and set up a TC ‘workshop’ series. The method to accomplish cost reduction, according to the project leader, was through product development. Through this method, the company could identify which suppliers to replace and which part of the product to re-design. Additionally, the choice of material and improvement of the manufacturing process could pave the way for cost savings.
According to CEHaul’s Improvement Project Chairman, the first attempt was failed. This failure was partly attributed to the complexity of the TC process. Despite some technical progress in emission reduction, the first TC attempt was a clear failure according to both the project manager and project leaders. The organization never managed to incorporate the new TC routines and informal responsibilities into the pre-existing SG product development process. This inability led to a feeling of lack of responsibility among participants and a feeling that the management control system was unable to support the TC initiative. This sense of confusion ultimately resulted in a situation in which the target cost was not achieved. The project manager and the project leaders at CEHaul realized that a clear process and project model for TC that everyone understands and can follow to create ‘order’ are necessary. The leaders of different subprojects in the cost reduction program at CEHaul highlighted the problems in implementing ideas when they described the situation as follows:

There is no lack of ideas. We have almost too many of them. The problem is how to execute these ideas.

All participants in the second attempt participated in the first failed attempt. The second attempt to introduce TC began in the fall of 2013. Even during the second attempt, a ‘workshop’ was the starting point. The TC process was implemented only once (during the TC workshop) and was directed by the consultants. In the TC workshop, employees from different departments were gathered to put forward improvement and cost reduction ideas. External consultants were hired, and they spent 15 weeks onsite at CEHaul together with the sub-project leaders. During this process, an articulated hauler was disassembled and studied to identify the areas for improvement. The work was performed in cross-functional teams, and several new ideas were obtained.

All ideas were subjected to a strict validation process and eventually resulted in the following four specific project categories.

1. Category 1: Large design changes and system upgrades

2. Category 2: Small improvements and cost savings on all existing products and processes as long as they do not require verification
3. Category 3: Large improvements of all manufacturing processes throughout the plant

4. Category 4: Renegotiate conditions with suppliers and possibly identify supplier

The project leader expressed his thoughts about the validation process as follows:

*The validation process aimed to “wash” all the ideas that had come in. We had two technical experts and the product manager with us during the meetings. For three weeks, we worked extremely hard in the validation process to determine if the ideas would reduce cost and can be implemented.*

These projects led to new activities, including altered responsibility for daily routines, in the product development process. The project manager and the project leader summarized the work as follows:

*However, the most significant challenge was to improve the product while cutting the cost before it is produced* (project manager and project leader).

**Product Development Process at CEHaul**

According to the project manager, CEHaul adopts the parent company’s GDP (Figure 1) for product development. This GDP is based on the concepts in the SG development process (Cooper, 1990; Cooper, Edgett & Kleinschmidt, 2002). It consists of pre-study, concept, detailed development, final development, industrialization and follow-up phases. Each phase is intended to indicate a particular emphasis on project work.
These two concepts are process arise when important decisions are to be made regarding products; these two concepts are validation and verification. Validation ensures that the products meet the customers’ needs in their actual situation and includes subjective aspects. Verification ensures that products, subsystems, functions, or parts conform to the requirements of the specification. To distinguish these concepts internally, the chairman explains that validation is to ‘build the right product’, whereas verification is to ‘build the product right’. A detailed description of the different phases is presented below.

Global Development Process (GDP): Pre-study Phase

In the first phase, pre-study, work with business requirements and opportunities is done and is viewed as a feasibility study. This phase includes product planning to improve the product, quality, lead times for product development and reduction of business risks. To avoid late changes, considerable emphasis is placed on the early phases. The most promising
projects are selected and prepared for the next phase, and the others are either rejected or worked on. The product manager pointed out that

During this phase, we start with the requirements or definitions, which include what we want, what the allowable cost level is, how much it is going to weigh and how profitable it has to be.

This phase is the main entry point for TC or for any goal. Notably, goals must be externally specified. In the past, the main set of goals was the engineering impetus to improve functionality based on the long-standing CEGroup strategy of having the ‘best product’. TC injects customer demands for both functionality and cost at this stage. Introducing these aspects created friction when the TC initiative was implemented because the company had never been considered at this stage previously.

The pre-study phase is one of the main phases to determine the target cost. A corporate decision by top management forced all the units in CEHaul to cut costs by a specified percentage. This percentage goal was mandated as the goal for the TC process at CEHaul. This step differs greatly from the normal TC view, in which the starting point is the market and its needs. Thus, one issue is that participant dedication may not be as great with externally imposed goals based on group needs that do not appear to be connected with the CEHaul employees’ understanding of their market.

Thus, CEHaul uses a hybrid model in which market research is performed to understand and measure customer requirements while the company follows a cost reduction target assigned by the upper management of the CEGroup. The target for cost reduction is broken down by assigning each reduction to a different department that deals with various aspects of the product life cycle. At CEHaul, this strategy is implemented at the pre-study phase. This step affects the structure of CEHaul’s TC process and is significantly different from traditional TC thinking.

VE combined with QFD is the key generation tool in Japanese versions of TC. VE is a tool to develop an in-depth understanding of the value perceived by a customer. The use of VE at CEHaul differs substantially from normal TC use. An obvious risk for conflict emerges when employees do not use VE but are, at the same time, afraid of neglecting functionality
and quality when they reduce cost. However, CEHaul does not seem to use VE for these purposes.

The articulated hauler project leader describes market development by referring to existing products and analysis of trends on the basis of profitability. This definition coincides with ‘physical-attributes-based adjustment’, which is used for products with a functionality that is changing gradually and where physical attributes are based on customer requirements. This situation sets a market price that the company thinks is appropriate based on contact with customers.

At this stage, we observe knowledge generation occurring as the project team looks outward to develop new functions or improve existing functions. Although several teams are cross functional in a limited sense, knowledge generation is fairly narrow in scope. Very little or no knowledge integration or knowledge reconfiguration exists indicated in this phase, which is different from the early stages of TC where all three stages indicate development.

Global Development Process (GDP): Concept Phase

The primary task in this phase is to generate the concept that has the potential to satisfy the requirements of customers. The difficulty in this part of the process is illustrated with the following excerpt from the interview with the product manager.

*We might have developed a smart concept but if it doesn’t ‘hit’ the product cost the right way, it does not take off. We need the product to be profitable when it is delivered to the customers. The first phase in which we set the requirements is straightforward, but to balance the different concepts along the requirements is where it gets tricky.*

The concept phase is divided in two parts by a ‘gate’. To pass the first gate, concepts have to be defined and ‘frozen’. This procedure includes identifying what has to be developed, specifying how and where development should occur and determining whether quality and risk analyses are required. In the second part of the concept phase, decisions regarding
suppliers and manufacturing activities are planned, and the timetable is updated. However, no actual contact with suppliers exists at this point, which is a violation of TC.

To reach the target for cost reduction, CEHaul applies a small measure of VE in the concept phase for components and items. Each component and item are assigned their own target cost, and together, they lead to the cost reduction target. In this step, cost engineers contribute with special tools, such as cost tables. These tables involve detailed cost information on raw materials, purchased components and processes. However, the bulk of the information needed is unavailable but is indicated in later stages because suppliers are not part of this analysis. This limitation exerts negative effects on the CEHaul development process because the company must ‘simulate’ the possible cost reduction by suppliers instead of obtaining help from actual suppliers.

According to the product manager, the process in the concept phase is unpredictable and produces negative effects. The entire TC process was only executed once during the TC workshop with consultants when the cost reduction program began. This is another reason for the weak support in the organization, processes and structure of CEHaul. These deficiencies lead to each task taking longer than necessary, which, according to the project leader, is wasteful and adversely affects the company in the long term when it comes to time-to-market. The tight integration of Japanese keiretsu members as suppliers and customers is part of the TC process in Japan. However, this condition is usually unnoticed by western observers. The use of TC by CEHaul appears to suffer from the lack of participation of all suppliers.

CEHaul performs benchmarking internally and externally according to the project leader of the articulated hauler design committee. He constantly compares CEHaul with its competitors and their strategies; however, this comparison is not a natural part of the original SG GDP process. Given that competition has increased and the market for haulers has become price sensitive, the need for knowledge about the products and value proposition of competitors is important at this phase. The effect of benchmarking is that the definition phase is prolonged to reduce the risk of overlooking something.
At this stage, we observe how the product designers seek to generate additional knowledge about competitors’ products and value proposition through benchmarking activities. Knowledge integration and partial knowledge re-configuration occur as the project team attempts to balance different concepts with customer requirements and breaks down cost reduction targets on a detailed level. We observe the footprints of the TC process introduced, but given that suppliers are not actively involved in the TC process, the depth of knowledge integration is limited.

**Global Development Process (GDP): Development Phase**

In the detailed development phase, the design of the individual components is assumed to meet standard requirements. Negotiations and agreement with critical suppliers are then made. This after-the-design contact with suppliers is a significant deviation from ideal TC practices. At CEHaul, development projects go through many ‘gates’ before reaching the industrialization phase, where they ensure that the target cost is not exceeded. At the development phase, they utilise a number of support measures to ensure that the target cost is within the accepted level. Several of the interviewees stressed that rather than multiple rework attempts, that projects are ‘killed’ when the target cost cannot be reached readily. Even when a project is in the middle of the development phase, when they discover that the cost savings are insufficient, the project is closed down (called the freeze gate). This shutdown creates a sense of frustration among employees when projects are cancelled without the possibility of continuing to work on them.

Failure of a component to achieve the target cost leads to strategic considerations. For CEHaul, the focus is on the components and items and not on the entire product. With respect to the competitive strategy of the company, the product manager said that having functionality and quality is important to make the product better than that of competitors. The product manager described a scenario wherein a designer cannot deliver a design according to the specification cost and have to trade the cost of another component, preferably within the functional group. This step is often applied in Category 1 projects because it deals with major changes in the product in comparison with all the other categories. A large project size in Category 1
could influence the cost structure in a manner that benefits the other project categories. In the detail development phase, even small components and items are developed; this phase can be implemented relatively quickly and with a small budget.

At this stage, we observe a low level of knowledge generation and integration given that the members of the product development team do not produce many new novel and useful ideas. The low level of knowledge integration is also observed through the fact that members of the organization are not systematically uncovering and correcting areas with which customers are dissatisfied. At this stage, we observe limited knowledge reconfiguration given that projects are ‘killed’ when they cannot reach the targets and no further changes to the existing features are accomplished. The members of the product development organization do not transfer or reconfigure knowledge to the rest of the organization or to outside actors for various reasons. Additionally, none of the steps in the TC process is observed at this stage.

**Global Development Process (GDP): Final Development Phase**

In the final development phase, the concept is finalized for final implementation. In both stages of development, cross-functional teams conduct all activities.

As mentioned above, CEHaul employs four project categories in their TC program. However, none of the project leaders is responsible for specific components or features, but several are responsible for projects based on size, complexity of the sub-project and lead time. The target cost is set on the project level and further distributed to sub-projects and suppliers on a unit level, which have to meet the goal together. This setup allows CEHaul to easily estimate the time and resources that each project and team require. The responsibility aspect was missing in the first attempt and in the earlier non-TC methods used. All interviewees indicated that this aspect, i.e. to have control and overview of work as well as clearer accountabilities, is a crucial part of the work with TC. Managers at CEHaul pointed out that they learned from past mistakes when the consequences of not allocating
responsibilities, objectives and costs, resulted in improvements failing to materialize. One important lesson from the first failed TC attempt is the importance of involving suppliers for them to propose feasible solutions and thus transfer the cost requirements to them. The purchasing coordinator believes a gap exists in the cost structure, which he plans to deal with in the future. He also intends to invite suppliers and discuss additional solutions. However, this action would still be at a level of involvement that is much lower than in most descriptions of TC.

Here, we observe a moderate level of knowledge generation through the cross-functional teams. Knowledge integration and reconfiguration are weak at this stage because the SG-approach and the first TC attempt did not involve suppliers in the development phase. Moreover, managers did not allocate responsibilities for the cost structure to the project team. The low level of involvement among employees and the low level of knowledge transfer to other parts of the organization at CEHaul indicated that all three dimensions of dynamic capabilities were weakly developed in the final development phase.

Global Development Process (GDP): Industrialization Phase

In the CEHaul standard design method, industrialization is the last phase before the production of components and product quality are accepted. The process deals with commercialization, which means that the manufacturing process is ready and that the Marketing Department is prepared for product launch and aftermarket activities.

The industrialization phase for CEHaul means that sub-projects have been verified and validated (which means that products have passed the pre-production gate) and are ready to be implemented. However, only profitable projects reach the industrialization phase because CEHaul follows up and closes down sub-projects that will not lead to expected results. At this phase, process development for production and the best process for a specific task are documented in the ‘White Book’. At this stage, the company also knows exactly what a product will cost according to the product manager. This stage is much later than normal TC processes. At this point, the company can prepare the market and receive orders before production begins. This
step is important for CEHaul to consider because traditional SG approaches can lead to late changes in materials, suppliers, construction, design or manufacturing process that can lead to unpredictable events (launch gate) in series production and thereby result in increased costs.

The value chain of CEHaul includes both supplier and customer companies in different ways. Customer information is primarily from customers and dealers about customer requirements according to the articulated hauler project leader. Involvement with suppliers in the value chain takes place mostly during purchasing coordination and applies to the largest portion of articles according to the purchasing coordinator. In addition, coordination with suppliers becomes crucial during the development of prototypes. For example, this may occur when a project does not reach the target cost for components and items. In several cases, the purchasers even analyse supplier efficiency during their production process. Even within the Purchasing Department, ‘supplier development’ includes collaboration with suppliers to secure their processes. Both ‘cost engineers’ and ‘supplier development’ work with suppliers, which can cause confusion and the risk of duplication. This step results in negative effects on time and trust with suppliers.

Another way that suppliers are involved is that they come up with product reviews. The manager for business planning emphasised that

*The importance of listening to suppliers and working with them as early as possible in projects leads to a higher value for the product. At CEHaul, this step does not happen to a great extent because of the lack of time. Nevertheless, it represents a major opportunity for development.*

Furthermore, opportunities for cost reduction might be neglected.

According to the product manager, CEHaul involves suppliers in different ways in several steps. However, ambiguity exists regarding cooperation because it is performed by both ‘cost engineers’ and ‘supplier development’. Furthermore, the selection of suppliers limits their possibilities for further cost reduction. According to the project leader,
There is a lack of structure in the purchasing process, which limits improvement possibilities. There is no point in making use of temporary vendors that offer better price or solution to a prototype when they cannot be used on a long-term basis. Costs increase when they go into production and have switched to existing suppliers.

The greatest potential, according to the project leader, is close cooperation with suppliers, clear division of responsibilities and great flexibility in sourcing and selecting suppliers.

During this stage, we observe a low level of dynamic capabilities but with an identified potential for improvement through improved cooperation with suppliers. The existing SG approach has cemented a low level of cost reduction efforts and a low level of dynamic capabilities. We also observe a low level of valuable knowledge elements in action. Despite TC attempts, members of the organization are unable to incorporate new ideas into their regular workflow.

**Global Development Process (GDP): Follow-up Phase**

The last phase, follow-up, consists of monitoring and cause analysis in accordance with ‘QDCF’, which denotes quality, delivery, cost and feature control. According to the chairman, these aspects are crucial to follow up because they determine customer satisfaction and the profit level for the unit. However, we did not observe this phase and thus do not report on it.

**Interaction between Global Development Process (GDP): Product Development Process and Target Costing (TC)**

The chairman of the steering group of the articulated hauler development project describes the product development process as starting with an idea-generating phase. At this phase, an idea is reviewed, realized and gradually matures. He argues that this stage is often associated with investment.
TARGET COSTING IN A STAGE-GATE DESIGN SYSTEM

Often, the problem is not a lack of ideas, but rather, giving priority to the right things. You go through these stages and have a “gate” for each reconciliation to decide what stuff goes to the next level. At this point, we assess the “pay-off” time and the likelihood that it will be realized. (Chairman, CEHaul)

He continued by illustrating the relationship between product development and the cost structure.

New products begin with the question, “how much will the product cost?” This decision is made in the cross-functional forum. You look at the market potential and what the employees think. Then you break it down and arrive at a structure for how to divide up a machine. Counting on component costs, you determine how much the products will cost, etc.

The chairman explained that CEHaul has developed its own tools for cost reduction in the product development process. The company has always worked with development and key factors for successful coordination of all parts. A classic tool that is widely used is benchmarking. Benchmarking is conducted at several levels, such as business, product and component, and works internally and externally. CEHaul appears to be using VE when it wants to take a close look at a feature that is desired to be sold. However, the members are not as active because the task involves much work with suppliers, fixed costs, economies of scale, etc. According to the project manager,

There are tools, such as VE, [but] we have proprietary methods on this where we compare. We buy a lot from within the group and know the majority of the costs. We have special engineers who can appreciate how realistic the setup is. It is, of course, many tools, I’m not so impressed by them. For me it’s the orderliness and persistence that matter. (Project manager, CEHaul)
When asked about the use of QFD, the chairman pointed out that CEHaul is using QFD in this manner:

*There are people who know QFD and can work with it. If you do it on a machine, at the level that we work, it is enormous and complicated. The matrixes become huge and difficult to handle in practice.*

*We have the requirements to work with “Systems Engineering” – ways to derive requirements for any kind of function. How big should the fuel tank be, for example, 400 litres? Then it becomes a requirement that persists. It knows you are not after a while, but it just “stays” there … but then watching it, you’ll be able to run a shift without having to refuel -- that is the requirement. Then you get to see how big the fuel tank should be. We are trying to work with functional demands as much as we can. Of course it also matters that you can disconnect the technological solutions that lock itself with the technology early, but instead know what function you want to have.* (Chairman, CEHaul)

**Cost Control**

The introduction of TC at CEHaul was regarded as a critical step by the top managers to maintain the profitability of the company. Traditional cost control methods do not consider the functions, quality and cost in the development process. Meanwhile, TC appears to be a tool that could allow these factors to be integrated into the product development process and could therefore play a key role at CEHaul. Previous experiences on cost reduction attempts were not good and had created a negative attitude among members of the organization. Cost reductions often ended in low profitability followed by layoffs, which worried the employees. The conclusion of both the manager for business planning and the project leader was that cost reductions must involve changes in daily work and ways of thinking. These changes can be difficult to understand, implement and accept. This view was expressed explicitly in the following manner.
Cost reduction is seen by CEHaul members as a sign of inferior product and it can take time to accept and understand [that this is not the case] (Project Leader).

Corporate culture is an important element in performance management that enables desirable behaviour. A weak corporate culture can thus be viewed as a cause of the low acceptance of VE. At CEHaul, a clash of cultures occurred when the company transitioned from being an engineering-driven to a cost-driven organization according to one of the project leaders. This shift is one of the main reasons why VE was a difficult part in implementing TC. The explicit customer and cost foci of VE were dropped into the pre-existing cultural friction created by the move to traditional cost reduction.

According to the project leader,

...it is hard to change ways of thinking overnight, from only constructing what is the “best solution” to designing the “best solution and at the same time the most cost effective” solution.

The absence of a supportive organization, structure and processes for TC may be explained by previous experience with temporary cost reduction activities according to the chairman. Furthermore, managers had difficulty incorporating TC into their existing culture and creating desirable behaviour. According to one of the project leaders,

To create acceptance for TC and avoid negative effects and unexpected results, knowledge about TC needs to increase all throughout CEHaul. It needs to be seen from a long-term perspective.

However, according to one of the project leaders, TC has contributed to better understanding among employees, and its activities have been incorporated as an integral part of the work of the product development process. If they fail to continue implementing deeper ideas in TC and if they revert to the previous way of working, they will likely encounter the same problem again.
Cross Functionality

Cross functionality is the basic principle in TC work at CEHaul and is considered one of the most important factors for successful implementation. The purchasing coordinator concluded that suppliers should have had an active role in concept development and that the complicated purchase process inhibited their opportunities for cost reduction. According to the project leader, CEHaul has only executed a full concept development via VE once, which means they did not have time to develop the cross-function process optimally. Thus, the scope for developing and inviting key actors is necessary if the company will repeat the process again. Doing so will provide new perspectives and possibly better proposals.

The cross-functional teams at CEHaul possess various skills and experiences to develop successful products. Furthermore, all respondents agree that knowledge is the most important asset and provides a competitive advantage. Hence, to develop the process,

…it is important for CEHaul to integrate, build and reconfigure internal and external capabilities. The lack of certain capabilities may have been the reason for the failure of the first initiative to implement TC (Chairman CEHaul).

Furthermore, the chairman emphasised that CEHaul did not use their resources to develop new procedures. An example of this situation is that project managers in the Category 2 project carried out most of the work during the first initiative because of the unclear division of responsibilities and accountability. Thus, employees in different departments did not know what to do and missed meetings, which increased conflicts among departments. According to one of the project leaders, this situation escalated during the second round when leaders in the projects were delegated the responsibility for delivery.

Projects in the cost reduction program at CEHaul possessed a cross-functional structure with a ground team, which means that they added people with the right skills when necessary and at different times in sub-projects. Project managers in Category 2 activities are decisive because TC provides useful information for decisions that improve the capacity and resource base of the organization.
Through the TC ‘workshop process’, problems were identified and problem solving methods were proposed to reduce cost and develop products. These activities ended, however, when the consultants left CEHaul. After the consultants left, no formal activities to identify problems continued. Instead, the task relied on the initiatives of individuals, as the Project Leader highlighted. The chairman stressed that

...problem identification was something that was expected of all employees. However the problem was getting them to take on sub-projects.

An activity that has been developed from this situation by members of CEHaul is the concept of ‘business development’, in which employees allot 5% of their working hours for improvement. While this practice contributed to minor improvements in each individual area, the initiative did not support the overall TC process according to one of the project leaders. CEHaul has a database that they call ‘White Book’, wherein ‘best practices’ and the conclusions of the projects are documented and disseminated.

In the second TC initiative, the employees at CEHaul developed new routines. The new routines were implemented to solve problems regarding concept development as well as product and process technology improvement. The TC process was adopted to reduce cost in the product development process by altering the flow of the tasks discussed earlier. For example, employees used VE at the concept and development phases for development and reduction of the cost of existing products.

**Value Engineering (VE)**

When TC was adopted in the product development process at CEHaul, VE was the first tool they began to use according to one of the project leaders. To reduce cost while maintaining quality and functions to increase the value of the product was the attraction of VE. The project leader pointed out that CEHaul used VE

...to analyse the features of products, processes and services and achieve them for the lowest possible total cost of ownership.
The value index was not utilised for the selection of components for cost reduction. Instead, they used the percentage of cost per component of the total cost. According to the project leader,

...the components that possessed the greatest cost percentage and at the same time showed high complexity and risk to change were selected first.

A list of components that should not be neglected was also available. The list contained components that needed cost reduction to improve the overall profitability of CEHaul. Clearly, this practice influenced the company’s creativity. Cost engineers used their previous experience to determine detailed cost information.

VE was utilised to develop ideas for cost reduction through creativity and brainstorming. At CEHaul, this practice was implemented during the ‘workshop’ that was arranged by consultants, during which several rounds of cross-functional team work led to the activities that could be reduced, eliminated, combined, replaced by a substitute, reclassified or improved. Another activity in which VE was used was testing and implementing promising ideas that required determination. This step was executed in CEHaul by compiling the ideas in Excel and ‘washing’ them through a validation process. In addition to the validation process, leaders attended meetings with technical specialists with extensive experience to ensure that the ideas were feasible. An important criterion for the selection of sub-projects was ‘pay-back time’ for the projects.

Given that VE has only been implemented once at CEHaul during the ‘workshop’, no formal standardized activities were conducted. Instead, Category 2 activities were repeated when the target cost was not achieved for components. An example of these activities was described by the product manager as the process where they analysed components to meet specification requirements. The extent to which this step was executed depended on which level the requirements were set. Category 2 activities consist of small projects that are ‘killed’ if the target cost cannot be achieved or quality is too low. This decision is also based on the budget, which is used to achieve ‘committed’ cost savings; thus, no room for experimentation was allocated. Priorities are given to new subprojects because the cost of
capital, according to all the respondents, is a very decisive factor in product development. Everything has a cost that must be covered. When a project does not meet the specifications in terms of function, quality or price of a ‘gate’ during the development phase, CEHaul decides if the company will outsource the component or ‘kill’ the project.

**Quality Function Deployment (QFD)**

None of the respondents at CEHaul mentioned QFD as one of their tools. The chairman believes that

> ...the QFD matrixes are much more difficult to manage in practice because they quickly become extensive and complicated.

However, he described ‘system engineering’ as a similar tool that they used as follows:

> ...it can be seen as an equivalent to QFD because it is a means to derive requirements for features.

Furthermore, the Chairman pointed out that

> ...it is important not to hang onto the technology early but to focus on the functionality and what the customer requires. Thus, there is flexibility to change the technology while the function remains.

However, the managers at CEHaul do not believe QFD is appropriate for their product and use their own corresponding tools.

**Process Development**

When a component is given a new design, it may require a different process to become sustainable. Therefore, part of the effort to achieve TC is about process development. According to the product manager,

> process development affects the workflow and efficiency of production and thus the cost.
Additionally, the product manager highlighted the importance of individuals as follows:

*the involvement of individuals with knowledge of the production stations of the cross-functional teams is required to perform constructive changes in the processes. To derive “design for manufacturing and assembly and design to cost” means to simplify the manufacturing or assembly of components or to eliminate them.*

CEHaul uses process development led by a group of cost engineers. The group possesses knowledge of manufacturing methods for developing a component or item to be as cheap as possible to meet its specification. The group utilises a comprehensive database with detailed information corresponding to cost tables. Furthermore, cost engineers gather information to analyse vendors’ manufacturing processes, which contributes to a better overview of the efficiency of the production of suppliers.

**CONCLUSION**

This study focused on developing an understanding how TC is utilised in the SG product development process at CEHaul. TC was added to the well-established traditional SG product development process as a cost reduction tool that is supplementary to the overall design process. The pre-existing process, although long established, was paradoxically not well defined and was subjected to a number of other cost reduction tool additions without much success. The overall process is a form of SG (Cooper & Kleinschmidt, 1987, 1988). Philosophically, the approach is a top–down method with a strong Taylorist distinction between thinking and doing, which is manifested in the linear and non-recursive sequencing of events.

Pressure for CEHaul’s price reductions efforts increased with market maturation, which created a need to control costs in the product refinement process. The company experienced moderate project-specific results with each attempt, but the introduced methods failed to become part of the fabric of the organization in the sense of becoming reliable and persistent dynamic capabilities. The introduction of TC was viewed by several participants as a critical step to maintain the profitability of the company in the face of
market changes. However, not all participants agreed with such a notion. These participants viewed TC as a dynamic capability or at least a process that would assist in developing dynamic capabilities. To several participants, TC was just another tool provided to them by the corporate management. These participants did not envision any persistent effect of TC activities in the sense of capabilities. Additionally, many of the participants associated cost reduction with inferior products and did not accept cost reduction as a design goal for CEHaul.

Table 2 shows the four TC activities and their usage at different phases of the product development process at CE. Rather than being used through the entire lifecycle, TC is only used at the earliest phases.

<table>
<thead>
<tr>
<th>Stage-gate phases</th>
<th>TC process at CEHaul</th>
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<tbody>
<tr>
<td></td>
<td>Identify need for cost reduction</td>
</tr>
<tr>
<td>Requirements</td>
<td>n/a</td>
</tr>
<tr>
<td>Concept</td>
<td>n/a</td>
</tr>
<tr>
<td>Detail development</td>
<td>n/a</td>
</tr>
<tr>
<td>Final development</td>
<td>n/a</td>
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<tr>
<td>Industrialization</td>
<td>n/a</td>
</tr>
</tbody>
</table>

At CEHaul, TC is not used in cost discussions with suppliers. CEHaul instead uses a traditional adversarial bidding process to obtain quotes from other suppliers that can offer a better price or solution to a prototype. This type of process does not develop dynamic capabilities because no knowledge generation, integration, or reconfiguration exists. Thus, suppliers do not receive benefits from collaboration. They take full responsibility for the cost requirements, and at the same time, they waste time and resources in the process. This situation appears to be the reverse of the TC general approach and is more consistent with traditional western approaches.
CEHaul attempts to use TC as if the approach were a free-standing dynamic capability within the SG process. However, given that VE is not used except sporadically, no formal means to identify and solve problems have been implemented. Instead, the task relies on spontaneous insights from individual members. Thus, improvements did not come from persistent dynamic capability but fortuitously. The use of VE is weak, and it is manifested only in the initial training ‘workshop’ and only to a very small degree in the rest of the work. Given that VE is the key tool in most versions of TC, this scenario is surprising. QFD is not used because of the lack of VE use. However, the customer-voice aspect of QFD can be identified in several existing tools. Overall, the lack of VE means that its role in development of dynamic capabilities is missing.

Interestingly, several interviewees appeared to resist using VE and felt that the approach was too intense. The degree of intellectual application demanded by VE is significant. This demand is caused by the recursive development of new perspectives on the problem. In many ways, the perception can be regarded as a precursor to a dynamic capability.

Overall, the dynamic capabilities within the product development department operate on a low level. In each of the three sub-categories of knowledge generation, integration, and reconfiguration, the capabilities were weakly developed in the SG setting. When TC attempts were initiated, several meetings were held to identify and solve problems. However, the methods (such as VE) were never institutionalized, which is to say that these methods did not become dynamic capabilities. Thus, the knowledge generation potential in the TC approach was not capitalized on. In a similar manner, knowledge integration among different departments and individuals was weak because the SG process was omitted. Knowledge reconfiguration was not deeply embedded in the GPD of the organization, and the need for combining knowledge or patterns, such as is frequent in TC, was not manifested. The employees of CEHaul showed limited interest in the knowledge reconfiguration process. This process includes the detection and handling of product issues to the extent needed and replacing old knowledge with new re-configuration (Compare: Tecce, Pisano & Shuen, 1997, Tecce, 2007; Prieto, Revilla & Rodriguez-Prado, 2009).
Widespread dissatisfaction exists among the organization members of CEHaul with regard to the organization’s ability to develop the dynamic capabilities required to consistently meet market needs, which is in line with Easterby-Smith and Prieto (2008). Although members are dissatisfied, they do not seem to have any ability to describe what dynamic capabilities they need or what they look like. The existing SG system does not allow dynamic capabilities to develop, and this limits the ability to adopt the dynamic capability-laden, iterative and multifunctional nature of the TC process and benefit from the potential of TC.

This study reveals that conflict exists between the SG method and TC, which is consistent with criticisms on SG raised by Sethi and Iqbal (2008). This conflict includes limitations on learning because of the truncation of sub-projects without iterations in TC. Additionally, we support Sethi and Iqbal’s finding that the extremely rigorous gate evaluation process reduces flexibility in the development system and presents a barrier for new initiatives, i.e. TC. We connect their observations with the concept of dynamic capabilities to make our analysis highly granular and to highlight the aspects of TC that are in conflict with SG-type design processes.

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