Production Planning & Control
The Management of Operations

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/tppc20

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To cite this article: Younès El Manzani, Mostapha El Idrissi, Rahma Chouchane, Michael Sony & Jiju Antony (2025) A meta-analysis of the relationship between quality management and innovation in small and medium-sized enterprises, Production Planning & Control, 36:7, 905-924, DOI: 10.1080/09537287.2024.2321284

To link to this article: https://doi.org/10.1080/09537287.2024.2321284

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PRODUCTION PLANNING & CONTROL
2025, VOL. 36, NO. 7, 905–924
https://doi.org/10.1080/09537287.2024.2321284

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A meta-analysis of the relationship between quality management and innovation in small and medium-sized enterprises

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ABSTRACT

This paper presents a comprehensive meta-analysis examining the relationship between Quality Management (QM) and innovation in Small and Medium-Sized Enterprises (SMEs). Through a statistical synthesis of the findings of 31 empirical studies published between 2008 and 2022, this meta-analysis reveals a significant positive correlation between QM and diverse innovation types in SMEs. More specifically, the results show that total quality management, soft and hard quality management practices and quality management systems all positively correlate with technological, non-technological and green innovations. Importantly, the results underscore the pivotal role of leadership styles – charismatic, team-oriented, participative and autonomous – in enhancing the QM-innovation relationship, while human-oriented and self-protective styles appear to diminish it. The findings offer strategic insights for SMEs managers to optimize innovation through tailored quality initiatives and leadership style.

ARTICLE HISTORY
Received 26 October 2023
Accepted 16 February 2024

KEYWORDS
Quality management; SMEs; innovation; green innovation; leadership style; meta-analysis

1. Introduction

Small and Medium-Sized Enterprises (SMEs), play a pivotal role in economic development through job creation, GDP growth and entrepreneurship. However, SMEs frequently struggle with innovation due to substantial barriers compared to large firms. SMEs face constraints including limited financial resources, lack of technical capabilities, small talent pools and inability to benefit from economies of scale (Lee et al. 2010). These obstacles often impede SMEs from undertaking R&D activities and adopting complex innovation processes (Laforet 2013). At the same time, implementing structured quality management (QM) practices can be challenging for SMEs given the investments required in training, documentation, consultants and audits (Dora, Kumar, and Gellynck 2016). Examining the impact of QM adoption on innovation outcomes specifically in SMEs is critical, as innovation and quality are indispensable for these firms to build competitive advantage, enter new markets and ensure long-term sustainability (Ruiz-Moreno, Tamayo-Torres, and García-Morales 2015).

Over the past decades, the impact of QM and innovation has been extensively studied, particularly focusing on how QM enables firms to be innovative. Some studies have attempted to systematically review the literature on the relationship between QM and innovation. Some have provided comprehensive summaries of this relationship in general (García-Fernández, Claver-Cortés, and Tarí 2022), while others have concentrated on specific aspects, such as the link between Total Quality Management (TQM) and organizational innovation (Foo, Nair, and Lim 2019), or QM standards like ISO 9001 and innovation (Riillo 2014), or even specific types of innovation, such as product innovation (Manders et al. 2016). Despite these valuable contributions, a definitive answer to the impact of QM on innovation remains elusive, as they do not offer a quantitative synthesis of the literature, which limits drawing decisive conclusions on this question.

Moreover, studies investigating the QM-innovation relationship in similar empirical contexts, such as SMEs, have often yielded conflicting findings. Some studies demonstrate a positive association between QM (or its practices) and innovation in SMEs (e.g. Abdallah, Alkhaldi, and Aljuaid 2021; Albloushi et al. 2023; Kafetzopoulos, Gotzamani, and Vouzas 2021; Ullah 2022), while others have found a negative association (e.g. Bon and Mustafa 2014; Cuerva, Triguero-Cano, and Córcoles 2014; Trivellas and Santouridis 2009; Udofia et al. 2021). Existing literature cannot provide explanations for these inconsistencies, due to the lack of research summarizing the state of the literature regarding the impact of QM on innovation for SMEs. Also, the conclusions drawn from existing studies (considering large firms), including systematic literature reviews, may not generalize well to SMEs, since QM implications in SMEs differ significantly from those in larger firms (Nair 2006). Consequently, there is a need for a focused examination of how QM impacts innovation in SMEs.

To address these issues, synthesize the existing research and guide future studies, we conducted a meta-analysis of published research between 2008 and 2022 that examines the link between QM and innovation in SMEs. By employing meta-analysis, we overcome the limitations of individual

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/09537287.2024.2321284.
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studies and existing systematic literature reviews and provide a more robust conclusion. Meta-analysis is a statistical technique that aggregates data from multiple studies to determine the overall effect size of relationships between variables and explore moderating factors (Borenstein et al. 2011). It can help synthesize contradictory findings from individual studies and provide a more comprehensive understanding of the overall relationship between variables. Through this method, we aim to address the following research questions: **RQ1**: *What is the aggregate correlation between QM and innovation in SMEs*? **RQ2**: *Which QM practices are positively correlated with innovation in SMEs?* **RQ3**: *Which QM practices are positively correlated with individual types of innovation in SMEs?*

While both QM and innovation play pivotal roles in driving SMEs' organizational success, it is imperative to underscore the intricate and context-dependent nature of their relationship. In this vein, leadership style is a context-dependent factor that plays a pivotal role in shaping the outcomes of QM and innovation. Previous research has empirically demonstrated the critical role of leadership style in the success of QM initiatives in SMEs (Alefari, Almanei, and Salonitis 2020; Burawat 2019). However, the existing literature has overlooked the impact of leadership style on the relationship between QM and innovation in SMEs. To address this gap, we propose to incorporate leadership style into our meta-analysis and pose the **RQ4**: *How does leadership style moderate the relationship between QM and innovation in SMEs?*

This research makes significant contributions to the existing literature. While prior meta-analyses have predominantly concentrated on the nexus between QM and organizational performance (Abreu-Ledón et al. 2018; Ahmad et al. 2015; Antony et al. 2022; Mackelprang and Nair 2010; Nair 2006; Xu et al. 2020), the present investigation stands as a pioneering effort, presenting a comprehensive meta-analysis that delves into the association between QM and innovation in SMEs. Unlike previous studies that have predominantly concentrated on separate dimensions of innovation – be it technological (like product or process innovation), non-technological (such as organizational and marketing innovations), or green innovation – our research distinctively encompasses all these types in a single analysis. Another key contribution of our meta-analysis is the inclusion of various leadership styles as a moderating variables. By exploring how varying leadership styles within SMEs affect the QM-innovation link, we offer new theoretical perspectives on the role of leadership in SMEs, particularly from a cross-cultural standpoint.

The structure of this article is as follows. Firstly, we develop hypotheses concerning the QM-innovation relationship and the moderating role of leadership styles. Next, we describe the methodology employed in our meta-analysis. Subsequently, we present and discuss the findings of our analysis. Finally, the conclusion section highlights the implications, limitations and potential directions for future research.

2. Literature review

2.1. Quality management and innovation in SMEs

To better understand the relationship between QM and innovation, it is essential to consider the multidimensionality of these two concepts. Innovation is a complex and multifaceted concept that has been defined and categorized in various ways (Geldes, Felzensztein, and Palacios-Fenech 2017; Tavassoli and Karlsson 2015).

A widely accepted classification proposed in the Oslo Manual delineates four types of innovation: product innovation, process innovation, organizational innovation and marketing innovation (OCDE 2005). Product and process innovations are considered technological innovations (TI) as they involve developing or utilizing new technologies, while organizational and marketing innovations are considered non-technological innovations (NTI) as they do not rely on technological advancements (Schmidt and Rammer 2007). In recent years, the concept of green innovation (GI) has also emerged, emphasizing innovations that incorporate environmental sustainability (Karimi Takalo, Sayyadi Tooranloo, and Shahabaldini Parizi 2021; Schiederig, Tietze, and Herstatt 2012). This classification is more apt as it conceives innovation broadly as going beyond technological changes to integrate non-technological advancements and sustainability, which gains prominence with the increasing focus on sustainable development practices. Adopting this categorization is essential to comprehensively capture QM's impacts on the full spectrum of innovation outcomes in SMEs.

Likewise, QM has been conceptualized and operationalized in different forms (Nair 2006). Main QM approaches include Total Quality Management (TQM), Quality Management System (QMS), and an array of associated practices often categorized as soft and hard QM practices (SQMPs and HQMPs) (El Manzani, El Idrissi, and Lissaneddine 2022; El Manzani, Sidmou, and Cegarra 2019; Tarí, Claver-Cortés, and García-Fernández 2023). As QM practices might have a different influence on innovation, this conceptualization can help to identify the best QM practices that foster innovation in SMEs. Moreover, it can provide a holistic view of QM and enable a more rigorous and systematic meta-analysis of the existing literature on QM-innovation relationships in SMEs.

Prior studies indicate that QM can promote both TI (Abdallah, Alkhaldi, and Aljuaid 2021; Antunes, Quirós, and Fernandes Justino 2017; Kafetzopoulos, Gotzamani, and Skalkos 2019; Psomas, Kafetzopoulos, and Gotzamani 2018; Rafailidis, Trivellas, and Polychroniou 2017) and NTI (Abdallah, Alkhaldi, and Aljuaid 2021; Kafetzopoulos 2022; Kafetzopoulos, Gotzamani, and Skalkos 2019) in SMEs. As a holistic management philosophy, TQM fosters a culture of continuous improvement, employee involvement, process optimization and customer focus, all of which can stimulate innovation (Antunes et al. 2021; Lim 2023; Matias and Coelho 2011; Mushtaq and Peng 2020; Prajogo and Sohal 2004; Shuaib and He 2023). QMS provides infrastructure enabling the smooth adoption of new technologies organization-wide. For instance, QM standards, like ISO 9001, have been found to positively impact firms' innovation performance, including technological innovations (Kafetzopoulos, Gotzamani, and Skalkos 2019; Ullah 2022). SQMPs focus on the human aspects of an organization, creating an optimal internal climate that reduces resistance to change, encourages information sharing and promotes creativity – essential enablers of innovation (Abdallah, Alkhaldi, and Aljuaid 2021; Zeng, Anh Phan, and Matsui 2015).

Alongside TI and NTI, QM also facilitates GI (Albloushi et al. 2023; Azam et al. 2023; Cuerva, Triguero-Cano, and Córcoles 2014; Hudnurkar et al. 2022) in SMEs. With its emphasis on waste reduction, process optimization and sustainability, TQM aligns well with GI objectives (El Manzani, Sidmou, and Cegarra 2017; Nazarian et al. 2023). Recent studies in SMEs report that TQM positively impacts GI and its two dimensions (process and product green innovation) in different contexts (Pakistani and UAE) (Albloushi et al. 2023; Azam et al. 2023). QMS provides a framework to track, integrate and optimize environmental improvements through its management components (Simon et al. 2011). Firms can meet GI goals by implementing management practices that influence the environment, such as the internal standard of the environmental management system (e.g. ISO 14001) (Abbas and Sağsan 2019; Albloushi et al. 2023). In the Spanish SMEs, Cuerva, Triguero-Cano, and Córcoles (2014) indicate that the use of QMS is one of the most important factors of environmental innovation strategy, the authors find out that SMEs that apply a standardized QMS (i.e. the ISO 9000 family of standards) are more encouraged to adopt GI. SQMPs, as customer focus, leadership commitment and teamwork, promote sustainable practices via adaptation, learning and waste reduction (Zeng et al. 2017). Coupled with motivation and the improvement of employee skills and knowledge, they may enhance the awareness of employees and managers regarding environmental concerns which encourages them to come up with innovations and be sure that their products and processes satisfy high standards and are ecologically responsible (Azam et al. 2023).

However, not all QM practices necessarily benefit innovation (including TI, NTI and GI) (Abdallah, Alkhaldi, and Aljuaid 2021; Trivellas and Santouridis 2009). As HQMPS emphasize quality control they appear better suited to quality improvement than innovation (Feng et al. 2006; Prajogo and Sohal 2003; Prester and Bozac 2012). They can increase formalization and standardization within SMEs leading to bureaucracy and rigidity which goes against the spirit of innovation (Dick 2000; Jayawarna and Pearson 2001; Prajogo and Sohal 2004). Consequently, that will largely harm creativity because of strict control since innovation involves extremely high levels of innovativeness (Song and Su 2015).

In summary, TQM, SQMPs and QMS are posited to exert a favourable association on TI, NTI and GI. Conversely, HQMPs may potentially constrain innovation. An amalgamated QM strategy, which integrates these components, is hypothesized to bolster a broad spectrum of innovation effectively. Consequently, our meta-analysis posits a central hypothesis: the aggregate impact of QM – a synthesis of the collective influence of TQM, SQMPs, HQMPs and QMS, as discerned across primary studies – correlates with an aggregate innovation construct. This construct encompasses the entire innovation types (TI, NTI and GI) as categorized in existing literature (OCDE 2005; OECD 2018). Such an aggregate view enables a thorough examination of the overarching link of QM with SMEs' innovation.

H1. Aggregate QM is positively correlated with aggregate innovation in SMEs.

To examine this relationship comprehensively, we also test the impact of individual QM approaches and practices on innovation types within SMEs (see Figure 1).

H1a. TQM is positively correlated with aggregate innovation in SMEs.

H1b. SQMPs are positively correlated with aggregate innovation in SMEs.

H1c. HQMPs are negatively correlated with aggregate innovation in SMEs.

H1d. QMS is positively correlated with aggregate innovation in SMEs.

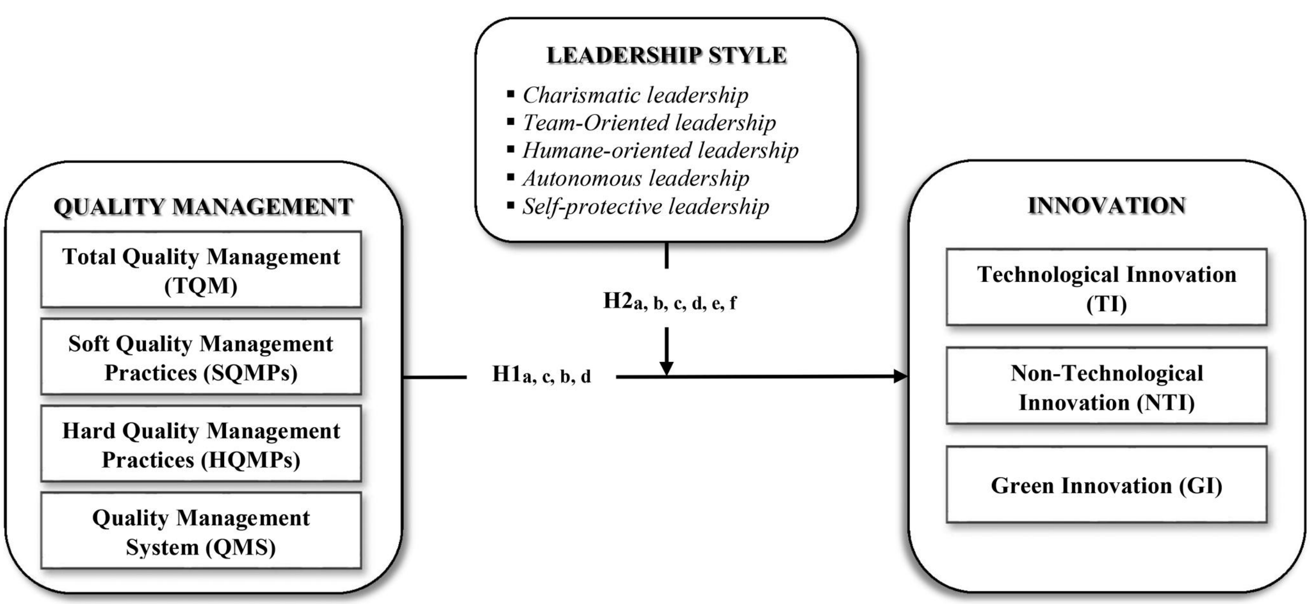

Figure 1. Conceptual model.

2.2. Leadership style moderation

While both QM and innovation are critical for organizational success, it is important to emphasize that the connection between the two is intricate and contingent on the organizational context. In this sense, leadership style is one of the most critical organizational factors that determines not only the success of QM and innovation but also their results.

Although leadership style is a key factor in both QM and innovation (Kumar and Sharma 2018; Silva et al. 2021), to the best of our knowledge, no study has explored how leadership style impacts the relationship between QM and innovation outcomes. Therefore, we investigate the six leadership styles identified in the Globe study (House et al. 2004): *charismatic leadership*, *team-oriented leadership*, *participative leadership*, *humane-oriented leadership*, *autonomous leadership* and *self-protective leadership*. The GLOBE Project provides a robust conceptualization and measurement of culturally endorsed leadership styles across various societies. Given the global scope and rigorous methodology of the GLOBE Project, its leadership style measures provide a strong foundation for examining cross-cultural differences in preferred leadership behaviours. The validity and reliability of these measures have been established across many diverse cultural groups (Dorfman et al. 2012). Using the extensively validated GLOBE leadership styles thus lends credibility to our exploration of how national culture and leadership moderate the QM-innovation relationship.

Charismatic leadership 'reflects the ability to inspire, motivate, and expect high-performance outcomes from others based on firmly held core values' (House et al. 2014, 19). Charismatic leaders, driven by strong core values, may inspire and motivate teams to cultivate a quality culture and innovation in SMEs. They infuse purpose and passion in employees, encouraging them to embrace QM practices and engage in innovation (Al-Sabi et al. 2023). These leaders articulate a clear vision where QM and innovation complement each other rather than conflict. This balance is vital because an exclusive focus on quality may hinder innovation while prioritizing innovation at the expense of quality can lead to failures. Thus, charismatic leadership, coupled with effective QM, inspires and propels organizational growth.

Team-oriented leadership 'emphasizes effective team building and implementation of a common purpose or goal among team members' (House et al. 2014, 19). Leaders who prioritize teamwork foster a sense of unity among team members, allowing them to work together towards common goals. van der Voet and Steijn (2021) highlight that this team-centric leadership style stimulates the exchange of ideas and collaboration, which are fundamental components of fostering innovation. Additionally, effective implementation of TQM relies on key elements such as teamwork (Cooney and Sohal 2004), significantly amplifying groups' capacity for innovation (Fay et al. 2015). By structuring QM around teamwork, this leadership stimulates employee engagement and collective learning conducive to innovation.

Participative leadership 'reflects the degree to which managers involve others in making and implementing decisions' (House et al. 2014, 19). Odoardi et al. (2015) found that participative leadership style, teamwork and information sharing positively predict perceptions of team support for innovation and team vision, which in turn foster psychological empowerment and innovative performance. By allowing employees to contribute their perspectives, participative management is important for employee innovation (Chang et al. 2019; Elsetouhi, Mohamed Elbaz, and Soliman 2023) and achieving QM (Tonnessen 2005). When participative leadership and collaborative QM work together, they provide an ideal setting for fostering innovation.

Humane-oriented leadership 'reflects supportive and considerate leadership but also includes compassion and generosity' (House et al. 2014, 19). Humane leaders treat team members with compassion and empathy to foster a supportive environment which is necessary in QM (Younis and Boland 1997). By addressing employees' socio-emotional needs, this type of leadership fosters their motivation to innovate in a psychologically safe work environment (Yidong and Xinxin 2013). Furthermore, this leadership may cultivate collective emotional intelligence, that supports innovation (Lee and Jin 2019). QM involved in an organizational environment with human-centred leadership will maximize employees' creative potential in SMEs (Zaitouni and Ouakouak 2018).

Autonomous leadership 'refers to independent and individualistic leadership attributes' (House et al. 2014, 19). Autonomous leaders empower team members by granting them the freedom and authority to make independent decisions. Jønsson, Unterrainer, and Kähler (2022) find that, through distributed leadership agency, job autonomy and trust in management indirectly influence idea generation, promotion and implementation. Therefore, in the context of QM, the presence of autonomous leadership optimizes innovation by affording increased autonomy to the individuals involved.

Lastly, self-protective leadership 'focuses on ensuring the safety and security of the individual and group through status enhancement and face-saving' (House et al. 2014, 19). It includes aspects like self-interest, concern for status, promotion of conflict, preservation of reputation and focus on procedures (Kroumova and Mittal 2023). Hence, this leadership breeds distrust, impairing the collaboration essential for innovation. Moreover, self-protective leaders are non-participative and place their agenda above the goals and welfare of the team. Consequently, contrary to the other leaders, they hinder innovation by restricting participation and initiative (Aktas, Gelfand, and Hanges 2016). Thus, self-protective leadership will harm QM's role in supporting innovation in SMEs by stifling employees' motivation and creativity.

From this discussion, we consider that the leadership style can either strengthen or diminish the relationship between QM and innovation in SMEs (see Figure 1).

H2. The correlation between aggregate QM and aggregate innovation is moderated by leadership style.

H2a. The correlation between aggregate QM and aggregate innovation is positively moderated by charismatic leadership.

H2b. The correlation between aggregate QM and aggregate innovation is positively moderated by team-oriented leadership.

H2c. The correlation between aggregate QM and aggregate innovation is positively moderated by participative leadership.

H2d. The correlation between aggregate QM and aggregate innovation is positively moderated by humane-oriented leadership.

H2e. The correlation between aggregate QM and aggregate innovation is positively moderated by autonomous leadership.

H2f. The correlation between aggregate QM and aggregate innovation is negatively moderated by self-protective leadership.

3. Methods

3.1. Literature search

The literature search was conducted in the following three steps following the PRISMA procedure (see Figure 2). The PRISMA procedure is a comprehensive set of guidelines designed to enhance the transparency, completeness and overall quality of reporting in systematic reviews and meta-analyses of studies, which is widely used and endorsed by many journals, editors and peer reviewers (Liberati et al. 2009; Page et al. 2021).

1. ***Article identification***: To locate relevant articles, an extensive search was performed primarily on the Web of Science and Scopus. These databases were chosen exclusively due to their esteemed reputation as they consistently update their content with peer-reviewed journals and conference papers across various domains of business management (El Manzani 2021). The search strategy employed a combination of keywords, employing Boolean operators, to construct the following search string for topic-based searches (i.e. title, abstract, keywords): *('ISO 900*' OR 'quality certification' OR 'quality management' OR 'quality practice*' OR TQM OR 'Total quality management') AND Innovation AND (SME* OR 'Small and medium')*. This search yielded a total of 275 articles from different journals. Of these, 156 papers were excluded based on the criteria that we focused solely on English articles and proceedings in the field of

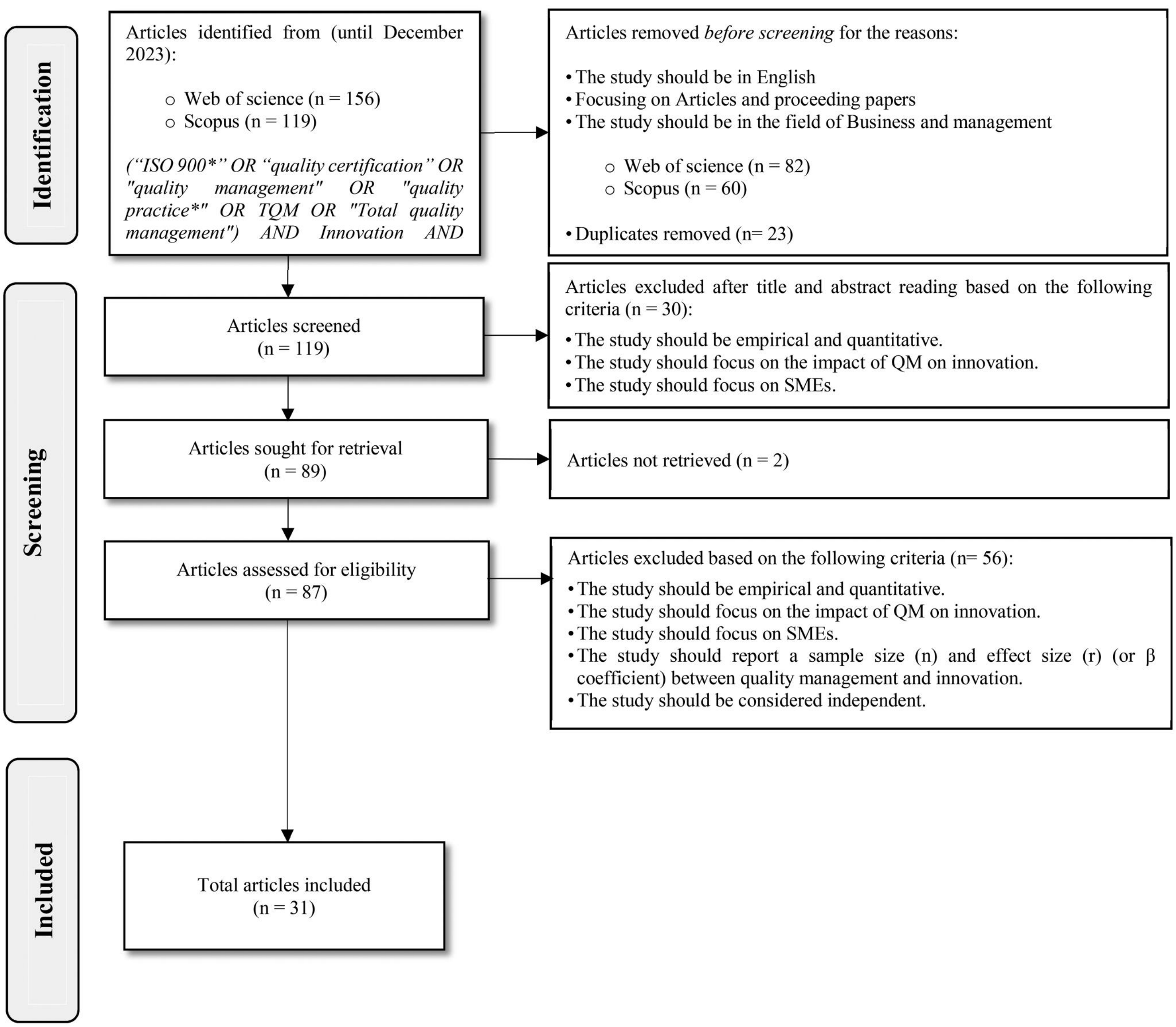

Figure 2. The PRISMA flow diagram of the study.

business and management, while also accounting for duplications. Consequently, this initial step resulted in the compilation of a primary article collection comprising 119 papers.

2. ***Article screening***: A two-step evaluation and selection process was employed. In the first step, the titles, abstracts and keywords of the articles were scrutinized to identify those that aligned with the objective of the meta-analysis. This initial screening phase yielded 89 papers (two papers were inaccessible). The second step involved a comprehensive reading of the selected articles to determine their relevance, applying pre-established inclusion criteria. These criteria stipulated that the study: (1) must be empirical and quantitative, (2) should focus on the impact of QM (or its practices) on innovation, (3) must concentrate on SMEs, (4) should report sample size (n) and effect size (r), or regression coefficient (β), of the relationship between QM and innovation and (5) should be deemed independent. By adhering to these criteria, 56 articles were excluded, resulting in the formation of a final article collection comprising 31 papers.
3. ***Final article inclusion***: The remaining 31 articles were meticulously examined and determined to be suitable for inclusion in the meta-analysis process. The sample size of these articles was considered sufficient when compared to other meta-analysis studies published in the field of operations management (Abreu-Ledón et al. 2018; Antony et al. 2023; Mackelprang and Nair 2010; Nair 2006; Xu et al. 2020).

3.2. Characteristics of included studies

Figures 3 and 4 show the evolution and journals of the 31 articles. From Figure 3, it is evident that there is a general upward trend in the number of articles published annually. This indicates an increasing volume of research being conducted and published in the form of articles over the years. However, this increase is not steady or uniform. There are years when the number of publications dips slightly compared to the previous year. For example, we can see such a dip between 2014–2015 and 2019–2020. This could be due to a variety of factors, including changes in research funding, global events and shifts in research trends. After 2020, there is a sharp increase in the number of journal articles, reaching its peak in 2021.

The articles included in this study were published in 21 different journals (Figure 4). We can observe that the *TQM Journal* has the highest number of articles among all, with a total of five articles, which comprises 17% of the total articles. The journal *Sustainability* comes next, containing three articles that account for 10% of the total articles. Three journals, *International Journal of Quality & Reliability Management*, *Journal of Manufacturing Technology Management* and *Total Quality Management and Business Excellence*, each contain two articles, making up 7% of the total. The remaining journals each contain one article, representing 3% of the total articles.

3.3. Coding procedures

Based on Lipsey and Wilson (2001), a coding manual was devised comprising two sections aimed at extracting pertinent information from the primary studies. The first section was dedicated to encoding data crucial for the meta-analysis, encompassing effect sizes, sample sizes and reliability coefficients (Cronbach's alpha (α) values) for both QM and innovation in each study. The second section encompassed the coding of study characteristics, such as industry, country and the results of each study. The authors independently carried out the coding process for all the studies. Examination of the two independent coding processes revealed an inter-rater agreement level of 98%. This high level of consistency indicates reliability in our coding scheme. Any divergent viewpoints were addressed through discussions between the authors, leading to a consensus. The resulting dataset from the coding process consisted of 31 studies, providing data on 169 effect sizes and a cumulative sample size of 173,040.

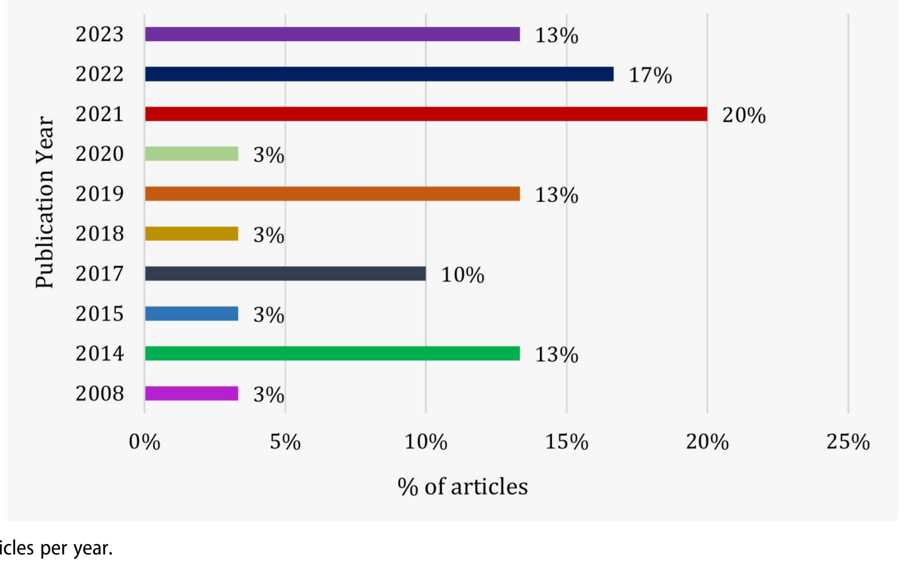

Figure 3. Percentage of articles per year.

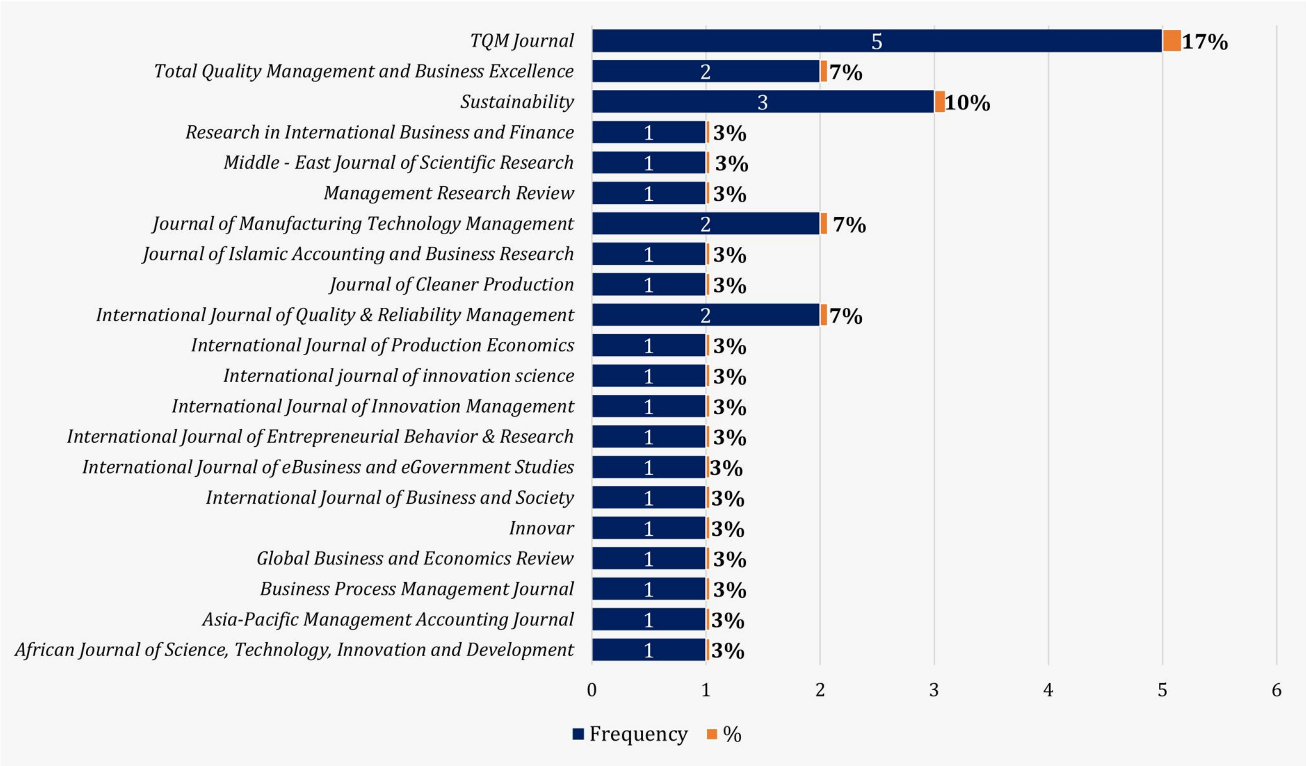

Figure 4. Number of articles per journal.

3.3.1. Coding variables

As in other meta-analytical studies, our coding process relied deductively on the variables included in the primary studies. Following the recommendation of Villiger, Schweiger, and Baldauf (2022), we categorized QM and innovation-related variables based on measurement items, variable labels and definitions as documented in each primary study.

- **Independent variables:**
  Quality management has evolved as a research area over time. Numerous advancements were made, which resulted in several naming changes, shifting from quality inspection and control to TQM nowadays passing by quality assurance and quality systems (Carnerud and Bäckström 2021; Weckenmann, Akkasoglu, and Werner 2015). The evolution of QM, together with research in the field of QM, has given rise to key QM concepts. In our meta-analysis, we coded QM according to four QM concepts (i.e. categories):
  1. ***TQM*** which defined as a philosophy that embraces concepts, methods, tools and techniques to form a language that is understood and applied as a business strategy at the 'top floor' and as a functional strategy at the 'shop floor'. This approach assists organizations in integrating business activities in leadership, people, customer focus, planning, quality assurance of processes and information and analysis (Terziovski and Samson 1999).
  2. ***SQMPs*** embody the concept of soft managerial transformation, encompassing elements like reflective involvement, empowerment, gathering of intelligence and the sharing and dissemination of knowledge (Bourke and Roper 2017). SQMPs comprise practices rooted in social dynamics, culture, learning and relationship-building within the realm of QM (Flynn, Schroeder, and Sakakibara 1995; Sitkin, Sutcliffe, and Schroeder 1994; Tarí, Claver-Cortés, and García-Fernández 2023; Wilkinson 1992). They include practices such as leadership, employee involvement and engagement, customer focus and relationship management (El Manzani, El Idrissi, and Lissaneddine 2022; El Manzani, Sidmou, and Cegarra 2019).
  3. ***HQMPs*** are associated with the concept of hard managerial shifts usually prioritizing aspects such as regulations, formality, adherence, discipline, stability and standardization (Bourke and Roper 2017). These practices rely heavily on technology and a control-oriented approach, centring on a cybernetic control system to minimize process and product defects, ensuring compliance with quality standards and meeting established manufacturing requirements and specifications (Dow, Samson, and Ford 1999; Flynn, Schroeder, and Sakakibara 1995; Powell 1995; Sitkin, Sutcliffe, and Schroeder 1994; Tarí, Claver-Cortés, and García-Fernández 2023). They involve practices such as process approach, continuous improvement, system approach to management and evidence-based decision-making (El Manzani, Sidmou, and Cegarra 2019).
  4. **QMS** which is defined as a formalized system that documents processes, procedures and responsibilities that organizations put in place for achieving quality policies and objectives. QMS is generally reflected in

quality standards like ISO 9001 and other industry-specific quality standards.

- **Dependent variables:**
Studies also conceptualized innovation differently considering numerous classifications and definitions of innovation. We grouped the studied innovation types (e.g. product, process, marketing innovations, etc.) into two main categories: technological innovation (TI), non-technological innovation (NTI) and green innovation (GI) (Geldes, Felzensztein, and Palacios-Fenech 2017; Heredia Pérez et al. 2019; OCDE 2005). *TI* involve the development or use of new technologies and includes product and process innovations (Schmidt and Rammer 2007). *NTI* refer to improvements not necessarily based on technical changes and comprise organizational and marketing innovations (Schmidt and Rammer 2007). *GI* involves the creation or implementation of significantly improved products, processes, marketing methods, organizational structures and institutional arrangements leading to environmental improvements compared to alternatives (OECD 2018; Schiederig, Tietze, and Herstatt 2012). Innovation types that do not fit these three categories were grouped into a fourth called Others.
- **Moderating variables:**
We considered leadership styles from the GLOBE Project (House et al. 2004) as a moderating factor in the QM-innovation relationship in SMEs. The GLOBE Project stands out as a crucial resource for examining cross-cultural differences in leadership and organizational practices. It is unique in providing comprehensive data on managerial leadership styles across various countries that have been used in various studies (e.g. Aktas, Gelfand, and Hanges 2016; Lee and Kelly 2019; Stephan and Pathak 2016; Wanasika et al. 2011). To our knowledge, no other database offers such extensive data on other leadership styles (e.g. transformational, transactional or servant leadership etc.) beyond what is available in the GLOBE Project.

We included the GLOBE Project's six leadership styles: (1) ***Charismatic leadership*** 'reflect the ability to inspire, motivate, and expect high-performance outcomes from others based on firmly held core values' (House et al. 2014, 19). (2) ***Team-oriented leadership*** 'emphasizes effective team building and implementation of a common purpose or goal among team members' (House et al. 2014, 19). (3) ***Participative leadership*** 'reflects the degree to which managers involve others in making and implementing decisions.' (House et al. 2014, 19). (4) ***Humane-oriented leadership*** 'reflects supportive and considerate leadership but also includes compassion and generosity' (House et al. 2014, 19). (5) ***Autonomous leadership*** 'refers to independent and individualistic leadership attributes' (House et al. 2014, 19). (6) ***Self-protective leadership*** 'focuses on ensuring the safety and security of the individual and group through status enhancement and face-saving' (House et al. 2014, 19). Each country's score for each leadership style was taken from the GLOBE study database.[1] For countries missing scores, we used the average regional score.

3.4. Meta-analytic procedure

3.4.1. Effect sizes calculation

Following the common practice in management meta-analysis, the Pearson product-moment correlation coefficient (*r*) was used to assess the relationship between QM and innovation-related variables (Geyskens et al. 2009). In cases where the correlation coefficient (r) was not reported, we converted the beta regression coefficient into a correlation coefficient using the formula proposed by Peterson and Brown (2005), which was $r = 0.98\beta + 0.05\lambda$, where λ equals 1 when β was non-negative and 0 when β was negative. Before analysis, the correlation coefficients (*r*) were adjusted for measurement and sampling errors based on the approach suggested by Schmidt and Hunter (2015). Measurement error correction involved dividing each reported correlation by the square root of the Cronbach alpha coefficient of the variables of interest. If Cronbach alpha was missing, the mean Cronbach alpha of all studies measuring the same construct was used as a substitute (Geyskens, Steenkamp, and Nirmalya Kumar 1998; Schmidt and Hunter 2015). The sampling error was addressed by calculating sample size-weighted correlations (Schmidt and Hunter 2015).

After applying the necessary corrections, we employed the random-effects meta-analytic procedure proposed by Schmidt and Hunter (2015) to combine the effect sizes across studies. This technique was selected due to its superior performance compared to other models in a Monte Carlo study (Field 2001). Considering the likelihood of heterogeneity in management meta-analyses due to variations in empirical settings, a random effects model was chosen, as it accounts for differences in effect size magnitudes or directions for the same phenomenon under investigation (Schmidt, Oh, and Hayes 2009). The significance of the aggregated effect sizes was determined by estimating 95% credibility intervals and considering effect sizes to be significant when the confidence interval did not include zero (Geyskens et al. 2009; Schmidt and Hunter 2015; Whitener 1990).

3.4.2. Moderation analysis procedure

The I^2 statistic (Higgins and Thompson 2002) and Cochran's *Q* (Hedges and Olkin 1984) were used to evaluate between-study heterogeneity. I^2 of 25% was deemed low, 50% moderate and 75% as substantial heterogeneity (Higgins et al. 2003). The percentage higher than 75% of I^2 statistic and the significance of Q-statistic indicate the likelihood that moderators explain the variability in the correlations across studies (Schmidt and Hunter 2015).

To assess moderation, meta-regression (MARA) was employed as it addresses the limitations of subgroup analysis, provided that the total number of effect sizes is sufficiently large (e.g. Higgins et al. (2011) recommend considering moderator analysis only when there are at least ten studies available). This approach involves utilizing effect sizes from primary studies as the dependent variable in weighted regression analysis, with potential moderators serving as independent variables (Gonzalez-Mulé and Aguinis 2018). To account for the possibility of multiple effect sizes being influenced by the same sampling error (Schmidt 2017), we followed the recommendation of Gonzalez-Mulé and Aguinis (2018) and utilized the *metafor package* in R (Viechtbauer 2010) to conduct multivariate meta-regression analyses using a random-effects model. The reliability-corrected effect sizes and sample size-weighted correlations were used as the dependent variable. Since significant correlations varying from medium to high were observed among the six leadership styles, their moderation effects were investigated using separate meta-regression models as recommended by the literature (Li et al. 2020).

3.4.3. Publication bias

To identify publication bias, Ferguson and Brannick (2012) proposed a tandem approach consisting of four tests: the trim-and-fill method (Duval and Tweedie 2000), the fail-safe N (Orwin 1983), the Egger regression test (Egger et al. 1997) and the rank order correlation test (Liu et al. 2016). This approach aims to minimize Type I error by considering publication bias problematic only when the trim-and-fill method, fail-safe N and either the regression test or the rank order correlation test indicate its presence (Ferguson and Brannick 2012). To enhance the persuasiveness of the results, publication bias analyses were restricted to relationships with $k \geq 10$ (Sterne, Egger, and Moher 2008).

4. Results

4.1. Direct relationships

Table 1 reports the mean correlations of all meta-analyses carried out for each relationship. At the aggregate level, the results indicate a significant positive correlation between aggregate QM and aggregate innovation (ES = 0.4968, $p < .001$). This positive relationship was also observed for TQM (ES = 0.5014, $p < .001$), SQMPs (ES = 0.3355, $p < .001$) HQMPs (ES = 0.5585, $p < .001$), QMS (ES = 0.5184, $p < .001$). Thus, the hypothesis H1 and all its sub-hypotheses H1a, H1b and H1d are supported while rejecting H1c.

In terms of specific types of innovation, the results indicate that TQM is significantly associated with TI (ES = 0.4709, $p < .001$), GI (ES = 0.8693, $p < .001$) and other forms of innovation (ES = 0.3567, $p < .001$). SQMPs also exhibit positive correlations with TI (ES = 0.3910, $p < .001$), NTI (ES = 0.1240, $p < .05$), GI (ES = 0.1240, $p < .001$) and other forms of innovation (ES = 0.3067, $p < .001$). HQMPs are positively correlated with TI (ES = 0.4333, $p < .001$), NTI (ES = 0.2323, $p < .001$), GI (ES = 0.5809, $p < .001$) and other forms of innovation (ES = 0.5001, $p < .001$). Finally, QMS demonstrates significant associations with TI (ES = 0.4786, $p < .001$), NTI (ES = 0.4861, $p < .001$) and other forms of innovation (ES = 0.6474, $p < .001$). It should be noted, however, that the relationships between TQM and NTI and QMS and GI have not been investigated due to the small number of studies available ($K < 3$).

4.2. Moderation effects

Tests for heterogeneity revealed significant heterogeneity in the effect size of the relationship between QM and innovation ($Q = 4417.1724$, $p < .001$, $I^2 = 95.94\%$) (Table 1). As indicated by the I^2 statistic, the level of heterogeneity is high suggesting great between-study variability that may be explained by the moderators (Huedo-Medina et al. 2006).

The results in Table 2 indicate that leadership style significantly moderates the relationship between QM and innovation across different styles, which confirms hypothesis H2. Specifically, team-oriented and autonomous leadership styles show a strong positive moderation, with estimates of 0.7685 and 0.2272, respectively, both significant at the $p < .001$ level. Conversely, humane-oriented leadership shows a significant negative moderation (estimate = −0.1961, $p < .001$), indicating

Table 1. Meta-analytic results.

Relationship	K	N	ES	se	zval	95% CI		Heterogeneity	
						CL_l	CL_u	Q	I^2 %
Aggregate QM -> aggregate Innovation	169	173,040	0.4968***	0.0400	12.4251	0.4183	0.5752	4417.1724 ***	95.94
TQM -> aggregate innovation	22	8333	0.5014***	0.0737	6.8022	0.3570	0.6459	887.5351***	97.50
Technological innovation	7	2078	0.4709***	0.1011	4.6582	0.2727	0.6690	143.4444***	95.02
Non-technological innovation	2	–	–	–	–	–	–	–	–
Green innovation	4	1503	0.8693***	0.0690	12.5905	0.7339	1.0046	69.1689***	94.19
Others	9	3894	0.3567***	0.1128	3.1632	0.1357	0.5777	314.2248***	97.03
SQMPs -> aggregate innovation	62	15,143	0.3355***	0.0359	9.3406	0.2651	0.4059	703.1955	91.13
Technological innovation	25	6259	0.3910***	0.0513	7.6254	0.2905	0.4915	250.1493***	89.82
Non-technological innovation	9	1508	0.1240 *	0.0523	0.0523	0.0215	0.2265	28.9278	68.56
Green innovation	6	2130	0.5982***	0.0597	10.0255	0.4813	0.7151	49.2821***	87.81
Others	19	3947	0.3067***	0.0625	4.9089	0.1842	0.4292	109.7605	83.07
HQMPs -> aggregate innovation	66	14,245	0.5585***	0.0390	14.3160	0.4821	0.6350	1079.3917***	93.85
Technological innovation	30	7314	0.4333***	0.0568	7.6305	0.3220	0.5446	452.8371***	93.28
Non-technological innovation	6	935	0.2323**	0.0785	2.9607	0.0785	0.3861	25.4920	75.98
Green innovation	6	2130	0.5809***	0.0234	24.8359	0.5350	0.6267	7.1333	15.86
Others	23	3433	0.5001***	0.0560	8.9326	0.3904	0.6099	173.2996	86.56
QMS -> aggregate innovation	19	135,319	0.5184***	0.0329	15.7462	0.4542	0.5833	1457.9388***	98.62
Technological innovation	10	60,752	0.4786***	0.0249	19.2177	0.4298	0.5274	160.9142***	92.79
Non-technological innovation	3	43,962	0.4861***	0.0494	9.8359	0.3892	0.5830	322.1515	99.07
Green innovation	1		–			–	–	–	–
Others	5	30,304	0.6474***	0.0631	10.2609	0.5680	0.5237	358.2627***	97.94

Note: K: number of effect sizes; N: cumulative sample size; ES: pooled corrected effect size; se: standard error; zval: value of the z-statistic; CL_l: 95%- lower confidence interval; CL_u: 95%-upper confidence interval; Q: Q statistic; I^2 %: I^2-statistic percentage; *p*: *p value* (*$p < .05$ and **$p < .01$, ***$p < .001$).

Table 2. Moderation of leadership style in the QM-innovation relationship.

		Charismatic	Team oriented	Participative	Humane oriented	Autonomous	Self-protective
Intercept		*−0.0034*	*−3.9603******	*0.3447******	*1.4929******	*−0.3928******	*0.7157******
Estimate		0.0760***	0.7685***	0.1520***	−0.1961***	0.2272***	−0.0694***
Se		0.0057	0.0424	0.0115	0.0165	0.0138	0.0076
Zval		13.2512	18.1362	13.2124	−11.8956	16.5090	−9.0890
95% CI	CL_l	0.0648	0.6855	0.1294	−0.2284	0.2002	−0.0844
	CL_u	0.0873	0.8516	0.1745	−0.1638	0.2542	−0.0545
Q_M		175.5946***	328.9201***	174.5669***	141.5064***	272.5458***	82.6104***
Q_E		4241.5778***	4088.2523***	4242.6055***	4275.6660***	4144.6265***	4334.5619***

Note: se: standard error; zval: the value of the *z*-statistic; CL_l: 95%- lower confidence interval; CL_u: 95%-upper confidence interval; Q_M (Q-statistic for moderators): tests whether the moderators included collectively account for a significant amount of heterogeneity. Significant Q_M indicates the moderators explain variability in effect sizes. Q_E (Q-statistic for residual heterogeneity): examines if significant heterogeneity remains after accounting for moderators. Significant Q_E means unexplained heterogeneity may exist beyond the moderators; *p*: *p* value (**p* < .05 and ***p* < .01, ****p* < .001).

Table 3. Publication bias tests.

			Trim and fill					Egger		B&M	
					95% $CI_{t\&f}$						
Relationship	k	ES	$k_{t\&f}$	$r_{t\&f}$	CL_l	CL_u	Δr	*Z*	*p(Z)*	*p(τ)*	FSN
Aggregate QM -> aggregate innovation	169	0.4968***	195	0.5150***	0.4278	0.6023	0.0182	−1.6987	0.0894	0.9664	958,936
TQM -> aggregate innovation	22	0.5014***	27	0.3979 ***	0.2437	0.5522	−0.1035	1.6216	0.1049	0.1836	18,846
SQMPs -> aggregate innovation	62	0.3355***	78	0.2303***	0.1523	0.3084	−0.1052	0.4979	0.6186	0.4903	29,524
SQMPs -> TI	25	0.3910***	28	0.4207***	0.3126	0.5288	0.0297	−1.1276	0.2595	0.1851	6400
SQMPs -> others	19	0.2625***	28	0.1563*	0.0232	0.2894	−0.1062	6.9539	< .0001	0.8360	1862
HQMPs -> aggregate innovation	66	0.5585***	83	0.4647***	0.3804	0.5491	−0.0938	1.3877	0.1652	0.8600	112, 036
HQMPs -> TI	30	0.4333***	36	0.5019***	0.3831	0.6206	0.0686	−1.9972	0.0458	0.0685	10,787
HQMPs -> others	23	0.5001***	32	0.3887***	0.2802	0.4972	−0.1114	4.9254	< .0001	0.0722	7288
QMS -> aggregate innovation	19	0.5187***	19	0.5187***	0.4542	0.5833	0	0.6393	0.5226	0.5034	168,748
QMS -> TI	10	0.4786***	13	0.4839***	0.4249	0.5430	0.0053	−3.2405	0.0012	0.5163	26,054

Note: K: number of effect sizes; ES: pooled effect size; $k_{t\&f}$: number of trim & fill imputed studies; $r_{t\&f}$: pooled effect size from trim & fill; 95% $CI_{t\&f}$: trim and fill-adjusted 95% confidence interval; Δr: difference between $r_{t\&f}$ and ES; Z: Egger's intercept; p(Z): significance of Egger's intercept; B&M: Begg and Mazumdar (1994) rank test; *p*(τ): significance of Kendall's tau; FSN: Orwin's Fail-Safe N; *p*: p value (**p* < .05, ***p* < .01, ****p* < .001).

a dampening effect on the QM-innovation relationship. This leads us to reject hypothesis H2d and accept H2b and H2e.

Charismatic, participative and self-protective leadership styles also demonstrate significant moderation effects. The positive estimates for charismatic (0.0760) and participative (0.1520) styles indicate a facilitative role in the QM-innovation linkage, while the negative estimate for self-protective style (−0.0694) suggests a hindering effect. Thus, hypotheses H2a, H2c and H2f are supported.

However, the substantial Q_E values across all leadership styles imply that there is still significant residual heterogeneity unaccounted for by these moderators. This suggests that other factors, beyond the scope of the current moderators, might be influencing the relationship between QM and innovation.

4.3. Publication bias

Table 3 presents the results of the publication bias tests. For the aggregate relationship between QM and innovation, the trim and fill method imputed 26 studies and increased the pooled effect size from 0.4968 to 0.5150, indicating a possible publication bias in favour of larger effects. However, the adjusted effect size was still significant, and the 95% confidence interval did not include zero. Egger's test and Begg and Mazumdar's rank test were not significant, suggesting no evidence of funnel plot asymmetry. Orwin's fail-safe N was very large (958,936), implying that the meta-analytic result was robust to the addition of missing studies.

For the specific relationships between different types of QM practices and innovation, the results were mixed. The trim and fill method imputed studies for all relationships except for QMS and aggregate innovation and QMS and TI. The adjusted effect sizes were generally smaller than the original ones, but still significant for most relationships. The only exception was SQMPs and other types of innovation, where the adjusted effect size became non-significant. Egger's test was significant for SQMPs and other types of innovation, HQMPs and other types of innovation and QMS and TI, indicating funnel plot asymmetry and possible publication bias. Begg and Mazumdar's rank test was not significant for any relationship. Orwin's fail-safe N varied across relationships, ranging from 1862 for SQMPs and other types of innovation to 168,748 for QMS and aggregate innovation.

The publication bias tests suggested some evidence of publication bias for certain relationships, but the overall meta-analytic results were largely unaffected by the imputation of missing studies. The effect sizes and confidence intervals remained significant and consistent for most relationships, except for SQMPs and other types of innovation. Therefore, Aligning with the tandem approach (Ferguson and Brannick 2012), the meta-analysis provided reliable evidence for the positive relationship between QM and innovation in SMEs.

4.4. Robustness analysis

To assess the robustness of our study, we examined the potential impact of outlier and influential studies on our findings.

Following the methodology outlined by Viechtbauer and Cheung (2010), we utilized the *metafor package* for R (Viechtbauer 2010) to run a sensitivity analysis. To evaluate the potential influence of individual studies on the overall results, Viechtbauer and Cheung (2010) recommended examining up to eight diagnostic plots. These plots are implemented in the *R metafor package* and include externally studentized residuals (rstudent), difference in fits (DFFITS), Cook's distances, covariance ratios, leave-one-out estimates of heterogeneity, leave-one-out test statistics for heterogeneity, hat values and weights. Thresholds for influence are denoted with dotted lines, while mean values are depicted with dashed lines. Studies identified as potential outliers via any of the diagnostic plots are highlighted in red in all graphs. This array of graphical diagnostics allows for a comprehensive assessment of the sensitivity of the meta-analytic results to the influence of individual studies. Among the 31 studies, the sensitivity analysis identified nine effect sizes as influential (see Supplementary Appendix 2). By excluding these effect sizes from the sample and conducting the analysis with the reduced sample size ($k = 160$), we obtained a revised pooled effect size of 0.4298 ($p < .0001$) for the overall relationship between QM and innovation. This revised effect size is slightly lower ($\Delta r = -0.067$) than the initial effect size observed across all 31 studies ($K = 169$) 0.4968 ($p <$ .0001). Consequently, we can assert that the impact of outliers on our results is negligible.

5. Discussion

In our meta-analysis, we have uncovered a compelling positive correlation between QM and innovation, both at the aggregate and individual levels. This finding corroborates previous research studies that have demonstrated the supportive role of QM practices in fostering innovations within SMEs across various innovation types, including TI (Antunes, Quirós, and Justino 2018; Cuerva, Triguero-Cano, and Córcoles 2014; Lee 2021; Mahmud et al. 2019; Tamayo et al. 2015; Trivellas and Santouridis 2009; Tsoukatos et al. 2017; Udofia et al. 2021; Ullah 2022), NTI (Abdallah, Alkhaldi, and Aljuaid 2021; Bon and Mustafa 2014; Kafetzopoulos, Gotzamani, and Vouzas 2021) and GI (Albloushi et al. 2023; Azam et al. 2023; Cuerva, Triguero-Cano, and Córcoles 2014). These findings can be attributed to the comprehensive nature of QM, encompassing some main principles and practices, shared between different QM initiatives, such as process improvement, customer focus, employee empowerment, organizational learning and the cultivation of a continuous improvement culture, all of which inherently nurture innovation (Albloushi et al. 2023; Psomas, Fotopoulos, and Kafetzopoulos 2011; Sila and Ebrahimpour 2002; Zu, Fredendall, and Douglas 2008).

QM's emphasis on process improvement directly fuels innovation (Benner and Tushman 2003; Moreno-Luzon, Gil-Marques, and Arteaga 2014). It entails the continuous enhancement of organizational processes, the identification and elimination of inefficiencies and the streamlining of operations. This process optimization liberates valuable resources within SMEs, which can then be redirected towards innovative initiatives.

QM places a strong emphasis on customer focus, driving innovation within SMEs (Morgan and Anokhin 2023). By actively engaging with customers, collecting feedback and addressing their pain points, QM facilitates the perpetual enhancement of the customer experience. This customer-centric approach leads to innovations such as the development of new product features (TI) and the improvement of customer service (NTI).

QM often incorporates employee empowerment, creating an environment conducive to creative solutions (Martínez-Costa and Martínez-Lorente 2008). By nurturing employee motivation, engagement and satisfaction, QM inspires employees to seek better methods and rewards innovative ideas. Consequently, an empowered workforce becomes a fertile source of a range of innovations

QM fosters organizational learning (Lee et al. 2012), a pivotal catalyst for innovation (El Manzani and Cegarra 2023; Hung et al. 2011; Roldán Bravo, Lloréns Montes, and Ruiz Moreno 2017). Through collaboration platforms, best practice sharing and lessons learned, employees can harness collective knowledge to spark innovative ideas. This bottom-up, employee-driven approach, which is an important avenue unique to QM, may effectively facilitate both technological (e.g. new technologies) and process innovation (e.g. efficiency improvements), along with advancements in GI.

QM instils a culture of continuous improvement and a climate of support for innovation (Ruiz-Moreno, Tamayo-Torres, and García-Morales 2015). This cultural mindset is characterized by the relentless optimization of operations and services, propelling SMEs to proactively pursue innovations. This commitment to ongoing innovation is essential for driving TI to maintain competitiveness, NTI to enhance processes and GI to demonstrate environmental responsibility, ensuring that SMEs meet the diverse expectations of their stakeholders effectively.

Contrary to existing literature suggesting that HQMPs do not support SMEs innovation (Abdallah, Alkhaldi, and Aljuaid 2021; Trivellas and Santouridis 2009), our findings demonstrate that they are positively associated with TI, NTI and GI. HQMPs refer to the technical aspects of QM that enable efficient and effective innovation through introducing new quality attributes and developing creative solutions to technical problems (Abdallah, Alkhaldi, and Aljuaid 2021). Specifically, HQMPs utilize data-driven decision-making and statistical analysis to systematically identify and integrate technologies aligned with quality objectives (Kafetzopoulos and Psomas 2015). Furthermore, HQMPs facilitate the implementation of GI across SMEs by using structured methodologies focused on waste and energy reduction (Kafetzopoulos, Gotzamani, and Gkana 2015). HQMPs, such as infrastructure, technical expertise, process management, information analysis, and the use of the latest technology are key drivers of GI activities in SMEs (Albloushi et al. 2023; Azam et al. 2023).

Our findings illuminate the multifaceted role of leadership styles in moderating the relationship between QM and innovation within the context of SMEs. Charismatic leadership emerged as a positive moderator. Given the smaller team sizes typical of SMEs, charismatic leaders can have direct and personal interactions with employees. These leaders, through their personal appeal and persuasive communication, can effectively cultivate a culture of continuous improvement, a fundamental aspect of QM (Kumar, Garg, and Garg 2011). This culture can stimulate innovation by fostering creative thinking and encouraging employees to continually seek improved operational methods (Rasheed, Shahzad, and Nadeem 2021). Charismatic leaders can also foster trust and respect among their followers, thereby enhancing the effectiveness of QM practices and promoting a more innovative work environment (Panuwatwanich, Stewart, and Mohamed 2008).

Team-oriented leadership also demonstrated a strong positive moderating effect. This effect can be attributed to the collaborative environment nurtured by team-oriented leaders, which enhances QM implementation by promoting shared responsibility for quality, particularly within the interdependent roles characteristic of SMEs (Naor et al. 2008). This collaborative environment also engenders psychological safety, encouraging risk-taking and the exchange of diverse ideas, thereby fostering innovation (Edmondson 1999).

Conversely, humane-oriented leadership negatively moderated the QM-innovation relationship. While this leadership style fosters a supportive work environment, it may not directly stimulate QM and innovation (Naqshbandi and Jasimuddin 2018). This suggests that leaders who prioritize employee well-being and foster a nurturing work environment may inadvertently stifle innovation, potentially due to an emphasis on stability and harmony over risk-taking and experimentation (Rosing, Frese, and Bausch 2011). Leaders employing this style should strive to balance the need for a supportive environment with the promotion of healthy conflict and debate, which are essential for innovation (Akram et al. 2017).

Autonomous leadership has a positive moderating effect, aligning with the idea that this leadership style empowers employees to make independent decisions (Ahearne, Mathieu, and Rapp 2005). By fostering a sense of ownership and responsibility, autonomous leadership can enhance QM as employees take personal responsibility for the quality of their work. This leadership style can instil a culture of continuous improvement, a key element of QM, leading to consistent innovation over time (Spreitzer 1995). In SMEs, where resources are often limited, granting employees decision-making autonomy can lead to more efficient and innovative solutions (Li, Mitchell, and Boyle 2016).

Participative leadership positively moderates the association between QM and innovation, primarily through its impact on decision-making, work environment and organizational culture (Lythreatis et al. 2022). By involving employees in decision-making, this leadership approach cultivates a sense of ownership and commitment, crucial for the effective implementation of QM practices and the emergence of innovative ideas (Wang, Hou, and Li 2022). It creates an inclusive work environment, fostering idea exchange and innovative solutions. Furthermore, participative leadership establishes a culture of trust and respect, enhancing employee satisfaction and retention (Chang et al. 2019), vital for maintaining an innovative and quality-centric organization. These factors collectively strengthen the link between QM and innovation in SMEs.

Finally, self-protective leadership could detrimentally moderate the relationship between QM and innovation. This perspective aligns with the notion that self-protective leadership, often characterized by fear and mistrust, may undermine the collaborative and open environment necessary for effective QM and innovation (Javed et al. 2019). In SMEs, where adaptability and teamwork are crucial, a self-protective leader's focus on self-interest and maintaining personal power might stifle creativity and hinder continuous improvement efforts. Such a leadership style could create a workplace climate that discourages risk-taking and open communication, essential for innovative processes. Instead of fostering a culture that supports innovation through quality management principles, self-protective leaders might impose overly rigid controls and discourage the experimentation and learning that are pivotal for innovation (Yıldız, Baştürk, and Boz 2014). This could result in a compliance-based approach to QM, which is less likely to lead to genuine innovation.

6. Conclusion

This research sought to study the association between QM and innovation within the context of SMEs, while also examining the moderating influence of leadership style. A comprehensive meta-analysis, incorporating 31 articles (yielding 169 effect sizes and a cumulative sample size of 173,040), substantiated that QM generally exhibits a positive and significant correlation with innovation. Specifically, TQM demonstrates a notable positive influence on both TI and GI, indicating its effectiveness in promoting innovations that are either technology-centric or environmentally focused. SQMPs, while also positively impacting TI and GI, exhibit a comparatively weaker effect on NTI. This suggests that SQMPs are less effective in fostering innovations that are not technology-based but more effective for environmentally oriented ones. HQMPs show a broad and strong positive effect across all types of innovation, with the most significant impact observed in GI. This underscores the versatility and effectiveness of HQMPs in nurturing a wide range of innovative activities within SMEs, particularly those aimed at environmental sustainability. QMS similarly exert a positive influence on all types of innovation, reinforcing the idea that structured and systemic QM approaches (e.g. ISO 9000 standards) can be crucial in driving diverse innovative outcomes.

Furthermore, the research underscored the moderating role of diverse leadership styles – including charismatic, team-oriented, participative, people-oriented, autonomous and self-protective – in the QM-innovation relationship. The subsequent sections delineate the main implications and limitations of the research.

6.1. Theoretical implications

Our research theoretically contributes to the existing literature in several ways. First, the link between QM and innovation is the subject of ongoing debate in academic literature, with no definitive answer. Various studies suggest that QM hinders innovation, while others argue that it promotes it (El Manzani, Sidmou, and Cegarra 2019). The main argument is that QM introduces more stability and bureaucracy, making organizations more rigid. While this argument may hold for large firms, it does not apply to SMEs. Our study brings a counterargument when it comes to SMEs. Due to their organic and flexible structures, SMEs can benefit more from QM as they can streamline it to fit their agile nature. Those SMEs' characteristics allow them, therefore, to reap process improvement benefits from QM without stifling their innovation capacity.

Second, our meta-analysis complements and bolsters those of systematic literature reviews by providing a quantitative answer to the question of the impact of QM on innovation. Contrary to the trade-off perspective between QM and innovation, our study offers a modern perspective suggesting that SMEs can follow both QM and innovation. This viewpoint holds that successful QM implementation can foster innovation in a cumulative improvement model way. Furthermore, it confirms that QM, in its different forms and practices, acts as an internal dynamic capability (El Manzani 2019; El Manzani and Cegarra 2023) that enables different types of innovations. More specifically, our results illuminate this impact within the SMEs' literature.

Third, we brighten the mechanism of this relationship within SMEs. By showing that leadership style moderates the QM-innovation association, we introduce an important contingency factor explaining how QM drives innovation in SMEs. This addresses a significant gap, as past studies largely focused on large firms, neglecting leadership differences across SMEs. Thus, our study reveals national culture's influence on QM-innovation links through leadership preferences, advancing institutional theory perspectives.

Finally, we extend the scope of QM's benefits beyond operational performance, as established in prior meta-analyses (Abreu-Ledón et al. 2018; Ahmad et al. 2015; Antony et al. 2022; Mackelprang and Nair 2010; Nair 2006; Xu et al. 2020). Our findings position innovation as a key additional outcome of QM adoption, highlighting its strategic value for the long-term competitiveness of SMEs.

6.2. Practical implications

This study provides empirically grounded insights for SMEs. We advocate for SMEs managers to strategically allocate resources towards the implementation of QM, as it catalyses fostering diverse forms of innovation. An initial advantageous step would be to invest in the establishment of an ISO 9001 QMS. QMS provides structured frameworks for SMEs to systematically implement QM practices that can increase innovation, especially for smaller firms with limited resources. However, SMEs should ensure a harmonious integration of both SQMPs and HQMPs. Prior research underscores that an inefficient and imbalanced implementation of these practices could potentially impede a firm's innovative capabilities (El Manzani, Sidmou, and Cegarra 2019; Kaynak 2003). Moreover, SMEs should transcend the limited perspective of QMS integration solely for certification purposes, and instead, persistently pursue system enhancements to achieve TQM and business excellence.

From our results, QM implementation could serve as a strategic approach for SMEs in developing GI, thereby reinforcing their sustainable development strategies. Specifically, it contributes to environmental sustainability by reducing waste, energy consumption and environmental impact (Albloushi et al. 2023). By implementing environmentally friendly practices, organizations not only fulfil their corporate social responsibility but also create opportunities for innovation. For example, SMEs may develop new eco-friendly products or implement sustainable manufacturing processes (Azam et al. 2023).

Our research findings highlight the significant role of leadership style in moderating the relationship between QM and innovation. Specifically, we found that charismatic, team-oriented, participative and autonomous leadership styles amplify the positive impact of QM on innovation. Consequently, we advise SMEs managers to adopt a balanced leadership approach, utilizing charismatic and team-oriented behaviours to inspire a shared vision and foster an empowered, collaborative culture. To fully harness the innovation-enhancing potential of QM, managers should incorporate elements of autonomous leadership, empowering employees with the freedom to be proactive problem-solvers. While granting moderate autonomy is optimal, managers must still provide direction and support to align efforts towards organizational goals.

Conversely, human-oriented leadership, which emphasizes interpersonal relationships and harmony, weakens the QM-innovation relationship. Managers should exercise caution against becoming excessively friendly or prioritizing harmony over innovation, as this human-oriented approach may inadvertently stifle innovation derived from quality initiatives. Similarly, Self-protective leadership hinders MQ's role in innovation. Thus, SMEs managers should avoid this leadership style as it creates a culture of fear and mistrust and leads to short-term thinking and risk aversion, which can hinder long-term quality improvement and innovation.

6.3. Limitations and future research avenues

Our study, while contributing to the existing body of knowledge, acknowledges several limitations that offer opportunities for future research. These limitations stem from both the literature we have reviewed and the methodological choices we have made. The limitations derived from the literature can be encapsulated in three main points. Firstly, our findings are primarily applicable to manufacturing SMEs due to the dearth of research in the context of service SMEs. This suggests that the influence of QM on innovation may vary in service SMEs (Sahoo 2019). Therefore, to gain a comprehensive understanding of QM's impact on innovation, future research should extend its focus to service SMEs, in knowledge-intensive industries. Secondly, the absence of consideration for the degree of innovation in most research prevented us from exploring the relationship between QM and both radical and incremental innovation. Future research could enrich our understanding by examining how QM affects different types of innovation (product, process, managerial, etc.) and their respective degrees of novelty in SMEs. Finally, we chose the six leadership styles identified in the GLOBE study due to their robust cultural foundation and comprehensive validation across various cultural contexts

Table 4. Suggestions for future research.

Research questions	• Research the impact of different quality management (QM) approaches such as total quality management (TQM), ISO, EFQM, Malcolm Baldrige National Quality Award (MBNQA), Six Sigma, lean management and Quality 4.0.
	• Examine the impact of integrated quality management systems.
	• Relate specific QM practices to different innovation types and degrees.
	• Conduct more studies on green/sustainable innovations.
	• Test for non-linear relationships between QM and innovation.
	• Study the bi-directional linkage between QM and innovation.
	• Examine potential negative or insignificant relationships to understand limiting factors.
Contextual and organizational factors	• Compare relationships across different sectors such as manufacturing vs. services and between low, medium and high knowledge-based industries.
	• Analyse contingent relationships and moderators such as firm culture, sector, national context and the personality and vision of SMEs owner-managers.
	• Study developing country contexts that are under-researched.
	• Study the QM-innovation relationship at the individual level instead of the organizational level.
	• Analyse mediating mechanisms such as knowledge management and organizational learning.
Research design	• Develop more consistent definitions and measures of key variables (i.e. QM and innovation).
	• Use longitudinal data and panel data analysis to establish causality over time.
	• Conduct qualitative studies such as case studies to provide more insight into how and why relationships between QM and innovation occur.
	• Use modern data analysis techniques (e.g. Fuzzy-set Qualitative Comparative Analysis (FsQCA), Necessary Condition Analysis (NCA), Neural Network Analysis, Multilevel Structural Equation Modelling).

(Dorfman et al. 2012; House et al. 2004). While other leadership styles, such as transactional, transformational, situational, or servant leadership, do exist, they were not included in our study due to the unavailability of relevant data for integration into our analysis. Future research could beneficially explore how these additional leadership styles might influence the QM-innovation relationship.

Turning to the limitations arising from our methodological choices, the first is our exclusive focus on SMEs. This approach overlooks the potential influence of QM on innovation within large-scale enterprises, where outcomes may vary based on the size of the enterprise. It is therefore crucial for future research to replicate this meta-analysis for large-scale enterprises, considering variations across different industry sectors. Secondly, our selection of only published studies potentially excludes valuable insights from unpublished works. While publication bias does not pose a problem in our meta-analysis, the inclusion of unpublished studies could provide a more nuanced understanding of the QM-innovation relationship. Lastly, our use of correlational meta-analysis as a technique limits our ability to include other mediating variables that influence the QM-innovation relationship, such as corporate social responsibility (Azam et al. 2023), employees' job satisfaction (Trivellas and Santouridis 2009). We propose that future research could leverage more advanced meta-analysis techniques, such as Meta-analytic Structural Equation Modelling (Meta-SEM). Meta-SEM allows for the testing of more complex models that include multiple variables and their interrelationships, accommodating more intricate relationships, such as mediating and moderating effects, while also accounting for measurement error and other sources of variability (Jak and Cheung 2020).

Beyond these limitations, Table 4 pinpoints gaps in current understanding, emphasizes the need for empirical studies and guides future research by identifying unexplored areas or avenues for investigation. These research avenues were proposed based on a systematic review of the 31 studies included in our meta-analysis. To do so, a qualitative content analysis has been done for all these studies according to predefined themes (e.g. the study objective, theoretical conceptualization and measurement of the main constructs, sample size, method etc.). Comparing and contrasting the themes across the studies has enabled us to identify the similarities, differences and gaps in the studies. Supplementary Appendix 1 gives a summary of the main themes.

Note

1. The scores are available on the link: https://globeproject.com/results/#country.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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