Clustering abstracts from the literature on Quality Management (1980-2020)

Manuel J. Sánchez-Franco

Department of Business Administration and Marketing, University of Seville, Av. Ramón y Cajal 1, 41018 Seville (Spain) email: majesus@us.es

Arturo Calvo-Mora

Department of Business Administration and Marketing, University of Seville, Av. Ramón y Cajal 1, 41018 Seville (Spain) email: schmidt@us.es

Rafael Periáñez-Cristobal

Department of Business Administration and Marketing, University of Seville, Av. San Francisco Javier, s/n, 41018 Seville (Spain) email: rafacris@us.es

The research analyses the intellectual structure of research publications on Quality Movement (1980–2020), indexed in the Scopus database. It examines how themes haveevolved, and it seeks to plan an editorial agenda. The research assumes a content-related method to reveal conceptual relationships in abstracts and conclude thematic trends, gaps, and weaknesses in the Quality Management domain and its implementation frameworks. In particular, the analysis is based on the BERTopic approach, *i.e.* it employs machine learning algorithms based on text summarisation and c-TF-IDF to create dense clusters using UMAP and hDBSCAN clustering. Although keywords are helpful in knowledge extraction, identifying hidden topics and their associations is a more robust approach to understanding the proper context of the analysed articles. As aresult, the study identifies 48 topics and 13 metatopics for Quality Movement. In addition, the paper shows the temporal evolution of the topics, and identifies the topicsand metatopics of growing interest in the emerging literature in QM.

Keywords: Quality Management; quality movement; trends; topic modelling;BERTopic

1. Introduction

The contributions proposed, over decades, by the so-called 'Quality gurus' (Edwards Deming, Joseph Juran, Kaoru Ishikawa, Philip Crosby, and Armand Feigenbaum, among others) made quality a critical factor in the management of organisations (Lo & Chai, 2012). Brown (2013) notes that during the 1980s and 1990s, there was considerable evidence of success in implementing Quality Management (QM), essentially in manufacturing companies. Moreover, in the 1990s, several pioneering studies of a theoretical or empirical nature shaped the concept of quality (Reeves & Bednar, 1994) and, complementarily, the principles and practices that characterise this academic domain (Ahire et al., 1996; Anderson et al., 1994; Black & Porter, 1996; Flynn et al., 1994; Saraph et al.,1989; Sitkin et al., 1994). Moreover, the QM philosophy is extended to other domains, sectors, and organisations due to the influence of QM principles and practices on business performance and competitiveness (Dahlgaard-Park et al., 2013; Sila & Ebrahimpour, 2005). It was also at this stage that the first Quality Assurance Standards (ISO 9000series of 1987) and Quality Awards and Business Excellence Models (Malcolm Baldrige in 1987 or EFQM in 1991) emerged, leading to an increasing interest among academics toinvestigate it in depth (Evans et al., 2013).

In this regard, the term Total Quality Management (TQM) arose to define a management philosophy that requires the participation and involvement of all the members ofan organisation. TQM pursues continuous improvement in organisational processes to satisfy customers and other stakeholders (Zhang et al., 2021). Market demands, growing competition, and the need to meet the changing needs and expectations of customers and other stakeholders have driven the continuous development of QM (Weckenmann et al., 2015), which has had to be done without losing sight of costs, competitiveness, and ensuring sustainable development. Accordingly, several systematic reviews and bibliometric and text mining analyses have been developed to synthesise and present overviews of the field in our academic community in a structured manner.

For example, relevant bibliometric studies focus on the service sector (Zhang et al., 2021), tourism (Garrigos-Simon et al., 2019), QM implementation frameworks, such as ISO 9000 standards (Hussain et al., 2020), Business Excellence Models (Ghafoor et al., 2022; Pohle et al., 2018), and on specific journals, such as Total Quality Management and Business Excellence (Lo and Chai, 2012), International Journal of Quality & Reliability Management (Carnerud, 2017) and Quality Management Journal (Evans et al., 2013; Radziwill, 2013).

In summary, QM practice is complex and has become a multidisciplinary, dynamic, and diverse research domain, with a growing literature of great interest to scholars and managers (Dahlgaard-Park et al., 2018; Fredriksson & Isaksson, 2018). On the one hand, in most cases, the systematic literature review identifies primary research themes or topics and trends, gaps, and weaknesses (Bajaj et al., 2018; Hietschold et al., 2014). On the other hand, as noted by Chen et al. (2020) and Suárez et al. (2017), bibliometric analysis is primarily qualitative, and data analysis strategies are based on a descriptive narrative of the data, for example, thematic analysis, narrative summary or descriptive statistics (Boiral, 2012). Furthermore, it employs an insufficient number of studies and focuses on specific research topics, for example, Quality Management Standards (Boiral, 2012; Tarí et al., 2020), Business Excellence Models (Doeleman et al., 2014; Kim et al., 2010; La Rotta & Pérez Rave, 2017; Suárez et al., 2017), the impact of TQM on performance (Bajaj et al., 2018), the measurement and identification of QM's critical success factors (Hietschold et al., 2014), QM and sustainable development (Siva et al., 2016), and QM and education (Manatos et al., 2017), among others. On the contrary, meta-analysis studies (1) employ a statistical analysis of the results from a wide range of studies to integrate their findings and conclusions, and (2) group the results of quantitative studies to perform new statistical analyses. In the QM field, the work of Xu et al. (2020) and Nair (2006) stands out for their use of correlations to analyse how QM practices affect the organisation's performance. The meta-analysis approach improves the accuracy, reliability, and validity of the measurements obtained in specific studies (Lee & Hew, 2017). However, the main drawback is generally to assume that the studies have homogeneous characteristics (e.g. dimensions, hypotheses, or methods) (Boiral, 2012).

Beyond the above considerations, bibliometric analysis allows us to carry out an objective and quantitative examination of a scientific discipline, to deduce the changes experienced in it, and to determine the profile and publication preferences on prevalent topics (Lee & Hew, 2017). Furthermore, it allows for synthesising and presenting overviews of the field in our academic community and recognising groups of relevant scholars and reliable publication sources to plan an editorial agenda. The results of the bibliometric analysis provide sound, practical and relevant implications for both academics and practitioners. It helps to explore future research trends and emerging managerial practices (Carnerud, 2017). From 1980 to the present, as far as we know, there has been no bibliometric analysis that covers the development of theoretical and empirical research on the different QM implementation frameworks (i.e. TQM, Quality Management Standards-ISO 9000 and Business Excellence Models), regardless of the academic environment, sector of activity, or scientific journal. Therefore, this research aims to analyse the QM research over the last 40 years, where it is today, and what can be expected. As stated by Carnerud and Bäckström (2021) and Barouch and Ponsignon (2016), the indications are that theoretical and practical advances in QM initiatives go hand in hand.

1.1. Research questions

Our bibliometric study provides descriptive and evaluative information on QM research. In this regard, the study applies advanced topic modelling and text analytics (focused on the structure and trends of a research domain), in particular, the BERTopic approach (cf. Grootendorst, 2020) based on Top2Vec (Angelov, 2020). Our procedure therefore allows '[our] researchers to evaluate its structure, (…) defining future research guidelines' (Nicolas et al., 2020, p. 1). In particular, bibliometric analysis and topic modelling enable (1) the combination of thematic trends, gaps and weaknesses in the QM domain, topic proportion distributions by year and topic clustering, and (2) the following research questions (cf. Dervis, 2019, p. 158; Zupic & Čater, 2015) to be answered:

- Which authors are the most prolific scholars? Who are the most cited scholars? Also, how has the research been distributed over time? Which countries collaborate? In which journal do scholars publish their research?
- What are the main topics prevalent in the QM domain and their implementation frameworks? How have QM topics, and their implementation frameworks, evolved over the past 40 years? What are the issues with the highest potential for growth in the QM domain and their implementation frameworks?

1.2. Previous bibliometric and/or text analysis research on quality management

Table 1 indicates the highlights of the most recent and relevant bibliometric or text analysis studies on QM. The analysis shows that the present study covers one of the most extended periods in the review (1980–2020). Only the study by Sadeghi Moghadam et al. (2021) has a more extended time scope. However, it does not reach 2020 and focuses on analysing the evolution of quality management techniques. Regarding the objectives and research questions, the present study has the novelty of specifically exploring the QM implementation framework and other QM domains, identifying the main QM topics and metatopics. Wen et al. (2022) also analyse the evolution of QM, although from the beginning of the century through systematic literature review, bibliometric analysis, and expert interviews. Studies that combine bibliometrics, analysis, text analysis, and advanced topic modelling are less frequent. This allows us to reach differentiated results and conclusions.

On the other hand, we find studies reviewing specific aspects or areas of QM and its implementation frameworks. For example, Ghafoor et al. (2022) focus on the analysis of Business Excellence; Zhang et al. (2021) carry out their study of TQM in the service sector; Ho et al. (2022) perform a bibliometric analysis since the 1990s, focused on TQM, and Hussain et al. (2020) analyse ISO 9000 standards as a field of research. Finally, although performing text mining analysis, Wawak et al. (2020) and Carnerud and Bäckström (2021) focus exclusively on a selected issue of Quality Management and Operations Management Journal.

2. Quality management: evolution and paradigms

The origin of QM can be traced to the beginning of the twentieth century when the industrialisation process in developed countries and mass production replaced the old guild systems of artisanal production (Maguad, 2006). QM evolved as required by the needs of organisations and market circumstances (Dahgaard-Park, 2011). Researchers identify the significant milestones that differentiate each stage based on this evolution. Thus, Weckenmann et al. (2015) distinguish between QM focused on the product, process, and system. Dahlgaard-Park et al. (2018) argue that the QM evolutionary process encompasses the most relevant management theories. At the same time, there is practical evidence of the impact of QM on the organisation's performance, theoretical propositions are formulated, and academic paradigms are built around QM (Carnerud, 2020; van Kemenade & Hardjono, 2019).

Until the mid-1940s, QM was focused on products, with its fundamental objective being to deliver faultless finished products to customers. The finished products were first inspected, and the defective items were separated ('Quality Inspection'). The system's inefficiency made it necessary to consider new modes of action that give attention to products and processes. Therefore, 'quality control' emerged (Dahlgaard-Park et al., 2018; Weckenmann et al., 2015). Similarly, the 'empirical paradigm' (van Kemenade and Hardjono, 2019), or the 'fronted quality paradigm' (Carnerud, 2020), predominated. Knowledge of reality is obtained by experimenting and seeking empirical evidence of the results of products and processes. Quality is a compliance with technical requirements or specifications. Therefore, this paradigm is focused on overcoming technical problems that can be solved by applying available scientific knowledge, measurements, standards, and rules (hard factors).

Starting in the 1960s, the increase in supply and competition caused a more proactive and preventive process-centred approach to detect the associated risks and problems before they arose ('Quality Assurance') (Weckenmann et al., 2015). Later, in the 1980s, the customer approach took on a leading role in ensuring that what was manufactured was in line with the customer's tastes, wishes, and expectations (Hussain et al., 2020). Additionally, the scope of the quality function was broadened, becoming a transverse activity in organisations (Dahlgaard-Park et al., 2018). In this evolutionary phase of QM, the first quality standards of the International Organization for Standardization (ISO) appeared in 1987. However, this first version of standards still had a clear technical and control orientation, focused on standards of components and products (Maguad, 2006).

Table 1. Recent bibliometric and/or text mining studies on QM.

Since the late 1980s, a change in approach and a qualitative leap in QM have been necessary. Satisfying customer demand requires the manufacture of increasingly complex products, involving all processes in the organisation's value chain and all areas (Carnerud & Bäckström, 2021). Therefore, QM would no longer focus on processes and products but on the entire organisational system (Weckenmann et al., 2015). This change can be seen in the ISO 9000 standards of 1994, which introduced the concept of preventive actions providing an essential shift towards management from a system perspective ('Quality Management System', or QMS) (Hussain et al., 2020). The ISO 9000 2015 standards are also designed to guarantee the continuity of companies. Analysing the internal and external context and risk-based management obliges the quality function to have growing transversality and a holistic vision. Quality risks can be found in any company's function, e.g. purchasing, human resources, etc., and not just in the primary process. In this context, the 'reference paradigm' (van Kemenade and Hardjono, 2019) and the 'middle-way quality paradigm' (Carnerud, 2020) maintain that not everything can be measured based on objective and observable characteristics, as many other critical aspects of the success of QM are left out. To solve this problem, standards, guidelines, or models are designed to include requirements and criteria that establish how things should be. They lay the foundation for continuous improvement in management.

The most advanced stage of QM is 'Total Quality Management', or TQM, which emerged at the end of the 1980s (Dahgaard-Park, 2011). Although it continues to refer to system-oriented quality, it is assumed that organisations which have a future are those that do not limit themselves to obtaining good customer-market- economic-financial results but rather broaden their goals towards other results related to other stakeholders, such as employees or society in general (Weckenmann et al., 2015). This causes the scope of QM to expand to other sectors, such as education, health, or public administration (Dahlgaard-Park et al., 2018). Additionally, awareness is raised of the decisive role of employees and their commitment to achieving quality results at all levels. Leadership, employees, processes, customer satisfaction, and other business outcomes are closely interconnected (Carnerud & Bäckström, 2021). For Carnerud (2020), QM has a high level of abstraction. It is oriented to cultural principles and values, groups and people (soft factors); that is, management aspects essential for the organisation's success. Carnerud (2020) terms this paradigm the 'backed quality paradigm' and van Kemenade and Hardjono (2019) a 'reflective paradigm'. As TQM has developed, during the first years of the new millennium, the so-called Business Excellence Models (BEMs) have emerged (Dahlgaard-Park et al., 2013). The most widespread BEMs in business practice and in the scientific literature are the EFQM model and the Malcolm Baldrige Award, which serve as references for the so- called Quality or Excellence Awards. The development of BEM would be framed within the 'reference paradigm' (van Kemenade and Hardjono, 2019) and the 'middle- way quality paradigm' (Carnerud, 2020).

At present, organisations face a 4th Industrial Revolution called 'Industry 4.0'. This revolution generates a new reality and way of organising production based on digitization and the massive use of information. Industry 4.0 allows companies to be more flexible and to be able to adapt to the changing needs of the markets, without excessive costs and with tight deadlines (Sony & Naik, 2020; Zonnenshain & Kenett, 2020). Undoubtedly, the digital transformation driven by Industry 4.0 is revolutionising all sectors. This challenge should encourage companies to invest in new technologies, train employees and adopt new business models that emphasise differentiation through innovation, product customisation, and improved quality and excellence (Fonseca et al., 2021; Wen et al., 2022). Industry 4.0 attempts to integrate information technologies and digital tools, such as cyber-physical systems, the Internet of things, BigData, Cloud computing, Smart products and services, and Artificial Intelligence, into all the value chain processes (Sony et al., 2020). It is unde- niable that the introduction of the abovementioned technologies and digitisation pose significant challenges and changes at the organisational and management level, to which the quality function will not be alien (Hyun Park et al., 2017).

Thus, the term Quality 4.0 began to be used. For Johnson (2019), Quality 4.0 is more than applying echnology and digital tools in QM activities. Cultural and human cues are equally essential to drive Quality 4.0 performance. Sony et al. (2020 and 2021) identify some readiness factors for implementing Quality 4.0. Among these factors are aspects of an organisational and management nature: leadership and support from top manage- ment, vision and strategy for Quality 4.0, training and rewards, knowledge and awareness for Quality 4.0, organisational culture, and the involvement of customers and suppliers. In addition, these elements identify other factors of a technical nature: the use of big data, prescriptive analytics, and vertical, horizontal, and end-to-end integration. The authors argue that organisations must implement these key factors methodically and systematically to implement Quality 4.0 successfully. For Haffar et al. (2019), the keys to Industry 4.0 and Quality 4.0 are automation, digitisation and data management, although the main barriers are not technological but cultural and resistance to change. In this regard, Sader et al. (2021) point out that the main challenges faced by companies seeking to implement Quality 4.0 are related to new human resource skills and resistance to change. Sony et al. (2021) consider that the absence of an enabling organisational culture is the leading cause of the failure of Quality 4.0 initiatives. Therefore, it is a matter of jointly

optimising human and technical systems. Zonnenshain and Kenett (2020) note that the discipline of quality and its management has stagnated in recent years, with few innovative models for quality management being proposed, and quality professionals have lost impor- tance within organisations. Along these lines, Sader et al. (2021) and Wen et al. (2022) add that Quality 4.0 has broadened the focus of quality from a local perspective aimed at excluding defective products or monitoring manufacturing processes to a more holistic view with intensive monitoring of all elements contributing to the production value chain. To sum up, the era of Industry 4.0 is an opportunity for the quality movement to become a leading force.

3. Materials

3.1. Data collection

Our research develops a mapping according to information found in Scopus, uncovers hidden research themes, and examines scientific output to identify influential publications, authors, and academic institutions. Additionally, our research applies a topic modelling through abstracts from selected quality management articles. Abstracts 'represent a concise summary of the article, which minimises the chance of identifying peripheral/minor topics (…) (and) are fairly comparable in terms of format/style across journals' (Daenekindt & Huisman, 2020). The refereed journal articles (as the higher-ranked scientific contributions) are collected by extracting them from Scopus to build our bibliometric analysis. Scopus is selected because it includes the journals most indexed in the Web of Science (WoS). Furthermore, Scopus has more journals (and therefore references) than WoS.

Furthermore, as commented above, the study aims to (1) identify the main topics pre- vailing in the field of QM (and TQM) and their application frameworks, (2) analyse their evolution over the last 40 years (1980–2020) and (3) highlight those topics with the most significant potential for future growth. In this regard, our method selected a trade-off between precision and recall, trying to control noise and overfitting- I.e.:

- First stage. The initial query included 'quality-management' or 'total-quality-management' (2,230 documents) and corresponded to the fields of business or economics. The sample was limited to all available documents in English that comply with the criteria above. We only considered journal articles and excluded documents such as conference proceedings, theses and book chapters. Our research, therefore, comprises refereed journal articles written in English on business and economics.
- Second stage. We added text strings such as excellence management or business excellence and terms related to the quality prize with Boolean operators 'OR' to obtain the universal set of documents. This approach generates the broadest sample possible that is still relevant to the research field (9,132 articles), combining the recall and precision criteria:
    - Excellence Management: excellence-management*; business-excellence; excellence- model; quality-award*; quality-prize*; EFQM; malcolm-baldrige; MBNQA
    - Quality management and assurance systems: quality-standard*; quality-assurance*; ISO-900*.
    - Digitalisation, technologies and quality management: quality-4.0*; quality-4.0*; quality-4.0*; quality-4.0*.

To sum up, the sample includes publications that contain the text strings 'excellence management' or 'business-excellence' or 'quality-standard*' or 'quality-management' or 'total- quality-management' or 'excellence-model' or 'ISO-900*' or 'EFQM' or 'malcolm-baldrige' or 'MBNQA' or 'quality-award*' or 'quality-prize*' or 'quality-assurance*' or 'quality-4.0*'.

3.2. Summary of data

The final data set yields 9,132 documents authored by 15,417 authors and 6,687 first authors in 836 publications (journals). The percentage distribution of the number of authors, affiliations and countries is shown in Figure 1. Our results indicate that multi- authored articles (73.2%) are more frequent than single-authored contributions (26.8%) in QM. Single-affiliations (54.8%) and single-countries (82.4%) represent significantly higher percentage values.

Twelve thousand seven hundred sixty authors (82.8%) published a single article, 1,490 authors (10.0%) published two articles, and 488 authors (3.17%) published three articles. Likewise, single-authored publications accounted for 2,451 articles (26.8%), two author publications accounted for 2,985 articles (32.7%), and three author publications accounted for 2,188 articles (24.0%).

The majority of documents were published by (co)authors (identified by author ID) in 127 countries (and 5,529 institutions), including the United States (2,278), the United Kingdom (1,215), India (503), Spain (452) and Australia

(409). In this regard, Figure 2ab shows the distribution of articles per country and affiliation. Moreover, the five most productive journals were Total Quality Management & Business Excellence (1,012), The TQM Journal (792), Quality Progress (486), International Journal of Quality Assurance of Health Care (428), and International Journal of Quality & Reliability Management (398); see Figure 3a. Figure 3b shows the top h-index per author. In particular, Barrie G. Dale published 57 articles in our dataset. His h-index is equal to 30, followed by Marti Casadesus (h-index: 26), Amrik Singh Sohal (h-index: 25), Samuel Rajkumar Devadasan (h-index: 24), Mohamed Ziri (h- index: 24) and Inaki Heras-Saizarbitoria (h-index: 24).

As a third-degree polynomial model, our results reveal a highly significant increase in the number of documents published between 1980 and 2020 (see Figure 4a). Although the QM domain becomes more productive over time, with an (average) annual percentage growth rate of 31.72% (see Figure 4b), the increase in the number of articles per unit of time (Relative Growth Rate or logP(t)-logP(t-1); hereinafter RGR) gradually decreases over the years (RGRaverage:1980–1989 = 0.38, RGR average:1990–1999 = 0.28, RGR average:2000–2009 = 0.006, RGR2010–2020 = 0.010). The overall collaboration index (CI), or the average number of authors in multiauthored articles, is 2.95 (median = 3 and sd = 1.26), suggesting that the research team is generally composed of two to four co-authors (see Figure 4c). The CI, by years, shows an upward trend; that is, single-authored articles significantly decline.

A minority of authors publish most of the articles (Beta coefficient of 2.34 and a constant C of 0.34 with r2 = 0.92; cf. Lotka's law to measure productivity). In this regard, applying a two-sample Kolmogorov–Smirnov test, the relative frequency distribution of the authors' number of articles is here more skewed right than expected by Lotka's law distribution ($p < 0.01$). Finally, the small-worldness index (SWI), estimated against 1,000 random networks, is 20.18 (neighbours > = 3; cf. Humphries & Gurney, 2008), evidencing a small-world structure. Our coauthorship network has high clustering and short average path lengths.

Figure 1abc. The distribution of individual articles.

Figure 2ab. The distribution of articles per country and affiliation.

Figure 3ab. The distribution of articles per journal and the h-index per author.

Figure 4. The number of articles over the years (on a logarithmic scale), RGR, and CI of the QM field.

3.3. Data cleansing process and terms extracted

Following Sánchez-Franco & Alonso-Dos-Santos (2021; cf. also Sánchez-Franco and Rey- Moreno, 2022), our research: (1) checks the spelling of narratives and removes duplicates; (2) discards punctuation, capitalisation, digits, and extra whitespaces; (3) removes a list of common stop words, to filter out overly common terms, and a customised list of proper nouns; (4) fixes contractions, and compound terms; (5) becomes text in ASCII, and standardises it by lowercasing; and (6) lemmatises the terms. Authors' names and publications'names, with different variations, are also normalised. Finally, the most frequent word n-grams (extracted from author keywords) are combined with unigrams. Figure 5 describes the steps to transform the free text into a structured form and find relevant topics.

4. Data mining

Our study compares the importance of terms between identified groups of document vectors, which are more informative and representative than the Latent Dirichlet Allocation (LDA) or Probabilistic Latent Semantic Analysis (PLSA) output (Sánchez-Franco and Rey-Moreno, 2022). Compared to LDA or PLSA, our finetuning approach fits a small number of parameters and does not require a preselection of the number of topics to be extracted.

Our research initially transforms our corpus-abstracts into 5,000-dimensional vectors by applying the Tf-Idf vectoriser function extracted with scikitlearn in Python 3.8. Secondly, following the BERTopic approach (Grootendorst, 2020), a Uniform Manifold Approximation and Projection for Dimension Reduction (UMAP through the UMAP-learn 0.5.1 package in Python 3.8; McInnes et al., 2018) is applied to the embedding to improve the efficiency of revealing patterns. UMAP performs significantly better than t-SNE in maintaining the local and global structure of the data sets. Our proposal reduces our embedding to 60d-dimensions and measures the distances between data points by cosine similarity. Based on experimentation and the related literature (McInnes et al., 2018), our research selects the 15 nearest neighbours to emphasise local structures preferentially. Additionally, the effective minimum distance between embedded points is set at 0.01. Thirdly, the 60d-UMAP set is clustered with the Hierarchical Density-Based Spatial Clustering of Applications with Noise algorithm (hDBSCAN, through the hdbscan 0.8.27 package in Python 3.8; Campello et al., 2013). The minimum size of the clusters is set at 50, to identify a sufficiently large number of articles to increase the relevance of our results. Likewise, the minimum number of samples is set at 25. Our research assumes a relatively conservative perspective on noisy points. The UMAP + hDBSCAN approach leads to 48 topics (Table 2,

Figure 7). The number of topics obtained is similar to the 45 trends in QM research identified in Wawak et al. (2020). Fourthly, one topic vector per cluster is identified to create a topic representation. See Figure 6. Our analysis converts abstracts to a single (joined) document per cluster. Likewise, it compares the importance scores for n-grams within a cluster using a class-based TF-IDF approach (c-TF-IDF). Finally, in Figure 7, the UMAP algorithm proposes a 2d-dimensional visualisation of the data with an equivalent topological structure.

Figure 5. From Scopus QM-abstracts to dense topics via NLP.

Table 2. Summary of clusters.

Figure 6. Top 7 terms to describe topics, according to c-TF-IDF scores.

Figure 7. Distribution of topics in a two-dimensional space.

5. Findings and discussions

5.1. Identification of the main QM topics

Next, the study highlights some characteristics of the 48 identified topics. Cluster 32 (QM in healthcare) is the largest topic with 741 articles, followed by cluster 40 (ISO standards certification) with 511 articles and cluster 46 (TQM implementation practices) with 485 articles. The smallest clusters are clusters 5 (Service quality measurement instruments) and 27 (Knowledge management), containing 55 articles each. See Figure 8 and column TPC in Table 2. Two thousand nine hundred thirteen of our 9,130 articles have not been assigned to a cluster (noise points).

Figure 9 provides relevant information on the strength of the clusters. The average probability of cluster membership ranges from 0.635–1, suggesting an acceptable degree of overall clustering.

In Figure 10, our research selects the Rao-Stirling diversity index to estimate the distribution of authors, affiliations, and countries of (co-) authors in each topic. Topics 8 (Laboratory accreditation and calibration, D = 0.03), 17 (QM and software development, D = 0.02) and 19 (Energy, water and pollution management, D = 0.02) are the lowest interauthors, in conjunction with topic 32 (D = 0.03), related to QM in healthcare. Topic 32 (D = 0.15) is also the lowest interaffiliation in the dataset. Topics 35 (Leadership, D = 0.09) in conjunction with topics 32 (D = 0.11) and 37 (Teamwork, D = 0.11) are the lowest intercountry.

In Table 2, our research shows an overall bibliometric description of each topic. In addition to the above, the high average number of authors per article (MAuPC) stands out in topics 2 (Lean manufacturing) and 19 (Energy, water, and pollution management). In particular, topic 32 (QM in Healthcare) stands out with 3.8 authors on average per article. Topics 2, 19, and 32 also show high collaboration indices (CI) (greater than 3.06), as do Topics 8 (Laboratory accreditation and calibration), 13 (Environmental management), 18 (Quality improvement programmes in clinical practice), 23 (Quality control and quality circles), 26 (Continuous improvement and flexible manufacturing) and 27 (Knowledge management). Regarding citations, the high average number of citations per author (MCiAuC) stands out in topics 5 (Service quality measurement instruments, 72.25), 13 (Environmental management, 63.81) and 42 (TQM critical success factors, 57, 32).

Figure 8. Summary of articles per topic.

Figure 9. Summary of probabilities per article and cluster (boxplots).

Figure 10. Variety of authors, affiliations, and countries reflected in clusters.

5.2. Identification of the main QM metatopics

According to terms associated with topics, distances between topics are shown on the 2d-UMAP mapping (Figure 7). Our research thus proposes 13 metatopics for QM, displayed in Figure 11. The articles most cited in each metatopic are shown in Appendix 1.

Figure 11. Metatopics.

- A: Process improvement and elimination of defects-waste methodologies. The research identifies these topics (1, 2, and 3): Six-sigma methodology, Lean manufacturing, and Business Process Reengineering. Metatopic A comprises the domain associated with methods whose objective is to optimise and improve production and organisational processes to reduce waste, increase productivity, and contribute value for the customer.

- B: QM in Healthcare services. Metopic B includes topics (8, 18 and 32), i.e. Laboratory accreditation and calibration, quality improvement programmes in clinical practice, and QM in healthcare. The exemplary articles analyse the domain associated with the technical infrastructure and organisational processes that affect patient care projects and programmes and improve clinical decision-making.
- C: Control and improvement operations tools. Metatopic C contains the largest number of topics (10, 23, 26, 35, 38, 43, and 44). It refers to tools and methodologies that are used mainly in the field of manufacturing for the control and improvement of aspects related to inventories, machines, products and processes (e.g. JIT practices, quality control and quality circles, continuous improvement and flexible manufacturing, quality cost and improvement, preventive maintenance, quality characteristics, design of experiments and Taguchi methods and statistical quality control, among others).
- D: QM in the Construction industry. Metatopic D focuses on models, systems and tools for quality management and improvement in the construction sector. It includes two topics (9 and 12), kg, QM in the construction industry and QM in the construction of public housing.
- E: QM in the tourism industry. The research identifies two topics (15 and 16): QM and the tourism sector, service quality and the hotel industry. Metatopic E addresses the problem of quality management in tourism services and hotel management.
- F: Environmental management. Metatopic F comprises the following topics: environmental management systems (13) and energy, water, and pollution management (19). Metatopic F relates to the impact of the decisions and activities of the organisation concerning the natural environment.
- G: QM in supply chain management. Metatopic G comprises topics 29 and 31, i.e. supply chain quality management and supplier quality management. It relates to applying QM models, principles, and practices in the complex network of activities and defines the life cycle of a product and its supply chain (design, supply, production, distribution, and reverse logistics).
- H: Quality and satisfaction of the service. Metatopic H comprises three topics (5, 33, and 34): service quality measurement instruments, customer and employee satisfaction, and service quality in e-commerce. In addition, metatopic H relates to excellence in services and customer satisfaction and loyalty (internal and external).
- I: Standardised management systems. Metatopic I includes four topics (22, 25, 39 and 40): integrated management systems, quality assurance and safety of food, quality management systems, and ISO standards certification. Metatopic I thus comprises a set of interrelated elements of an organisation to establish policies, processes, and structures to achieve objectives related to quality, the environment, occupational health and safety, food safety, and information security. Since 2012, ISO has established a standard structure and vocabulary for the different SMS (High-Level Structure) to facilitate the integration of diverse management systems.
- J: Sustainability. Metatopic J comprises two topics (4 and 14): corporate social responsibility and sustainability. Sustainability is a growing demand in all business environments, and social responsibility can be considered to achieve sustainability.
- K: Business Excellence Models. Metatopic K comprises the most widespread BEM worldwide, the EFQM Excellence Model (20) and the Malcolm Baldrige National Quality Award (21). BEM is a simplified schematic representation using diverse variables or criteria of the complex web of elements and describes how an outstanding organisation operates to achieve high levels of excellence and performance. In particular, the EFQM model has recently undergone a significant change. The latest version of the model, for the year 2020, considers the quality management of an organisation as outstanding management and as equivalent to the complete management of an organisational system. In this sense, three main sections or groups of criteria are established from which to approach this management: Direction, Execution (as agent elements), and Results considering that an outstanding (exceptional) organisation can be defined as one that leads its ecosystem with its management system. In addition, an excellent organisation achieves superior results that match or exceed the expectations of its key stakeholders (Fonseca, 2021). The new EFQM 2020 model is forward-looking and has evolved towards the design of a generic model that focuses on the organisation's future requirements rather than on shaping a simple model of business excellence. Thus, adopting the EFQM 2020 model would facilitate and pave the way for implementing Industry 4.0 and digitilisation, and monitoring their impact on the organisation (Murthy et al., 2021).
- L: TQM critical success factors. Metatopic L includes a significant number of topics related to the key factors that determine success in the design, implementation, development, and improvement of TQM, as a comprehensive management philosophy of organisations: marketing orientation and TQM (30), leadership (36),

teamwork (37), Empowerment and commitment (40), TQM in SME (41), Critical factors of TQM are success (42), TQM and organisational culture (45), and TQM implementation practices of TQM (46). In this sense, given the diversity of key factors for the success of TQM initiatives, the literature has made an effort to classify them according to their nature: social, cultural, and behavioural aspects (Soft) and factors related to the technical part of the management system (Hard).

- M: QM, innovation, and knowledge. Metatopic M is formed by three topics (24, 27 and 28): Innovation, knowledge management, and organisational learning. It analyses how the QM practices adopted by companies facilitate the creation, transfer, and use of knowledge to learn, be more innovative and achieve better results.

In addition, there are a series of topics that we cannot group with others of similar semantics. These address the implementation of QM in particular areas, such as software development (Topic 17), higher education (Topic 11) or the public sector (Topic 6). A topic related to establishing performance indicators and measures (Topic 7) and another with QM's impact on organisations' results and performance (Topic 0) are also identified. In the study, carried out by Carnerud and Bäckström (2021), in journals specialising in quality and operations management (1980 and 2017), 7 clusters or central topics are ident- ified: Service Quality and Customer Satisfaction; Process design and Control; ISO Certification and Standards; TQM Implementation, Performance and Culture; QM Practices and Performance; Reliability, Costs, Failure and Problems; BEMs, Quality Awards and Excellence in Higher Education. All of them were identified in the present study.

To sum up, the topics and metatopics identified above include the different ways of understanding QM, from quality inspection and control (C), through assurance and management systems (F and I), to TQM (L) and BEM (K). This evolution shows the dynamic character of QM. The development of QM can be equated with a process that ranges from entirely reactive actions to preventive and proactive ones (Weckenmann et al., 2015).

In the same way, our research could associate the metatopics identified in the different QM paradigms proposed by van Kemenade and Hardjono (2019) and Carnerud (2020). In metatopic C, quality is measured based on observable characteristics, such as reliability, durability, or costs. This proposal fits the empirical and front-end quality paradigm, focused on overcoming technical problems, which can be solved by applying scientific knowledge, measurements, standards, or rules. Assurance, QMS (F and I) and BEM (K) correspond to the reference and middle-way quality paradigm. They assume that in QM not everything is objective and that quality is achieved by integrating all the functional areas. In this sense, it proposes implementing management systems and models that establish 'how things should be' and provide the guidelines for continuous improvement. Finally, implementing the TQM philosophy requires the participation of all the people in the organisation to generate value for customers and other stakeholders. Culture, groups, and individuals are critical factors for TQM. This high level of abstraction is explained through the reflective and back-end quality paradigm. For Dahlgaard- Park et al. (2018), the QM of the twenty-first century must be eclectic and use the principles, values, tools, methods, and models of each of the paradigms, depending on the problem it faces, to adapt to the context and the change. Wen et al. (2022) point out that there will be significant changes in existing QM methods and tools in the future, e.g. due to the necessary integration of new technologies and digitalisation into management.

The transverse nature of QM (production, A; environment and sustainability, F and J; supply chain, G; innovation and knowledge, M) can also be observed, together with its universal character (Health, B; Construction, D; Tourism, E; Services, H; Public sector, 6; Education, 11 and Software, 17). In this sense, QM has experienced an increasing expansion of its scope and influence within organisations. Initially, the emphasis was on products, manufacturing, and the operations department. However, over time, with the complexity of the organisation, and its openness to the environment, QM has spread to other processes and departments until it covers the entire system and all kinds of activity sectors (Carnerud & Bäckström, 2021; Wen et al., 2022).

5.3. Temporal evolution of QM topics

Figures 12 and 13 complementarily display the temporal distribution of topics on 2d- and 1d-UMAP, with publication dates on the y-axis, respectively. In Figure 12, we can see how, in the 1980s, the research is dispersed into various topics, although the aspects related to quality control and improvement stand out. During the 1990s, the research about implementing TQM, QMS, and other standardised management systems and analysing the main BEMs emerged with force. These results are consistent with QM's evolution within organisations (Dahlgaard-Park et al., 2018; Weckenmann et al., 2015; Wen et al., 2022). Research into the previous topics was consolidated in the following decade (2000–2010), and interest in aspects related to the six-sigma methodology, innovation, knowledge and quality in the educational and health fields grew notably. In the last decade analysed (2010–2020), research related to supply

chain management, environmental management, social responsibility, and sustainability has also strongly appeared. Indeed, Wawak et al. (2020) identify sustainability, or supply chain management, as an emerging research topic today.

Figure 12. Temporal evolution of topics.

Figure 13. Temporal distribution of topics on 1d-UMAP with publication dates on the y-axis.

In Figure 13, the topics are represented according to the median or central position. The topics related to QM practices and performance (Topic 0), energy, water, and pollution management (19), sustainability (14), supply chain quality management (29), quality management systems (39) and Lean manufacturing (2), are concentrated in the last five years (2015–2020). In this regard, the literature indicates how the study of the impact of QM on organisational performance is a recurring theme in the literature (Bajaj et al., 2018; Nair, 2006). In addition, QMS are the most widely used QM implementation framework by companies. Therefore, the study of motivations and barriers to QMS implementation and key factors raises growing interest among researchers (Taylor et al., 2020). Also, new versions of quality standards emerge from time to time, keeping research alive. There is also a growing concern in the academic domain about the sustainable development and efficient use of resources (Siva et al., 2016). Along these lines, there is also a burgeoning interest in methodologies, such as Lean manufacturing, which focuses on optimising and continuously improving the production system by eliminating waste and activities that do not add value to the processes (Antony et al., 2021).

Finally, companies are increasingly aware of extending QM to the entire supply chain and involving suppliers, distributors, other partners, and customers in achieving their objectives (Soares et al., 2017; Wen et al., 2022). Likewise, topics whose median is between the years 1990 and 2000 are also identified: Reengineering of business processes (3), teamwork (37) and JIT practices (10). According to the trail of points left by the topics, we can observe a series of primary research topics or 'hotspots'. These are aspects of QM that present a continuous interest in the literature (continuous and intense trace of points): Accreditation and quality assurance in HE (11); QM in healthcare (32); ISO standards certification (40); and TQM implementation practices (46). In this regard, Wawak et al. (2020) identify themes that remain over the years and have constant contributions: TQM implementation, HE quality, or healthcare quality.

5.4. Topics and metatopics of growing interest in the QM literature

Figures 14 and 15 show the evolution in publications on the different topics and metatopics, taking the previous year as a reference. Our research identifies topics of growing interest in recent years (see Table 3). In this same regard, Carnerud and Bäckström (2021) identified as research areas with growth prospects the following topics: QM practices and performance, service quality and customer satisfaction, excellence and BEM, and reliability, costs, failure and problems. Wawak et al. (2020) also extract aspects related to Lean manufacturing and six-sigma, statistical methods, supply quality management, integrated management systems and balanced scorecard as research trends. Wen et al. (2022) further find that QM will grow in the future around new methods and tools for quality control, management, and improvement, as well as the extension of QM throughout the supply chain, and the importance of data and knowledge for quality control and management. Finally, in Industry 4.0, no topics related to QM have been identified. One possible explanation is that Quality 4.0. is an emergent research topic, and there is still no significant published literature.

Figure 14. Interannual growth rates by topics.

Figure 15. Interannual growth rates by metatopics.

Table 3. Topics and metatopics of growing interest in the QM literature.

6. Conclusions

The main objective of the research is summarised in the analysis of the evolution of research in QM and its implementation frameworks during the last 40 years, what the current situation is like and what can be expected in the near future. The methodology and findings have allowed us to answer the research questions posed at the outset. In this regard, analysing the research process from a global perspective, it is worth highlight- ing specific issues that we understand to be of particular interest.

First, previous bibliographic studies have analysed a small number of articles. On the contrary, our study analyses a massive set of abstracts and applies a novel latent topic extrac- tion proposal to summarise the semantic structure of the proposed corpus, i.e. BERTopic. In particular, our study focuses on a hierarchical (unsupervised) clustering, using

embeddings that identify documents similar in their subject matter in each cluster (or topic or metatopic) and variable densities. As a result, our study extracts a more informative latent semantic structure than that proposed by the classic LDA or PLSA models, without the additional need to predefine the number of topics or pre-set multiple parameters.

Second, the findings achieved in terms of topics and metatopics are consistent with the research carried out by other authors on QM (i.e.Carnerud & Bäckström, 2021; Ho et al., 2022; Wawak et al., 2020; Wen et al., 2022). Additionally, our study proposes identifying additional elements not located by the said authors. Likewise, it is striking how research in QM has been experiencing a progressive broadening of focus to increasingly encompass the study of more extensive areas of impact within organisations. QM research has progressively incorporated the incidence of more organisational areas and more sectors of activity (education, health, provision of services in general, public management, etc.).

Thirdly, it is relevant to note the parallelism between the evolution of the issues that have been concentrating the interest of academics over time and how the practice of QM has been changing in the world of organisations (cf.Dahlgaard-Park et al., 2018; Weckenmann et al., 2015; Wen et al., 2022). For example, in the 1980s, research focused on con- trolling and improving the quality of products and services. Then, the 1990s witnessed a relative neglect of these topics in favour of others, such as implementing TQM, QMS and other standard management systems, and BEMs. Our analysis allows us to observe how the interest is consolidated in the following decades, although already mediated by issues, such as Six-sigma methods, innovation, knowledge management or the applicability of QM philosophy and techniques to organisational settings (e.g. healthcare or education).

Fourth, in the last decade (2010–2020), an integrated vision of QM with efficiency in the consumption of resources associated with the production process (supply chain management), Lean manufacturing, concern for environmental issues (energy, water, or pollution management), social responsibility, or, in general, everything related to sustainability, have acquired a remarkable growth. QM research has progressively echoed what management practitioners have introduced as fields of action in their daily evolution as decision-makers.

Finally, it should be noted how interest in certain issues, related to QM, has been maintained over the years. Until reaching its highest form as TQM, the evolution of QM has meant a progressive broadening of focus on the topics selected by researchers in their tasks, i.e. from an emphasis on production to an interest in the system as a whole; from the focus on the client to the broadening of vision towards the results for other stakeholders, and from the concern for the internal agents of production to the search for the involvement of different elements of the supply chain (suppliers, partners or other external agents). However, and without detracting from the importance of these issues, it is curious to note the maintenance of interest in topics so crucial for companies, such as the link between QM and the maintenance and improvement of organisational performance. Inevi- tably, the expansion of interest in the relations between QM and its more socially respon- sible aspects should not obscure the fact that the validity and strength of this management philosophy are determined above other less critical issues. This has been due to the veri- fication that it brings about improvements in the performance of organisations while making them more modern, more adapted to the circumstances of their ecosystem and more solid to face increasingly dynamic, complex, and turbulent environments.

Research limitations and future research lines

Regarding future research lines, first, some of the metatopics identified allude to QM in different subsectors. Healthcare (B), construction (D), tourism (E), or services in general (H). All have been heavily affected in recent years by Covid-19, so it would be interesting to investigate what QM can contribute to organisations in these sectors that have been affected by the pandemic. For example, the impact has been devastating in the healthcare and tourism sectors, and studies in this type of organisation could be particularly interesting. In the tourism sector, the lack of studies that analyse the relationship between QM and issues related to universal accessibility is also striking. Accessibility

has an unquestionable ethical and social aspect. However, the economic aspect is becoming increasingly important due to the market's growing importance for people with disabilities. Going deeper into these issues would be necessary to provide good quality management practices that favour the access of organisations to this growing market. Progress should also be made in the area of excellence in service management. To be competitive, organisations must be excellent and strive to offer services that surprise the customer, i.e. they must go beyond their expectations to achieve delight. Today it is not enough to satisfy the customer.

Other identified metatopics are closely related to operations management (A), control and improvement tools (C), and supply chain management (G). Linking these dimensions with those associated with sustainability issues (F and J) would be useful in advance of the analysis of the impacts derived from the implementation of QM on social and environmental aspects. For example, studies on how QM principles, practices, models, and systems can contribute to

the achievement of the UN Sustainable Development Goals (SDGs) or other national and international programmes to improve organisations' environmental and social performance would be relevant. In the same direction, there is still a lack of in-depth studies on the relationships between QM, the circular economy, the supply chain, and the improvement of organisational operational performance.

On the other hand, QM research must make progress in the empirical validation of the new versions of excellence models (metatopic K), for example, the EFQM 2020 model. In this sense, it is essential to analyse the suitability of these models to enable organisations to improve their strategic and operational performance while being in an advantageous position to meet the challenges of prospective management that respond to the increasingly demanding challenges of the new ecosystems and the development of Industry 4.0. Evidence should also be provided on the effectiveness of the recent versions of some standardised management systems (metatopic I) that have shown the most significant growth in recent years: ISO 9001 (2015), ISO 140001 (2015), ISO 45001 (2018), ISO 27001 (2017), ISO 22000 (2018), or ISO 50001 (2018). In addition, there must be research that demonstrates the advantages of the integration of standardised management systems and good practices and tools into the integration procedures.

Concerning the models and standards mentioned above, researchers should analyse to what extent these new management proposals alter the configuration of the critical success factors identified in recent years by researchers (metatopic L) and the performance of organisational actions focused on innovation and knowledge management and organis- ational learning (metatopic M).

Finally, research on the impact of Industry 4.0 technologies and digitalisation on QM (Quality 4.0) is incipient and scarce. Therefore, there is still a long way to go, and many theoretical and empirical contributions are needed to lay the foundations of this new para- digm in QM. Relevant topics for the advancement of Quality 4.0 include the most important enabling technologies; the necessary skills and capabilities of human resources; the key factors for implementation; the main challenges and barriers to implementation; the benefits and impact of Quality 4.0 on organisational performance; and the different per- spectives that Quality 4.0 can adopt in manufacturing and service companies. Moreover, several limitations should be recognised. Firstly, it is proposed to improve the search query. Although a broad search strategy that maximises coverage of relevant publications is ideal for this multidisciplinary study of the QM domain, our method selected a trade-off between precision and recall, trying to control noise and overfitting. The allocation is thus accomplished by creating and iteratively testing different queries to find a balance between recall and precision. However, in subsequent research, our studies will also design the sample of articles from a complementary perspective, i.e. not only with a keyword-based query but also with a combination of keywords and key journals in the area of knowledge to be studied. Consequently, papers published in journals that have influenced the QM/TQM domain would be included in a bibliometric study that seeks to capture their historical and future trajectories. Second, Scopus is one of the most comprehensive social science databases (Mongeon & Paul-Hus, 2016), and it is similar to databases like WoS in that it is designed for document searches (e.g. peer-reviewed journals) and citation analysis (Meho & Yang, 2007). According to Terán-Yépez et al. (2020), Scopus has access to about 84 percent of WoS papers and more indexed journals, i.e. by selecting Scopus the risk of overlooking documents during the search is reduced. However, to avoid excluding references, future research should complement our study with other databases such as Web of Science. Thirdly, despite the magnitude of the number of abstracts, and depending on the proposed query, there is always the relative risk of incom- pleteness, inaccessibility and a lack of representativeness of the analysed abstracts. Likewise, future research should assess whether the localised topics and metatopics have been stable, over time, and with this, the different interannual (or whatever proposed time window) ranking of the relevance of each term in each topic. Finally, future research should compare its results with those obtained by other topic modelling approaches or other bibliometric analytical methodologies.

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Wen, D., Sun, X., & Yan, D. (2022). The quality movement: where are we going? Past, present and future. Total Quality Management & Business Excellence, 33(1-2), 92-112.

Xu, L., Peng, X., Pavur, R., & Prybutok, V. (2020). Quality management theory development via meta-analysis. International Journal of Production Economics, DOI: 10.1016/j.ijpe.2020.107759.

Zhang, C., Moreira, M. R., & Sousa, P. S. (2020). A bibliometric view on the use of total quality management in services. Total Quality Management & Business Excellence, DOI: 10.1080/14783363.2020.1732811.

Zonnenshain, A., & Kenett, R. S. (2020). Quality 4.0—the challenging future of engineering. Quality Engineering, 32(4), 614-626.

Zupic, I., & Čater, T. (2015). Organisational research methods. Bibliometric methods in management and organisation, 18 (3), 429-472.

APPENDIX I: MOST CITED ARTICLES

Metatopic A. Process improvement and elimination of defects-waste methodologies

Dahlgaard, J. J., & Dahlgaard-Park, S. M. (2006). Lean production, six sigma quality, TQM and company culture. The TQM magazine, 18(3), 263–281.

Pettersen, J. (2009). Defining lean production: some conceptual and practical issues. The TQM Journal, 21(2), 127–142.

Zu, X., Fredendall, L. D., & Douglas, T. J. (2008). The evolving theory of quality management: the role of Six Sigma. Journal of Operations Management, 26(5), 630–650.

Metatopic B: QM in Healthcare

Carman, J. M., Shortell, S. M., Foster, R. W., Hughes, E. F., Boerstler, H., O'Brien, J. L., & O'Conner, E. J. (1996). Keys for successful implementation of total quality management in hospitals. Health care management review, 21(1), 48–60.

Kaplan, R. S., Witkowski, M., Abbott, M., Guzman, A. B., Higgins, L. D., Meara, J. G., … & Feeley, T. W. (2014). Using time-driven activity-based costing to identify value improvement oppor- tunities in healthcare. Journal of Healthcare Management, 59(6), 399–412.

Young, G. J., Charns, M. P., Daley, J., Forbes, M. G., Henderson, W., & Khuri, S. F. (1997). Best practices for managing surgical services: the role of coordination. Health care management review, 22(4), 72–81.

Metatopic C: Control and improvement operations tools

Fullerton, R. R., & McWatters, C. S. (2001). The production performance benefits from JIT implementation. Journal of Operations Management, 19(1), 81–96.

Su, C. T., & Tong, L. I. (1997). Multi-response robust design by principal component analysis. Total Quality Management, 8(6), 409–416.

Waeyenbergh, G., & Pintelon, L. (2004). Maintenance concept development: a case study. International Journal of Production Economics, 89(3), 395–405.

Metatopic E: QM in the Tourism Industry

Albacete-Saez, C. A., Fuentes-Fuentes, M. M., & Lloréns-Montes, F. J. (2007). Service quality measurement in rural accommodation. Annals of Tourism Research, 34(1), 45–65.

Camison, C. (1996). Total quality management in hospitality: an application of the EFQM model. Tourism Management, 17(3), 191–201.

Wang, C. H., Chen, K. Y., & Chen, S. C. (2012). Total quality management, market orientation and hotel performance: The moderating effects of external environmental factors. International Journal of Hospitality Management, 31(1), 119–129.

Metatopic F: Environmental Management

Buysse, K., & Verbeke, A. (2003). Proactive environmental strategies: A stakeholder management perspective. Strategic Management Journal, 24(5), 453–470.

Corbett, C. J., & Klassen, R. D. (2006). Extending the horizons: environmental excellence as key to improving operations. Manufacturing & Service Operations Management, 8(1), 5–22.

Li, H., Wang, J., Li, R., & Lu, H. (2019). Novel analysis–forecast system based on multi-objective optimisation for air quality index. Journal of Cleaner Production, 208, 1365–1383.

Metatopic G: QM in Supply Chain Management

Hartley, J. L., Zirger, B. J., & Kamath, R. R. (1997). Managing the buyer-supplier interface for on- time performance in product development. Journal of Operations Management, 15(1), 57–70. Kannan, V. R., & Tan, K. C. (2005). Just in time, total quality management, and supply chain man- agement: understanding their linkages and impact on business performance. Omega, 33(2), 153–162.

Modi, S. B., & Mabert, V. A. (2007). Supplier development: Improving supplier performance through knowledge transfer. Journal of Operations Management, 25(1), 42–64.

Metatopic H: Service Quality and Satisfaction

Talib, F., Rahman, Z., & Qureshi, M. N. (2013). An empirical investigation of relationship between total quality management practices and quality performance in Indian service companies. International Journal of Quality & Reliability Management, 30(3), 280–318.

Tan, K. C., & Shen, X. X. (2000). Integrating Kano's model in the planning matrix of quality function deployment. Total Quality Management, 11(8), 1141–1151.

Edvardsson, B., Johnson, M. D., Gustafsson, A., & Strandvik, T. (2000). The effects of satisfaction and loyalty on profits and growth: products versus services. Total Quality Management, 11(7), 917–927.

Metatopic I: Standardised management systems

Jørgensen, T. H., Remmen, A., & Mellado, M. D. (2006). Integrated management systems–three different levels of integration. Journal of Cleaner Production, 14(8), 713–722.

Karapetrovic, S., & Casadesús, M. (2009). Implementing environmental with other standardised management systems: Scope, sequence, time and integration. Journal of Cleaner Production, 17(5), 533–540.

Terziovski, M., Samson, D., & Dow, D. (1997). The business value of quality management systems certification. Evidence from Australia and New Zealand. Journal of Operations Management, 15(1), 1–18.

Metatopic J: Sustainability

Garvare, R., & Johansson, P. (2010). Management for sustainability–a stakeholder theory. Total Quality Management & Business Excellence, 21(7), 737–744.

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McAdam, R., & Leonard, D. (2003). Corporate social responsibility in a total quality management context: opportunities for sustainable growth. Corporate Governance, 3(4), 36–45.

Metatopic K: Business Excellence Models

Calvo-Mora, A., Picón, A., Ruiz, C., & Cauzo, L. (2014). The relationships between soft-hard TQM factors and key business results. International Journal of Operations & Production Management, 34(1), 115–143.

Hendricks, K. B., & Singhal, V. R. (2001). The long-run stock price performance of firms with effec- tive TQM programs. Management Science, 47(3), 359–368.

Wilson, D. D., & Collier, D. A. (2000). An empirical investigation of the Malcolm Baldrige National Quality Award causal model. Decision Sciences, 31(2), 361–383.

Metatopic L: TQM critical success factors

Fotopoulos, C. B., & Psomas, E. L. (2009). The impact of "soft" and "hard" TQM elements on quality management results. International Journal of Quality & Reliability Management, 26(2), 150– 163.

Saraph, J. V., Benson, P. G., & Schroeder, R. G. (1989). An instrument for measuring the critical factors of quality management. Decision Sciences, 20(4), 810–829.

Sila, I., & Ebrahimpour, M. (2005). Critical linkages among TQM factors and business results. International Journal of Operations & Production Management, 25(11), 1123–1155.

Metatopic M: QM, innovation and knowledge

Choo, A. S., Linderman, K. W., & Schroeder, R. G. (2007). Method and psychological effects on learning behaviors and knowledge creation in quality improvement projects. Management Science, 53(3), 437–450.

Prajogo, D. I., & Sohal, A. S. (2001). TQM and innovation: a literature review and research framework. Technovation, 21(9), 539–558.

Prajogo, D. I., & Sohal, A. S. (2004). The multidimensionality of TQM practices in determining quality and innovation performance—an empirical examination. Technovation, 24(6), 443–453.

Topic 0: QM practices and performance

Lakhal, L., Pasin, F., & Limam, M. (2006). Quality management practices and their impact on per- formance. International Journal of Quality & Reliability Management, 23(6), 625–646.

Molina, L. M., Lloréns-Montes, J., & Ruiz-Moreno, A. (2007). Relationship between quality man- agement practices and knowledge transfer. Journal of Operations Management, 25(3), 682– 701.

Nair, A. (2006). Meta-analysis of the relationship between quality management practices and firm performance—implications for quality management theory development. Journal of Operations Management, 24(6), 948–975.

Topic 6: QM in the public sector

Eskildsen, J. K., Kristensen, K., & Juhl, H. J. (2004). Private versus public sector excellence. The TQM Magazine, 16(1), 50–56.

Galloway, L. (1998). Quality perceptions of internal and external customers: a case study in edu- cational administration. The TQM Magazine, 10(1), 20–26.

Wisniewski, M. (1996). Measuring service quality in the public sector: the potential for SERVQUAL. Total Quality Management, 7(4), 357–366.

Topic 7: Balanced scorecard and performance measurement systems

Lee, S. F., & Ko, A. S. (2000). Building balanced scorecard with SWOT analysis and implementing "Sun Tzu's The Art of Business Management Strategies" on QFD methodology. Managerial Auditing Journal, 15(1-2), 68–76.

Neely, A., Adams, C., & Crowe, P. (2001). The performance prism in practice. Measuring Business Excellence, 5(2), 6–12.

Sim, K. L., & Koh, H. C. (2001). Balanced scorecard: a rising trend in strategic performance measurement. Measuring Business Excellence, 5(2), 18–26.

Topic 11: Accreditation and quality assurance in HE

Hwarng, H. B., & Teo, C. (2001). Translating customers' voices into operations requirements-A QFD application in higher education. International Journal of Quality & Reliability Management, 18(2), 195–225.

Kanji, G. K., Malek, A., & Tambi, B. A. (1999). Total quality management in UK higher education institutions. Total Quality Management, 10(1), 129–153.

Jensen, R. A., Thursby, J. G., & Thursby, M. C. (2003). Disclosure and licensing of University inventions:'The best we can do with the s** t we get to work with'. International Journal of Industrial Organization, 21(9), 1271–1300.

Topic 17: QM and Software development

Parzinger, M. J., & Nath, R. (2000). A study of the relationships between total quality management implementation factors and software quality. Total Quality Management, 11(3), 353–371.

Ravichandran, T., & Rai, A. (1999). Total quality management in information systems development: key constructs and relationships. Journal of Management Information Systems, 16(3), 119– 155.

Yang, Y. H. (2001). Software quality management and ISO 9000 implementation. Industrial Management & Data Systems, 101(7), 329–338.

Tables

Table 1. Recent bibliometric and/or text mining studies on QM.

Authors	Research questions/Aims/Purpose	Source/Databases	No. of documents	Method	Period
Ghafoor et al. (2022)	To identify and analyse all academic journal papers that have been published on Business Excellence (BE) to help researchers and practitioners find relevant BE information more easily and guide them on which journals to publish in	· Scopus	415	· Bibliometric analysis · Thematic review	1990–2020
Ho et al. (2022)	(1) To provide scholars and practitioners with a comprehensive view of the extant literature on TQM; (2) To highlight the advances in research, the results achieved by previous studies, the gaps in the literature and the most current trends	· Web of Science	3,110	· Bibliometric analysis	1990–2019
Wen et al. (2022)	(1) How has quality management evolved historically? (2) Where are we? What is the research focus of quality management in the twenty-first century? What are the trends? What changes are taking place? (3) Where are we going? What are the future directions of the quality movement?	· Scopus	20,930	· Systematic literature review · Bibliometric analysis · Expert interviews	2001–2020
Carnerud and Bäckström (2021)	(1) To identify and depict the key areas around which research on quality has orbited during the past 37 years; (2) To explore longitudinal patterns and trends in the identified key areas	· 4 Quality Management Journals and 2 Operations Management Journals	4,741	· Text and data mining	1980–2017
Sadeghi Moghadam et al. (2021)	(1) To review the history of quality management and its trends; (2) To identify the most well-known journals in formation of quality management literature; (3) To determine the value of quality management techniques, (4) To cluster the quality tools, (5) To map the extracted quality tools and techniques, and (5) To interpret implementations effects studied by the scholars	· Web of Science	22,800	· Systematic literature review · Text mining	1900–2016
Zhang et al. (2021)	(1) What are the most salient themes in implementing TQM in major services sectors? (2) What are the trends, gaps, and weaknesses in this field?	· Web of Science · Scopus	268	Bibliometric analysis	1990–2017
Hussain et al. (2020)	To develop a better view of ISO 9000 standards, as a field of research, by investigating the intellectual structures of summative knowledge, underlying dynamics, temporal progression, current development, and future evolution of research dimension	· Scopus	123	· Bibliographic Coupling Technique · Factor Analysis	1987–2015
Wawak et al. (2020)	To discover the trends in quality management literature in 2000–2019	· 8 Quality Management Journal	4,833	· Systematic literature review · Text mining	2000–2019

Table 2. Summary of clusters

Topic	dateL	dateH	date.median	TPC	TAuC	MAuPC	MPAuC	CI	TPC.CI	TAuC.CI	MAuPC.CI	MPAuC.CI	MCoC	MAfidC	MCiAuC	SWI
0	1987	2021	2015	130	254	1.95	0.512	2.98	110	241	2.19	0.456	1.26	1.72	38.19	6.98
1	1993	2021	2011	200	382	1.91	0.524	2.79	159	355	2.23	0.448	1.15	1.76	43.62	14.60
2	1995	2020	2015	108	273	2.53	0.396	3.07	97	262	2.70	0.370	1.22	1.88	46.89	8.99
3	1993	2019	1999	61	120	1.97	0.508	2.68	41	103	2.51	0.398	1.19	1.62	22.66	12.90
4	1989	2020	2010	97	186	1.92	0.522	2.63	65	159	2.45	0.409	1.15	1.70	16.58	31.04
5	1992	2021	2006	55	132	2.40	0.417	2.87	46	125	2.72	0.368	1.11	1.62	72.25	11.13
6	1993	2020	2010	70	153	2.19	0.458	2.69	51	136	2.67	0.375	1.14	1.48	13.09	22.82
7	1988	2020	2006	110	232	2.11	0.474	2.67	79	207	2.62	0.382	1.24	1.60	34.01	52.79
8	1983	2019	2008	72	178	2.47	0.404	3.07	54	160	2.96	0.338	1.07	1.48	7.18	7.72
9	1987	2021	2004	155	294	1.90	0.527	2.62	115	262	2.28	0.439	1.19	1.50	25.09	52.08
10	1983	2021	2000	71	142	2.00	0.500	2.69	51	124	2.43	0.411	1.26	1.58	34.31	42.50
11	1983	2021	2010	323	643	1.99	0.502	2.77	225	556	2.47	0.405	1.15	1.53	12.75	68.87
12	1994	2019	2003	59	113	1.92	0.522	2.73	44	100	2.27	0.440	1.30	1.57	19.00	12.66
13	1991	2021	2009	77	185	2.40	0.416	3.06	62	172	2.77	0.360	1.36	1.84	83.81	8.87
14	1993	2021	2014	66	134	2.03	0.493	2.81	47	121	2.57	0.388	1.31	1.72	21.77	7.22
15	1996	2020	2013	62	125	2.02	0.496	2.92	48	115	2.40	0.417	1.24	1.60	13.97	8.29
16	1988	2021	2013	57	133	2.33	0.429	2.94	49	126	2.57	0.389	1.23	1.55	22.49	13.50
17	1983	2020	2002	91	181	1.99	0.503	2.75	57	148	2.60	0.385	1.14	1.94	15.91	18.46
18	1985	2020	2008	103	231	2.24	0.446	3.24	62	191	3.08	0.325	1.14	1.72	14.82	8.75
19	1983	2021	2017	95	359	3.78	0.265	4.31	81	345	4.26	0.235	1.40	2.17	20.81	2.31
20	1983	2021	2011	196	406	2.07	0.483	2.91	163	380	2.33	0.429	1.24	1.79	21.23	16.59
21	1989	2020	2004	138	247	1.79	0.559	2.67	84	204	2.43	0.412	1.08	1.37	28.93	28.91
22	1987	2020	2006	108	183	1.69	0.590	2.83	71	151	2.13	0.470	1.17	1.56	14.54	9.53
23	1981	2021	2009	67	156	2.33	0.429	3.27	44	135	3.07	0.326	1.17	1.64	10.57	4.78
24	1993	2021	2011	147	320	2.18	0.459	2.86	115	293	2.55	0.392	1.17	1.65	36.97	31.02
25	1982	2021	2010	117	273	2.33	0.429	2.81	93	250	2.69	0.372	1.24	1.62	15.30	30.14
26	1985	2021	2005	61	147	2.41	0.415	3.09	44	130	2.95	0.338	1.37	1.95	17.38	6.50
27	1996	2021	2009	55	134	2.44	0.410	3.07	41	120	2.93	0.342	1.18	1.78	32.82	8.82
28	1987	2020	2002	59	118	2.00	0.500	2.67	40	100	2.50	0.400	1.26	1.59	28.92	13.32
29	1995	2021	2014	199	443	2.23	0.449	2.94	158	407	2.58	0.388	1.33	1.87	36.79	18.03
30	1992	2021	2013	61	146	2.39	0.418	3.06	49	135	2.76	0.363	1.34	1.71	22.34	5.82
31	1983	2020	2005	104	236	2.27	0.441	3.02	81	214	2.64	0.379	1.32	1.79	48.53	11.21
32	1982	2021	2012	741	2081	2.81	0.356	3.58	608	1965	3.23	0.309	1.18	2.00	13.28	20.33
33	1992	2020	2002	76	163	2.14	0.466	2.68	65	152	2.34	0.428	1.25	1.70	43.45	27.79
34	1991	2021	2008	99	231	2.33	0.429	2.81	78	210	2.69	0.371	1.09	1.62	37.98	28.28
35	1984	2019	2002	56	105	1.88	0.533	2.42	36	87	2.42	0.414	1.18	1.73	29.41	38.13
36	1990	2020	2007	80	151	1.89	0.530	2.57	54	128	2.37	0.422	1.08	1.51	17.07	39.67
37	1983	2020	2000	83	169	2.04	0.491	2.63	54	140	2.59	0.386	1.16	1.53	24.48	28.29
38	1992	2020	2004	64	132	2.06	0.485	2.61	46	116	2.52	0.397	1.19	1.47	20.64	28.38
39	2000	2020	2017	71	153	2.15	0.464	2.78	60	146	2.43	0.411	1.17	1.57	11.14	15.36
40	1990	2021	2008	511	852	1.67	0.600	2.74	385	767	1.99	0.502	1.22	1.60	31.11	30.05
41	1996	2020	2010	74	148	2.00	0.500	2.68	57	134	2.35	0.425	1.23	1.69	41.55	33.12
42	1989	2021	2010	63	154	2.44	0.409	2.85	54	147	2.72	0.367	1.32	1.94	57.32	15.63
43	1989	2021	2001	97	189	1.95	0.513	2.57	69	164	2.38	0.421	1.21	1.52	17.14	37.76
44	1982	2020	2001	158	305	1.93	0.518	2.69	104	260	2.50	0.400	1.19	1.53	13.50	43.10
45	1990	2020	2008	104	216	2.08	0.481	2.66	83	198	2.39	0.419	1.26	1.63	27.71	27.18
46	1989	2021	2003	485	805	1.66	0.602	2.63	345	708	2.05	0.487	1.24	1.58	41.08	41.26
47	1993	2020	2008	83	203	2.45	0.409	2.93	67	190	2.84	0.353	1.22	1.81	19.22	18.18

Topics: Topic 0: QM practices and performance; **Topic 1**: Six-sigma methodology; **Topic 2**: Lean manufacturing; **Topic 3**: Business process re-engineering; **Topic 4**: Corporate Social Responsibility and ethics; **Topic 5**: Service quality measurement instruments; **Topic 6**: QM in the public sector; **Topic 7**: Balanced scorecard and performance measurement systems; **Topic 8**: Laboratory accreditation and calibration; **Topic 9**: QM in the construction industry; **Topic 10**: JIT practices; **Topic 11**: Accreditation and quality assurance in HE; **Topic 12**: QM in public housing construction; **Topic 13**: Environmental management; **Topic 14**: Sustainability; **Topic 15**: QM and the tourism sector; **Topic 16**: Service quality and the hotel industry; **Topic 17**: QM and Software development; **Topic 18**: Quality improvement programs in clinical practice; **Topic 19**: Energy, water, and pollution management; **Topic 20**: EFQM Excellence Model; **Topic 21**: Malcolm Baldrige National Quality Award; **Topic 22**: Integrated management systems; **Topic 23**: Quality control and quality circles; **Topic 24**: Innovation; **Topic 25**: Quality and safety of food; **Topic 26**: Continuous improvement and flexible manufacturing; **Topic 27**: Knowledge management; **Topic 28**: Organisational learning; **Topic 29**: Supply chain quality management; **Topic 30**: Marketing orientation and TQM; **Topic 31**: Supplier quality management; **Topic 32**: QM in Healthcare; **Topic 33**: Customer and employee satisfaction; **Topic 34**: Service quality attributes in e-commerce; **Topic 35**: Quality cost and improvement; **Topic 36**: Leadership; **Topic 37**: Teamwork; **Topic 38**: Preventive maintenance; **Topic 39**: Quality management systems; **Topic 40**: ISO standards certification; **Topic 41:** Critical factors of TQM critical factors in SMEs; **Topic 42**: Critical success factors; **Topic 43**: Quality characteristics, design of experiments, and Taguchi methods; **Topic 44**: Statistical quality control; **Topic 45**: TQM and organisational culture; **Topic 46**: TQM implementation practices; **Topic 47**: Empowerment and commitment.

Columns: dateL: lower date range; **dateH**: higher date range; **date.median**: median of date; **TPC:** total publications per cluster; **TAuC**; total authors per cluster; **MAuPC**: average authors per article and cluster; **MPAuC**: average publications per author and cluster; **CI**: collaboration index; **TPC.CI**: total publications per cluster among co-authored articles; **TAuC.CI**: total authors per cluster among co-authored articles; **MAuPC.CI**: average authors per article and cluster among co-authored articles; **MPAuC.CI**: average publications per author and cluster among co-authored articles; **MCoC**: average countries per cluster; **MAfidC**: average institutions per cluster; **MCiAuC**: average citations per author and cluster; **SWI**: small-world-index.

Table 3. Topics and metatopics of growing interest in the QM literature.

	Incipient to a slight increase.	Significant to high increase
Topic	(0) QM practices and performance (1) Six-sigma methodology (14) Sustainability (24) QM and innovation	(5) Service quality measurement instruments. (6) QM in the public sector (7) Balanced scorecard and performance measurement systems (9) QM in the construction industry (13) Environmental management (15) QM and the tourism sector (20) EFQM Excellence Model (23) Quality control and quality circles (26) Continuous improvement and flexible manufacturing (27) Knowledge management (31) Supplier quality management (39) Quality management systems (41) Critical factors in TQM in SMEs (43) Quality characteristics, design of experiments, and Taguchi methods
Metatopic	(A) Process improvement and elimination of defects-waste methodologies (I) Standardised management systems (K) Business Excellence Models	(C) Control and improvement operations tools; (E) QM in the tourism industry (L) TQM critical success factors

Figures

Figure 1abc. The distribution of individual articles.

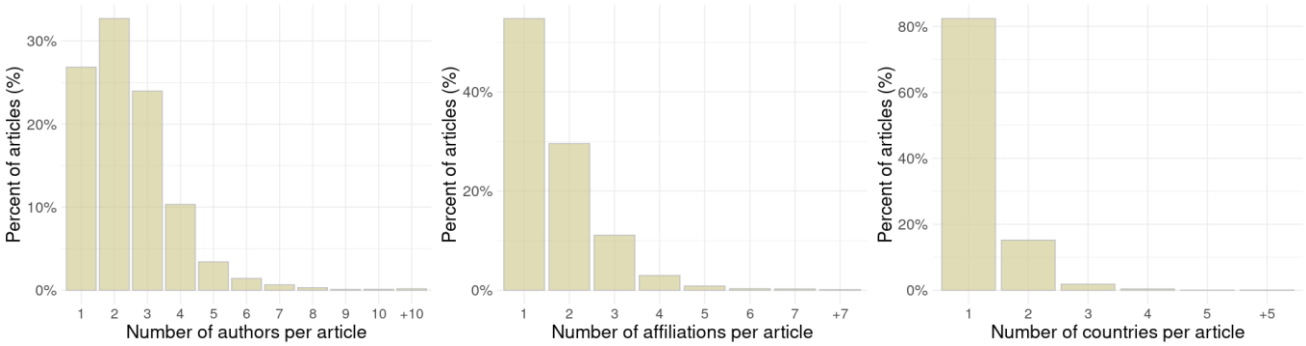

Figure 2ab. The distribution of articles per country and affiliation.

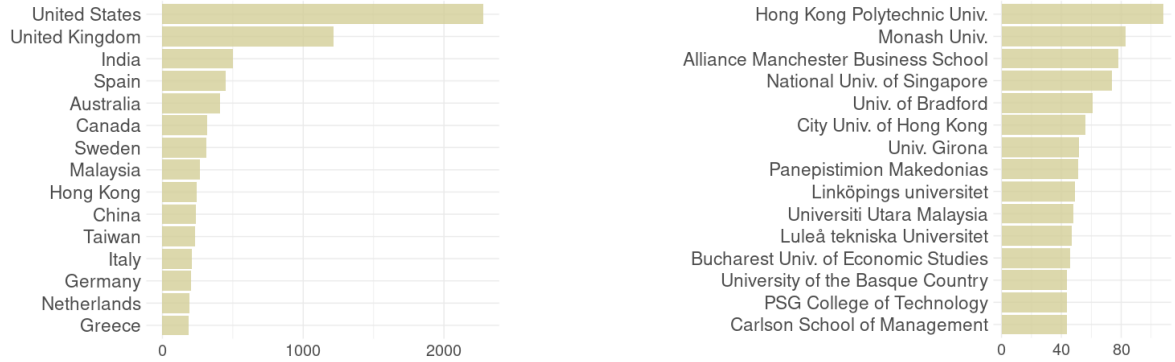

Figure 3ab. The distribution of articles per journal and the h-index per author.

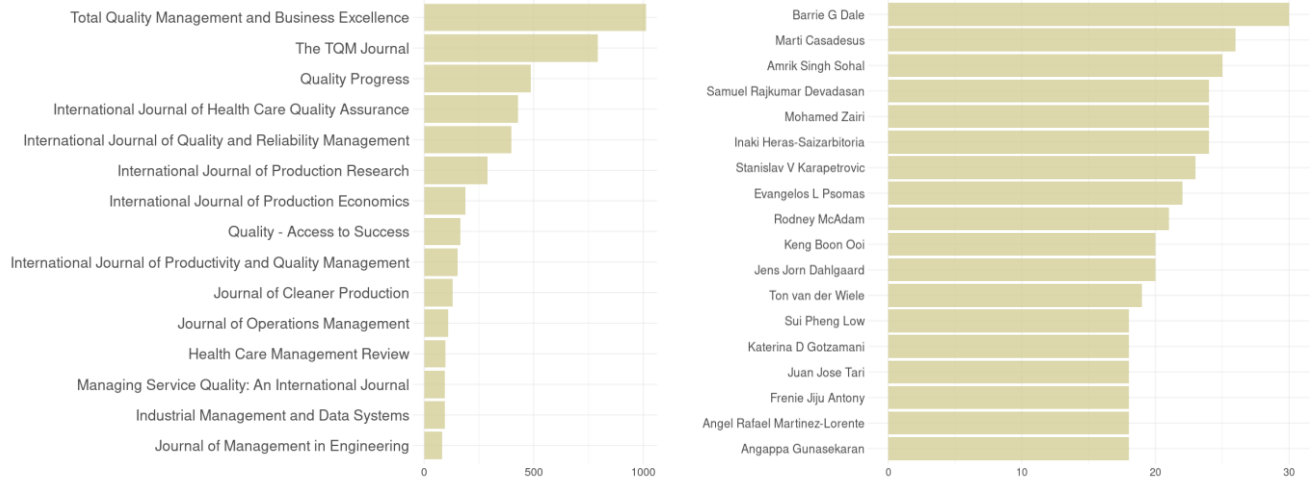

Figure 4. The number of articles over the years (on a logarithmic scale), RGR, and CI of the QM field.

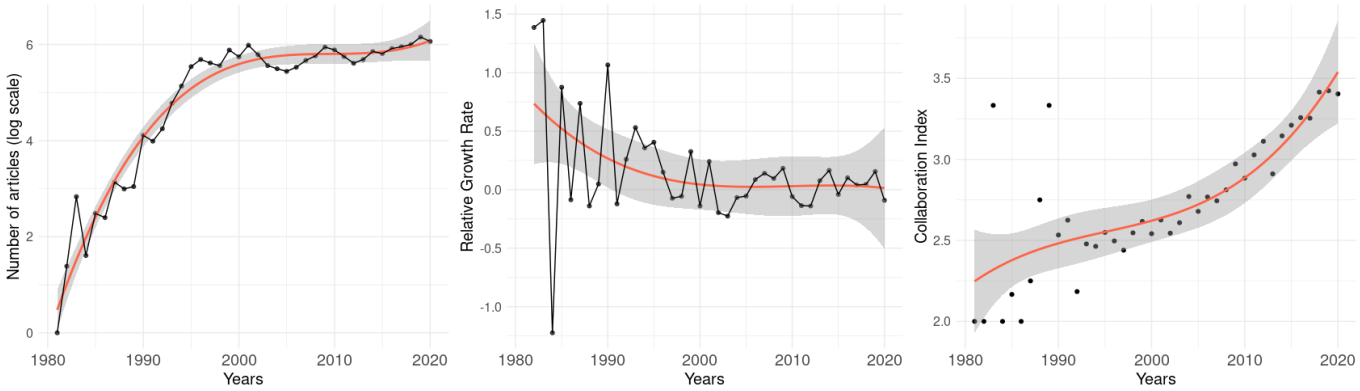

Figure 5. From Scopus QM-abstracts to dense topics via NLP.

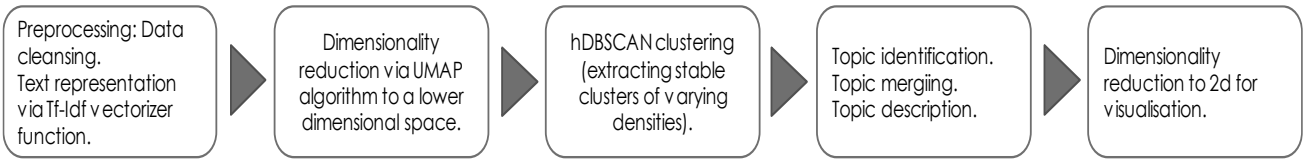

Figure 6. Top 7 terms to describe topics, according to c-TF-IDF scores.

Figure 7. Distribution of topics in a two-dimensional space.

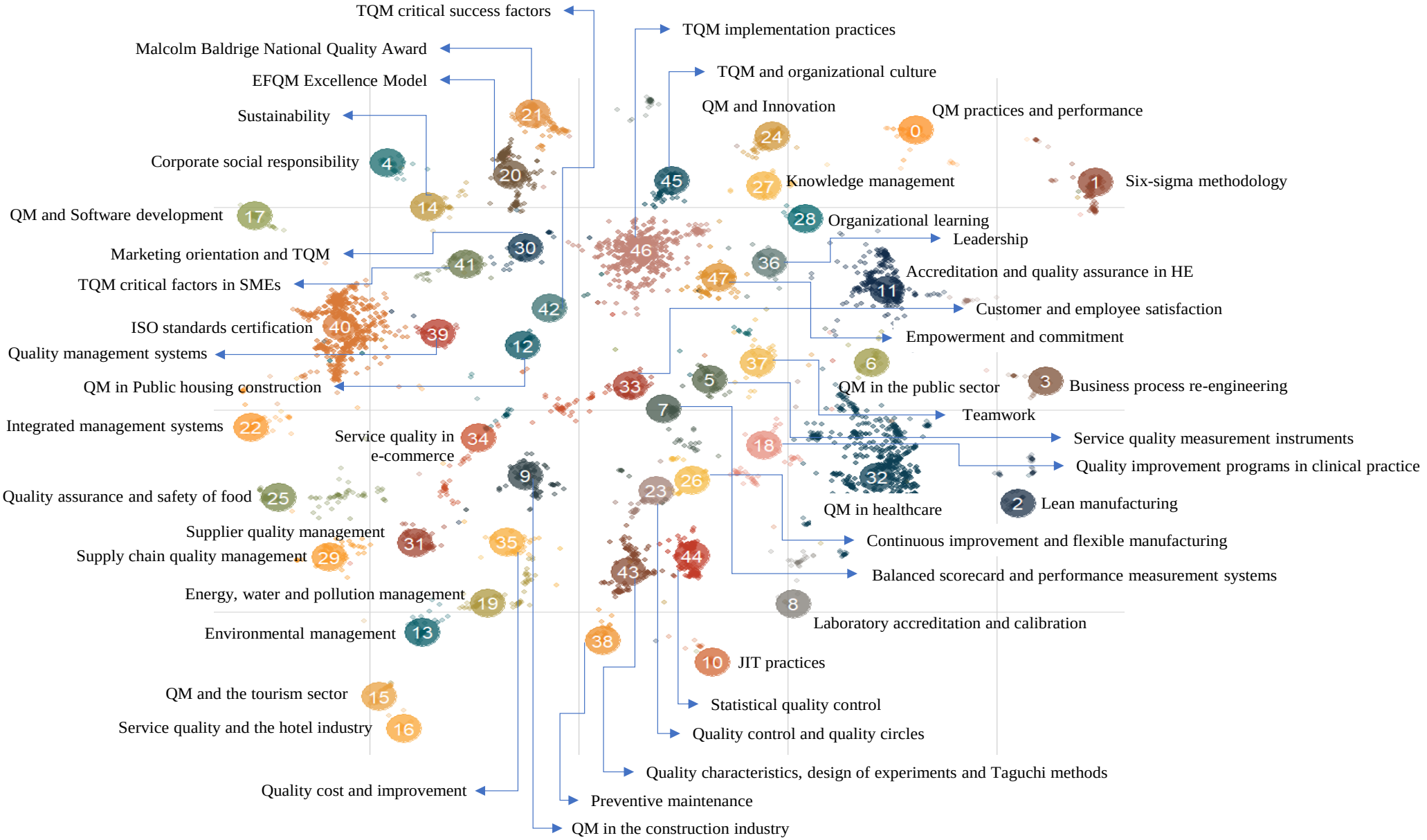

Figure 8. Summary of articles per topic.

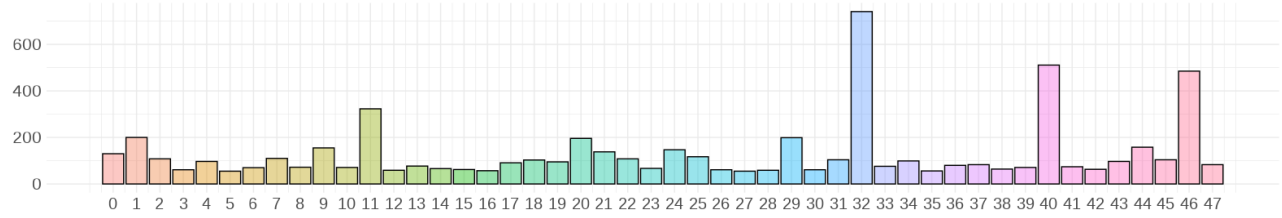

Figure 9. Summary of probabilities per article and cluster (boxplots).

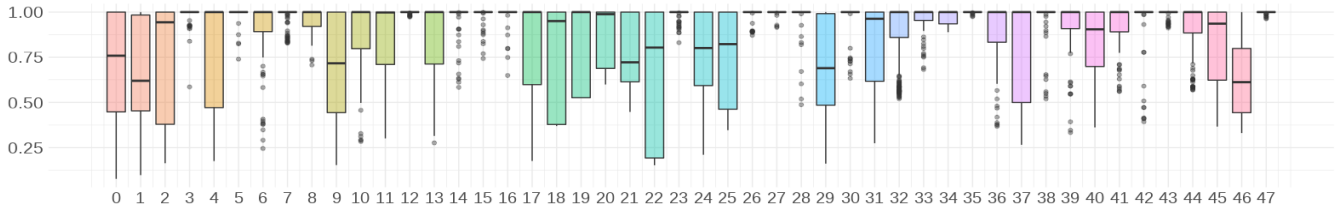

Figure 10. Variety of authors, affiliations, and countries reflected in clusters.

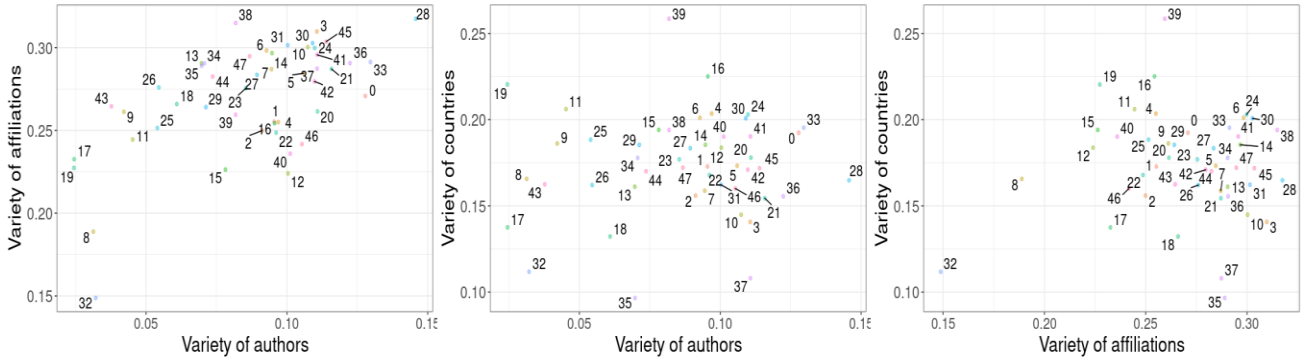

Figure 11. Metatopics.

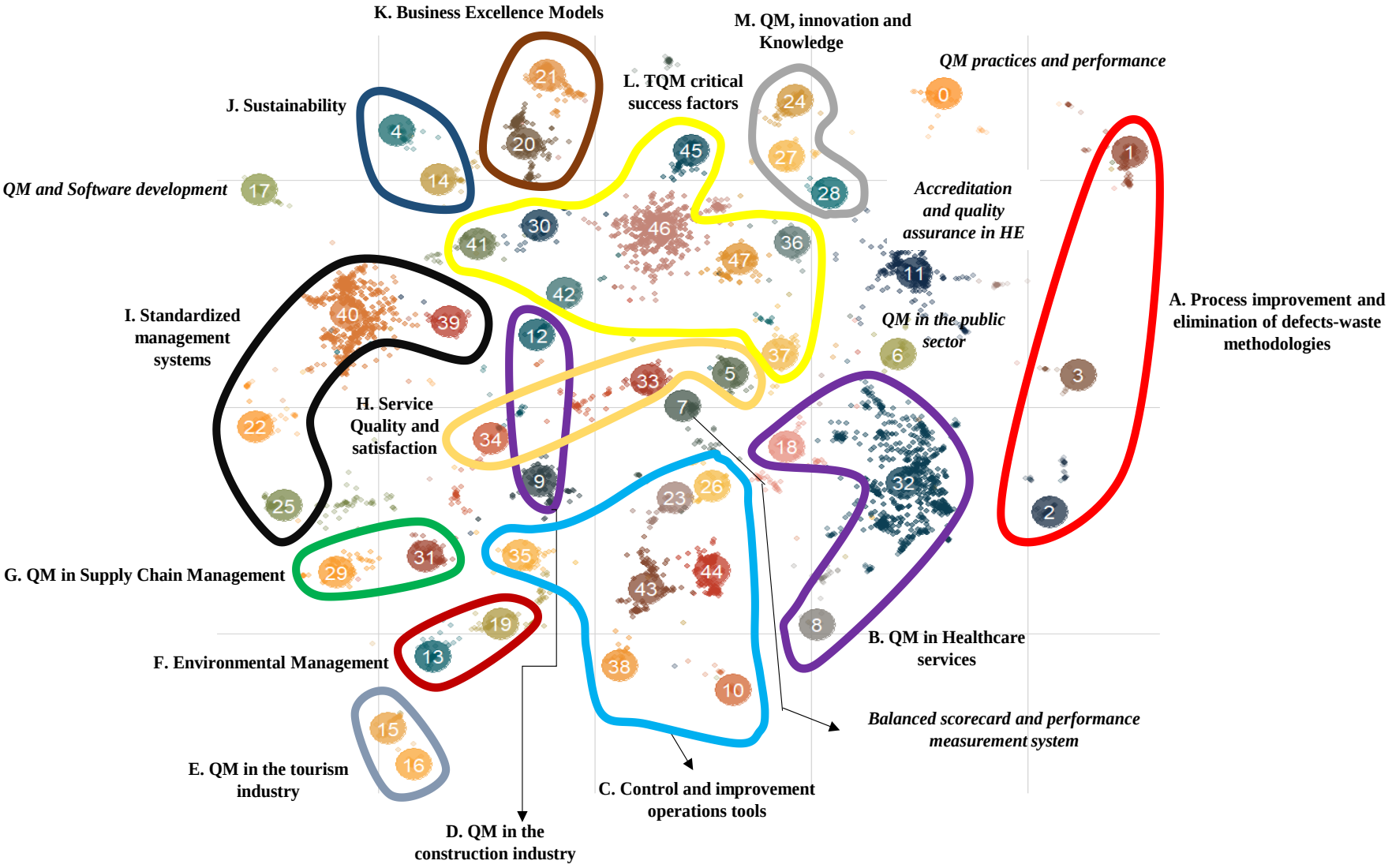

Figure 12. Temporal evolution of topics.

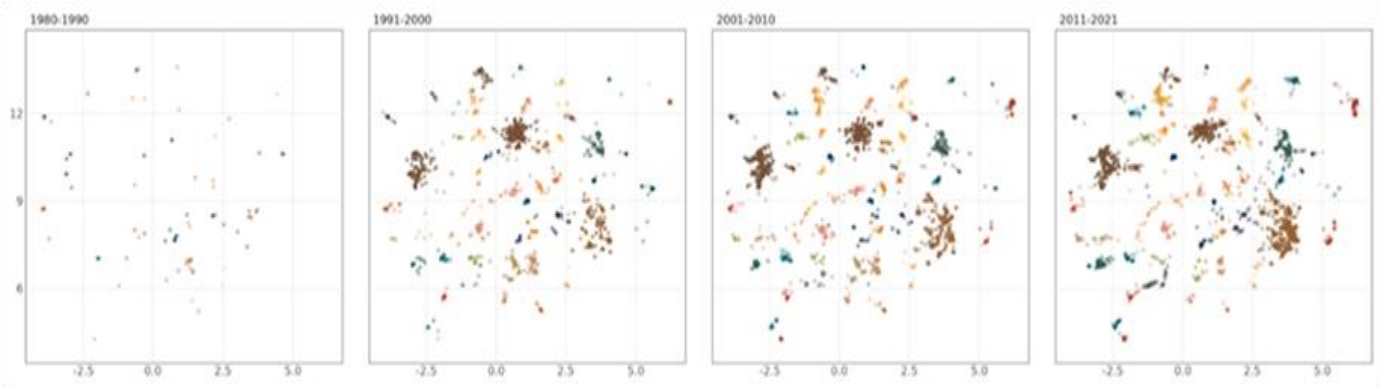

Figure 13. Temporal distribution of topics on 1d-UMAP with publication dates on the y-axis.

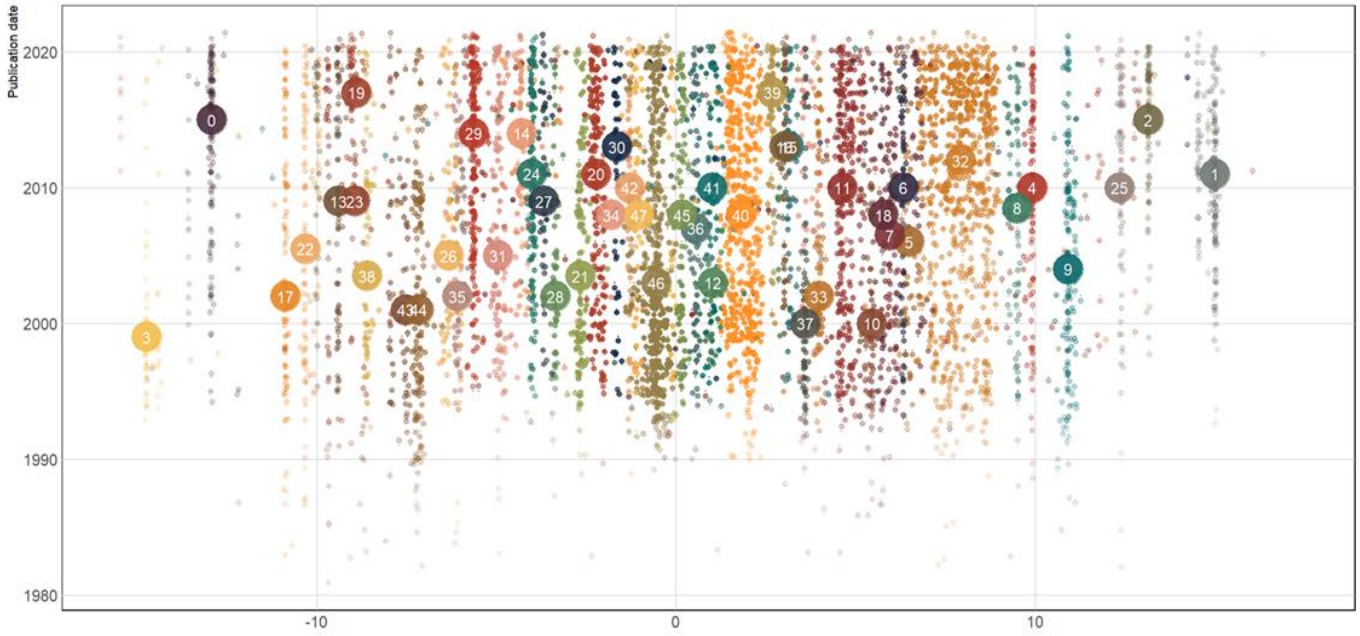

Figure 14. Interannual growth rates by topics.

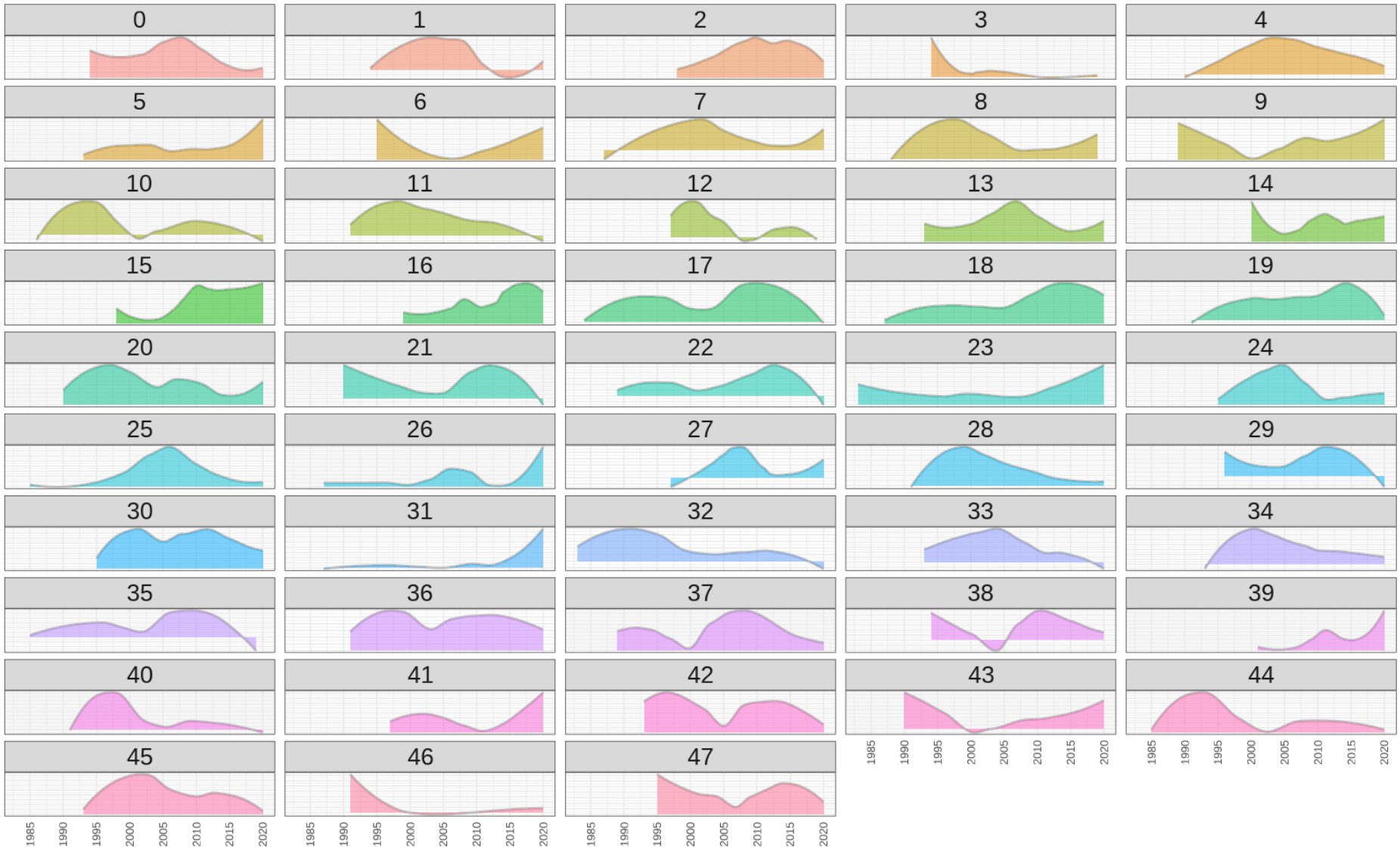

Figure 15. Interannual growth rates by metatopics.