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Ambidexterity as basis for cumulative capability: Extending the “sand cone” model

Javier Tamayo Torres, jatamayo@ugr.es

(University of Granada)

Jens Roehrich

(University of Bath, School of Management)

Mike Lewis

(University of Bath, School of Management)

Abstract

Ambidexterity, combining exploration and exploitation, has long been considered as a strategic choice for managers as a possible response to environment uncertainty. This research aims to analyse the influence of ambidexterity in the performance improvements through the development of cumulative capabilities. We analyse 231 Spanish production firms, using SEM. This paper contributes to extant literature by addressing the importance of ambidexterity in overall performance, serving as a basis to the improvements of quality, speed, flexibility and finally cost, through the sequential progression defined by sand cone model.

Key words: Ambidexterity, Sand Cone, Performance

1. Introduction

Dynamic markets force companies to perform different tasks, to explore new possibilities, to improve processes and to exploit abilities workers and firm possess to adapt to changing customer needs (Lavie & Rosenkopf, 2006). Due to this necessity, research on exploration, exploitation and ambidexterity strategies can now be found in different areas of management research such as when considering organizational learning and the search for competitive advantage (Patel et al. 2011). Taking into consideration the Resource Based View (RBV) perspective (Barney, 2001), competitive advantage achievement depends on resources and capabilities that are available in the companies. Exploration, exploitation and mix of both strategies constitute a way to achieve and maintain competitive advantage achievement.

Extant literature focusing on ambidextrous organizations seeks to demonstrate whether March's (1991) suggestions about the impossibility of developing exploration and exploitation at the same time, due to the scarce resources of the companies, can be proven wrong. A number of empirical studies have demonstrated that ambidexterity can be realised by companies (Cao et al., 2009). Ambidexterity may help general managers and especially managers of production departments to maintain an advantage through refining existing routines and establishing new competencies absorbed around the department and/or wider environment (Birkinshaw and Gupta, 2013). When March (1991) presented the idea of exploration and exploitation, it was considered as two ends of a single continuum. Two decades later, it is considered to be an important objective for managers to simultaneously embrace both in order to enhance an organisation's

operational strategy (Patel et al., 2012). Companies capable of simultaneously pursuing exploitation and exploration are more likely to achieve superior performance than firms emphasizing one at the expense of the other (O'Reilly and Tushman, 2013).

Performance is usually considered the most important aim for managers. Extant literature has investigated the concept in different ways, but one perspective has been really important for manufacturing departments is the cumulative capabilities model or *sand cone* (Ferdows and De Meyer, 1990). The central thesis of this model is that manufacturing firms improve quality, followed by delivery, flexibility and cost, and these improvements help to achieve better performance. Ferdows and De Meyer's study (1990) illustrates how improvements in quality will benefit firstly the delivery part of the company, secondly to flexibility improvements and, finally, cost performance. The argument that manufacturing capabilities should be, and frequently are, developed along multiple dimensions simultaneously led to the idea of cumulative capabilities (Noble, 1995). In other words, the cumulative theory allows managers to develop a proactive approach to capability development (Amoako-Gyampah and Meredith, 2007), in contrast of trade-off theory which considers that companies cannot develop different capabilities simultaneously (Skinner, 1969).

However, extant literature still offers only limited empirical insights into the factors or antecedents that can benefit these improvements. This study addresses this gap, by offering one of the first empirical investigations into how managers can drive these improvements. While prior studies have investigated the different dimensions of the sand cone model and their link to performance, prior studies neglected to investigate which tasks of the company employees are beneficial to these improvements. Thus, this paper tries to answer the overall research question: Does ambidexterity drive manufacturing performance in manufacturing firms? In other words, this study offers an empirical count to investigate whether the development of cumulative capabilities is fostered by companies being able to explore and exploit at the same time. To answer this question, we collected data through a cross-sectional telephone questionnaire administered directly to general managers or the head of the production department of 231 manufacturing Spanish firms. To contrast the remaining hypotheses and analyse the relationships between variables, we have used Structural Equation Modelling (SEM).

This research contributes to extant literature by marking a way to drive improvements realised by the sand cone model. Companies who benefit from obtaining new knowledge of the wider environment, competitors or costumers, will get performance improvements through better quality, higher speed, more flexibility, and finally, cost reductions. Moreover, it addresses the trade-off discussion which argues that firms cannot achieve high levels of performance for multiple competitive priorities simultaneously because an improvement in one necessitates a decrease in another (Slack, 1991). Additionally, we provide empirical evidence of the existence of cumulative capabilities through quality, speed, flexibility and cost, as it was suggested by Ferdows and De Meyer (1990), as well as empirical evidence of the possibility of the company to develop both at the same time, considering ambidexterity behaviour, resolving the productivity dilemma that was presented by Adler et al. (2009).

The remainder of the paper is structured as follow: Following this introduction, we present the literature review about ambidexterity and cumulative capabilities. We also position our hypotheses and proposed model. In section 3, we describe the methodology and the analysis performed. Section 4 illustrates the results of the research, while section 5 presents the discussion of the results and main conclusions.

2. Theoretical foundation and literature review

2.1. Ambidexterity behaviours

Since the work of March (1991, p.91), literature about exploration and exploitation has evolved considerably. Exploration is defined as “search, variation, risk taking, experimentation, play, flexibility, discovery, innovation” and exploitation as “refinement, choice, production, efficiency, selection, implementation and execution”. While the debate was initially centred on whether the possibility exists to develop both options, recent studies are centred on issues of how to develop both efficiently in the company (Birkinshaw and Gupta, 2013). Levinthal and March (1993) considered that the long survival of the company with good performance in short- term depends on the ability to engage in enough exploitation to ensure the company’s current viability and to engage in enough exploration to ensure future viability. Moreover, as exploration and exploitation are two different ways of redefining tasks and processes (O’Reilly III and Tushman, 2008), they must be considered by the managers as some of the important factors of the global strategy.

Recently, studies have suggested two possible explanations, punctuated equilibrium and ambidexterity (Gupta et al., 2006). Punctuated equilibrium suggests separating periods of exploration, with other periods of exploitation, or vice versa (Adler et al., 2009). From another point of view, there are other studies who consider that companies can share both activities at the same time (Jansen et al., 2009), labelled ambidexterity. O’Reilly III and Tushman (2008) argued that under the appropriate conditions firms may be able to both explore new capabilities and exploit existing capabilities.

March (1991) considered that if a company tries to develop ambidexterity, wasting scarce resources of the company, may have a high risk of being mediocre at both of them. In contrast, later studies (e.g. Auh and Mengac, 2005) have contrasted that firms, in high tech environment, developing both strategies at the same time achieve better performance than companies which only develop one. Also, Raisch and Birkinshaw (2008, p.392) suggested that “organizational ambidexterity is a key driver of long-term firm performance”. Raisch and Birkinshaw (2008) concluded that firms involved in both exploration and exploitation, balanced or combined, are more likely to achieve superior performance compared with firms who emphasize one of the behaviour.

In the literature, there are papers which study ambidexterity as a mediator variable, related to intensity or market orientation, or related to environmental munificence or to sales growth rate. But if there is an aspect especially important of organizational ambidexterity is that it is a source for sustained competitive advantage (Gibson and Birkinshaw, 2004) and that there is a positive and significant relationship with performance (Junny et al., 2013). They suggested that companies who develop ambidexterity are more likely to achieve superior performance compared with firms emphasizing one dimension over the other.

2.2. Sand cone model

Manufacturing strategy theory focuses on the nature, formation, and combination of competitive capabilities (Skinner, 1969). Various models were established to illustrate how the companies can get these improvements. The trade-off model proposed by Slack (1991) suggests that firms cannot achieve high levels of performance for multiple competitive priorities simultaneously because an improvement in one necessitates a decrease in the others. On the other hand, and following the ideas of Nakane (1986), it has been demonstrated that firms are able to get improvements on multiple objectives because the improvements reinforce each other in a cumulative way (Noble, 1995). Also, some authors consider that these improvements usually happen in a pre-specified sequence (Schroeder et al., 2011).

Since Nakane's (1986) proposition of sequential cumulative capabilities, other studies have emerged. Firstly, the sequence was considered as quality, delivery, cost and flexibility; even we can find it with product innovation at the top (Noble, 1995); or with cost instead of flexibility on the top of the sand cone, as the last consequence of improvements (Ferdows and De Meyer, 1990).

As Abella et al. (2011) illustrate, the initial emphasis should be placed on obtaining quality and, once a suitable quality level has been attained, then work should begin on improving delivery but at the same time, work should continue on quality. When a suitable standard has been reached for delivery, work should begin on flexibility, while continuing with the two objectives already reached. Finally, having reached the desired level of flexibility, the focus should turn to cost efficiency. The Rosenzweig and Easton's (2010) meta-analysis of competitive capability progression illustrates the variety of contexts in which the concept has been studied, and revealed an overall preference for the sand cone model over the trade-off model. The trade-off model has been phased out, because considerations of different papers have contrasted the cumulative capabilities models which explain the simultaneous development of different dimensions (Schroeder et al., 2011). Moreover, as Liu et al. (2011) concluded, the cumulative model will improve manufacturing business performance through a "balanced" strategy. This balanced strategy is better if the capabilities are pursued in a certain sequence, because the sequence represents the foundation upon which other cumulative capabilities are built, and as Narasimhan and Schoenherr (2013) suggest, alternative configurations of the dimensions can be considered, but capability progression about sand cone model is a fact that managers must realize.

2.3. Theoretical model and hypotheses development

Continuing the idea of Cao et al. (2009) about the study of ambidexterity importance to realize performance, we position our theoretical model.

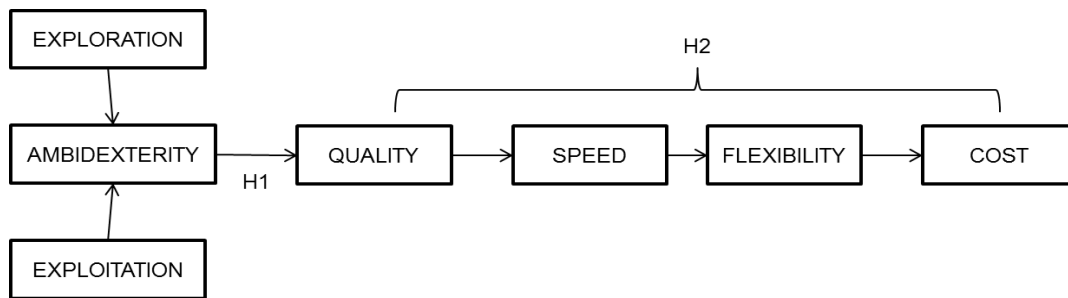


Figure 1: Theoretical model

Organizational ambidexterity can enhance the overall performance (Chandrasekaran et al, 2012) to a higher and more sustainable financial performance (Simsek, 2009), as the company shows efficiency in managing current business demands, while at the same time trying to adapt the company to the environment (Birkinshaw and Gibson, 2004). So, the main objective for managers is how to develop ambidexterity. O'Reilly III and Tushman (2013) considered that when a firm's magnitude of exploitation well exceeds that of its exploration, the firm is likely to be subject to the risk of obsolescence. The synergistic fusion of exploration and exploitation within units unleashes the unused potential of both, such that the achievement of ambidexterity at units increases subsequent performance (Cao *et al.*, 2009). Organizational units that regularly change and implement adaptations to existing products while also developing new products will

benefit from both the penetration of existing markets (and higher market share) and the creation of new revenue sources (resulting in market leadership) (Jansen et al., 2012).

Ambidexterity goal is to benefit the company through new knowledge or improvements of the process that the company already develop to get better process, activities or performance; as Birkinshaw and Gupta (2013) consider it is almost tautological to justify that ambidexterity is correlated to performance, because if exploration is focused on performance and exploitation is focused in performance as well, of course that ambidexterity, the ability of the firm to develop exploration and exploitation at the same time, will be focused in performance.

On the other hand, sand cone goals explains how firms can make improvements to their manufacturing performance by building manufacturing capabilities cumulatively that follow a pre-specified sequence. On this way, both ambidexterity and sand cone try to get improvements to the performance of the company, one trying to improve the tasks of the company and the other as a sequence that, since the quality improvements to the cost efficiency are getting the firm to take an advantage against their competitors.

Looking for the antecedents of sand cone, Liu et al. (2011) argue that absorptive capacity explains how firms integrate their organizational learning, operations, and technology into the process of exploring and exploiting new knowledge, suggesting the first important relation between ambidexterity and cumulative capabilities. This is suggested because exploration and exploitation “serves as the impetus for combinative capabilities development and the progression, in term of its competitive capabilities, through the cumulative model” (Liu et al., 2011, p.1255).

O’Reilly and Tushman (2013) consider that ambidexterity is developed to be able to compete in markets where efficiency, control and improvements are prized and where flexibility, autonomy and experimentation are needed, considering some of the dimensions of manufacturing strategy such as improvements, flexibility or quality. In addition, they conclude that in uncertain environments, “ambidexterity is positively associated with increased firm innovation, better financial performance, and higher survival rates” (O’Reilly III and Tushman, 2013, p.326). Moreover, ambidexterity has a strategic orientation; it is considered that the long survival of the company depends on the ability to engage in enough exploitation to ensure the organization’s current viability and to engage in enough exploration to ensure future viability (Levinthal and March, 1993), this mix orientation of the firm, benefit the cumulative capabilities model as Liu et al. (2011) concluded, in contrast that trade-off model.

Even if it is known that costs associated to ambidexterity is high for some companies (Gibson and Birkinshaw, 2004), we can consider that an extensive level of ambidexterity in the companies can benefit performance. While there is a significant body of empirical research on the content of manufacturing strategy (Roth et al., 2008), “there is a dearth of literature that identifies antecedents of firms’ combinative competitive capabilities” (Liu et al., 2011, p.1257), and that is why we suggest:

Hypothesis 1: Organizational ambidexterity will benefit performance improvements through cumulative capabilities.

Hypothesis 2: Manufacturing performance is improved through a sequential progression of quality, speed, flexibility and, finally, cost.

3. Research methodology

3.1. Target population and questionnaire procedure

The data used in this study was derived from a cross-sectional study that attempts to analyse the organizational strategic behaviours, and its relation to perceived

performance of companies operating in the Spanish manufacturing sector. To measure each variable, we asked the company CEOs or manager of manufacturing department to indicate their degree of agreement or disagreement with the items proposed on a Likert-type 1- to 7-point scale (1=totally disagree; 7=totally agree). The data were collected through a telephone questionnaire administered by a private company that is specialized in telephone questionnaire to perform the study. The sample was taken from the SABI database. Logically, the study was focused on firms belonging to manufacturing sector, as variables observed match this sector. Sand cone model try to explain how different dimensions of manufacturing strategy are developed, thus all the companies of the sample must belong to manufacturing sector. From the initial sample of 1854 companies, we obtained¹ 231 valid questionnaires, a global response rate of 12.49%.

Then, we examined possible sample bias. We compared the mean value of the size variables between all of the firms and of those included in the sample and obtained similar values in both cases. The results show that firms that did not respond to the questionnaire do not introduce significant bias into the final results of the study and that there is no reason not to extrapolate from the results to the total population. Besides, sampling error was calculated (6.03%). This error is caused by observing a sample instead of the whole population and its maximum level in social science studies is 10%

3.2. Sample demographics

All of the responses used in the research come from Spain, although the firms may operate in either national or international territory. All respondents held the position of general manager or head of the production department. All of the companies belong to the manufacturing sector, although they have different production configurations. The sample is distributed between the different production systems as follows: job shop (3.24%), batch flow (26.38%), line flow (16.20%), continuous flow (13.88%), Just-In-Time (0.09%), Flexible Manufacturing System (32.87%), and others (6.48%). Of the total of 231 companies, around 12% reported sales over 40 million Euros, about 77 % reported annual sales between 7 and 40 million Euros, 7.40% had annual sales between 1 and 7 million Euros, and less than 4% had annual sales less than 1 million Euros. Finally, if we consider the number of employees, firms were divided as follow: 13.89% had 50 or fewer employees, 43.05% from 51 to 250 employees, 32.87% from 251 to 1000, and 10.18% over 1000 workers.

3.3. Measures

Our model has two kinds of variables, 6 of them have been considered as reflective variables (Table 1). Last one is a second-level variable called ambidexterity, a variable considered as the ability to explore and exploit at the same time. This kind of construct is usually used in Operations Management literature as Barrales-Molina et al. (2013). All the scales were accompanied by a 7-point Likert-type scale (0=totally disagree; 7=totally agree).

Table 1. Scales

Variable	Number of items	Source
Exploration	5	Mom et al., 2007
Exploitation	4	Mom et al., 2007
Quality performance	3	Raymond and St-Pierre, 2005
Flexibility performance	3	Raymond and St-Pierre, 2005
Speed performance	3	Larso, 2004
Cost performance	3	Raymond and St-Pierre, 2005

¹ Of the 1854 companies phoned by the company, 231 were valid, 531 told that they have to phone again in other moment, 420 were wrong numbers, 13 leave the questionnaire not finished and 165 were difficult to localize.

We have used exploration and exploitation activities to build a second-level variable. This kind of construct is usually used in Operations Management literature as Barrales-Molina et al. (2013). Both factors correlated significantly ($p < 0.01$) with this second-order factor, with standardized loads that ranged between 0.63 and 0.77. Both factors were therefore considered indicators of a single factor called “ambidexterity”.

3.4. Tests for reliability and validity

This section analyses the reliability, unidimensionality, convergent validity, and discriminant validity of the scales used in the study. First, to determine the scales’ reliability, we calculate the Cronbach α , all of them are higher than the recommended value of 0.7 (Nunnally, 1978) (see Table 2). Besides, to test convergent validity, we calculate the average variance extracted (AVE) values. All the scales showed values higher than minimum recommended (Gupta and Kim, 2008). Second, to ensure the scales’ unidimensionality, we performed an exploratory factor analysis, which showed that the items in each scale explained a single factor. To perform both of these tests, we used the statistical programme SPSS 15.0.

Table 2. Descriptive statistics and reliability analysis

Variable	Cronbach’s α	Mean	SD	Correlations						
Exploration	0.878	4,8586	1,20421	1						
Exploitation	0,798	5,2857	1,07045	,374**	1					
Quality improvements	0.769	5,5527	1,01248	,215**	,225**	1				
Speed improvements	0.827	4,4894	1,36746	,251**	,181**	,131*	1			
Flexibility improvements	0.769	4,9424	1,21046	,202**	,249**	,340**	,229**	1		
Cost improvements	0.755	4,8252	1,22022	,193**	,147*	,359**	,132*	,550**	,1	

*Correlation is significant at the 0.05 level (two tailed)

Next, all scales were subjected to a confirmatory factor analysis (CFA) using the computer programme EQS 6.2, which demonstrated the scales’ convergent validity. All of the scales show results higher than the established minimums. According to Hulland (1999), three conditions must be fulfilled for convergent validity to exist. First, the factor loadings must be significant ($t > 1.96$; $p < 0.05$). Second, they must be greater than 0.4. Finally, individual reliability (R^2) must be greater than 0.5. Figure 2 show all of the values for the factor loadings, their significance, and their reliability.

Finally, to complete validation, we analysed discriminant validity, following Howell (1987). We compared the correlation value observed in the CFA to the correlation value calculated for the case of perfect correlation. The correlation value calculated should be greater than the value observed. In all cases, the results show that the value calculated was greater than that observed, ensuring discriminant validity.

4. Results

To contrast the remaining hypotheses and analyse the relationships between the variables, we used Structural Equation Modelling (SEM), employing EQS 6.2. The fit indices used to estimate the measurement models are presented in Table 3.

Table 3. Goodness of fit statistics of the structural model

Types of fit	Measures	Levels of	Summary for
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		acceptance	Robust Model
Absolute	χ^2 (sig.)	Significance level	455.592 (p=0.00)
	Degrees of freedom		176
	Root Mean Square Error of Approximation (RMSEA)	<0.08 ^a	0.061
Incremental	Comparative Fit Index (CFI)	>0.9 ^b	0.91
	Non-Normed Fit Index (NNFI)	>0.9	0.90
	Bollen's (IFI)	>0.9	0.91
Parsimony	Normed Chi-square χ^2 / df	<3.0 ^a	2.588

^aHair et al., (2004) and Byrne (1998).

^bByrne (1998).

Figure 1 describes the SEM results of the influence of ambidexterity as basis for cumulative capabilities. Each path in the figure indicates the associated hypothesis, as well as the estimated path coefficients and t-values (t-values for path coefficients greater than 1.64 are significant at $p < 0.1$; t-values for path coefficients greater than 1.96 are significant at $p < 0.05$; t-values for path coefficients greater than 2.58 are significant at $p < 0.01$).

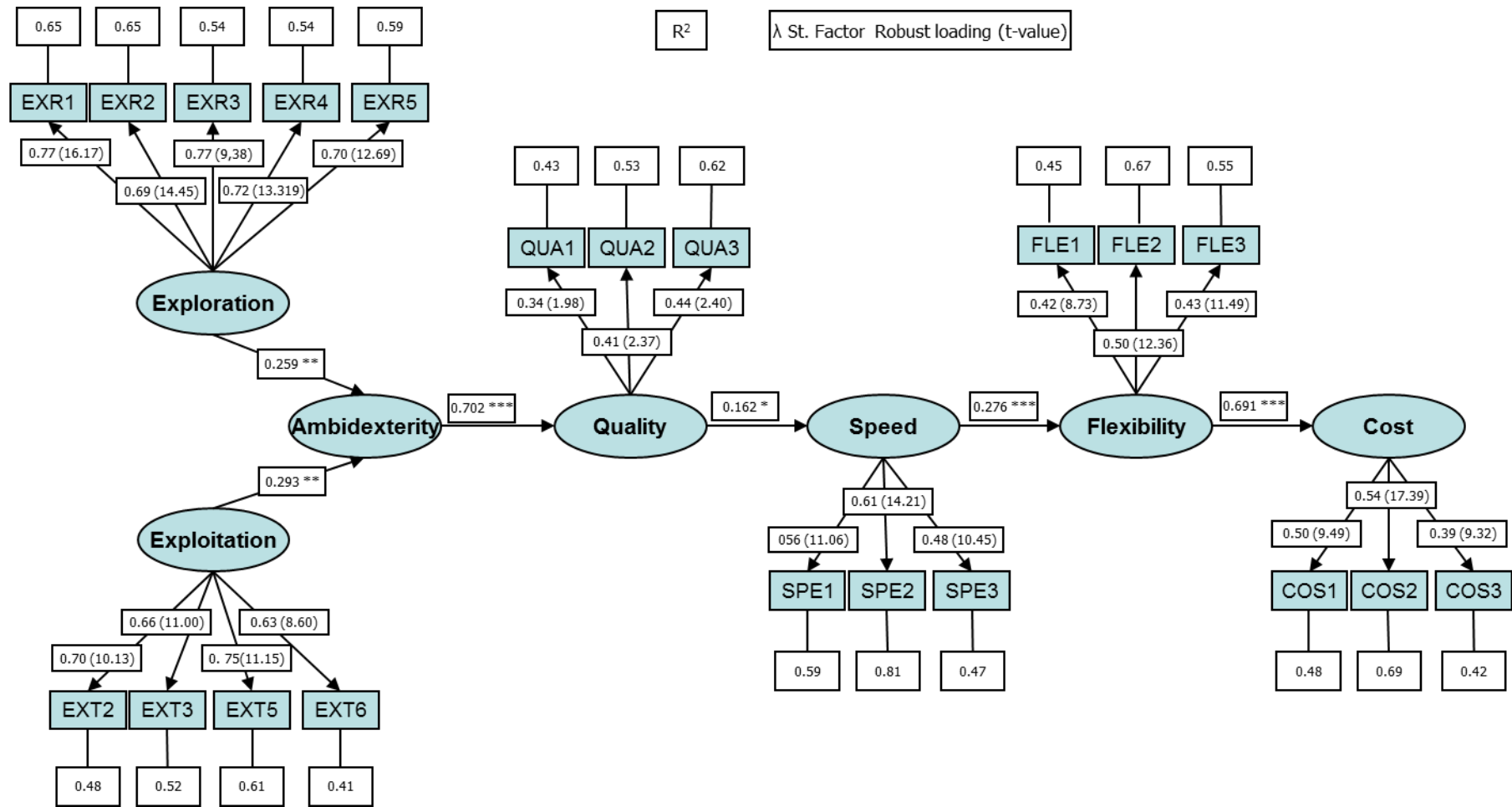
We need to comment that the overall fit of the structural model showed on table 3 was good and it fits on absolute fit (χ^2 , degrees of freedom and RMSEA), incremental fit (CFI, NNFI and IFI) and parsimony fit, as Hair et al. (2004) suggest. This let us to confirm our main hypothesis of the study. Moreover, significant results of the influence of ambidexterity into the other variables are show with a t-value significant at $p < 0.01$.

5. Discussion and conclusions

The main goal of this research is to show whether organizational ambidexterity of the firm, the ability of the companies to exploit their abilities and to explore new knowledge at the same time, forms the basis for cumulative capabilities through the sand cone model. With our analysis, we can conclude that this relation is positive and statistically significant. Companies trying to improve the characteristics of their own workers and foster at the same time the research exploring the wider environment will enjoy performance improvements as illustrated by the sand cone model.

When Ferdows and De Meyer (1990) concluded that the development of one manufacturing capability need not be necessarily at expense of another, they suggested that the traditional managerial approach for improving manufacturing performance should be changed. We are suggesting a bigger change to this approach. With our empirical analysis, we can confirm our main hypothesis, which affirms that ambidexterity is an antecedent to the sand cone model. Literature has already mentioned the importance of ambidexterity as a strategic behaviour of the company, presenting different benefits as facilities to a better adaptation (Jansen et al., 2005) or performance (Chandrasekaran et al, 2012). However, we are concluding that ambidexterity can benefit performance in two different ways. First showing how to improve to your workers and the tasks of the company, with the possibility of mix exploration and exploitation, and secondly, helping to develop manufacturing capabilities that will mean improvements in manufacturing performance as a whole.

Fig. 2: Structural modelling of the influence of ambidexterity to sand cone model.



As well, authors suggest that every capability requires continuous attention, and we are considering that the best way to do it is learning around everywhere through the development of ambidexterity, not only through the improvements of the own workers, neither only researching out of the company; we consider that is your are trying to be the best, and as benchmarking process, you must get the best ideas of the environment to adapt them to your company, and that is where ambidexterity is a key.

We also support extant studies which consider that the trade-off model proposed by Skinner (1969) is not logical in complex and industrialized companies. We find empirical results which let us conclude that the sequential approach of the sand cone model (Ferdows and De Meyer, 1990) can benefit the cost improvement performance, focusing firstly on quality improvements then on speed of manufacturing departments and lastly on flexibility improvements.

The practical contributions of this study are manifold. First, we empirically ground the idea that ambidexterity is one of the ways that managers should improve companies' performance based on cumulative capabilities. Companies can realise higher manufacturing performance across four distinct, yet inter-related, dimensions - quality, speed, flexibility and cost. Second, ambidexterity improves all four dimensions separately, but the highest performance improvements are achieved when improvements are realized across all four dimensions simultaneously. Third, we add to the limited extant literature providing empirical support to those researchers who consider the sand cone model as a strategic tool for managers.

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