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Influence of top management team vision and work team characteristics on innovation

The Spanish case

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Abstract

Purpose – This work has three main objectives – to analyse whether the strategic vision of the top management team (TMT) directly affects firms' innovation performance; to shed some light on which of the intrinsic characteristics of work teams proposed in the literature influence innovation; and to analyse the joint effect that the TMT's vision and the work team's characteristics may exert on innovation performance.

Design/methodology/approach – The sample for this study was chosen from the Dun & Bradstreet database. The population consists of firms with more than 50 employees belonging to the three sectors of the Spanish economy with the largest number of registered patents according to statistics from the Spanish Office of Patents and Brands (960 firms).

Findings – The results indicate that the TMT's strategic vision alone does not explain companies' innovation performance. Innovation also requires the existence of diverse, cohesive, and autonomous work teams whose members engage in fluent informal communication.

Research limitations/implications – The empirical evidence demonstrates the complexity of the innovation performance that has to be encouraged by the TMT, but also supported by the existence of teams with specific characteristics.

Practical implications – These results offer relevant implications for R&D managers about the way teams should be formed to increase innovation. The paper derives some conclusions about the key characteristics of work teams that, in combination with the view of the TMT, can affect innovation in firms.

Originality/value – The majority of earlier studies have analysed theoretically the effect of both variables – the strategic vision of the TMT and the intrinsic characteristics of teams – on innovation, but separately. This paper analyses the joint effects that the intrinsic characteristics of work teams have on innovation, which resolve some contradictions regarding the way some variables affect innovation of the firm. Finally the results offer empirical evidence on how Spanish firms obtain innovation performances.

Keywords Innovation, Team working, Senior management, Spain

Paper type Research paper

1. Introduction

A significant amount of research has been devoted to analyzing the direct impact of the vision and perspectives of a firm's top management team (TMT) on various decisions

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and results relating to activities such as innovation (Hambrick and Mason, 1984; Bantel and Jackson, 1989; Wiersema and Bantel, 1992; Bantel, 1993; Hambrick *et al.*, 1996; Thamhain, 2003). However, recent research has revealed deficiencies in this type of research as a consequence of contradictory and inconclusive results (Romanelli and Tushman, 1986; Murray, 1989; Smith *et al.*, 1994; Knight *et al.*, 1999). In parallel to this, a new research stream has emerged that emphasises the use of work teams to improve innovation performance (McAdam and McClelland, 2002; Sethi *et al.*, 2002).

Firms' growing interest in finding ways to raise their innovation performance has led to a vast literature centred around the concept of work teams regarded as a form of organisation that promotes creativity at the individual, group, and organisational levels. The studies have tried to identify what characteristics these teams should possess in order to promote innovation in organisations, but they have suffered from two important limitations. The first relates to the theoretical nature of most of the studies. They have tried to determine the effect of some group variables on innovation performance from a purely theoretical perspective. The second limitation is that some of the relations have been proposed independently, ignoring the joint effects that the variables may have, as well as their interaction with other organisational factors upon which innovation depends, such as management's strategic vision (Langfred, 2004).

For this reason, in the current work we have three objectives: first, to analyse whether the strategic vision of the TMT directly influences firms' innovation performance; second, to identify the intrinsic characteristics of the work teams that may affect these results; and third, to analyse the joint effect that the TMT's vision and work team characteristics may exert. Analysis of the characteristics of work teams such as diversity in skills and knowledge, autonomy, cohesion, and informal communication has allowed us to establish how they affect firms' innovation performance both separately and jointly. Our findings offer empirical evidence about the joint impact of the intrinsic characteristics of work teams on firms' innovation performance as well as the effect these characteristics have jointly with the managers' vision. The majority of earlier studies have analysed the effect of both variables on innovation, but separately, and although there have been some theoretical studies arguing that both perspectives are necessary in the study of innovation, there have been few empirical studies to complement them (Penrose, 1959; Itami and Numagami, 1992; O'Sullivan, 2000).

This paper is organised in four parts. After this brief introduction, we outline the innovation dimension to be analysed. In the second section, we develop the theoretical approaches that explain the impact of the TMT's vision and work teams' intrinsic characteristics on firms' innovation performance. In the same section, we propose the research hypotheses. The following sections describe the sample, establish the variables, and present the data analysis and results. Finally, we summarise the most relevant conclusions drawn from our analysis.

2. Innovation performance

The nature of innovation is not always clear, and there have been different approaches to this concept in the literature (Rowe and Boise, 1974; Wolfe, 1994). Tushman and Nadler (1986) define innovation as the creation of a product, service, or process that is new for a particular business unit. Damanpour (1996, p. 126) points out that innovation involves the:

> . . . adoption of an idea that is new for the organisation that adopts it, so that the term refers to both the creation and acquisition of a product or service that is new for the unit adopting it.

In general, three dimensions that underlie the different definitions of this concept can be identified: innovation in terms of results, which entails the creation of a product that is new for the business unit (Tushman and Nadler, 1986; Damanpour, 1996); innovation in terms of process (O'Sullivan, 2000); and innovation as an attribute of organisations – hence, innovative firms (Kimberly, 1981; Bantel and Jackson, 1989).

Bantel and Jackson (1989) suggest that these different approaches to the concept of innovation may be different aspects of a single reality such that an innovative process would lead to an innovative result, whether in products or in processes, and both would cause firms to be regarded as innovative. This plural nature of innovation means that we need to centre on partial or restricted aspects of the variable to make it operative and hence be able to study it.

In our current research, we have opted to focus on technological product innovation, i.e. on the material result of the innovation, which, according to the *Oslo Manual* (1992), includes both goods and services, whether totally new or improved with respect to previously existing models. A product is regarded as new if its technological characteristics or uses differ significantly from those previously offered by the firm. These innovations may include radically new technologies, may be based on a combination of existing technologies applied to new uses, or may derive from the use of new knowledge (*Oslo Manual*, 1992). On the other hand, a product is regarded as being improved if it is an existing product of the firm and better components or materials are used in its manufacture, or one of its physical parts is improved (*Oslo Manual*, 1992).

In the study of firms' innovation behaviour, measured or materialised in their innovation performance, the TMT's decisions are particularly significant (Bantel and Jackson, 1989; Bantel, 1993). Innovation is a cumulative, collective, and uncertain process, and the management system supports, directs and drives it (O'Sullivan, 2000). Managers' preferences may impose serious restrictions on the firm's renewal, making it incapable of perceiving or reacting to profitable opportunities (Penrose, 1959). However, because the relation between innovation performance and the TMT's vision has not yet found empirical support, there appears to be a need to consider the impact that some organisational design factors such as the use of work teams with certain intrinsic characteristics may have on firms' innovation performance.

3. Influence of TMT's strategic vision and work teams on innovation in firms

3.1 Influence of strategic vision on innovation performance

The productive and innovative activities of a firm are governed by its opportunities. These include productive possibilities that the firm's TMT is able to perceive and exploit (Penrose, 1959). There will be fewer opportunities for innovation if the managers are unable to perceive them, do not wish to exploit them, or are unable to respond to them. Managers' specialisation in knowledge and skills is not in itself a serious restriction to innovation in firms. However, when the TMT is not sufficiently interested, is static, unimaginative, and unambitious, or the managers' mental structures are not characterised by variability or flexibility (Penrose, 1959), these characteristics impede innovation (Johannessen *et al.*, 1999).

The TMT is made up of individuals with the power and authority to make strategic decisions, and therefore, to develop strategies aimed at innovation (Daellenbach *et al.*, 1999). Upper Echelon theory states that TMTs exert a fundamental influence on strategic choice in their organizations, and, hence, in their results (Wiersema and Bantel, 1992; Finkelstein and Hambrick, 1990). In this theoretical framework, it is argued that the leaders' cognitive bases are the mental guidelines that support their decisions and condition the firm's tendency to innovate and renew itself (Wiersema and Bantel, 1992; Smith *et al.*, 1994; Hambrick *et al.*, 1996; Daellenbach *et al.*, 1999; Knight *et al.*, 1999; Pegels *et al.*, 2000).

These arguments lead us to define the strategic vision as the set of aspirations that the TMT has for its organisation. It constitutes the managers' model of the future strategy that the firm should follow (Nonaka and Takeuchi, 1995; Schwarz and Nandhakumar, 2002). If the TMT's set of aspirations is dynamic, ambitious, and innovative in the sense of demonstrating proactive attitudes and a capacity to respond to market changes and needs, these aspirations will materialise in strategies that drive dynamism and innovation in the firm (Itami and Numagami, 1992).

In short, the premise is that if the TMT develops an innovative strategic vision, it will lead the firm to search for opportunities that may arise in the future beyond the domains of its traditional products such that a real incentive is created to develop the option of innovation (Pavitt, 1991; Meyer and Utterback, 1993; Kim and Kogut, 1996; Nobeoka and Cusumano, 1997). On the basis of this reasoning, we derive our first hypothesis:

H1. The TMT's development of an innovative strategic vision positively influences the firm's innovation performance.

However, the complex nature of the innovation (Jensen and Harmsen, 2001; Ahmed, 1998) leads us to analyse other variables that can affect this performance.

3.2 Influence of work team characteristics on innovation performance

Although we have justified our position that the TMT conditions and directs the firm's propensity to innovate in theory, the effective realisation of any innovation is determined by an adequate context for the implementation of such strategies. On the three levels at which innovation can be analysed – individual, group and organisational – the formation of work teams stands out in the literature as a fundamental factor (Paulus, 2000; Barczak and Wilemon, 2003).

Researchers have differed in their theoretical concept of work teams, and this provokes increasing confusion in their specification. Cohen and Bailey (1997) identify four types of teams: work teams, project teams, parallel teams, and management teams. In the current study, we focus our analysis on the characteristics of work teams and project teams because the former are the most widely used in industrial firms and have a fundamental function in processes of new knowledge generation, while project teams are the ideal tool for firms to use to transfer and integrate knowledge outside the specialist work teams, thereby enabling knowledge to be generated at the organisational level and subsequently applied in innovations (Meyer and Utterback, 1993; Sánchez, 1993, 1995; Brown and Eisenhardt, 1995; Garud and Kumaraswamy, 1995; Nobeoka and Cusumano, 1997; Helfat and Raubitschek, 2000).

Both types of team are fundamental tools for achieving not only the creation of new knowledge at the group level but also its application in the organisation, leading to innovations (Grant, 1996; Leonard and Sensiper, 1998; Jassawalla and Sashittal, 1999; Helfat and Raubitschek, 2000; Lovelace *et al.*, 2001). Work teams and project teams work on a stream of products related by a combination of new and old technologies. Thus, when developing multiple generations of products, the team members become the carriers and supporters of a system of integrated knowledge, seeking to transform new ideas that may arise from one or various individuals into something useful through the conceptualisation of new products (Iansiti, 1993; Leonard and Sensiper, 1998).

In order to develop new knowledge at the group level, skills specialisation is the fundamental factor (Kogut and Zander, 1992; Hedlund and Nonaka, 1993). In this way, individual knowledge, due to its tacit component, is transferred by means of teaching, which requires interactions within small functionally related groups by means of the development of a common language and codes. Sharing a common stock of technical and organisational knowledge facilitates knowledge transfer within the group (Kogut and Zander, 1992). Both work teams and project teams are basic units for materialising the creation of new knowledge in innovation.

The main research relating firms' capacity for innovation and developing work teams focuses on the degree to which the teams are used and on their characteristics (Woodman *et al.*, 1993; Jackson *et al.*, 1995; Barczak and Wilemon, 2001; Sethi *et al.*, 2002). In this study, we consider the characteristics of these teams.

The interest in focusing on work team characteristics within an analysis of innovation is fundamentally due to two reasons. On the one hand, it seems obvious that work team characteristics will significantly affect the teams' propensity to generate new ideas and knowledge and hence develop innovations (Campion *et al.*, 1993; Brown and Eisenhardt, 1995; Austin, 1997; Cohen and Bailey, 1997; Sethi *et al.*, 2001). On the other hand, the scholarly community has recommended more research on this aspect, given that the results obtained by previous research have not proved conclusive. In this respect, Sethi *et al.* (2001, p. 73) point out:

> ... it is somewhat surprising to find an absence of research examining factors that affect new product innovativeness ... understanding factors affecting innovativeness at the product development project level will provide a valuable complement.

The literature generally distinguishes between two types of work team characteristics: intrinsic characteristics concerning internal features of the group and the characteristics of its members; and external or contextual characteristics, designed outside the group limits (Amabile, 1988; King and Anderson, 1990; Woodman *et al.*, 1993; Sethi *et al.*, 2001). Among the intrinsic characteristics are the diversity of the members, relating to the composition of the team; cohesion, concerning members' psychological limits; and autonomy, defined as the members' degree of freedom of action (Amabile, 1988; King and Anderson, 1990; Woodman *et al.*, 1993; Paulus, 2000; Sethi and Nicholson, 2001; Thieme *et al.*, 2003). Among the contextual variables that act as determinants of innovation we might mention the size of the group in terms of number of members; the tolerance to risk, or the extent to which risk is assumed; and external communication, measured by the flow of information between the group and

its stakeholders (Magjuka and Baldwin, 1991; Ancona and Caldwell, 1992; Woodman *et al.*, 1993; Cohen and Bailey, 1997; Troy *et al.*, 2001).

This research centres its analysis on the intrinsic design factors, including informal communication because, like the variables mentioned above, this emerges from the team members, and it seems particularly important to examine the group's internal functioning to explain this factor's relation to innovation.

The abundant literature that has analysed the influence of work teams' intrinsic characteristics on innovation and the widely varying results of the empirical studies make it necessary and important to examine these characteristics, as well as their impact on organisations' innovation performance, in more detail.

3.2.1 Diversity of skills and social cohesion. Studies of the effects of diversity on performance have flourished in recent years, and according to Jackson *et al.* (2003) nearly 75 per cent of the studies that they reviewed examined the effects of diversity on financial indicators of firm performance. However, this paper offers a new perspective in the analysis of the characteristic more relevant in the innovation literature, analysing the influence of the diversity of teams on innovation. Before looking at the relations between both variables, we shall distinguish between two types of diversity (Milliken and Martins, 1996). The first type concerns attributes that are unchangeable, such as ethnic origin, age and sex; the second concerns attributes that relate to the job position and are more modifiable, such as education, functional training, and tenure (Tsui *et al.*, 1992; Cummings *et al.*, 1993; Jackson *et al.*, 1995, 2003).

This study focuses on the second type of diversity – specifically analysing the diversity in skills, knowledge and experience of the team members – because this type of heterogeneity within the team is an important source of innovation, and may in turn be linked to other types of diversity such as functional or educational diversity, or members' tenure in the organisation (Milliken and Martins, 1996; Pelled *et al.*, 1999; Barczak and Wilemon, 2003).

Because innovation and creativity require a combination of skills and knowledge, the existence of diversity in the team has been thought to have a positive impact on innovation (Iansiti, 1993; Leonard and Sensiper, 1998; Thieme *et al.*, 2003). However, studies of the impact of diversity of skills and knowledge on innovation in firms have produced diverging results (Sethi, 2000; Keller, 2001). On the one hand, diversity has traditionally been regarded as having a positive influence on innovation –, i.e. diversity as an enabler of innovation (Andrews, 1979; Ancona and Caldwell, 1992; Jackson *et al.*, 1995; Amabile *et al.*, 1996; Milliken and Martins, 1996; Sethi *et al.*, 2002; Thompson and Brajkovich, 2003). The argument goes that diversity in skills and experience in the position means that a greater variety of ideas, knowledge, and perspectives are introduced and shared by the team, and hence there is a greater likelihood of finding solutions that are more innovative.

On the other hand, diversity has also been regarded as a variable having a negative impact on innovation performance –, i.e. diversity as an inhibitor of innovation (Ancona and Caldwell, 1992; Milliken and Martins, 1996). This is explained by greater conflict and lower cohesion inside the group – a consequence of the diversity of languages, vocabularies, and objectives among the team members that complicates the decision-making process (Shrivastava and Souder, 1987; Jackson *et al.*, 1995; Lovelace *et al.*, 2001). In this approach, diversity may lead to information overload, internal conflicts, and difficulties in finding a common perspective (Olson *et al.*, 1995). Team

members with diverse experiences and knowledge are said to speak a different language, and this makes exchange of knowledge a complex task (Maznevski, 1994; Milliken and Martins, 1996).

These arguments lead us to assume that in order for diversity in skills and experience to positively affect innovation, a certain level of cohesion is necessary within the team. The social cohesion of group members – defined as the degree of consensus achieved by the group members through interaction – is a variable that has an unclear relation to innovation when analysed individually because its influence is conditioned by the level of group diversity (Nemeth, 1997). It seems obvious that the existence of cohesion in homogenous groups will negatively affect innovation performance, but cohesion in heterogeneous groups has a more complex effect (Sethi *et al.*, 2001). When there is diversity, cohesion appears to have a positive effect on innovation because the consensus achieved allows the conflict that the diversity produces – whether due to personal or functional differences – to be redirected (Barczak and Wilemon, 2003). That is, both variables jointly may have a positive impact on innovation performance (Pinto *et al.*, 1993). In this respect, diversity up to a certain level permits the convergence of a multitude of perspectives and raises innovation. But beyond this point, negative consequences for innovation begin to appear due to the conflict inherent in the diversity of perspectives. This may be mitigated when a certain degree of cohesion among the members is achieved, allowing the conflict to be redirected and leading to the generation of innovation (Zaccaro and McCoy, 1988; Hogg, 1992). Along this line, a certain degree of consensus is necessary to resolve individual differences and arrive at a shared position.

3.2.2 Autonomy. Another team characteristic that promotes innovation in organisations is autonomy. Amabile (1997) defines this as an intrinsic factor in the motivation to innovate. Research framed within the knowledge-based theory of the firm analyses autonomy and its effects on the process of knowledge integration and transfer that can lead to innovation (Nonaka, 1991, 1994; Nonaka and Takeuchi, 1995; Chen and Lin, 2004).

Autonomy can be defined as the extent to which organisations allow individuals to work with the greatest degree of freedom possible, controlling their own work and their ideas (Amabile *et al.*, 1996; Kirkman and Rosen, 1999; Langfred, 2004). By encouraging autonomy, organisations can create conditions that allow ideas and creativity to emerge from the individuals within the groups. Thus, autonomy is a factor that boosts and provides meaning to personal commitment, and should be managed at the organisational level (Ghoshal and Bartlett, 1994; Nonaka, 1994).

Reviewing the literature on teams, the importance of autonomy has been emphasised both for productivity and innovation (Amabile, 1988; Cohen and Bailey, 1997). Authors such as Campion *et al.* (1993) and Cohen and Bailey (1997) identify autonomy as one of the main design characteristics influencing group efficacy measured in terms of innovation. Amabile *et al.* (1996) show how different studies have concluded that creativity is favoured when teams possess relatively high autonomy as well as control over their work and ideas (Pelz and Andrews, 1966; Paolillo and Brown, 1978; Bailyn, 1985; King and West, 1985; West, 1986). These studies have revealed that individuals produce more creative work when they feel that they have the choice of how to carry out the tasks they have been assigned (Amabile and Gitomer, 1984).

3.2.3 Informal communication. Promoting informal communication by means of debate and discussion has been defined as another of the characteristics of work teams that is directly associated with innovation (Thamhain, 2003; Hirst and Mann, 2004). Although the process by which groups generate ideas is not well understood, many researchers have stressed that informal communication among team members is a critical process for innovation (Ancona and Caldwell, 1992; Sethi *et al.*, 2002). Encouraging informal communication processes has an impact on innovation because informal communication permits the sharing of knowledge and feedback of visions and perspectives, and it is the best way to develop creative proposals by means of the connection of ideas from different fields or areas (Ancona and Caldwell, 1992). Through informal interaction, the team members overcome barriers of communication, routines, and the division of labour that may exist in different functional areas and increase information flow (Brown and Eisenhardt, 1995). Smith *et al.* (1994) argue that a greater flow of informal communication leads to a greater and deeper interaction among the members, which raises proximity and trust among them. This in turn favours the generation of creative ideas and hence innovation (Smith *et al.*, 1994).

The above arguments lead us to propose the following hypothesis and sub-hypotheses:

H2. Intrinsic work team characteristics such as diversity in skills, social cohesion, autonomy, and informal communication influence organisations' innovation performance, such that:

H2a. Diversity in skills affects innovation performance as long as there is social cohesion among the group members.

H2b. Work team autonomy affects firms' innovation performance.

H2c. Informal communication within the work teams affects a firms' innovation performance.

At this point, we need to consider the joint effect on firms' innovation performance of the TMT's innovative vision and the design of the work teams with intrinsic characteristics that encourage members' propensity to be creative and innovate. Thamhain (2003) points out that the innovation process is complex and non-linear.

According to the knowledge-based theory of the firm (Hedlund and Nonaka, 1993; Nonaka, 1994; Nonaka and Takeuchi, 1995), the creation of new knowledge – the source of innovation in organisations – should be founded on the existence of elements of organisational design that permit the newly created knowledge to be directed, developed and validated. Among the fundamental factors are the development of an organisational intention (the TMT's vision of the future) and the existence of diverse, cohesive, and autonomous work teams (Ashby, 1960; Morgan, 1990; Nonaka, 1991, 1994; Ghoshal and Bartlett, 1994; Nonaka and Takeuchi, 1995; Chen and Lin, 2004).

In this theory, the model of knowledge creation proposed by Nonaka and Takeuchi (1995) holds that in innovative firms management desires change and renewal and drives both. The role of top management consists of tracing out a framework of action that guides the firm toward a future that has been visualised and is desired. This stimulates the firm's managers toward developing new knowledge that will allow them to build that future (Prahalad and Hamel, 1994). However, top management must also establish mechanisms for introducing the necessary design changes in the

organisation. For this, the use of cohesive work teams, which are autonomous and diverse and in which informal communication is encouraged, will drive individual intention, commitment, and understanding within the groups. This will enable creative and innovative solutions to emerge that satisfy the innovation objectives of the TMT. Iansiti (1993) takes a similar approach, considering that the use of integrated but diverse work teams, along with the guidance or framework of action established by the management, is also an essential design element for innovation. Bowen *et al.* (1994) mention certain key factors that are required if the firm is to successfully undertake new product creation or new business. These elements are applied holistically and optimise development, promote learning, and initiate change throughout the entire organisation. Among these elements are the innovative vision of the TMT and integrated and creative work teams.

All these arguments lead us to conclude that the TMT's innovative strategic vision is a guide to the wealth of perspectives of the diverse teams that work in an atmosphere of autonomy and freedom to achieve the innovation objectives set down. Thus, we propose our third working hypothesis:

H3. Intrinsic work team characteristics such as diversity, cohesion, autonomy, and informal communication, together with the development of an innovative vision by the TMT, affect firms' innovation performance.

Figure 1 shows the relations postulated in each hypothesis.

4. Methodology

The sample for this study was chosen from the Dun & Bradstreet database (2000). The population consists of firms with more than 50 employees belonging to the three sectors of the Spanish economy with the largest number of registered patents according to statistics from the Spanish Office of Patents and Brands (960 firms). The sectors chosen were: manufacture of industrial and agricultural machinery; electrical and electronic machinery and material; and basic chemicals. We received responses from 366 firms. To collect relevant information from the firms' management teams, we established the minimum requirement of receiving at least four completed questionnaires from managers in each firm, including the chief executive. From the responses received, 97 were considered valid. Thus, in this research we analyse the strategic vision of 97 TMTs alongside the work teams' intrinsic characteristics that are most associated with an innovative attitude.

To collect the data, we were guided by the extant literature and designed two questionnaires that were completed via telephonic interview. The first was directed at the TMTs and consisted of 13 items. Its objective was to obtain information to determine the TMT's strategic vision (Knight *et al.*, 1999). The second questionnaire contained five items and was directed at the director of R&D or production. The questionnaire was given to the R&D or production manager because in Spanish firms this individual is responsible for the creation of teams, the key gatekeeper who relates directly with the innovation of firms, and the person who can provide information about the composition of teams and the characteristics of the groups. Because of the temporary existence of groups (Pinto *et al.*, 1993), especially groups related by innovation, we decided to complete the questionnaire from the viewpoint of a person who knew the characteristics of teams, in general terms, independent of the lifetime of

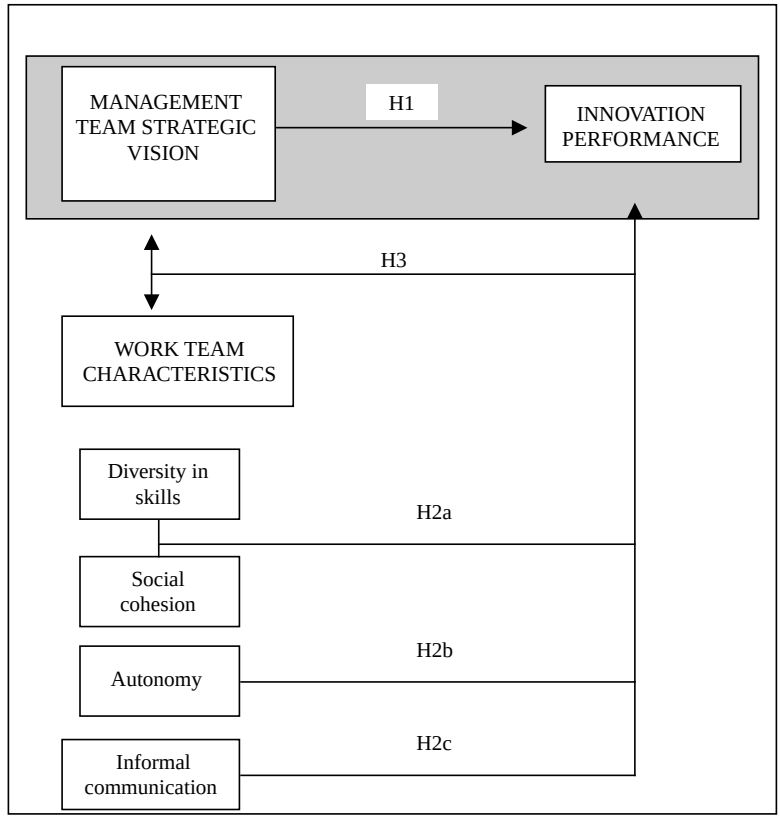

Figure 1.
Strategic vision and work teams: theoretical model of their effect on innovation

the teams. Our goal was to analyse the existence of work teams in the firm, their characteristics, and the firm's innovation performance.

The questionnaires were tested on ten firms in order to establish their content validity in the Spanish context. In order to ensure the effective participation of the TMTs and the R&D or production managers in the data collection process, we verified by telephone that the individuals surveyed were indeed currently active in the strategic decision-making processes of their firms.

4.1 Variable measurements

4.1.1 Innovation. To measure innovation in the sample firms, we used three variables that are directly proportional to innovation performance: number of new products, number of improved products, and number of patents registered. These have been used in many studies as indicators of firm innovation, and the positive correlations between them have been amply demonstrated (Cordero, 1989; Ministry of Industry and Energy, 1994; Coombs *et al.*, 1996). Through the method of principal components (Table I), it can be seen that the established indicators comprised a construct that evaluates innovative results in companies.

The weight coefficients of the first component are all positive and statistically significant ($z1 = 0.358776 \times$ Npatents $+ 0.661255 \times$ NExistprods $+ 0.658803 \times$ Nnewprods). All the variables have a positive weight, with the number of patents being the least influential. This component can be labelled "innovation results," measured in terms of number of new products and improved products. High values in the three initial variables will correspond to high values in the first principal component. This first principal component is the best one-dimensional linear predictor of the original data, with which no other linear combination of the original variables exists to explain more clearly the total variability of the observations.

The second component contrasts the innovation variables "number of new products" and "number of improved products" with the variable "number of patents." The weight obtained is different ($z2 = 0.93335 \times$ Npatents $- 0.245306 \times$ NExistprods $- 0.262072 \times$ Nnewprods). This component shows how the innovation variables have an internal dimension when contrasted with previous effects. We find companies with a large number of patents but very few new or improved products, or vice versa. This variable does not define innovative results, but is better defined as "type of innovation." It shows us, therefore, two different forms of innovation: with or without patents.

The third component explains very little and should be not considered (eigenvalue $= 0.474579 \ll 1$). Thus, the final dimension of the data is reduced to two principal components. However, in the current paper we only consider the component "result of innovation" (first component), established in terms of the number of new products and improved products, because it constitutes the dimension of the innovation the research is centred on. According to the *Oslo Manual* (1992), the result of the innovation includes both goods either totally new or improved with respect to previously existing goods in the firm.

4.1.2 Innovative strategic vision. In this paper, we aim to determine the extent to which the TMT shares a common strategic vision of an innovative nature. For this, we use the 13 items measured by a five-point Likert scale borrowed from the questionnaire used by Knight *et al.* (1999) that unequivocally identify the innovative nature of the TMT's strategic vision. These items were chosen because we are interested in analysing the value managers lend to strategic attitudes and actions oriented towards innovation, proactivity, risk, and so on. To calculate this variable we took the means of the responses given to each of the 13 items and calculated a global mean from them. (We also calculated the index r(WG (J))) (James *et al.*, 1984), confirming that the grouping was adequate ($\alpha = 0.7416$).

Component number	Principal components analysis			Table of component weights		
	Eigenvalue	Percentage of variance	Cumulative percentage	Npatents	NExistprods	Nnewprods
1	1.61642	53.881	53.881	*0.358776*	*0.661255*	*0.658803*
2	0.909	30.300	84.181	0.93335	− 0.245306	− 0.262072
3	0.474579	15.819	100.000	–	–	–

Notes: Npatents, number of patents; NExistprods, number of improved products; Nnewprods, number of new products

Table I.
Principal components analysis

This measure constitutes a direct estimator of the degree to which the TMT shares an innovative strategic vision. It is important to point out that this measure is not an objective evaluation of the firm's current strategy, but rather a proxy that attempts to measure the TMT's perception about the more or less innovative nature of the organisation's strategic affairs (Knight *et al.*, 1999, p. 453).

4.1.3 Work team characteristics. In the questionnaire directed at the R&D or production managers, we introduced a filter question about the existence of work teams and project teams in their firms. An affirmative answer led to a battery of questions relating to the characteristics of these teams. Using five items measured on a five-point Likert scale, from 1 (totally disagree) to 5 (totally agree), we collected information about the existence of diversity in skills and knowledge, social cohesion, autonomy, and informal communication. To find out about work team diversity, we requested that respondents evaluate if the group components possess a wide variety of skills and capabilities (Pelled *et al.*, 1999). To establish the degree of autonomy, we asked about the presence of operational autonomy in the groups (Campion *et al.*, 1993; Amabile *et al.*, 1996). Social cohesion was estimated by asking respondents about the level of interaction on the job among the group members (Zaccaro and McCoy, 1988; Smith *et al.*, 1994; Sethi, 2000; Sethi *et al.*, 2002; Thieme *et al.*, 2003). Finally, to measure informal communication, we asked about the degree to which group members share information internally and the degree to which internal discussion is encouraged (Smith *et al.*, 1994).

4.2 Control variable

Research has demonstrated that the size of the company may be linked to a greater or lesser tendency for innovation (Bantel and Jackson, 1989; Cohen and Mowery, 1984; Rothwell and Zegveld, 1985; Ettlie *et al.*, 1984). Some scholars state that an increase in the size of the organisation adds complexity to the structure, formalised control systems and planning, and resources localisation (Quinn and Cameron, 1983). Others consider that large organizations have more complex and diverse facilities that aid the adoption of a large number of innovations (Nord and Tucker, 1987). Greater resources give large organizations the leeway to tolerate the potential loss due to unsuccessful innovations (Damanpour, 1992). On the other hand, some organisational scholars argue that small organizations can be more innovative because they have more flexibility, a higher ability to adapt, and less difficulty in accepting and implementing changes (Damanpour, 1992). In any case, a difference in organisational size may stimulate or create resistance to change and a greater or lesser organisational agility (Tushman and Romanelli, 1985). Thus, organizations may show a greater or a lesser likelihood to innovate or change as a function of their size. Therefore, the introduction of size as a control variable enables us to analyse the incidence of TMT demographic characteristics on innovative results of the company once the effect has been isolated.

Organisation size variable has been determined through the number of workers in the firm. The values of this variable fluctuate between 50 and 2,250 workers. Because of its wide dispersion, neperian logarithm of the number of workers in the firm has been used to estimate it in order to avoid the scale effect, which could be produced if we consider the original variable.

5. Analysis of data and results

In the analyses carried out, we have considered only those firms responding affirmatively to the filter question about the existence of work teams and project teams in their organisation.

In order to test the first hypothesis, we estimated a linear regression model, with the dependent variable being innovation performance and the independent variable the TMT's degree of innovative strategic vision. The results obtained are reported in Table II.

The results reveal that the proposed model is deficient; it is not significant and it explains only 0.4 per cent of the relation ($p = 0.592$; $R^2 = 0.004$). Thus, it seems that the TMT's strategic vision does not have any direct influence on the firm's innovation performance.

In order to test the hypotheses relating work team characteristics with firms' innovation performance (*H2a*, *H2b* and *H2c*) and the joint effect of the TMT's vision with these characteristics (*H3*), we carried out a univariate analysis of covariance (ANCOVA). With this we aimed to determine if the innovation performance differed according to the degree of the TMT's innovative vision as well as the work team characteristics analysed. In this model innovation is the independent variable, with work team characteristics and TMT vision being the dependent variables. We have included the size of the firms as a control variable in the analysis. The revised model (model 1) is not significant as a whole, although we obtained a $R^2 = 0.91$. Also, we observe that the size of the firm, the control variable, is not significant; therefore, it does not affect the innovation performance of the firms. However, the results show that autonomy and informal communication individually influence firms' innovation performance at the 90 per cent level. There are also joint effects of some intrinsic team variables on the innovation factor. In this respect, we see that the interaction of the variables work team autonomy and cohesion affects innovation performance at the 95 per cent level. Moreover, innovative strategic vision, together with each of the intrinsic characteristics analysed (except informal communication), also have an impact. The level of significance for diversity of skills and autonomy is 90 per cent, while for cohesion it is 95 per cent.

Because the control variable is not significant, we could delete model 1, expecting model 2 to be more significant. Model 2 includes an analysis of variance (ANOVA) including the identical previous variables excepting the size of the firms.

The results of the model are reported in Table III.

The model is significant as a whole at the 90 per cent level, with $R^2 = 0.9$, which explains 90 per cent of the variance. The effects of the variables on the innovation performance are the same as in the previous model (model 1). However, model 2 is more robust because is significant as a whole. Therefore, the size of the firms does not affect the innovation performance and does not affect the relations between intrinsic work

	Non-standardised coefficient		Standardised coefficient		
	β	Std. error	β	t	Significance
Constant	0.558	1.057		0.528	0.599
Strategic vision	−0.155	0.289	−0.062	−0.538	0.592
$R^2 = 0.004$					

Table II.
Linear regression model of innovation (dependent variable) and strategic vision (independent variable)

Table III.
Results of ANCOVA and ANOVA on innovation

	Model 1			Model 2		
	F statistic	Significance	Observed power	*F* statistic	Significance	Observed power
Corrected model	1.719	0.21	0.479	1.943	*0.1***	0.591
Intersection	0.260	0.624	0.074	2.606	0.141	0.303
Size Ln	0.118	0.740	0.061			
Innovative strategic vision	1.557	0.275	0.293	1.752	0.223	0.344
Diversity in skills	0.32	0.875	0.092	0.342	0.843	0.097
Cohesion	0.213	0.885	0.075	0.252	0.858	0.082
Autonomy	2.751	*0.1***	0.493	3.028	*0.077***	0.563
Informal communication	3.147	*0.1***	0.346	3.429	*0.097***	0.380
Inn. strategic vision × diversity in skills	2.452	*0.1***	0.445	3.228	*0.067***	0.593
Inn. strategic vision × cohesion	5.064	*0.055**	0.507	5.692	*0.041**	0.567
Inn. strategic vision × autonomy	2.210	*0.1***	0.259	3.014	*0.1***	0.342
Inn. strategic vision × informal commun.	0.068	0.935	0.057	0.082	0.922	0.059
Diversity in skills × autonomy	0.213	0.656	0.069	0.235	0.639	0.072
Autonomy × cohesion	6.496	*0.034**	0.609	7.106	*0.026**	0.661
R^2		0.91			0.9	

Notes: * Significant at 95 per cent; ** significant at 90 per cent

group characteristics and performance innovation. The relations between variables are shown in Figure 2.

6. Discussion, conclusions, and limitations

The aim of this research has been to analyse the impact of the TMT's strategic vision and the existence and design of work teams on innovation in firms. To develop the analysis of these questions, we first established three working hypotheses.

The results of the first hypothesis (*H1*) have demonstrated that, alone, the TMT's strategic vision cannot explain improved innovation performance in firms, so this hypothesis is rejected. In the theoretical framework we proposed that the TMT's development of an innovative strategic vision was a necessary condition for innovation. But it does not appear to be a sufficient condition because actually materialising innovation requires the existence of other design mechanisms such as the

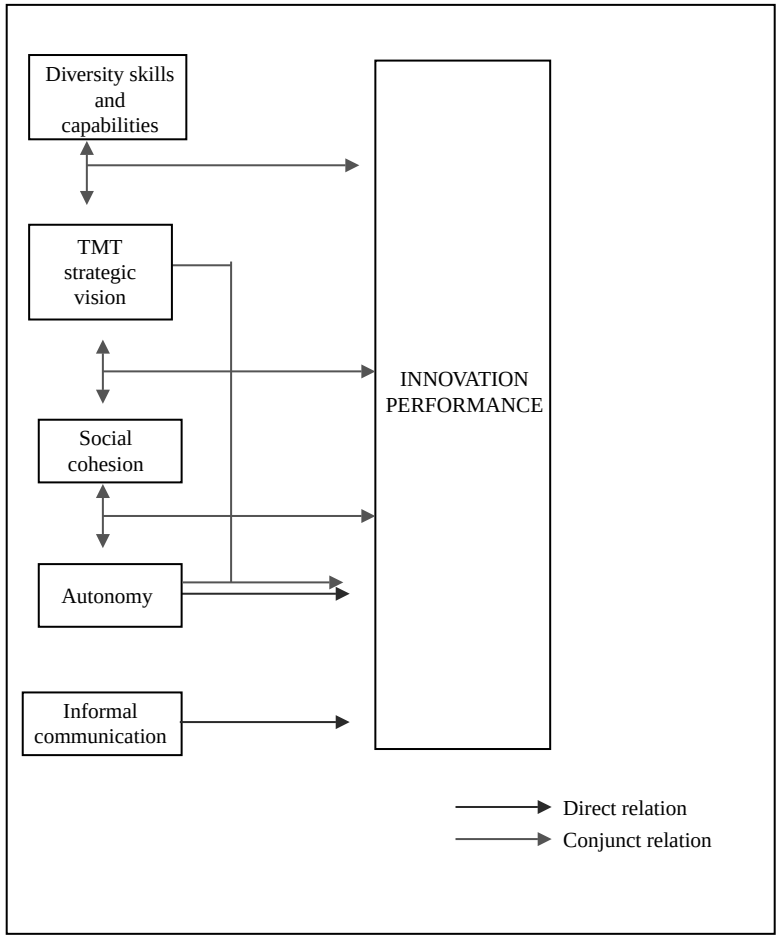

Figure 2.
Strategic vision and work teams: results of their effect on innovation

use of work teams with certain characteristics capable of stimulating knowledge development processes and, hence, innovation.

The second hypothesis (*H2a*, *H2b*, *H2c*), which directly relates the intrinsic characteristics of work teams (diversity, cohesion, autonomy, and informal communication) with innovation, has been partially verified. The results obtained in the analysis have shown that diversity in skills and cohesion of team members do not appear to have any joint effect on organisations' innovation performance (*H2a*). By analysing both characteristics jointly, we attempted to shed some light on the controversial effects that both individually appear to have on innovation. However, perhaps their positive impact depends on getting the right levels of diversity and cohesion, which we have not been able to isolate. Thus, a high degree of group diversity leads to a greater number of diverse ideas and perspectives and hence raises creativity, but at the same time it lowers consensus and raises internal conflict (Austin, 1997). In turn, a high degree of cohesion among group members facilitates communication within the group as a consequence of the consensus achieved. At the same time, in very cohesive groups the members prioritise the defence and maintenance of their personal relationships with other group members over their own proposals of innovative ideas, thereby hampering the generation of new ideas and creativity. The difficulty in reconciling the diverging effects of both variables leads us to reject this sub-hypothesis (*H2a*).

However, we have found evidence that work team autonomy has a direct effect on firms' innovation performance in isolation, which leads us to confirm sub-hypothesis *H2b*. Amabile *et al.* (1996) and Kirkman and Rosen (1999, p. 70) arrived at identical results, with the latter affirming "in order for teams to be highly effective, they must be autonomous". Amabile *et al.* (1996) propose that when the teams have high autonomy, the members of the team control and have choices regarding their job and tasks, and therefore, creativity is encouraged and thus there is the possibility of an increase in the number of new and improved products in the firm (Pelz and Andrews, 1966; Paolillo and Brown, 1978; Amabile and Gitomer, 1984; Bailyn, 1985; King and West, 1985; West, 1986).

The results also demonstrate the direct effect that informal communication has on innovation, which seems to be congruent with previous research (Thamhain, 2003; Hirst and Mann, 2004). Ancona and Caldwell (1992) find that "teams with more thorough internal communication had superior performance;" while Brown and Eisenhardt (1995, pp. 346-7) observe that:

> ... high internal communication increases the amount and variety of internal information flow and, so, improves development-process performance.

With this, sub-hypothesis *H2c* is also supported. In the development of new and improved products internal communication is key, because it leads to shared knowledge and ideas. The best way to develop creative ideas is to connect and encourage communication among different members of the team.

The third hypothesis (*H3*) postulates a joint effect of the TMT's innovative vision and work team characteristics on a firm's innovation performance. The results obtained can be summarised in the following conclusions. First, the diversity of the teams, along with the establishment of an innovative vision by the TMT, affects innovation in firms in terms of new products and improved existing products. To

promote innovation, firms appear to need diverse teams guided by the TMT's vision. The influence of the TMT's vision over this diversity will help manage any conflict that may arise given the variety of perspectives without cohesion that have to exist as a mediating variable in this relationship. Therefore, the cohesion is only necessary when a vision does not exist, because the existence of a vision of the TMT is a guarantee that there is a guide that will manage the diversity and potential conflict such diversity can create. We conclude that an orientation toward innovation must come from the TMT, but at the same time there is a need for diverse teams, without which innovation will not occur (Amabile, 1997). This result enriches previous research that has found a confusing relationship between diversity and innovation.

Second, we have found a joint influence of cohesion and strategic vision on innovation. Again, this is an interactive relation that allows us to clarify the effect of cohesion on innovation. This result makes a contribution to other researchers who have verified a direct relationship between cohesion and innovation (Keller, 1986; Cohen and Bailey, 1997; Thieme *et al.*, 2003). Thus, we can conclude that the integration that arises in cohesive teams, as long as it is accompanied by top management's guiding influence, reduces uncertainty and promotes interaction among team members, improving communication flow, resolving any potential inter-departmental conflict that may surface within the team, and hence leading to agreement over the necessity of initiating processes in order to achieve the development of new and improved products (Smith *et al.*, 1994).

Finally, the results show, on the one hand, a conjunct effect between the autonomy of the team and the vision of the TMT, and on the other hand, between autonomy and cohesion. The results from hypothesis *H2b* confirm that autonomy is a design variable of the team that directly affects the development of new and improved products.

However, both conjunct effects evidence a relation that is even more interesting. The vision of the TMT constitutes the external guide that drives the freedom of the teams (Nonaka and Takeuchi, 1995). The autonomous teams lead the organisation to increase the chance of introducing unexpected opportunities. Autonomy increases the possibility that individuals will be internally motivated to create new knowledge. The vision of the TMT must offer minimum critical specification in order to guide the development of knowledge that the team creates, and to verify the validity of this knowledge as a source of organisational innovation. The theory of knowledge creation of Nonaka and Takeuchi (1995) points out that the vision of the TMT provides the most important criterion for judging the truthfulness of a given piece of knowledge. Without the TMT's vision, it would be impossible to judge the value of knowledge created to develop organisational innovations.

On the other hand, cohesion in autonomous teams can compensate for the dysfunctions that can derive from individual freedom. In teams with cohesion, individual autonomy is relative, making possible the generation of new and different ideas in a climate of consensus. This can provide a higher capacity of action to teams – in short, a higher capacity to improve existing products and to develop new products. Thus, both findings show that team cohesion and the existence of an innovative vision are factors that reinforce the effect of the autonomy on innovation.

Four main conclusions can be drawn from this research. First, the results show that the innovative vision of the TMT should be accompanied by some intrinsic organisational design factors that produce higher innovation performance. On the

other hand, we derive some conclusions about the key characteristics of work teams that can affect innovation in firms, thereby overcoming the lack of consensus on this issue in the literature. In this respect, autonomy and informal communication are confirmed as the only informal team characteristics that directly influence innovation in organisations. We also confirm the ambiguity in the way characteristics such as diversity or cohesion in teams affect innovation performance. None of these affect innovation individually, but they do have an impact when they are guided by the TMT's vision, or interrelated with autonomy in the case of cohesion. Finally, the results of this research have important implications for academics and managers because we provide recommendations about the importance of and need for work teams in firms, as well as the characteristics of those teams that affect the propensity of firms to develop new and improved products.

Three limitations of this study stand out. One is concerned with the fact that we have analysed the characteristics of work teams in a general way, without distinguishing between the types of team that may influence innovation – work teams or project teams. As Cohen and Bailey (1997) point out, these may have opposite results. The second limitation relates to our analysis of diversity. We have only considered diversity in skills and capabilities, ignoring functional diversity or diversity in the education and training of the team members. Third, we have pointed out the characteristics of work teams that favour innovation in firms, but we have not indicated how these characteristics may be fostered or included in the teams.

All these limitations could be addressed in future research, thereby helping to build a richer and more solid theoretical basis for the study of innovation in firms.

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