Formal Strategy Formulation and New Technology Anticipation: The Role of Internal Communication

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Abstract
This study analyzes the antecedents of ANT, emphasizing the role of strategy formulation (SF) as an enabler to identify new technological demands significant for production process in the future as well as its adoption. Additionally, it highlights the importance of communication to convey strategy and anticipate technological needs, since it facilitates the exchange of knowledge and the transmission of goals and strategy. Ordinary least squares multiple regressions were performed using data from the international High-Performance Manufacturing project, including European plants in the three sectors. The findings show that SF positively influences ANT, and intra-functional and shop-floor communication moderate this relationship.

Keywords: Internal communication, technologies anticipation, strategic process.

Introduction
To remain competitive, manufacturers must continually improve and introduce new techniques, methods and tools in order to improve internal process (Tao et al., 2017). Especially important are the investments that organizations dedicate to the introduction of new technologies, both in own development or in external acquisition, because theoretically they are crucial for achieving reduced costs, improved flexibility, faster customer deliveries and improved quality (Beheregarai et al., 2014). However, the association between technology investment and manufacturing performance have been confirmed partially (Bello-Pintado et al., 2018).

One of the reasons behind this fact is that the association between technology adoption and competitive manufacturing performance hinges on organizational ability to transform it on a valuable, unique, rare and inimitable resource (Bello-Pintado et al., 2018). This link should be understood in the period of an organization´s SP process (Grant, 1999); technology and associated capabilities must be durable, not easily transferred or replicated in the long run. In this sense, it is important to distinguish between two times related to technology adoption. Once the technology has been introduced, it is readily imitable by competitors. The competitive advantage is easily eroded and, therefore to be competitive organizations need to implement and develop unique capabilities linked to technology (Khanchanapong et al., 2014). The full potential of new technologies to improve flexibility and quality and reduce cost depends on the presence of skills. If not, technology can be easily imitable and substitute. With this regard, recently it has been demonstrated that skills and capabilities related to technology implementation are determinant to improve manufacturing performance (Pisano, 2017) and the competitive position of manufacturing organizations (Wu and Chiu, 2015).

On the other hand, previous time to technology acquisition or implementation. During this time, an organization have to identify and anticipate the new technological demands important for production process in the future, select between different options and implement them, in advance of actual need (Hayes and Wheelwright, 1984). According to Hayes and Pisano (1996) the anticipation of new technologies is determinant for improving the efficiency in the use of resources, and for the competitive position of manufacturing organizations (Das and Narasimhan, 2002). However, this process depends on the ability of an organization to anticipate new internal (process improvement, efficiency) and external needs (customer demands) in order to be the first to develop or acquire the technology. It requires having the resources and foresight to acquire new technologies in advance to customers' needs and the development of specific capabilities for its successful implementation (Beheregarai et al., 2014).

In this paper, we analyze how the strategy planning process may affect the capacity of organizations to anticipate new technologies. In particular, our work hypothesis is that manufacturing strategy formulation (SF) may help organizations to identify the potential need of new technologies in the future through a formal strategic planning (SP). SF is a planning mechanism to provide support for strategic business objectives, guiding the decision-making process and providing the basis for trading off and selecting options (Alcaide-Muñoz et al., 2018). Organizations implicated in formal SP, develop capabilities of planning which has been associated with competitive performance (Grant, 2003). In this line, Beheregarai et al., (2014) stated that the identification of structures facilitating knowledge assimilation, transformation and exploitation is required to develop the capabilities for anticipation of new technologies. However, the impact of SF on anticipation of new technologies is an open question. On the one hand, SF positively affects competitive performance by providing a roadmap for effective strategy implementation, allocating resources to pursue the strategy (Yam et al., 2011). On the other, formalization of strategy could also be detrimental for organizational performance, in particular, over organizational innovation and creativity. Formalized SP makes the strategy process and decision-making inflexible, inhibiting the adaptation to changes and innovation such as the development of new products (Song et al., 2011).

In addition, SF is highly dependent on the capacity to coordinate and integrate the information from several sources in order to update and respond to both internal and external changing forces. In this sense, it has been stated that communication, understood as the process by which organizational members generate and share information in order to reach a common understanding, can affect the strategy process (Alcaide-Muñoz et al., 2018). Thus, we analyze and check for potential moderation effect of communication on the link between SF and new technology anticipation (ANT).

The paper contributes to the current literature in several ways. Firstly, we analyze the antecedents of ANT, indentifying factors that foster it, such as SF, since it is a source of internal and external knowledge. It may help to develop this capacity with organization. In addition, we emphasize the moderating role of communication between SF and ANT, as it is associated with the development of dynamic capabilities, facilitating the exchange of knowledge and the transmission of ideas, goals and strategy.

This paper is organized as follows. Next section elaborates a theoretical argumentation on the relationship between SF and ANT based on resource based view theory (RBVT) taking into consideration related frameworks such as organizational routines theory and dynamic capability approach. In addition, absorptive capacity approach (ACAP) and most relevant related empirical evidences, are considered to propose three research hypothesis. The third section, describe the data source, the statistical treatment and the econometric model used to test hypothesis. Finally, it closes with the discussion, conclusions, and future research.

Theoretical Framework

SP is crucial in manufacturing. It involve several stages, including the assessment of both internal and external factors, the identification of own strengths and weakness as well as the potential opportunities and threats, according with the industry and competitors (Dombrowski et al., 2016). It provides organizations with sense of direction and outlines measurable goals, looking for efficiency, prioritizing investment, optimizing the resources allocation, guiding the decision-making process and providing the basis for trading off and selecting options, especially when SP is formalized (Bryson, 2011). It also ensures the link between manufacturing strategy and operations, determinant to mitigate risks related with technologies, given that one of main failures in their implementation is the misalignment between the selected technology and the business strategies of the organization (Iakymenko et al., 2016). Thus, SP may help manufacturers to effectively integrate and reinforce resources, especially technological resources to improve process and respond adequately to customer and suppliers demands.

According with the RBV theory (Barney, 1991) organizations can achieve a competitive advantage derived from the presence of a unique combination of valuable, rare, inimitable and non-substitutable resources. This resources can be divided in physical, human and organizational (Grant, 1999). What we are analyzing in this article in some way involves these three types of resources. On the one hand, the technology and knowledge associated with its implementation and use are physical and human resources (intangible knowledge). On the other hand, organizational resources capture the ability of the organization to identify needs in advance and how to anticipate new technology demands. Organizational resources are more related to the strategic process and the company's capabilities to incorporate the information through strategic analysis and respond appropriately.

The internal and external analysis formalized in the strategic plan allows us to compare their technological resources and associated capabilities with their competitors in order to anticipate the needs for successfully compete. Thus, during this process organizations learn and fosters their knowledge about new technologies, customers' and suppliers´ needs and organization's stakeholders' requirements, not only at present but also in the future (Beheregarai et al., 2014). It contributes to make technology a valuable resource not only for the company but also for customers and suppliers since it respond to internal and external needs. In addition, anticipation make technology rare resource because it doesn´t exist at competitors. However, once a technology is implemented it is easy to imitate by competitors who can acquire or develop it in the short run (Beheregarai et al. 2014). In this sense, the RBV consider knowledge associated with technology as a competitive resource (Grant, 1999). Knowledge should be considered in terms of transferability, since tacit knowledge linked to technology is difficult and costly to transfer and to imitate (Nonaka, 1994). Zhang et al. 2015 stated that the inimitability that RBV theory predicts to achieve a sustainable competitive advantage can be achieved by the combination of new technologies and organizational elements. This idea of complementarity refers to the nature of the resources required to capture the benefits associated with a particular strategy or technology.

The organizational routines theory (Nelson & Winter, 1982) reinforces the view of the existence of organizational capabilities linked to SP in dynamic context. Organizational routines involve complex patterns of coordination among people and between people and other resources (Grant, 1999). In this sense, the development of superior capabilities around SP process involves a number of organizations routines that coordinates individuals of organizational functions to identify opportunities and treats and the resources to respond to these. Thus, theoretically the formulation of manufacturing strategy may help organizations to anticipate new technology's needs as a respond to the changing environment as well as to face internal deficiencies (Kohtamäki et al., 2012). Formalizing their SP, organizations are able to improve the coherence between operational decisions of different functional areas and the efficient allocation of resources between them (Acur et al., 2003).

However, it is important to remark that an efficient deliberate strategy might be described as top-down, rigid and mechanistic process that may strangles the ability of manufacturing organizations to innovate (Song et al., 2011). The existence of routines improves efficiency associated with skills carried out automatically by individuals within organization; there may be a trade-off with flexibility to respond rapidly and in coordination to contingencies and changes.

On the other hand, the dynamic capability approach proposed by Teece et al. (1997 p. 516) considers "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments". The capabilities of organizations include organizational skills, functional competencies and learning paths that allow organizations to rapidly adapt to dynamic environments anticipating needs and developing new technologies in advance. Therefore, this approach is related to building unique organizational resources in connection with the SP process that analyze internal and external factors to identify new opportunities and needs. Formal SP has been associated with planning capabilities and organizational performance (Grant, 2003). The range of internal capabilities leading to a resource-based strategy in manufacturing, linked to technology use, includes physical assets as well as intangible resources (Brown & Bessant, 2003). So, we hypothesize:

H_1: Formal SP positively affects ANT.

Formal SP and ANT: The moderating role of communication.

Communication can be defined as the process by which organizational members generates and shares information in order to reach a common understanding (Keyton, 2005). Communication is really important in a manufacturing environment where multiple shifts are employed. Collaboration and interaction among individuals, groups and organizations are fundamental not only for knowledge creation and exchange, but also for its assimilation, transformation and exploitation (Nonaka, 1994). Additionally, when communication does not occur, production and quality must suffer and resentment among workers may occur (Hancock & Zayko, 1998).

In the last years, special focus has been paid to the linkage between communication and innovation, particularly, the development of new product (NPD), as the core product of NPD is knowledge, and it cannot be created without interaction between organizational members or experts (Leenders & Dolfsma, 2016). Likewise, we propose that communication is the vehicle of ANT.

From a strategic standpoint, communication takes on even great relevance. In fact, Ocasio et al. (2018) emphasize the importance of communication for SP, since it allows for organizational members to jointly attend to and co-orient themselves with changes in strategic issues, initiatives and activities throughout the organization, resulting in improved strategy practices to manage strategic changes and renewal processes. Tracey et al. (1999) find out that organizations with high level of manufacturing manager´s participation in SF and technology adoption have high levels of competitive capabilities and improved performance.

Moreover, Jansen et al. (2005) set out that formalization helps in the codification of new knowledge, but “connectedness” related to internal communication is determinant in disseminating such new knowledge within organizations.

From a different perspective, researchers on innovation and technological capabilities, find that SP can restrict creativity flexibility that leads to innovation (Song et al., 2011). Slotegraaf and Dickson (2004) set out that the SP produces rigidities and routines are structural impediments to updating knowledge of market trends and knowledge that fuels new ideas.

According to Bates et al. (2001) manufacturing strategy must be communicated to the plant personnel for it to be used as a guide in decision-making in order to select the more appropriate technology for future needs and for technology implementation. In this line, Montgomery (2008) highlights the need of a fluid and open processes of planning to ensure that organization respond adequately to internal and external changes. Thus, SF only makes sense if it is continually reviewed and updated. In this line, researchers that indentify SP as a determinant for technological capabilities within manufacturing organizations, also highlight internal communication as one of them (Yam et al., 2011).

In our study, we analyze the moderating role of two type of communication: inter-functional communication (IFC) and shop-floor communication (SFC). Ruekert and Walker (1987) proposed that an important aspect of inter-functional interaction is communication among employees in different functional areas, given that organizations internally create specialized functional units, which have unique capabilities, resources and skills in order to accomplish their own functional tasks and consequently to achieve organizational goals (Ghalayini, 2016). The lack of communication among these units generates great inter-functional conflicts, resulting in negative consequences over cross-functional interaction and the organizational performance (Ashraf et al., 2015). Therefore, IFC is really needed to achieve desired organizational goals, reduce agency costs and achieve inter-functional integration.

With regard to SFC, little attention has been paid to the effects of the communication flow among plants supervisors and operators. Despite of the fact that they are familiar with the misalignment between existing products, services and technologies, hence they hold greater information about operations problems (Wei et al., 2011) which may contributes to the effective implementation of new practices and process as well as the development of new technologies.

SFC refers to communication practices which take places on the shop-floor level aimed to facilitate the achievement of implementation of new practices and process (Alcaide-Muñoz, 2018). They help to identify problems and concentrate managers' attention on problems really needing their attention (Forza & Salvador, 2000) and to encourage knowledge transfer, which stimulates learning and the continuous improvement of individuals resulting in increasing performance over the course of time (Letmathe et al., 2012).

The view of plant supervisors is really crucial not only for the development of manufacturing strategy, but also the anticipation of new technology, as they are the first to know and examine problems in the plant, through their interaction with shop-floor operators (Alcaide-Muñoz et al., 2018). On the one hand, they convey SP and goals from plant management to shop-floor operators and, on the other, information flow generated at the lower level helps to update SP and enrich SF, identifying implementation barriers, weakness and strengths. As a result, organizations achieve a better adaptation of strategy to internal and external changes, improving their products, services, processes, practices and technologies.

In brief, communication is important to recognize the potential of a new technology. It allows for organizational members to combine their existing and newly acquired knowledge, leading to the assimilation, transformation and exploitation of knowledge. In addition, communication is considered relevant not only to control and evolve over time in order to respond to changes, but also to identify implementation barriers, resources, weakness and opportunities. At the same time, effective communication reduces agency costs creating a common strategic understanding and organizational culture in such a way that organizational members pursue the same strategic goals. So, we hypothesize:

H_2: IFC positively moderates the relationship between manufacturing SF and ANT.
H_3: SFC positively moderates the relationship between manufacturing SF and ANT.

Empirical Strategy

Data collection, sample, measures and method

The database comes from 151 plants from eight European countries participating in the fourth round of the international HPM project, operating in automative, machinery and electronics industries; however, only 96 plants comprise our sample. The items are based on one-to-five Likert scales ranging from 1 "strongly disagree" to 5 "strongly agree".

The scales related to the topic under study suggest that they should be treated as reflective indicators (MacKenzie, 2005), so explanatory factor analysis and confirmatory factor analysis were performed to prove the constructs' reliability and to verify the validity and unidimensionality of the measures for latent constructs (Cronbach's > or nearby 0.6) (Nunnally, 1978) (see table I).

To verify discriminant validity, the root square of the average variance extracted (AVE) shared between the constructs and its measures and the correlation with the rest of constructs are compared (the root square of AVE for each construct is larger than the correlation with the other constructs). In addition, the measurement model for each construct has a good global, parsimonious and incremental fit.

SF is based on the Skinner scales (1978). The interviewers were Plant Management and a principal components analysis (PCA) revealed one dimension that represents

75.04% of the variance of this variable. ANT was measure perceptually, using items provided by HPM projects. The questionnaire includes four items related to Hayes and Wheelwrigth's (1984) definition and described above. The process engineers were interviewed and one dimension was detected, explaining 60.17% of the variance of this variable.

IFC was measured perceptually, trying to capture Ruekert and Walker's (1987) definition. The interviewers were Plant Supervisor and, one dimension was revealed, representing 45.49% of the variance of this variable. Likewise, SFC was measured; interviewing both Plant management and Plant supervisors, and one dimension was identified, representing 46.11% of the variance of this variable.

Finally, three control variables (size, industry and country) were included. The size of the plant was measured by the logarithm of the number of workers and, the industry variables in combination with country are represented by dummy variables.

Table I

Validity and reliability of factors	**Eigenv.**	**α Cronbach**
Strategy formalization	**2.251**	**0.830**
Our plant has a formal manufacturing strategy process, which results in a written mission, goals and strategies.	0.885	
This plant has a manufacturing strategy, which is put into writing.	0.901	
Plant management routinely reviews and updates a long-range manufacturing strategy.	0.809	
Anticipation of new technology	**2.407**	**0.775**
We pursue long-range programs, in order to acquire manufacturing capabilities in advance of our needs.	0.791	
We make an effort to anticipate the potential of new manufacturing practices and technologies.	0.767	
Our plant stays on the leading edge of new technology in our industry.	0.733	
We are constantly thinking of the next generation of manufacturing technology.	0.809	
Intra-functional communication	**1.819**	**0.594**
Departments in the plant communicate frequently with each other.	0.642	
Management works well together on all important decisions.	0.677	
Cooperative relationships with our internal partners lead to better performance than adversarial relationships.	0.699	
We believe that the need for cooperative relationships extends to both employees and external partners.	0.679	
Shop-floor communication	**1.844**	**0.580**
In the past three years, many problems have been solved through small group sessions.	0.743	
Our supervisors encourage the people who work for them to work as a team.	0.531	
We are encouraged to make suggestions for improving performance at this plant.	0.776	
Managers in this plant believe in using a lot of face-to-face contact with shop floor employees.	0.639	

Ordinary least squares multiple regression (OLSMR) models were used to test the hypotheses. We first estimated a model with ANT as the dependent variable, and then, one model with moderating variables was developed. After that, we tested the moderating roles of both IFC and SFC by two interaction models.

Findings

Table II provides an overview of the relationship between SF and communication as moderator to explain ANT. Model 1 shows the development of formal SP as a determinant to anticipate new technologies within manufacturing organizations. Model 2 integrates the main effects of moderating variables related with both IFC and SFC, which seem not to have significant impact on success in ANT.

Table II

MOLS regression models: Dependent Variable: Anticipation of new technology.

	Model 1	Model 2	Model 3	Model 4	Model 5
SF	**0.271*** (0.068)**	**0.268*** (0.070)**	**0.252*** (0.007)**	**0.232** (0.041)**	**0.232** (0.069)**
Moderating variables					
IFC		-0.033 (0.077)	0.003 (0.075)	-0.048 (0.077)	-0.020 (0.076)
SFC		0.0516 (0.089)	0.040 (0.081)	0.119 (0.079)	0.092 (0.079)
Moderating effects					
SF x IFC			**0.148** (0.049)**		**0.096* (0.053)**
SF x SFC				**0.166** (0.051)**	**0.119*** (0.061)**
_Cons	**3.116*** (0.324)**	**3.070*** (0.339)**	**2.975*** (0.315)**	**3.099*** (0.327)**	**3.029*** (0.322)**
R^2	0.388	0.400	0.434	0.438	0.449

*p < 0.1, **p < 0.05, ***p < 0.001.

Note: Standard error between ( ). All estimations include the control variable described in the section 3.

Model 3 and 4 included the interaction effects of each communication, confirming H1, H2 and H3. Finally, the last model (model 5) includes both main and interaction effects. These findings corroborate our premise that formal SP positively affects ANT; moreover, they prove that IFC and SFC moderate this relationship.

Conclusions, limitations and future research

This study analyzes the antecedents of ANT, identifying what factors may foster it within manufacturing organizations. It found that SF is associated with ANT, as it helps to acquire external and internal knowledge, identifying strengths, weakness as well as potential opportunities and threats. SF allows organizations to anticipate new demands related to new products, processes and technology through the comparison with their competitors as well as to identify internal problems through their own internal analysis.

On the other hand, our study takes into account the moderating role of communication between manufacturing SF and ANT. We focus on two types of communication such as IFC and SFC, since they take on great relevance on the development of absorptive capacity within organizations. They are determinant to recognize the potential of a new technology, since they facilitate the assimilation, transformation, exchange and exploitation of knowledge, combining their existing and newly acquired knowledge. As a result, they strengthen the relationship between competitive SF and ANT.

Our study has important implications for academics, since it sheds new insights to the literature on ANT, emphasizing the role of manufacturing SF as an enabler of the identification of new technological demands and the moderating role of communication. Furthermore, the empirical evidence in this study may be useful for both practitioners and employers seeking ways of improving business value and competitive position.

Our study is not free of limitations. It is a cross-sectional study, that includes plants from three industries where communication may differ significantly, making comparison difficult. Our data comes from industrial organizations, so future studies might analyze and compare these results to those from the service sector.

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