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The complementary effect of quality management and proactive market orientation on radical product innovation under environmental uncertainty

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Abstract

Empirical research shows that there is a synergistic relationship between quality management and market orientation that promotes the creation and delivery of value, customer satisfaction, and performance (El Manzani, 2021). By calling on the theory of dynamic capabilities, the main objective of this research is to enrich the literature by studying the effect of the complementarity between quality management and proactive market orientation on radical product innovation, considering the moderating role of environmental uncertainty in this relationship. The results of a quantitative study of 130 ISO 9001 certified companies that have rolled out radical product innovations reveal that the complementarity between quality management and proactive market orientation improves radical product innovation. This synergistic effect becomes more pronounced when the level of environmental uncertainty is high.

Keywords: quality management (ISO 9001), TQM, proactive market orientation, complementarity, radical product innovation, environmental uncertainty, PLS-SEM, Morocco.

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Jean-Jack Cegarra is Professor and Deputy Dean at the IAE Lyon School of Management, Jean Moulin Lyon 3 University, France. He has spent part of his career abroad (Lebanon, Poland, Bulgaria) where he has notably managed an international higher education institution and several research teams. As a member of the Magellan Research Centre (iaelyon School of Management), his involvement in research includes the area of marketing especially brand management.

Introduction

Globalization has drastically changed the economic landscape, which is characterized by rapid change and great uncertainty challenging traditional management models. As a result, firms are obliged to base their business models on both quality and innovation simultaneously to meet market needs with highly innovative products at competitive prices.

To date, empirical studies on the relationship between Quality Management (QM) and product innovation have yielded inconclusive results. This relationship becomes even more ambiguous when considering radical product innovation (RPI). The few studies that have examined the impact of QM on RPI has shown that QM can hinder the development of RPI (Benner and Tushman, 2002; Prester and Bozac, 2012; Blank and Naveh, 2014; Khan and Naeem, 2018; Santos, Miguel-Dávila and Antolín, 2018). To the best of our knowledge, no study has attempted to explore how to make the QM more conducive to this type of innovation. Several authors have simply argued that QM needs to be integrated with other organizational capabilities to strengthen its relationship with product innovation (Prajogo and Sohal, 2006a; Pekovic and Galia, 2009; Manders *et al.*, 2016; El Manzani, El Idrissi and Lissaneddine, 2022). Nevertheless, these authors do not specify what these organizational capabilities are, what their nature is or what the organizational conditions are that would enable them to be integrated appropriately into the QM process to improve product innovation (El Manzani, 2019, 2021).

This research paper proposes Proactive Market Orientation (PMO) as an appropriate organizational capability to be integrated into the QM to support RPI. The choice of PMO is justified by four main points. (1) Both QM and MO are based on a similar theoretical architecture founded on a basic philosophy translated into practical and operational approaches and explicitly anchored in the notion of customer satisfaction (Day, 1994; Mohr-Jackson, Mohr-Jackson and Mohr-Jackson, 1998; Lai, 2003; Yam *et al.*, 2005; Demirbag *et al.*, 2006; Mele, 2007; Lai, Yeung and Cheng, 2012). (2) There is ample empirical evidence that market orientation, in general, supports product innovation (March, 1991; Narver, Slater and MacLachlan, 2004; Baker and Sinkula, 2007) and that PMO, in particular, is a key organizational determinant of RPI (Atuahene-Gima *et al.*, 2005; Bucktowar *et al.*, 2015; Cai, Liu, *et al.*, 2015; Cai, Yu, *et al.*, 2015; Chen, 2015; Li *et al.*, 2008; Tan & Liu, 2014; Tsou *et al.*, 2014). (3) There is a synergistic relationship between QM and MO (Lam *et al.*, 2012; Malik *et al.*, 2012; Pattanayak *et al.*, 2017; Raju & Lonial, 2001; Samat *et al.*, 2006; San Miguel *et al.*, 2016; Santos-Vijande & Álvarez-González, 2009; Sittimalakorn & Hart, 2004; Wang *et al.*,

2012; Yam et al., 2005), and (4) this complementarity enables effective management of the process of creating and delivering customer value (Mele, 2007) and improving business performance (Lai et al., 2012; Lai & Cheng, 2005; Sussan & Johnson, 1997).

Some academics have applied the complementarity concept to gain a deeper understanding of how organizational resources and capabilities complement one another in such a way as to enhance product innovation development (Baker and Sinkula, 1999; Ngo and O’Cass, 2012; O’Cass and Heirati, 2015; Bogers and Lhuillery, 2018). The complementarity between QM and MO nevertheless still lacks strong empirical validation, as there is a predominance of conceptual papers that bring these two concepts closer together than empirical papers (El Manzani, 2021). QM and MO continue to be treated separately and the literature is both theoretically and empirically silent on their complementarity in the context of product innovation.

The main purpose of this study is to understand the extent to which the complementarity between QM and PMO could be beneficial to RPI. It does so in three ways: (1) it examines the separate effects of QM and PMO on QM and RPI; (2) it considers the joint effect of QM and PMO to analyse their complementarity concerning RPI; and (3) rather than just searching for complementarity per se, this study identifies the moderating role of environmental uncertainty in the relationship between the QM-PMO complementarity and RPI as technological innovations are mainly developed to react to environmental factors (e.g. market conditions, technological upheavals).

We view the complementarity relationship between QM and PMO as their ability to work together, overcome their boundaries, and reinforce the impact of each other (Tece, Pisano and Shuen, 1997; Someh, Shanks and Davern, 2019). According to Milgrom & Roberts, (1995), QM and PMO are complementary when the marginal benefits gained from one of them increases with the contribution of the other and vice versa. More precisely, we focus on the QM-PMO complementarity from the complementarity-in-performance approach rather than the complementarity-in-use (Ballot et al., 2015). Through this approach, we are interested in studying the outcomes, in terms of RPI, of using QM and PMO in combination instead of just exploring the existence of a good fit or the mutual link between QM and PMO in practice. To establish the theoretical complementarity between QM and PMO, we rely on the dynamic capabilities framework to conceptualize QM-PMO complementarity as the firm’s capacity to build, integrate, reconfigure and renew market and technological resources and capabilities

simultaneously that allow firms to pursue innovation and value-creating strategies in response to rapidly changing environments (Teece, Pisano and Shuen, 1997; Teece, 2007; Wang and Ahmed, 2007). More specifically, we argue that QM-PMO complementarity is a specific higher-order dynamic capability with emergent properties arising from the interplay between two dynamic capabilities which are QM and PMO.

We proceed as follows: first, we provide a review of the literature and establish the hypotheses for the conceptual model of our research. Second, we describe the study sample and the data collection procedure. Third, we present the results of the estimation of the measurement and structural models. Finally, we conclude with a discussion of the results as well as the theoretical and managerial implications of our research before highlighting the limitations of our study and suggestions for future research.

1. Theoretical framework and hypotheses

1.1. An overview of dynamic capabilities

Dynamic capabilities (DC) are one of the most well-known modern theoretical frameworks in management research. The conceptualizations of DC are often anchored on the three authoritative definitions of Teece, Pisano and Shuen (1997), Eisenhardt and Martin (2000) and Zollo and Winter (2002). According to Teece et al. (1997, p. 516) DC are « *the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments* ». By refining this definition, Eisenhardt & Martin (2000, p. 1107) consider DC as « *the firm's processes that use resources - specifically the processes to integrate, reconfigure, gain and release resources - to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die* ». Following the evolutionary theory, DC are apprehended by Zollo & Winter (2002, p. 340) as « *a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness* ». In brief, DC may be thought of as a distinct subset of organizational capabilities transcending the other capabilities (Teece, 2007) and driving strategic change in the organization (Winter, 2003; Zahra, Sapienza and Davidsson, 2006; Helfat and Winter, 2011) and in its external ecosystem (Schilke, Hu and Helfat, 2018).

The dynamic capabilities framework is theoretically relevant to addressing the question of complementarity between QM and PMO and its implication for RPI. Our choice of this theoretical framework is justified in three points. First, dynamic capabilities are a contemporary framework to understand and explain new sources of competitive advantage by integrating and building on research in the innovation management field. This corresponds closely to our research since we are studying RPI which comes under the management of innovation and is considered a new form of sustainable competitive advantage. Second, dynamic capabilities also stress the development of organizational capabilities and their combinations which are difficult to imitate and allow for the achievement of high performance (Teece, Pisano and Shuen, 1997). In line with this perspective, our research empirically addresses the complementarity between two organizational capabilities (e.i, QM and PMO). Their complementarity is a higher-order dynamic capability that is difficult to imitate, ensuring a high level of performance and a persistent competitive advantage achieved through RPI. In this sense, several studies have used DC to conceptually ground the issue of complementarity between organizational capabilities and their importance for innovation performance (e.g., Moorman and Slotegraaf, 1999; Song *et al.*, 2005). In our research, QM-PMO complementarity is the firm's capacity to build, integrate, reconfigure, and renew market and technological resources and capabilities simultaneously that allow firms to peruse innovation and value-creating strategies in response to rapidly changing environments. Third, since our field concerns innovative firms that often operate in turbulent environments, the dynamic capabilities framework is more appropriate for studying such firms.

1.2. Quality management and radical product innovation

QM is a management philosophy that puts quality at the heart of an organization by involving all its members in its implementation to achieve long-term performance by satisfying the demands of the various stakeholders. In practical terms, QM is a set of principles focusing on the continuous improvement in the efficiency of an organization's processes by empowering and motivating employees to meet market needs (El Manzani, Sidmou and Cegarra, 2017).

Empirical studies on the relationship between QM and product innovation have produced contrasting results. This suggests that there is not enough empirical or theoretical evidence to accept or reject a clear hypothesis of a positive effect of QM on product innovation (Manders *et al.*, 2016). Most existing studies adopt a general approach to product innovation without distinguishing between incremental and radical product innovation. Consequently, little attention has been paid to the association between QM and RPI in the literature. Benner &

Tushman (2002) were among the first to study the relationship between QM and RPI. They found that the process management practice of QM hinders RPI at the expense of incremental innovation because QM is based on a rationale of continuous improvement focusing on exploitative rather than explorative innovation. In contrast, Prester & Bozac (2012) found no association between process orientation and RPI. According to those authors, the lack of association suggests that process management techniques promote exploitation-oriented innovation but not radical exploration innovation. Blank & Naveh (2014) found that the quality climate has no significant effect on RPI performance because it could conflict with some principles of radical innovation, notably risk-taking and thinking “outside the box”. El Manzani, Sidmou & Cegarra (2019) found that QM (ISO 9001) has a stronger positive and significant impact on incremental rather than radical product innovation. This could be due to the structure and particularities of the ISO 9001 standard which does not largely favour the development of RPI. Recently, the study of Escrig-Tena, Segarra-Ciprés and García-Juan (2021) also did not find a significant association between QM and radical product innovation capability proving that the enabling role of QM for breakthrough innovations seems to be more complex.

According to these studies, QM does not strongly promote RPI and may even hinder its development. This is because QM has much in common with incremental innovation from both a tactical and operational standpoint (Nowak, 1997), with both seeking minor improvements to existing products more deeply rooted in the exploitation of the organization’s existing technological capabilities and knowledge. The progressive change generated by QM, based on formalizing and standardizing work inside the organization, remains incompatible with the spirit of radical innovation, which requires more flexibility in its processes and a high degree of uncertainty in the execution of its tasks (Santos-Vijande and Álvarez-González, 2007; O’Connor and Rice, 2013). Moreover, QM places a strong emphasis on current customer needs, which could easily lead the organization to focus solely on incremental improvements to their current products rather than trying to create radical solutions (Prajogo and Sohal, 2001). Consequently, it could be trapped in the *tyranny of the served market* where they see the world only through the eyes of their current customers (Hamel & Prahalad, 1994). Research has shown that paying too much attention to the needs expressed by customers leads firms to be incapable of proposing RPI (Atuahene-Gima, 1996a; Narver et al., 2004).

Hypothesis 1. QM has a negative and significant impact on RPI.

1.3. Proactive market orientation and radical product innovation

MO is among the most important strategic orientations for contemporary firms. Despite the different conceptualizations of MO in the literature (see Lafferty and Hult, 2001; Crick, 2021), they generally build upon two main theoretical and operational perspectives: behavioural (Kohli and Jaworski, 1990) and cultural (Narver and Slater, 1990). The behavioural perspective considers MO as a set of organizational activities related to the generation and dissemination, of and responsiveness to market intelligence, while the cultural perspective conceives MO as corporate culture encompassing organizational norms and values that foster the customer value creation and, as a result, constant superior performance.

In response to the OM's critics, Jaworski et al. (2000) have proposed the two approaches of market-driven (understanding and responding to the behaviour of actors within a given market structure) and market driving (influencing the market structure and/or the behaviour of actors to improve the firm's competitive advantage) for MO. Likewise, Narver et al. (2004) have dichotomized MO into RMO (responsive MO) and PMO (proactive MO). Considered as a customer-led culture, RMO is a set of capabilities to address customer expressed needs related to current products and markets (Narver, Slater and MacLachlan, 2004; Atuahene-Gima, Slater and Olson, 2005; Li, Lin and Chu, 2008; Tsai, Chou and Kuo, 2008). Viewed as a lead-the-customer culture, PMO is a set of capabilities allowing the firm to meet latent customer needs and focus on new products and emerging markets (Narver, Slater and MacLachlan, 2004; Atuahene-Gima, Slater and Olson, 2005; Li, Lin and Chu, 2008; Tsai, Chou and Kuo, 2008). Since our research focuses on PMO, we followed Narver et al. (2004), Jaworski et al. (2000) and Kohli & Jaworski (1990) to conceptualize it as the organization-wide generation of market intelligence about latent customer needs, the dissemination of this intelligence across organizational departments and organization-wide responsiveness to it.

The literature presents a broad consensus on the positive impact of PMO on RPI (Li, Lin and Chu, 2008; Cai *et al.*, 2014; Chen, 2015; Bucktowar, Kocak and Padachi, 2015; El Manzani, El Idrissi and Lissaneddine, 2022). This is because a strong PMO provides the firm with the capacity to obtain, process, and store market information that can alert it to opportunities relating to the new market and technological developments (Atuahene-Gima, Slater and Olson, 2005; Tsai, Chou and Kuo, 2008; Zhang and Duan, 2010b). To identify these opportunities, proactively market-oriented firms use new mechanisms allowing them to observe customer behaviour closely and obtain a deeper understanding of their latent needs within a shorter

timeframe. For example, they can conduct in-depth analyses of customer data such as complaints, product returns, and warranty claims (von Hippel, 1986; von Hippel, Thomke, & Sonnack, 1999). They can also establish cooperative relationships with various environmental stakeholders (Leenders and Wierenga, 2002; Deeds and Rothaermel, 2003), including working closely with lead users (Hippel, 1986; Slater and Narver, 1998; Atuahene-Gima, Slater and Olson, 2005; Bodlaj, Coenders and Zabkar, 2012) who represent a prominent source of new RPI ideas (Atuahene-Gima et al., 2005; Narver et al., 2004).

Radical innovation involves a change in the technical or conceptual paradigm that guides the development of a firm's new products (Mckee, 1992; Chandy and Tellis, 1998). This change requires generative learning (Slater and Narver, 1999). According to theoretical frameworks of organizational learning, PMO can be conceptualized as a process that places greater emphasis on exploring changing customer needs and market trends and is characterized by discovery, variation, risk-taking, and innovation (Tsai, Chou and Kuo, 2008; Tan and Liu, 2014). In this respect, PMO is associated with generative learning, or double-loop learning (Argyris and Schon, 1978), which encourages the exploration of new and diverse information and knowledge, and takes the firm beyond past experiences and experiments by adopting new mental models that pave the way for RPI (Atuahene-Gima et al., 2005; Baker & Sinkula, 2007; March, 1991; Narver et al., 2004).

Hypothesis 2. PMO has a positive and significant impact on RPI.

1.3. Quality management, proactive market orientation, and radical product innovation

QM and PMO build on each other to be mutually reinforcing (Sussan and Johnson, 1997; Longbottom, Mayer and Casey, 2000; Warwood and Roberts, 2004; Bigné *et al.*, 2005; Wang and Wei, 2005; Lai and Cheng, 2005; Demirbag *et al.*, 2006; Samat, Ramayah and Saad, 2006; Mele, 2007; Zelbst *et al.*, 2010; Wang, Chen and Chen, 2012; Lai, Yeung and Cheng, 2012; Lam *et al.*, 2012; Malhotra, Lee and Uslay, 2012; Miguel, Heras-Saizarbitoria and Tarí, 2016; El Manzani, 2021). It has been empirically shown that the synergy between QM and OM leads to value creation and delivery as well as improved customer satisfaction and firm performance (Sussan and Johnson, 1997; Lai, 2003; Mele, 2007). QM and OM nevertheless continue to be treated separately (El Manzani, 2021) and the literature does not consider the effect of their complementarity on product innovation.

Our study anchors the QM-PMO complementarity in the dynamic capability theory. We conceptualize QM-PMO complementarity as the firm's capacity to build, integrate, reconfigure and renew market and technological resources and capabilities simultaneously that allow the firm to pursue innovation and value-creating strategies in response to rapidly changing environments (Teece, 2007; Wang & Ahmed, 2007). We see it as a high-order dynamic capability that encompasses the properties of dynamic capabilities of both QM and PMO. It comprises the more metaphysical strategic insights, as defined by Collis (1994), that enable firms to recognize the intrinsic value of other resources (especially knowledge resources) or to develop novel innovation strategies before competitors. Because innovation is the result of a new application of existing and acquired knowledge, QM-PMO complementarity represents organizational processes by which firms acquire, synthesize and exploit technological and marketing knowledge in a combinatorial manner and generate new applications from this knowledge in the form of RPI (Kogut and Zander, 1992). QM is an internal dynamic capability by which an organization implements continuous improvement actions designed to enhance operational efficiency through process improvement (Yeung, 2008; Lai, Yeung and Cheng, 2012). PMO is seen as a more external dynamic capability that allows an organization to respond actively, proactively, and even aggressively to market demands by using knowledge from customers, competitors, and dynamic market trends (Kohli and Jaworski, 1990; Day, 1994; Lai, Yeung and Cheng, 2012). Accordingly, QM is a dynamic capability that refers to technology-based organizational behaviour while OM refers to market-based behaviour (Gummesson, 1991; Easterby-Smith and Prieto, 2008).

RPI requires integration between technological opportunities and market needs (Tushman and Nadler., 1986; Dougherty, 1992) by combining technology and market-related organizational capabilities (Danneels, 2002; Danneels & Kleinschmidt, 2001; Dougherty, 1992; Hoffmann, Mathieu, Roehrich & Valette-Florence, 2007). Several studies have demonstrated the positive effect of combining ordinary technological and marketing capabilities with product innovation (Gatignon and Xuereb, 1997; Moorman and Slotegraaf, 1999; Leng et al., 2015; Zang and Li, 2017). On the one hand, a firm with strong technological capabilities needs marketing capabilities to be able to use scientific knowledge to rapidly develop products offering new benefits and creating value for customers (McEvily, Eisenhardt and Prescott, 2004). On the other hand, a firm with strong marketing capabilities needs technological capabilities to be able to use its in-depth understanding of customer needs to drive new product development and organize marketing activities offering unique value to customers (Day, 1994).

Developing ordinary technological and marketing capabilities requires dynamic capabilities (Cepeda and Vera, 2007; Protogerou, Caloghirou and Lioukas, 2012; Wilden and Gudergan, 2014). QM-PMO complementarity can enable an organization to modify or design new technological and marketing capabilities when seeking to introduce RPI. In this sense, adopting QM has been shown to have a positive effect on the development of technological capabilities (Perdomo-Ortiz, González-Benito and Galende, 2009; Camisón and Puig-Denia, 2015), while it has been demonstrated that MO has a positive impact on the development of marketing capabilities (O’Cass and Ngo, 2011; Ngo and O’Cass, 2012; O’Cass and Heirati, 2015). While the complementarity between these ordinary capabilities might be crucial for RPI, the complementarity between the dynamic capabilities responsible for their conception would be even more essential for RPI.

Hypothesis 3. QM-PMO complementarity has a positive and significant impact on RPI.

1.4. The moderating role of environmental uncertainty

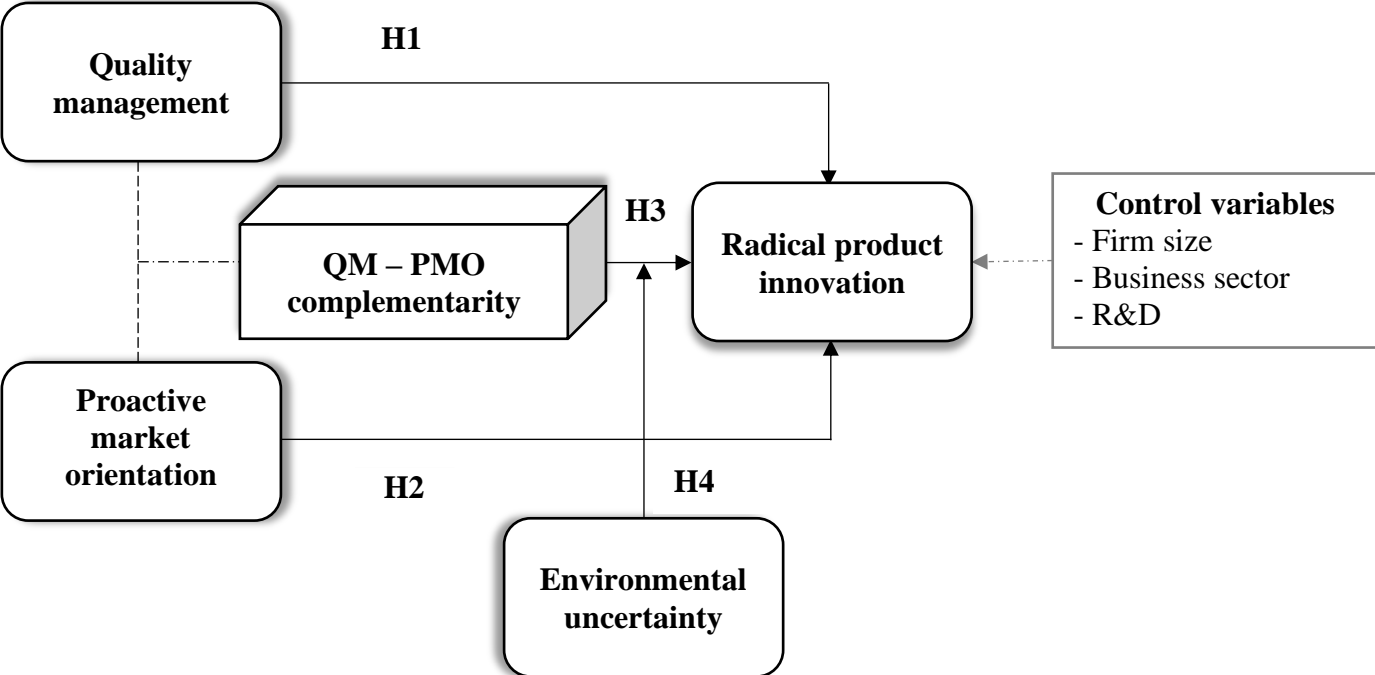
The external environment is an important element that firms cannot ignore because it conditions their strategic choices. In this sense, environmental uncertainty is the degree to which the external environment is perceived as predictable or unpredictable by an organization. The importance of MO and the scope of its consequences vary according to the environmental context of an organization (Jaworski and Kohli, 1993). Several empirical studies have found that MO has a greater effect on innovation when environmental uncertainty is higher (Grinstein, 2008a; Prakash and Gupta, 2008; Augusto and Coelho, 2009; Zhang and Duan, 2010a). Moreover, some academics have incorporated environmental characteristics into the direct relationship between PMO and product innovation (Tsai, Chou and Kuo, 2008; Bodlaj, Coenders and Zabkar, 2012). Others have recommended that the external environment be taken into account when considering the complementarity of MO with other strategic orientations (e.g. Grinstein, 2008b).

Preliminary work in the field of Quality has investigated the role of environmental uncertainty in adopting QM (e.g. Hashem & Tann, 2007). Authors argue that QM outcomes can be influenced by the external environment (Reed, Lemak & Montgomery, 1996; Sitkin & Sutcliffe, 1994). For instance, the meta-analyses of Nair (2006) and Xu, Peng, Pavur & Prybutok (2020) highlighted the presence of a moderation effect of certain factors of environmental uncertainty (e.g. competition) in QM practice–performance relationships. However, no research has incorporated environmental factors into the relationship between QM and product innovation.

Lai & Cheng (2005) highlighted the relevance of including variables from the external environment to moderate the effect of the complementarity between the QM and MO on performance. In a similar vein, we feel that it is important to incorporate the role of environmental uncertainty into the association between QM-PMO complementarity and RPI. As this uncertainty often conditions the processes underpinning a firm’s innovation-related decision-making and behaviours (Zhang et al., 2019), a high level of environmental uncertainty will reinforce the need to better combine QM and PMO to achieve RPI. According to the findings of Cassiman & Veugelers (2006), the complementarity of any two organizational activities for the success of a new product can be sensitive to other factors of the firm’s strategic and external environment. We expect that environmental uncertainty will positively moderate the relationship between the QM-PMO complementarity and RPI.

Hypothesis 4. Environmental uncertainty positively and significantly moderates the impact of QM-PMO complementarity on RPI.

Figure 1 Conceptual research model



2. Research methodology

2.1. Sample and data collection

The sample firms in this research were innovative Moroccan firms with ISO 9001 certification. The reason for focusing only on ISO 9001 certified firms is to avoid certain biases related to the degree of maturity of the QM system between certified and non-certified firms. As the population of the ISO 9001 certified and innovative Moroccan firms remains unknown, we decided to build our database using the non-probability method of purposive sampling. Purposive sampling may be the only option when a researcher does not have a sampling frame, or the desired population for the study is rare or very difficult to identify (Burnette and Williams, 2005). To do so, we followed a two-step process: (1) we began by identifying innovative firms, and (2) we excluded innovative firms not certified ISO 9001. During this process, a variety of information sources were prioritized. We mainly used firms' websites, and some commercial websites offering directories of Moroccan firms (e.g., www.kerix.net, www.maroc1000.net, www.ma.kompass.com). In addition to these websites, we consulted the directories of public institutions and professional associations of Moroccan industries. At the end of the process, we shortlisted 320 firms that we contacted to determine if they met the study criteria and would agree to participate, before arriving at a sampling frame containing a sample of 240 firms.

A self-administered online questionnaire, translated following the conventional back-translation process from English to French, was used to collect data since all items were adopted from prior English-language studies with the help of two French-English bilingual professors. The French version of the question was revised with a group of 11 individuals, comprising both professionals and academics, to avoid any potential ambiguities in the questions/items and to improve their clarity. Furthermore, this version was pre-tested with 20 firms, allowing us to run an initial assessment of their psychometric quality before the questionnaire was distributed.

Between January and June 2017, the questionnaire was sent to the quality managers, R&D managers, and owners/directors of the selected firms. These managers were better qualified to enjoy a thorough understanding of QM, MO, and innovation within their organizations and to provide relevant information (El Manzani, Sidmou and Cegarra, 2019; El Manzani, El Idrissi and Lissaneddine, 2022). Also, collecting the answers for the dependent and independent variables from those different respondents helps to avoid concerns of common method bias. After several follow-up emails, 130 usable questionnaires were retained after eliminating those

with missing answers and those showing signs of suspicious answers, giving a response rate of 54.16%. This rate is deemed to be good as it is similar to studies in top-tier journals that report response rates above 50% (see Baruch & Holtom, 2008).

From a statistical point of view, a sample size of 130 firms is satisfactory as it ensures the minimum sample size required to perform partial least squares structural equation modelling (PLS-SEM) and complies with Cohen's (1992) recommendations on sample size for the PLS method (see Henseler et al., 2014, p. 21). Indeed, this sample allows (1) a statistical power of 80% for a minimum R^2 value of 0.25 (Cohen, 1992), (2) a probability of error of 1% and (3) a value of $R^2 = 0.25$, reflecting the minimum variance in the endogenous variable (RPI) explained by the exogenous variables (Hair, Ringle and Sarstedt, 2011; Hair *et al.*, 2014; Hair *et al.*, 2017; Ringle *et al.*, 2018). Table 1 presents the demographics of the sample and the profile of the respondents.

Table 1 The demographics of the sample and the profile of respondents

Firm characteristics	Frequency	%	Respondent characteristics	Frequency	%
● Industry types			● Gender		
<i>Industry</i>	95	73.1	<i>Female</i>	52	40
<i>Service</i>	35	26.9	<i>Male</i>	78	60
● Annual revenue (in millions of MAD)			● Age		
< 1	11	8.5	20 - 30	48	36.9
1 - 10	28	21.5	31 - 40	52	40
10 - 175	78	60	41 - 50	23	17.7
> 175	13	10	> 50	7	5.4
● No. of employees			● Position		
< 50	12	16.2	<i>Owner</i>	14	10.8
50 – 200	41	13.5	<i>Quality manager</i>	40	53.8
200 – 500	54	41.5	<i>R&D manager</i>	11	8.5
> 500	14	10.8	<i>Others</i>	35	26.9

2.2. Variables measure Measurements of the variables

Quality management was operationalized as a reflective-reflective second-order (Type I, Mode A) (Becker, Klein and Wetzels, 2012) construct with six quality practices as its first-order indicators. These practices concern leadership, customer focus, involvement of people, mutually beneficial supplier relationships, process approach and continuous improvement. The first five practices were measured by items adopted from Lee, To & Yu (2009), while the last practice of continuous improvement was measured by items adopted from Psomas & Antony

(2015). We used these six practices because they have often been cited as important QM practices in the QM field of research, and some of them implicitly cover or incorporate other practices (see Xu et al., 2020).

Proactive market orientation was measured using the Narver et al. (2004) eight-item scale. This scale has been widely adopted by researchers dealing with various issues related to product innovation, in different sectors and countries (Tsai, Chou and Kuo, 2008; Zhang and Duan, 2010b; Beck et al., 2011; Chou and Yang, 2011; Bodlaj, Coenders and Zabkar, 2012; Yannopoulos, Auh and Menguc, 2012; Ozdemir, Kandemir and Eng, 2017)

For ***QM-PMO complementarity***, this study followed Tanriverdi & Venkatraman (2005) in operationalizing QM-PMO complementarity as a higher-order formative construct consisting of QM and PMO as two theoretically distinct, non-interchangeable constructs, each of which contributes to its composition (Diamantopoulos and Winklhofer, 2001). Our approach was similar to that adopted by several authors (Tanriverdi and Venkatraman, 2005; Pavlou and Sawy, 2006; Chen, Li and Evans, 2012; Bauer and Matzler, 2014) who have operationalized complementarity as a higher-order construct under the PLS method.

We chose this operationalization for statistical and theoretical reasons. Statistically, researchers often study the complementarity effect, opting for the pair-wise interaction test which is designed more for the moderation effect rather than the complementarity effect. It is not clear, therefore, whether the significance of the pair-wise interaction term provides empirical evidence for the complementarity of the variables or the moderation effect. Such interpretational confounding can break down the sophisticated theoretical development and explanation underpinning a complementarity hypothesis (Tanriverdi and Venkatraman, 2005). Theoretically, we conceptualized QM-PMO complementarity as a higher-order dynamic capability resulting from an effective articulation between QM and PMO. Based on this conceptualization, a statistical interaction cannot directly conceptualize the unique properties of QM-PMO complementarity that emerge from the combination of QM and PMO and their value (Someh, Shanks and Davern, 2019).

Radical product innovation refers to the market rollout of a new product that differs significantly from the firm's previous products and those of its competitors. It was measured through eight items drawn from Guimarães, Severo, Dorion, Coallier, & Olea (2016), Kim, Kumar, & Kumar (2012) and Prajogo & Sohal, (2006).

Environmental Uncertainty was operationalized as a reflective second-order construct consisting of two dimensions which are competitive intensity and market turbulence. Competitive intensity refers to uncertainty about competitors, their market strategies, and product offerings (Slater, Mohr and Sengupta, 2014). Market turbulence represents the magnitude, frequency, and unpredictability of changes in client-related issues (e.g. changes in client preferences and composition) (Jaworski and Kohli, 1993; Workman and Jr., 1993; Menon, Jaworski and Kohli, 1997). All of the items of competitive intensity and market turbulence have been adapted from Jaworski & Kohli (1993).

All first-order constructs were based on multi-item Likert scales ranging from 1: strongly disagree to 5: strongly agree.

Control variables: given the differences between the firms in our sample, the study controlled for the firm's business sector, age, and R&D. These variables might directly influence the firm's RPI or lead to an over- or underestimation of the relationships in the conceptual model. The larger the firm, the more it would have the means to carry out R&D activities related to RPI. Again, RPI differs across industries, as some sectors are more dynamic and have higher innovation potential. Firm size was measured by the number of employees, while the business sector was measured by a dummy variable distinguishing between industrial and service firms. Similarly, for R&D, we asked managers if their firms have an R&D department.

3. Data analysis

The conceptual framework of our study was tested through structural equation modelling (SEM) using the partial least squares (PLS) method, employing the statistical software SmartPLS 3.0. We opted for this method for the following reasons. (1) PLS-SEM is more appropriate for prediction-oriented research (i.e., theory development) rather than confirmatory studies (Hair, Ringle and Sarstedt, 2011; Hair *et al.*, 2012; Richter *et al.*, 2016). In this study, the goal of our conceptual model focuses on prediction and explaining the variance of RPI through the QM-PMO complementarity, this relationship between QM-PMO complementarity and RPI is a new phenomenon to be investigated and developed. (2) PLS-SEM is suitable for analysing complex structural models with many constructs and indicators (Richter *et al.*, 2016; Sarstedt *et al.*, 2016). This research starts from a structural model containing 13 constructs. (3) The PLS algorithm does not require a normal distribution of data (Hair, Hult, Ringle, & Sarstedt, 2017). (4) The PLS algorithm does not require a normal distribution of data (Hair, Hult, Ringle, & Sarstedt, 2017). The normality test showed that our data do not follow a normal

distribution. (5) PLS is more efficient and has good statistical power when the study sample is smaller than 250 observations (Reinartz, Haenlein and Henseler, 2009), as in our study. Finally, PLS is also more appropriate for estimating research models that incorporate formative and higher-order constructs. In this study, the QM-PMO complementarity is a higher-order formative construct. All these reasons that apply to our study justify the use of PLS-SEM.

3.1. Common method bias

The use of a single survey method raises the potential of common method bias. To examine our study for common method bias, we performed Harman's single-factor test through an exploratory principal components factor analysis of all the construct items to determine if a single latent factor could emerge from our data (Podsakoff et al., 2003). The results of the principal component factor analysis revealed that only one factor accounted for 41.9% of the variance (less than 50%) (Podsakoff et al., 2003). Besides, the variance inflation factors (VIFs) of the latent constructs in all our models are below the 3.3 threshold recommended by Kock (2015). Taken together, these results indicate that our study is free from common method bias.

3.2. Measurement model assessment

The reflective latent low constructs were assessed for convergent validity (item loadings, composite reliability, average variance extracted (AVE)), and discriminant validity (heterotrait-monotrait (HTMT) ratio of correlations). The same criteria were also applied to evaluate the reflective high-order constructs of QM and environmental uncertainty created using the disjoint two-stage approach (Sarstedt et al., 2019). As shown in Table 2, the item loading of all the lower-order constructs exceeded the recommended value of 0.70 (Hair, Hult, Ringle, & Sarstedt, 2017), except for items MBSR1, CoI4, CoI6 which were deleted because their items loading were below this cut-off value. The composite reliability for each construct was greater than 0.70 (Hair, Sarstedt, Ringle, & Gudergan, 2017; Henseler, Ringle, & Rudolf, 2009), and the AVE exceeded the threshold of 0.5 (Chin, 1998).

QM-PMO complementarity was operationalized as a reflective-formative higher-order construct (Type II, Mode B) (Becker, Klein and Wetzels, 2012) by applying the disjoint two-stage approach (Sarstedt et al., 2019). We then applied the assessment of the formative measurement model's guidelines for the construct of QM-PMO complementarity operationalized as a higher-order construct. In that sense, we evaluated the multicollinearity between QM and PMO and the significance and relevance of their outer weights. In table 4, we

noted that multicollinearity is not present, as no value of VIF exceeded the suggested threshold of 3.3 (Diamantopoulos and Siguaw, 2006). Furthermore, the outer weights of QM and PMO on the construct of QM-PMO complementarity are significant. There is empirical support to retain the dimensions. QM and PMO are two dimensions that form the QM-PMO complementarity. More specifically, QM accounts for 45.9% and PMO 61.1% of the variance in QM-PMO complementarity.

Table 2 Validity and reliability for constructs

Construct	Measurement items	Loadings	Composite reliability	AVE
Leadership	L1	0.841	0.942	0.764
	L2	0.867		
	L3	0.876		
	L4	0.887		
	L5	0.897		
Customer focus	CF1	0.857	0.944	0.771
	CF2	0.873		
	CF3	0.897		
	CF4	0.896		
	CF5	0.866		
Involvement of people	IOP1	0.783	0.937	0.749
	IOP2	0.845		
	IOP3	0.912		
	IOP4	0.908		
	IOP5	0.874		
Mutually beneficial supplier relationships	MBSR2	0.892	0.919	0.790
	MBSR3	0.889		
	MBSR4	0.803		
Continuous improvement	CI1	0.869	0.958	0.82
	CI2	0.921		
	CI3	0.936		
	CI4	0.927		
	CI5	0.872		
Process approach	PA1	0.929	0.959	0.855
	PA2	0.888		
	PA3	0.949		
	PA4	0.932		
Quality management	Leadership	0.88	0.949	0.758
	Customer Focus	0.866		
	Involvement of people	0.87		
	MBSR	0.804		
	Continuous improvement	0.938		
Proactive market orientation	Process approach	0.861	0.951	0.707
	PMO1	0.808		
	PMO2	0.814		

		PMO3	0.871		
		PMO4	0.836		
		PMO5	0.745		
		PMO6	0.905		
		PMO7	0.86		
		PMO8	0.874		
		RPI1	0.905		
		RPI2	0.96		
		RPI3	0.961		
	Radical product innovation	RPI4	0.967	0.988	0.913
		RPI5	0.944		
		RPI6	0.968		
		RPI7	0.971		
		RPI8	0.967		
		CoI1	0.798		
	Competitive intensity	CoI2	0.876	0.884	0.657
		Co3	0.757		
		CoI5	0.808		
		MT1	0.82		
		MT2	0.867		
	Market turbulence	MT3	0.904	0.906	0.659
		MT4	0.73		
		MT5	0.722		
	Environmental uncertainty	Competitive intensity	0.811	0.861	0.757
		Market turbulence	0.925		
	Higher-order constructs	Lower-order constructs	Outer weight	T-value	VIF
	QM-PMO complementarity	Quality management	0.459	27.105***	2.223
		Proactive market orientation	0.611	29.107***	2.223

* $p < 0.10$ ($t > 1.645$); ** $p < 0.05$ ($t > 1.96$); *** $p < 0.01$ ($t > 2.57$)

The HTMT criterion was used to test the discriminant validity constructs because it is more conservative and strongly recommended for establishing discriminant validity. According to Table 3, the HTMT values are below 0.9 (Henseler, Ringle and Sarstedt, 2015), indicating that discriminant validity is achieved for all constructs.

Table 3 Heterotrait-monotrait ratio of correlations (HTMT)

	Environmental uncertainty	Firm size	Business sector	PMO	QM	R&D
Environmental uncertainty						
Firm size	0.042					
Business sector	0.103	0.2				
PMO	0.737	0.15	0.121			
QM	0.557	0.088	0.132	0.787		

R&D	0.146	0.122	0.198	0.129	0.094	
RPI	0.566	0.167	0.022	0.372	0.281	0.329

3.3. Structural model assessment

Once the measurement model is reliable and valid, the next phase of the assessment of the proposed structural model is conducted. Before, we began by analysing the multicollinearity between the exogenous variables through the variance inflation factor values that should be below the common cut-off threshold of five (Hair, Hollingsworth, Randolph, & Chong, 2017). The VIFs for all our constructs in the three structural models are below five, indicating the absence of multicollinearity issues.

A bootstrapping procedure using 5,000 bootstrap resamples with no sign change (Chin, 1998; Hair et al., 2012) was then carried out to generate the statistical significance (t-values) for each path in the three models. As PLS does not produce overall goodness-of-fit indices, the quality of our models was established by evaluating the coefficient of determination (R^2), the effect size (f^2), the cross-validated redundancy (Q^2) and the standardized root mean square residual (SRMR) (Henseler, Ringle and Rudolf, 2009; Hair et al., 2014; Henseler, 2017; Ringle et al., 2018).

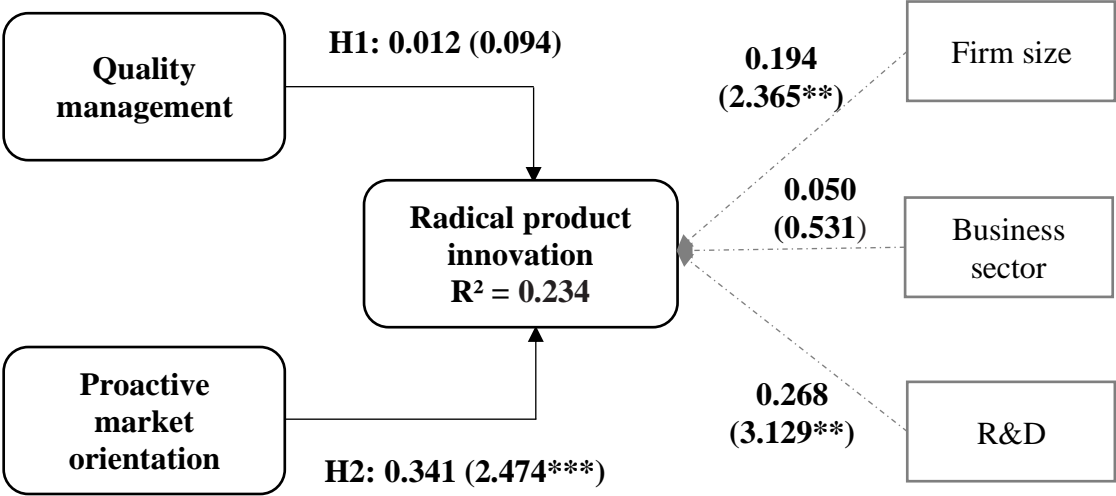
To accept R^2 , this study followed the recommendation of Cohen (1988) indicating that values of 0.02, 0.13, 0.26 are respectively considered as weak, moderate, and substantial levels of predictive accuracy. Likewise, effect size values (f^2) of 0.02, 0.15, and 0.35 are interpreted as small, moderate, and large effects (Cohen, 1988). The cross-validated redundancy (Q^2), obtained by the blindfolding procedure, stipulates that a Stone-Geisser Q^2 value greater than zero for a specific endogenous construct verified that the structural model has a satisfactory predictive relevance (Henseler, Ringle and Sinkovics, 2009). Finally, the SRMR examined the predictive relevance of the model with a value of 0.08 or 0.10 indicating that it has a good model fit (Hu and Bentler, 1999; Henseler et al., 2014). All these model assessment criteria are summarized in Table 4.

3.3.1. The separate effects of quality management and proactive market orientation on radical product innovation (Model 1)

The results of Model 1 indicate that QM does not significantly impact RPI ($\beta = 0.012$; $T = 0.094$) and that PMO positively and significantly impacts RPI ($\beta = 0.341$; $T = 2.747$; $p < 0.01$). This leads us to reject hypothesis H1 and accept H2.

The examination of the coefficient of determination R^2 shows that the first model accounts for 23.4% of RPI, which indicates an acceptable moderate level of predictive accuracy (Chen, 1988). The effect size of QM on RPI is $f^2 = 0.000$. This very small value confirms that QM does not affect RPI. For the effect size of PMO, $f^2 = 0.068$ indicates that PMO has an acceptable and low effect on RPI. The predictive relevance Q^2 for IPR ($Q^2 = 0.151$) is greater than 0, which indicates that the model has sufficient predictive relevance. The SRMR is 0.047, showing that the first model has a good level of fit.

Figure 2 Model 1 of the separate effects



* $p < 0.10$ ($t > 1.645$); ** $p < 0.05$ ($t > 1.96$); *** $p < 0.01$ ($t > 2.57$)

3.3.2. The complementarity effect of quality management and proactive market orientation on radical product innovation (Model 2)

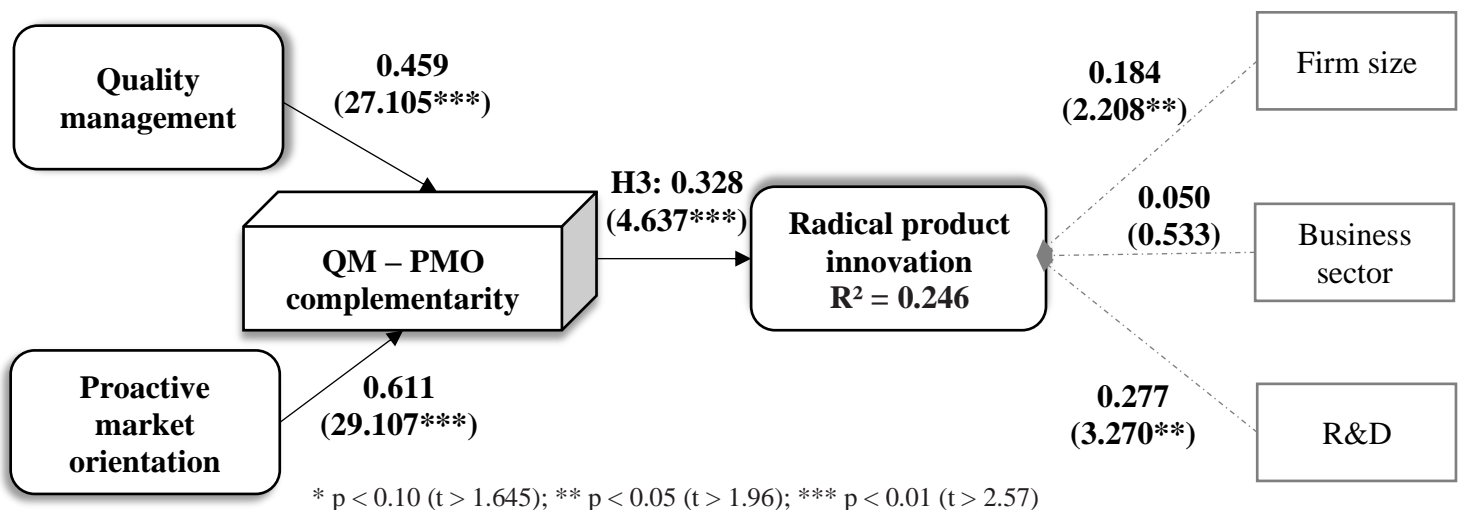
The results of the second model (figure 3) show that QM-PMO complementarity, as a second-order formative construct accounting for the combined effect of QM and PMO, positively and significantly impacts RPI ($\beta = 0.328$; $T = 4.637$; $p < 0.01$). We obtain supportive evidence of complementarity from the significant and positive standardized beta coefficient. Thus, hypothesis H3 is supported.

Examination of the predictive power of RPI shows that QM-PMO complementarity explains 23.4% of the variance of RPI considered at a moderate level (Chen, 1988). The effect size (f^2) of the QM-PMO complementarity on RPI is 0.134 showing that the effect is moderate. Compared to the effect sizes in model 1, we notice that the effect of QM-PMO complementarity is greater than the sum of the separate effects of QM and PMO, f^2 (QM-PMO complementarity)

= 0.134 > f^2 (QM + PMO) = 0.068. On the other hand, if we compare the R^2 of the RPI between models 1 and 2, we notice a small improvement in R^2 of 0.012. Although this increase may appear small, it could reflect the complementarity effect and should not be ignored. Referring to Ennen & Richter (2010), complementarity depends largely on the output sought, which in our case is RPI. It should not be forgotten that radical innovation is complex, requiring complementarities between several different organizational capabilities. That said, other forms of complementarities that improve R^2 more than QM-PMO complementarity may exist.

The Q^2 value, which is well above zero for IPR ($Q^2 = 0.210$), confirms the predictive relevance of the second model. Furthermore, the value of the SRMR (0.083) is well below the threshold of 1.00 (Hu & Bentler, 1999) concluding that the second model has a good fit.

Figure 3 Model 2 of the complementarity effect



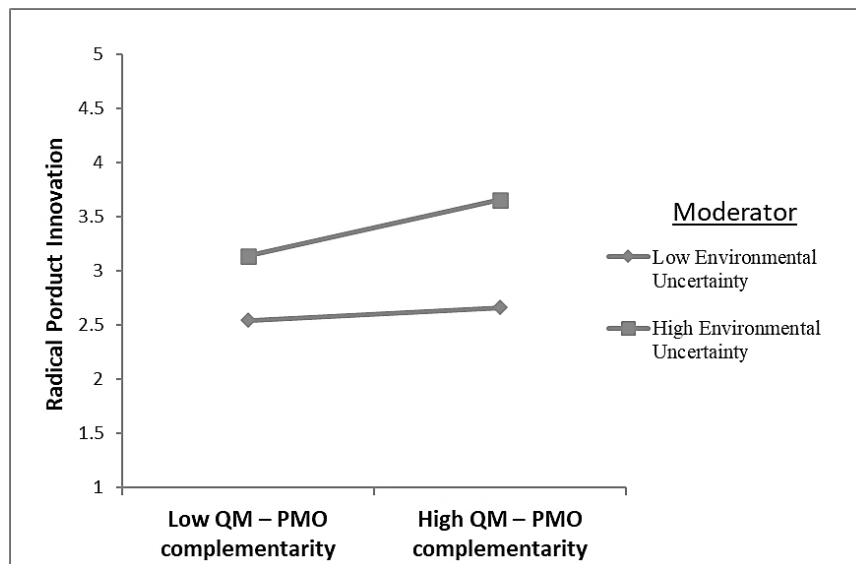
3.3.3. The moderating effect of environmental uncertainty (Model 3)

For a moderation analysis under PLS-SEM, the approach adopted to calculate the interaction term must be carefully chosen (Henseler and Chin, 2010). We applied the two-stage approach because it is more appropriate when the independent and/or the moderating variable is formative (Fassott, Henseler, & Coelho, 2016; Hair, Hult, et al., 2017). This choice is justified, as the independent variable of the complementarity between QM and PMO is a formative high-order construct.

To confirm the existence of a moderation effect, it should be significant and assist the causal relationship between the exogenous and endogenous variables. Accordingly, our results show that the impact of QM-PMO complementarity on RPI varies with the degree of environmental uncertainty. In other words, a high level of environmental uncertainty reinforces this impact (β

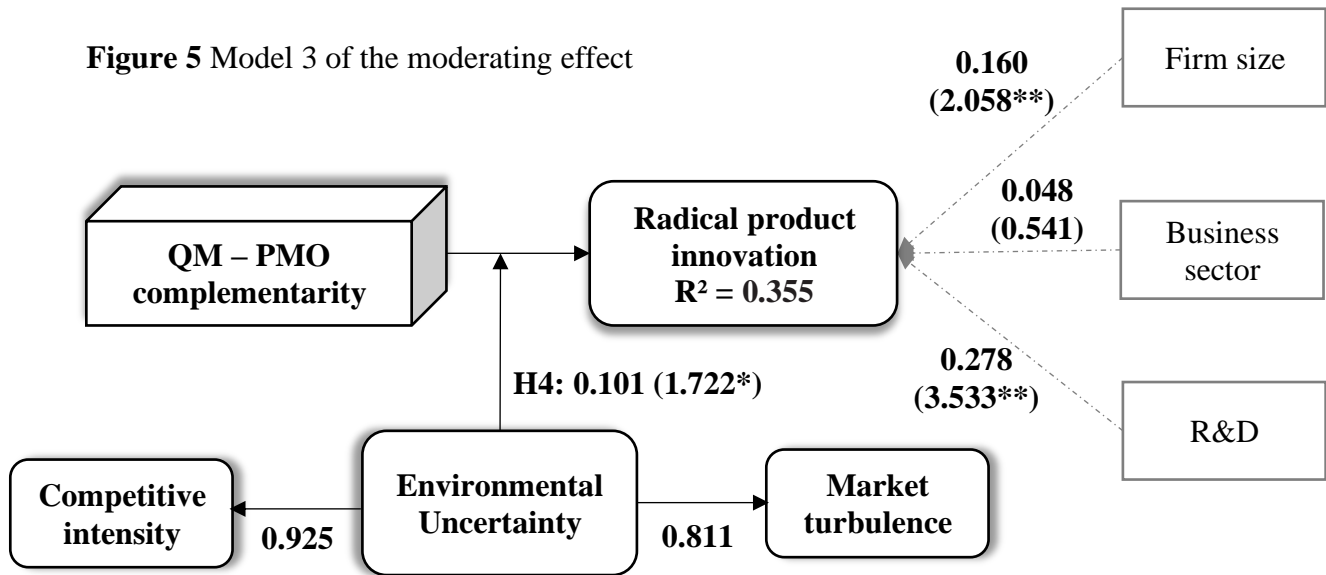
= 0.101; $T = 1.722$; $p < 0.10$). Therefore, hypothesis H4 is supported. Figure 4 provides a visual representation of the moderating effect of environmental uncertainty. The graph reveals that the effect of the complementarity QM-PMO on RPI is stronger when the level of environmental uncertainty is higher.

Figure 4 The interaction between QM-PMO complementarity and environmental uncertainty on radical product innovation (Model 3)



The moderating model accounts for 35.5% of the RPI. When calculating the effect size of the environmental uncertainty, the results suggest a small effect size ($f^2 = 0.029$). According to Chin, Marcolin, Newsted, & Newsted (2003), a small effect size does not necessarily mean that the moderating effect is negligible. The results of the Blindfolding procedure for RPI ($Q^2 = 0.381$) show that the model has a satisfactory predictive relevance. The SRMR analysis gives a value of 0.083, which is below the 0.10 threshold (Hu & Bentler, 1999), thus confirming the overall fit of the moderation model.

Figure 5 Model 3 of the moderating effect



* $p < 0.10$ ($t > 1.645$); ** $p < 0.05$ ($t > 1.96$); *** $p < 0.01$ ($t > 2.57$)

Table 4 Hypotheses testing results

Hypotheses	Beta	T-value	R ²	f ²	Q ²	SRMR	Decision
H1: QM --> RPI	0.012	0.094	0.234	0.000	0.221	0.047	Rejected
H2: PMO --> RPI	0.341	2.474**	0.234	0.068	0.221	0.047	Supported
H3: QM-PMO complementarity --> RPI	0.328	4.637***	0.246	0.134	0.210	0.083	Supported
H4: EU* QM-PMO complementarity --> RPI	0.101	1.722*	0.355	0.027	0.318	0.083	Supported

* $p < 0.10$ ($t > 1.645$); ** $p < 0.05$ ($t > 1.96$); *** $p < 0.01$ ($t > 2.57$)

3.3.4. Robustness test

To test the potential interaction or moderation effect of QM and PMO, we tested the moderating effect of PMO in the relationship between QM and RPI ($\beta = 0.021$; $T = 0.53$). The interaction term is not significant, which suggests that the moderating effects of QM and PMO on RPI does not exist and instead proves their complementary effect.

4. Discussion

Testing of the hypothesis linking QM with RPI reveals that its effect is insignificant. This result shared similarities and complements several existing studies (Benner and Tushman, 2002; Prester and Bozac, 2012; Blank and Naveh, 2014; El Manzani, Sidmou and Cegarra, 2019; Escrig-Tena, Segarra-Ciprés and García-Juan, 2021; El Manzani, El Idrissi and Lissaneddine, 2022). This can be explained by the principle of continuous improvement, which is at the heart of the QM. This principle leads to gradual changes within the organization at the strategic,

organizational, and operational levels that are more conducive to incremental rather than radical product innovation.

At the strategic level, QM places more emphasis on cost reduction, which could limit the capacity and opportunities for RPI. It increases risk aversion and imposes an adaptive approach on the firm, which becomes strategically imitative or a follower rather than being innovative or leader (Prajogo and Sohal, 2001). Such a strategic orientation is closely associated with the production of incremental innovations for existing markets involving a low degree of uncertainty. At an organizational level, QM leads to the emergence of a culture characterized by conformity and standardization (Naveh, Erez and Paradigm, 2004). As a result of this culture change, the organization can focus more on incremental improvements, which limit the scope for creative ideas, overcoming current organizational routines, and risk-taking, which are the bases for radical innovation (Blank and Naveh, 2014; Manders *et al.*, 2016). At the operational level, QM focuses on gradual changes in the different operational processes of an organization that require standardization and formalization to establish control and stability within the organization. Song & Su (2015) explain that the creation of entirely new products implies a high level of innovativeness, and that strict control of processes largely hampers the creativity required. By focusing on compliance and reducing errors and variations in processes, employees, especially those in R&D, will be locked into adaptive learning with a low degree of enthusiasm and initiative, as they will be less willing to give free rein to their creativity or envisage radical changes in work processes or products (Song and Su, 2015). Continuous improvement develops an analytical, structural, and linear thinking in employees that is better suited to incremental product innovation as opposed to the synthetic, unstructured, and non-linear thinking necessary to create RPI (Benner & Tushman, 2002; Prajogo & Sohal, 2001; Tushman & Anderson, 1986).

On the question of the impact of PMO on RPI, our study finds that PMO is a determinant of RPI. This finding provides further support for existing empirical findings that reveal the importance of a PMO for the success of RPI (Atuahene-Gima, Slater and Olson, 2005; Li, Lin and Chu, 2008; Cai *et al.*, 2014, 2015; Tan and Liu, 2014; Tsou, Chen and Liao, 2014; Bucktowar, Kocak and Padachi, 2015; Chen, 2015; El Manzani, El Idrissi and Lissaneddine, 2022).

PMO provides the cultural foundation for generative, or double-loop, learning that emphasizes the development of new ways of looking at the external environment (Narver and Slater, 1998;

Argyres and Mayer, 2007; Chang *et al.*, 2014). This form of learning is revolutionary and more likely to lead to radical innovation (Slater & Narver, 1995). Firms with a PMO explore latent and future customer needs over the long term (Cai *et al.*, 2014), allowing them to learn from the market and generate highly innovative ideas that will translate into RPI. They lead customers in meeting their latent needs by thinking creatively about how to provide radical solutions to those needs (Jaworski and Kohli, 1993; Day, 1994; Slater and Narver, 1998). In the same vein, PMO leads employees towards generative learning by adopting new mental models that pave the way for RPI (Baker & Sinkula, 2007; Chen, 2015). More specifically, PMO develops a culture of risk-taking, seeking new information and experimenting with new ideas within the organization that is compatible with radical innovation (Atuahene-Gima and Ko, 2001; Baker and Sinkula, 2007). This culture makes an organization more open to different sources of information (customers, suppliers, competitors, and public and private research institutions) to acquire resources and new ideas that will give rise to RPI. All this allows PMO to play an important role in the evolution of a firm's innovative capacity (Atuahene-Gima and Ko, 2001). It positively influences the development of exploration and innovation capabilities. When firms can absorb key knowledge that is sometimes difficult to access on the market, they use it to modify their existing capabilities or integrate new capabilities to change market conditions by introducing RPI (Morone, 1993; Tsou, Chen and Liao, 2014).

Our research confirmed that the synergy between QM and PMO has a positive and significant impact on RPI. It extends existing studies that have shown that the synergy between QM and OM leads to value creation and delivery and improved customer satisfaction and firm performance (Sussan and Johnson, 1997; Lai, 2003; Mele, 2007). We also support studies that have confirmed the joint effect of some internal and external capabilities on the firm's product innovation capacity (Baker and Sinkula, 1999; Filippini, Salmaso and Tassarolo, 2004; Fores *et al.*, 2011; Ngo and O'Cass, 2012; O'Cass and Heirati, 2015; Bogers and Lhuillery, 2018). Looking at the previous hypotheses, PMO has a positive and significant impact on RPI, while the link between QM and RPI is not significant. It appears that the PMO contributes to the enhancement of the role of QM in RPI by transforming it from market-driven QM to market-driving QM. Market-driving QM involves QM practices that aim to discover the unknown and to pursue new products and processes that are more innovative for the firm (Zhang *et al.*, 2012). On the other hand, QM further supports PMO involvement in RPI development. Baker & Sinkula (2005) argue that strong OM needs to be complemented by capabilities that strengthen the marketing-R&D relationship. The absence of such a connection would risk paralyzing the

ability of firms to develop RPI successfully. For this purpose, QM – with its systemic and holistic approach – is the best organizational capacity to establish and strengthen the marketing-R&D relationship.

The effect of the complementarity between QM and PMO in RPI can be discussed through the lens of the tripartite division of dynamic capabilities into *sensing*, *seizing*, and *reconfiguring* capabilities developed by Teece (2007). In light of this, QM-PMO complementarity may be viewed as a high-order dynamic capability that incorporates systematic learning and knowledge creation routines for sensing, seizing, and reconfiguring business models based on radical innovations (Eisenhardt & Martin, 2000; Helfat & Winter, 2011; Teece, 2007).

Sensing: to develop RPI, the firm must monitor and analyse the environment to gather information on market needs, competitors' movements, and new technologies so that managers can identify new product opportunities and decide to commit to product innovation activities (Pavlou and El Sawy, 2011). PMO is particularly useful in helping to search, track, store, and disseminate market information within the organization to better understand product innovation opportunities. QM contributes to this by helping the firm to build lasting relationships with its various stakeholders, especially suppliers and customers. It also increases the quality of the market knowledge provided by PMO using the control it applies to its processes to improve their efficiency.

Seizing: once opportunities for RPI have been identified, the firm should know how to seize them. The synergy between QM and PMO may help the firm in studying and selecting the investments most likely to succeed in product innovation, especially those that lead to the development and/or creation of capacities in the technological and marketing fields required by RPI. These investments may relate to the machines and equipment to be acquired, the training to be programmed for the personnel involved in new work methods/techniques, the appropriate organizational structure, the resources to be deployed, etc.

Reconfiguring: QM-PMO complementarity effectively reconfigures the organizational structures, resources, and capabilities needed to achieve product innovations, particularly technological and marketing capabilities (Danneels, 2002; Danneels & Kleinschmidt, 2001; Dougherty, 1992; Hoffmann, Mathieu, Roehrich & Valette-Florence, 2007). QM and OM allow a firm to modify or design new technological capabilities (Perdomo-Ortiz, González-Benito and Galende, 2009; Camisón and Puig-Denia, 2015) and marketing capabilities (O'Cass and

Ngo, 2011; Ngo and O’Cass, 2012; O’Cass and Heirati, 2015) respectively, which are essential for an organization to develop and introduce RPI in the market.

The development of RPI is based on generative learning (Baker & Sinkula, 2007; Danneels, 2004; Slater & Narver, 1995), also described as exploratory learning. This learning reflects an organization’s ability to change its worldview by unlearning obsolete perspectives, systems, and procedures and proactively replacing them with new approaches that create or maintain a competitive advantage (Baker and Sinkula, 1999). Combining QM and PMO helps an organization to adopt generative learning. PMO supports this type of learning as it encourages the discovery of latent and unreported customer needs by guiding customers rather than reactively responding to these (Atuahene-Gima et al., 2005; Narver et al., 2004). QM involves practices that can be associated with generative learning (Jayawarna and Pearson, 2003; Asif and de Vries, 2014). More specifically, social QM practices may encourage creativity and affect exploratory (generative) learning because they tend to seek new possibilities including variation, risk-taking, and flexibility within an organization (March, 1991; Choo, Linderman and Schroeder, 2007). Furthermore, some hard QM practices might help in stimulating generative learning. For example, the creation and refinement of knowledge through the principle of continuous improvement is mainly involved in the double-loop (generative) learning process (Wang & Ahmed, 2002).

Our results clearly show that environmental uncertainty positively moderates the link between the QM-PMO complementarity and RPI. They, therefore, support the importance of this complementarity in a rapidly changing environment. This is in line with one of the central principles of contingency theory, according to which the synergistic effect depends on the degree of adjustment between an organizational system and the environment. Our results support research calling on the concept of complementarity that points to contextual factors as key factors in the synergistic effect (Ennen and Richter, 2010). They are partially consistent with previous research that has analysed the moderating role of environmental uncertainty in conceptual frameworks including both QM and PMO. For example, Wang, Chen & Chen (2012) concluded that external environmental factors act as moderators between TQM, OM, and performance. Moreover, research indicates that QM, or some of its practices (Sitkin, Sutcliffe and Schroeder, 1994; Reed, Lemak and Montgomery, 1996; Benner, 2009), and OM (Kohli, Jaworski and Kumar, 1993; Tsai, Chou and Kuo, 2008; Augusto and Coelho, 2009; Zhang and Duan, 2010b) are more effective in environments with low uncertainty. We showed

that QM and PMO can also be effective when the environment is highly uncertain by complementing each other.

Our results suggest that firms operating in more uncertain environments can develop RPI by combining QM and PMO. Environmental uncertainty increases managerial uncertainty for organizations when they invest in the exploration of radical innovations necessary for survival (Lant and Mezias, 1992; Sidhu, Volberda and Commandeur, 2004). In this respect, QM-PMO complementarity is an organizational capability that could help in reducing this managerial uncertainty and increase the generative learning process that is essential to the RPI creation. In the face of environmental uncertainty, QM-PMO synergy will allow the organization to rely much less on existing knowledge and much more on the rapid creation of new knowledge and the search for new work practices.

5. Conclusion

The present article seeks to shed light on the consequences of the synergistic relationship between QM and PMO on RPI. Considering QM-PMO complementarity from a complementarity-in-performance standpoint (Ballot et al., 2015) and as a dynamic capability, our results provide empirical evidence for the hypothesis of the increasing returns of the synergy combining QM and PMO vis-à-vis RPI advanced by this research, that is, QM and PMO are complementary, not substitutional, with a synergistic effect on RPI. This effect is more pronounced when the firm's external environment is uncertain.

5.1. Theoretical implications

The effect of MO on the firm's performance depends on its complementarity with other organizational components (Menguc and Seigyoung, 2006; Ketchen, Hult and Slater, 2007). Regarding product innovation, Atuahene-Gima et al. (2005) noted that MO is likely to lead to better performance in terms of product innovation when combined with appropriate organizational capabilities. Our research provides additional empirical support to these authors by showing that QM is among the organizational capabilities that can assist the role of the PMO in RPI. On the other hand, several authors have argued that the effect of QM on RPI might be weak (El Manzani, Sidmou and Cegarra, 2019) or may even hinder the development of this type of innovation (Roldán et al., 2017). Our results provide a relevant solution to the ambiguous and still inconclusive empirical results concerning the impact of QM on exploratory innovations by proposing PMO as the missing link in this relationship. That said, we have

provided an answer to the question of how QM can be used to develop large-scale innovation in organizations where discontinuities are required (McAdam and Mitchell, 2007). Furthermore, studies have examined the QM-product innovation and PMO-product innovation relationships, but the investigation of the complementarity effect between QM and PMO on RPI has not been studied until now. Because of this gap in the literature, we consider this research to be the first to analyse this effect. In addition to the studies that have shown that QM-MO complementarity is important in improving performance (Sussan and Johnson, 1997; Lai and Cheng, 2005; Lai, Yeung and Cheng, 2012; El Manzani, 2021), we provide empirical evidence that QM and PMO also reinforce one another in improving RPI, and responded to El Manzani's (2021) call for more research to understand the impact of the QM-MO synergy in developing the organization's innovation capacity.

By conceptualizing QM-MO complementarity as a dynamic capability, our research empirically consolidates the conceptual framework of dynamic capability theory. This theory is very rich from a conceptual standpoint but is widely criticized for the scarcity of empirical research studying dynamic capabilities. We also provide empirical support for the general arguments presented by authors, such as Teece et al. (1997), Eisenhardt & Martin (2000), and Helfat et al. (2007), that the effects of dynamic capabilities on a firm's performance depend on the external context. We found that environmental uncertainty reinforces the impact of QM-PMO complementarity on RPI. In this respect, our research highlights the importance of contingency theory in understanding dynamic capability theory by showing the contingent effect of external environmental conditions on the consequences of dynamic capabilities.

Our research also extends the new product development literature, which has tended to ignore the combined effects of organizational determinants on product innovation. We have pointed out that these determinants should not be considered in isolation, as some of them will contribute significantly to the development and performance of product innovation when they are efficiently combined. The presence of several determinants is not always, or necessarily, synonymous with the success of product innovation, but rather it is their interdependencies that determine it.

5.2. Practical implications

The emphasis on the effect of QM-PMO complementarity on RPI is the main managerial implication of this study. We show company managers the importance of investing more in the simultaneous implementation of QM and PMO to develop RPI. If they aim to create products

that are different from their firm's existing products and those already on the market, it is essential to combine QM and PMO. Furthermore, QM-PMO complementarity is a relevant organizational configuration to be implemented by Moroccan firms to cope with changes and uncertainty within their environment, especially since Moroccan managers, like Moroccan society in general, have a pronounced tendency to seek to avoid uncertainty.

To implement this complementarity with fewer difficulties at an organizational level, closer integration and collaboration between the quality and marketing departments is a key requirement (El Manzani, 2021; El Manzani, El Idrissi and Lissaneddine, 2022). While the marketing department absorbs and allocates market information to guide organizational processes, the quality department provides the methods and tools needed to implement, control, and improve these processes. We, therefore, suggest that these two departments should help each other, especially during an RPI project. Accordingly, managers should break down the organizational and psychological barriers that have usually arisen between the staff of these two departments, as several firms lack effective interaction between the two departments. The principles of QM and marketing should nevertheless be communicated to quality and marketing staff and other members of the organization to build the cultural aspect of QM-PMO complementarity (Lai et al., 2012). In addition to being an enabler of RPI, synergistically configuring QM and PMO could help firms to achieve a sustainable competitive advantage because QM-PMO complementarity is an idiosyncratic dynamic capability that could be difficult for competitors to imitate (El Manzani, 2019).

5.3. Limitations and future research recommendations

The main limitation of our research is that it did not undertake a deep exploration of the underlying processes that determine how QM and PMO complementarity occurs at the product innovation project and organizational levels. Hence, there is a need for a comprehensive and integrated view of QM-PMO complementarity that identifies the organizational factors necessary to its creation, its underlying dimensions and propitiates, and how it can be managed within the organization. Regarding this last point, it will be interesting to investigate how QM and PMO complementarity is managed in each phase of the RPI process, i.e., pre-development, development, and commercialization. The aim would be to follow the dynamics and the evolution of QM-PMO complementarity throughout this process and to determine the phase in which it contributes most to the success of the RPI. To do that, an in-depth qualitative case study methodology is more appropriate. Furthermore, QM-MO complementarity could be

studied from an individual perspective through the exploration of the collaboration between quality and marketing departments during the RPI process.

We also invite future research to take a configurational approach to study the effect of the complementarity between QM and PMO on RPI for a very large sample. Echoing Lai et al. (2012), this approach will help to establish the different possible organizational configurations according to the degree of the combined implementation of QM and PMO, in the presence of product innovation or other innovation types. It will be a means of proposing a typology of firms based on the association between QM, MO, and innovation.

Another limitation of this research is the use of a cross-sectional study that does not allow the evolution of QM-OM complementarity over time to be investigated, given that radical innovations are a long and time-consuming process. Future research may be willing to add a temporal dimension to estimate causality between QM-MO complementarity and RPI.

Finally, since environmental uncertainty has been only studied through the dimensions of competitive intensity and market turbulence, it would be highly relevant to consider the effect of QM-MO complementarity on RPI in highly technology-based industries compared to others with low technology requirements.

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