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Design Management and the SME Product Development Process: A Bibliometric Analysis and Review

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Abstract
Academic interest in design management has grown exponentially over the past several decades. Design management in the context of Small and Medium-Sized Enterprises (SMEs) is particularly important and challenging. These economically influential organizations generally fail to benefit from good design practices. This study is part of a broader investigation seeking to improve and optimize the process of design integration and management inside SMEs with little or no prior experience in design and who collaborate with external designers. Here we present a bibliometric analysis methodology and review of the main contributions to the literature in the SME design management. Our findings contribute to the analysis of the evolution and quality of research in the field of SME design management and can support future methodological research.

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Introduction

Good design does not happen by accident—it is the result of a managed process.[1] This process leads to the creation of a product, true, but the concept of design is more than its result. Design is also the (strategic) selection and mobilization of sets of activities, practices, capabilities, and (organizational) resources necessary for that product to be developed. This orchestration is known in the literature as "design management,"[2] a term used for the first time in 1964.[3]

Design management as a discipline has evolved in four stages.[4] From 1964 to 1992 (first stage), scholarly focus was on enhancing product qualities, and so on economic and aesthetic value. Between 1993 and 2005 (second stage), researchers became interested in the types of value a design process might offer to organizations, especially within the context of new product development (NPD) and innovation management. As the character of design evolved, it became noteworthy as an organizational resource that could be integrated into internal processes and functions. Accordingly, in the period from 2005 to 2014 (third stage) scholars shifted their attention to the optimization of human value in service of the organization's (product/artifact) design strategies. The current (2015–present) academic focus is on design's strategic value to the organization as a whole—in terms of processes, operations, strategy, and so on—and making a company sustainable in the globalized context of social well-being.[5]

Design management articulates and supports a multidisciplinary developmental process. Practitioners discern, coordinate, negotiate, and design an artifact or artifacts that integrate and embody strategic and operational plans according to an organization's vision and mission.[6] Its scope ranges from the operational management of project design and development—including design team(s), operations, processes, and methods—to the strategic scaling of design across an entire organization.[7]

Design management in the SME context is particularly important and challenging. The SME sector is responsible for a significant share of European economic activity.[8] These organizations face numerous financial and human resource constraints; sometimes they lack the design skills and experience they need[9] which means they must find those experts and resources externally. In addition, and unlike large companies, many SMEs have no formal methodology to frame design development[10] and run on outdated management models[11] designed to be rigid and isolated which block their desired strategy from becoming reality.

Given the value that design can contribute to business performance,[12] for SMEs, optimizing the product development process and its management have become strategic imperatives. The design process, however, requires input from multiple disciplines, and may consist of several integrated methodological approaches. SMEs may not have the required expertise in house, and so the company and external project contributors may conduct the process jointly. In this article, we present a survey and analysis of the literature identifying the key parameters, dependencies, and connections involved in SME design management (at the operational level) during the product development process. It is our hope that this

1 Margaret Bruce and John Bessant, *Design in Business: Strategic Innovation through Design* (Harlow: Pearson Education Limited, 2002).

2 Ricardo Chiva and Joaquín Alegre, "Linking Design Management Skills and Design Function Organization: An Empirical Study of Spanish and Italian Ceramic Tile Producers," *Technovation* 27, no. 10 (2007): 616–27, DOI: https://doi.org/10.1016/j.technovation.2007.05.015; Ricardo Chiva and Joaquín Alegre, "Investment in Design and Firm Performance: The Mediating Role of Design Management," *Journal of Product Innovation Management* 26, no. 4 (2009): 424–40, DOI: https://doi.org/10.1111/j.1540-5885.2009.00669.x.

3 Brigitte Borja de Mozota, *Design Management: Using Design to Build Brand Value and Corporate Innovation* (New York: Allworth Press, 2003).

4 Brigitte Borja de Mozota and Fabiane Wolff, "Forty Years of Research in Design Management: A Review of Literature and Directions for the Future," *Strategic Design Research Journal* 12, no. 1 (2019): 4–26, DOI: https://doi.org/10.4013/sdrj.2019.121.02; Rachel Cooper, Sabine Junginger, and Thomas Lockwood, eds., *The Handbook of Design Management* (London: Bloomsbury, 2011).

5 Borja de Mozota and Wolff, "Forty Years," 9.

6 Luis Avendaño, "A Importância do Ensino da Gestão do Design," *Revista Belas Artes* 2, no. 4 (2010): 1–28, available at http://www.belasartes.br/revistabelasartes/downloads/artigos/4/a-importancia-do-ensino-da-gestao-do-design.pdf.

7 Jan Kramoliš and Pavla Staňková, "Design and Its Impact on The Financial Results of Enterprises (Based on Managers' Opinions)," *Journal of Competitiveness* 9, no. 2 (2017): 62–77, DOI: https://doi.org/10.7441/joc.2017.02.05.

8 David Audretsch et al., *First Section of the Annual Report on EU Small and Medium-Sized Enterprises* (Zoetermeer: EIM Business & Policy Research, 2009), available at http://ec.europa.eu/enterprise/policies/sme/files/craft/sme_perf_review/doc_08/spr08_annual_reporten.pdf.

9 Mark Oakley, "Product Design and Development in Small Firms," *Design Studies* 3, no. 1 (1982): 5–10, DOI: https://doi.org/10.1016/0142-694X(82)90073-4; Margaret Bruce, Rachel Cooper, and Delia Vazquez, "Effective Design Management for Small Businesses," *Design Studies* 20, no. 3 (1999): 297–315, https://doi.org/10.1016/S0142-694X(98)00022-2; Alan Lewis and Robert Brown, "Key Issues in Managing the Product Development Process in Very Small Manufacturing Companies," in *PICMET '99: Portland International Conference on Management of Engineering*

and Technology. Proceedings Vol. 1: Book of Summaries (IEEE Cat. No.99CH36310) (New York: IEEE, 1999), 261–65, DOI: https://doi.org/10.1109/PICMET.1999.808092; Anabel Fernández-Mesa et al., "Design Management Capability and Product Innovation in SMEs," *Management Decision* 51, no. 3 (2013): 547–65, https://doi.org/10.1108/00251741311309652.

10 Hans Berends et al., "External Designers in Product Design Processes of Small Manufacturing Firms," *Design Studies* 32, no. 1 (2011): 86–108, https://doi.org/10.1016/j.destud.2010.06.001; Joaquin T. Iduarte and Martha P. Zarza, "Design Management in Small- and Medium-Sized Mexican Enterprises," *Design Issues* 26, no. 4 (2010): 20–31, available at https://www.jstor.org/stable/40983101.

11 Jilema Alarcón, Manuel Lecuona, and Gio Ormeño, "Design Management to Increase Small and Medium Multisector Enterprises (SMEs) Competitiveness: Interdiciplinarity Experience with Public Funding," in *Edulearn15 Proceedings: 7th International Conference on Education and New Learning Technologies Conference Proceedings*, ed. L. Gómez Chova, A. López Martínez, and I. Candel Torres (Valencia: IATED Academy, 2015), 3067–75, available at https://library.iated.org/view/ALARCON2015DES.

12 Ibid.; Bruce et al., "Effective Design Management"; Chiva and Alegre, "Investment in Design"; Berends et al., "External Designers."

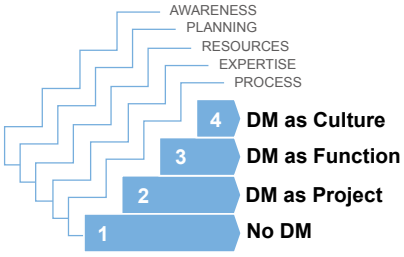

Figure 1
Design Management (DM) Staircase. Redrawn based on Gert L. Kootstra, *The Incorporation of Design Management in Today's Business Practices. An Analysis of Design Management Practices in Europe*, trans. Erwin Postma (Rotterdam: The Hague and INHOLLAND University, 2009), 12, figure 1.1. Image © 2021 by authors.

contribution will allow further elucidation of this complex web of interdependencies in future research.

In this article, we begin by outlining the theoretical background on design management and product design in SMEs, and the involvement of external design expertise in product design. We then present our research methodology, results, analysis, and discussion. To conclude, we reflect on the limitations of this study and the key contributions it makes to the domain of design management more broadly.

Theoretical Background

Design Management

Design management has become an important domain of academic research[13] and component of business practice.[14] In 2009, Gert Kootstra[15] developed the Design Management Staircase (DM Staircase) model (Figure 1) to assess the role played by design management in European SMEs. Each step represents a different approach to design management inside an organization. The staircase shape of the model falsely implies that reaching the highest level is imperative, because the higher a company is positioned (in the model) the greater is the remit of design within the company. However, as the author warns,

> "Not every company will need to focus its strategy on the role of design as a driving force for innovation. Depending on their nature, market position, or strategy, a level 2 or level 3 approach may well suffice. Still, most companies cannot afford to neglect design management altogether, as in the case of companies stuck on the first tread of the staircase model."[16]

The four levels of the model are, briefly,

- Level 1 (no design management): Internal expertise related to design methods, tools, and processes is virtually nonexistent. Any design activity performed will produce uncertain results.
- Level 2 (project): Design's remit is limited to aesthetics/styling, product line extensions, and product improvement. Design as a tool for creating added value is largely neglected.
- Level 3 (function): The priority is on optimized design processes and high-quality outcomes across the organization. The organization has a dedicated design function.
- Level 4 (culture): Design actively participates in developing, supporting, and optimizing company strategy.

Kootstra's[17] study on the overall assessment of design management at European SMEs revealed that 59% of the companies surveyed were at level 1 (36%) and level 2 (23%).

Product Design in SMEs

Design is applied inside organizations in diverse ways. In manufacturing industries, design methods, tools, and techniques serve to generate a physical artifact: a tangible product. In the service and information and

communications technology (ICT) industries, where the offering is not a physical artifact or artifacts,[18] the focus of design is often on the intangible aspects of an offering, such as process, engineering, branding and brand communication, and so on. There are also organizations that combine both—they utilize design to create tangible and intangible products. Product-service systems are an example of this. Our investigation focuses on the first type: product design.

Design is essential to the creation and implementation of product innovations.[19] Its remit is not limited to aesthetics; design also means process management, materials selection, prototyping, etc.[20] Several studies have shown that the effective use of design can positively contribute to business performance.[21] And yet, the introduction and application of robust product design practices is marginal in most SMEs.[22] Unlike large corporations, innovating SMEs suffer from serious resource constraints: no internal design competencies, limited timeframes, and modest budgets.[23] They tend to make "silent" design decisions—design activity is carried out by people who are not designers and do not consider themselves as such. They are unaware that they are participating in design activity.[24] Some have criticized the SME product development and innovation process for being ad hoc, unplanned, and unstructured, and for failing to adopt systematic procedures.[25] Design is often considered costly, time-consuming, and unnecessary in the SME world—just another activity at the front end of the product development process—a perspective that marginalizes the benefits of good design practices.[26] Examples of this marginalization are some SMEs exclusive use of internally-generated market data, excessive emphasis on engineering without attention to users' needs and tastes, or regular use of non-designers to carry out design activities.[27] Evidently, for SMEs to begin using design as a strategic resource, some learning is required.

Involving External Designers in Product Development

Bringing in support from the outside can be of great benefit to SMEs, and a great way to introduce design to an organization in search of product innovation but with little to no prior design experience.[28] Outsourcing design enables SMEs to minimize the risks associated with introducing design capability into the organization, and facilitates its integration more broadly.[29] External experts can introduce new ideas, greater levels of innovation and creativity, and new solutions that the organization could never realize on its own.[30] Their complementary expertise and knowledge enables the organization to continually update its approaches and methods of product development,[31] a form of resilience and responsiveness to ever-changing conditions is extremely important nowadays. Developing increasingly complex (interconnected, digital, modular, and so on) products requires the expertise of multiple disciplines, and the cooperation of team members jointly seeking to achieve the same objectives. Overall, the involvement of external project teams, designers, and design agencies and entities can significantly contribute to the successful development of small or medium-sized companies[32] and help them recognize the strategic value of design for the organization.

Several countries have implemented support programs that further

13 Rachel Cooper and Mike Press, *The Design Agenda: A Guide to Successful Design Management* (Chichester: Wiley, 1995).

14 Bilgen T. Manzakoğlu and Özlem Er, "Design Management Capability Framework in Global Value Chains: Integrating the Functional Upgrading Theory from OEM to ODM and OBM," *The Design Journal* 21, no. 1 (2018): 139–61, https://doi.org/10.1080/14606925.2018.1395577.

15 Gert L. Kootstra, *The Incorporation of Design Management in Today's Business Practices. An Analysis of Design Management Practices in Europe*, trans. Erwin Postma (Rotterdam: The Hague and INHOLLAND University, 2009), available at http://Lastrategiedesign.com/public/DME_Survey09.pdf.

16 Ibid., 13.

17 Ibid., 1–64.

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18 Peter Gorb, "Design and Its Use to Managers," *Journal of the Royal Society of Arts* 128, no. 5283 (1980): 144–58, available at https://www.jstor.org/stable/41373058.

19 Helen Perks, Rachel Cooper, and Cassie Jones, "Characterizing the Role of Design in New Product Development: An Empirically Derived Taxonomy," *Journal of Product Innovation Management* 22, no. 2 (2005): 111–27, DOI: https://doi.org/10.1111/j.0737-6782.2005.00109.x.

20 James Utterback et al., *Design-Inspired Innovation* (Singapore: World Scientific Publishing, 2006), DOI: https://doi.org/10.1142/6052.

21 Bruce et al., "Effective Design Management"; Chiva and Alegre, "Investment in Design"; Martti Lindman, Barbara Scozzi, and Carmen Otero Neira, "Low Tech, Small and Medium Sized Enterprises and the Practice of New Product Development," *European Business Review* 20, no. 1 (2008): 51–72, DOI: https://doi.org/10.1108/09555340810843690; James Moultrie, P. John Clarkson, and David Probert, "A Tool to Evaluate Design Performance in SMEs," *International Journal of Productivity and Performance Management* 55, no. 3-4 (2006): 184–216, DOI: https://doi.org/10.1108/17410400610653192.

22 James Moultrie, P. John Clarkson, and David Probert, "Development of a Design Audit Tool for SMEs," *Journal of Product Innovation Management* 24, no. 4 (2007): 335–68, DOI: https://doi.org/10.1111/j.1540-5885.2007.00255.x.

23 Bruce et al., "Effective Design Management"; Lewis and Brown, "Key Issues"; Oakley, "Product Design"; Berends et al., "External Designers"; Claudia Acklin, "Design Management Absorption Model: A Framework to Describe and Measure the Absorption Process of Design Knowledge

by SMEs with Little or No Prior Design Experience," *Creativity and Innovation Management* 22, no. 2 (2013): 147–60, DOI: https://doi.org/10.1111/caim.12022.

24 Peter Gorb and Angela Dumas, "Silent Design," *Design Studies* 8, no. 3 (1987): 150–56, DOI: https://doi.org/10.1016/0142-694X(87)90037-8.

25 Berends et al., "External Designers"; Kurt Hoffman et al., "Small Firms, R&D, Technology and Innovation in the UK: A Literature Review," *Technovation* 18, no. 1 (1998): 39–55, DOI: https://doi.org/10.1016/S0166-4972(97)00102-8; Isidre March-Chordà, A. Gunasekaran, and Begoña Lloria-Aramburo, "Product Development Process in Spanish SMEs: An Empirical Research," *Technovation* 22, no. 5 (2002): 301–12, DOI: https://doi.org/10.1016/S0166-4972(01)00021-9; Barbara Scozzi, Claudio Garavelli, and Kevin Crowston, "Methods for Modeling and Supporting Innovation Processes in SMEs," *European Journal of Innovation Management* 8, no. 1 (2005): 120–37, DOI: https://doi.org/10.1108/14601060510578619; Acklin, "Absorption Model."

26 Huw Millward and Alan Lewis, "Barriers to Successful New Product Development within Small Manufacturing

encourage novice organizations to incorporate design resources and knowledge internally.[33] Within these frameworks, companies are provided with some form of subsidy to engage design professionals in a series of design activities that may include product development.

Methodology

A systematic literature review is a research methodology that aims to establish a formal survey of the state of the art of a discipline, in a robust and consistent manner, based on meticulous planning and execution.[34] The systematic literature review methodology represents a structured, unambiguous, and reproducible research process.[35] Its sequence of steps is methodically defined according to an explicit research protocol. Originating in medicine, the systematic literature review was intended to support medical practice based on scientific evidence,[36] "to improve research performance and the quality of the review process."[37]

We adopted the systematic literature review methodology devised by David Tranfield, David Denyer, and Palminder Smart,[38] which is characterized by 3 main stages: planning, execution, and reporting of data. Figure 2 illustrates this process.

Through a series of steps, detailed in the following sections, we selected relevant articles and built a database to house and organize their contents. Using this database, we conducted a bibliometric analysis and extracted

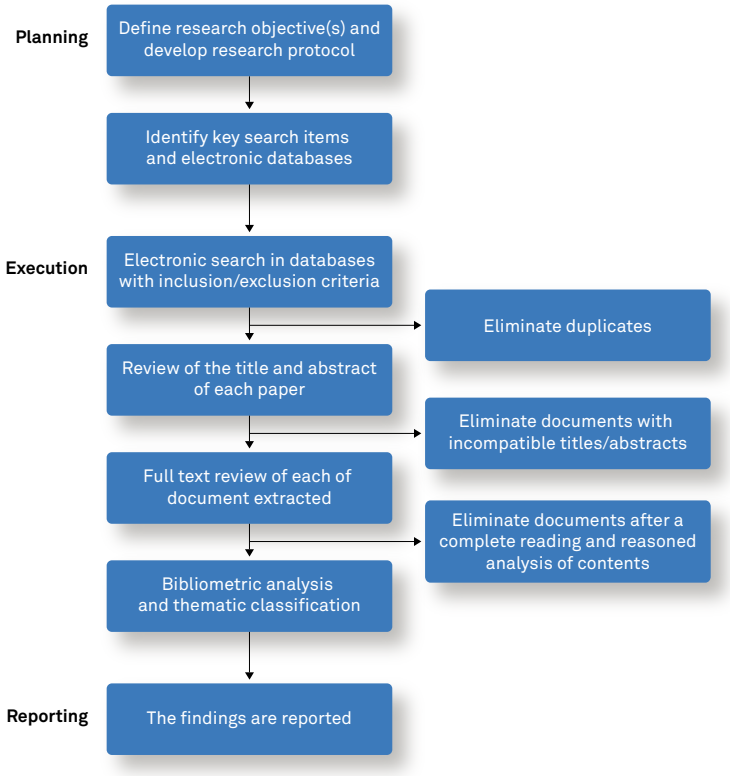

Figure 2
Systematic review methodology. © 2021 by authors.

Companies," *Journal of Small Business and Enterprise Development* 12, no. 3 (2005): 379–94, DOI: https://doi.org/10.1108/14626000510612295; Berends et al., "External Designers."

27 Moultrie et al., "Development of a Design Audit Tool for SMEs."

28 Margaret Bruce and Barny Morris, "Managing External Design Professionals in the Product Development Process," *Technovation* 14, no. 9 (1994): 585–99, DOI: https://doi.org/10.1016/0166-4972(94)90041-8; Chiva and Alegre, "Linking Design Management Skills"; Berends et al., "External Designers."

29 Centro Português de Design, *Manual de Gestão de Design* (Lisboa: Porto Editora, 1997).

30 Berends et al., "External Designers"; Bruce and Morris, "Managing External Design Professionals"; Bruce et al., "Effective Design Management"; Celine Abecassis-Moedas and Pierre-Jean Benghozi, "Efficiency and Innovativeness as Determinants of Design Architecture Choices," *Journal of Product Innovation*

information under various headings, including general characteristics, methodologies employed, and main themes. This procedure provided a complete image of the international literature on design management as it relates to the product development process inside SMEs worldwide.

Planning

The planning phase consists of the definition of a protocol to limit systematic error and bias. For this study, we developed a literature review protocol based on the work of Jennie Popay and her colleagues.[39] We summarize the objectives, strategies, and parameters of our article selection according to the protocol (by period covered, source database, keywords, type of document, etc.) in Figure 3.

Databases

Our elaboration of the theoretical review began with an identification of relevant databases. We defined the sample space of articles for consideration "as the set of all possible articles available in the defined databases."[40] We selected Web of Science, Scopus, and Science Direct for inclusion; given their profusion of international journal and publisher contributions, they present three of the most complete sources of articles for a systematic review process.

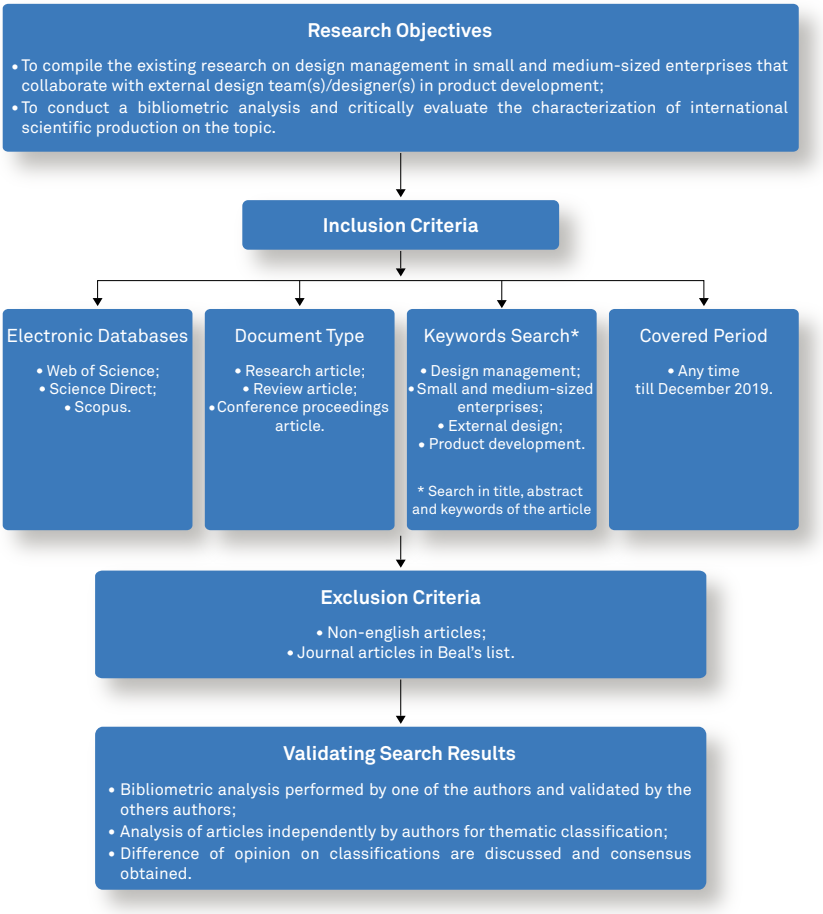

Figure 3
Literature review protocol. © 2021 by authors.

Management 29, no. 3 (2012): 405–18, DOI: https://doi.org/10.1111/j.1540-5885.2012.00914.x; Celine Abecassis-Moedas and Joana Rodrigues Pereira, "External Design for Reputation, Perspective, and Exposure," *Creativity and Innovation Management* 25, no. 3 (2016): 396–407, DOI: https://doi.org/10.1111/caim.12166; Claudio Dell'Era and Roberto Verganti, "Collaborative Strategies in Design-Intensive Industries: Knowledge Diversity and Innovation," *Long Range Planning* 43, no. 1 (2010): 123–41, DOI: https://doi.org/10.1016/j.lrp.2009.10.006; Claudio Dell'Era and Roberto Verganti, "Design-Driven Laboratories: Organization and Strategy of Laboratories Specialized in the Development of Radical Design-Driven Innovations," *R&D Management* 39, no. 1 (2009): 1–20, DOI: https://doi.org/10.1111/j.1467-9310.2008.00541.x.

31 Dell'Era and Verganti, "Collaborative Strategies"; Berends et al., "External Designers"; Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure."

32 Berends et al., "External Designers."

33 Acklin, "Absorption Model"; Robin Roy and Stephen Potter, "Managing Design Projects in Small and Medium-Sized Firms," *Technology Analysis & Strategic Management* 2, no. 3 (1990): 321–36, DOI: https://doi.org/10.1080/09537329008524018; Paul W. Wormald and Mark A. Evans, "The Integration of Industrial Design Capability within UK SMEs: The Challenges, Opportunities and Benefits," *International Journal of Product Development* 9, no. 4 (2009): 343–56, DOI: https://doi.org/10.1504/IJPD.2009.027469; Design Council, *Designing Demand: The Importance of Design* (Boston: Beacon Press, 2008), also available at https://www.designcouncil.org.uk/sites/default/files/asset/document/designing-demand-review.pdf.

Keywords

Once the sample space was defined the keywords identified, their results comprised the first filter for article selection. Given the scope and nature of our research undertaking, we organized our efforts along four research axes: design management, SMEs, external design, and product development. To gain a more representative and significant sample of articles for selection, we combined the 4 sets of research axis keywords to obtain 9 research combinations. We then converted these combinations into Boolean strings, and used them to guide our preliminary database search for relevant articles (see Appendix A).

Inclusion/Exclusion Criteria

We defined the inclusion and exclusion criteria for articles as follows

- String search fields should only include title, abstract, and keywords;
- Eligible documents were research articles, review articles, or conference proceedings exclusively, thereby excluding potentially less rigorous sources, such as book chapters and monographs.[41] Although some researchers recommend excluding conference proceedings articles from systematic literature reviews,[42] we did not — we sought the insights to be garnered from these valuable, first-hand sources[43] of emerging knowledge;
- Articles must be in English; and
- Articles found on Beall's list[44] would be removed.

Execution

The execution of the 9 search strings together with the exclusion and inclusion criteria returned a total of 135 articles (Appendix B). We filtered these using a multi-step process (Figure 4) to remove duplicates, verify title/abstract relevance, check against exclusion and inclusion criteria, and, finally, perform the full text review.

To better manage the screening and verification process for the initial set of articles, we exported them in *.bib format for upload to the StArt tool.[45] From the initial set of 135 articles, the tool identified 71 duplicates, reducing the sample to 64. These we analyzed by title and abstract, according to the fit for purpose method, and included only articles with substantively relevant

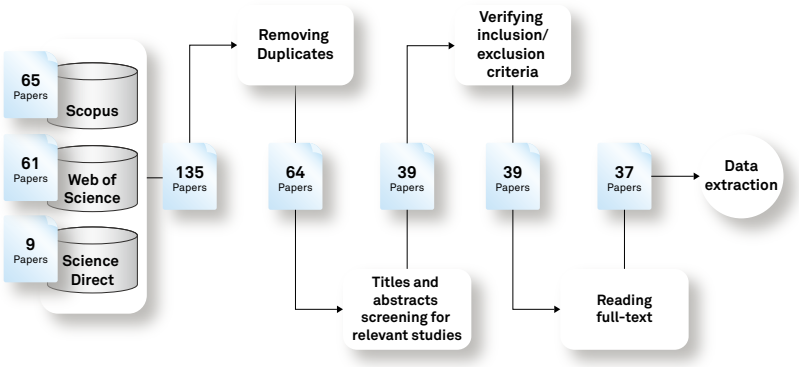

Figure 4
Systematic literature review outline. © 2021 by authors.

abstract content.[46] After this analysis, we eliminated a further 25 articles misaligned with our investigation, reducing the sample to 39. We then checked to ensure that these articles met the inclusion/exclusion criteria, resulting in no eliminations. Finally, and to guarantee that the articles we had selected were aligned with our object of analysis, we read each one in its entirety. The full text analysis yielded a further two exclusions, resulting in a final sample of 37 articles.

Results and Discussion

We have divided our analysis of the results into two parts. In the first, we analyze the various characteristics of the articles. In the second, we identify, classify, and outline the articles' main ideas to reveal their research orientation and contribution.

Article Characteristics

The portfolio of selected articles provided some interesting information, even at a general level. In this section we discuss their temporal distributions, publication types, academic relevance, and author locations.

Publication Dates and Types

Design management research efforts in the SME sector have gained momentum only in the last decade (see Figure 5). Although design management publications date back to the 1980's with Peter Gorb as one of the field's main drivers,[47] studies specifically related to SME product development and possible approaches to design competence at the operational level have only recently increased in frequency.

Three publication periods are visible in Figure 5. 1990 to 2005 was when the first (five) articles devoted to the topic under consideration were published. The publications during that first period are few and far between—the longest interval between them is seven years, and the shortest is four. The second period, between 2009 and 2013, saw a more regular publication distribution (16 articles) and significant leaps in quantity as each year passed—there were as many articles published in 2009 alone

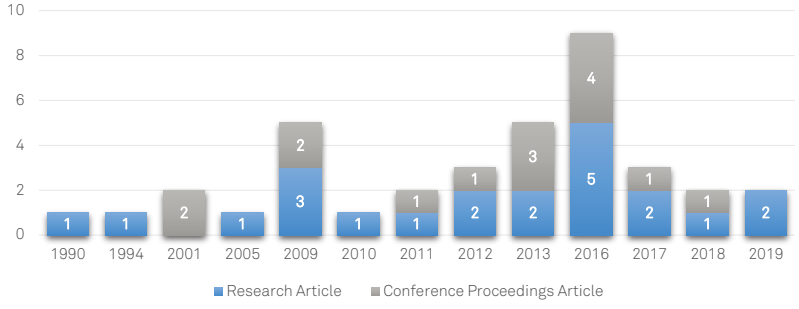

Figure 5
Publication distribution by year/type of publication. © 2021 by authors.

34 Elizabete Munzlinger, Fabricio Batista Narcizo, and José Eustáquio Rangel de Queiroz, "Sistematização de Revisões Bibliográficas em Pesquisas da Área de IHC," in *IHC '12: Companion Proceedings of the 11th Brazilian Symposium on Human Factors in Computing Systems* (New York: ACM, 2012), 51–54, available at https://dl.acm.org/doi/10.5555/2400076.2400099.

35 Rosana Ferreira Sampaio and Marisa Cotta Mancini, "Estudos de Revisão Sistemática: Um Guia Para Síntese Criteriosa Da Evidência Científica," *Revista Brasileira de Fisioterapia* 11, no. 1 (2007): 83–89, available at http://www.scielo.br/pdf/rbfis/v11n1/12.pdf; for the English version, see: Rosana Ferreira Sampaio and Marisa Cotta Mancini, "Systematic Review Studies: A Guide for Careful Synthesis of the Scientific Evidence," *Brazilian Journal of Physical Therapy* 11, no. 1 (2007): 77–82, available at http://www.scielo.br/pdf/rbfis/v11n1/en_12.pdf.

36 Munzlinger et al., "Sistematização de Revisões."

37 Michela Piccarozzi, Barbara Aquilani, and Corrado Gatti, "Industry 4.0 in Management Studies: A Systematic Literature Review," *Sustainability* 10, no. 10 (2018): 3821: 3, DOI: https://doi.org/10.3390/su10103821.

38 David Tranfield, David Denyer, and Palminder Smart, "Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review," *British Journal of Management* 14, no. 3 (2003): 207–22, DOI: https://doi.org/10.1111/1467-8551.00375. –

39 Jennie Popay et al., "Guidance on the Conduct of Narrative Synthesis in Systematic Reviews: A Product from the ESRC Methods Programme" (research report from the ESRC Methods Programme, Lancaster University, 2006), available

as there were in total, in all the years prior. Clearly, the domain was arousing interest in the researcher community. The final period, from 2016 to 2019, was one year shorter than the period before. Despite this, there were as many publications in this period as in the previous one, which demonstrates the importance and relevance the subject currently represents. Take note that in the years after 2016, however, there was a significant decrease in relevant publication frequency overall.

The sample yielded not a single review article, which is not surprising considering the newness of the research domain. Research articles predominated (22 articles, 59%), and conference proceedings were the minority (15 articles, 41%) (Figure 5).

Academic Relevance

To classify and analyze the articles according to their academic relevance, we adopted two axes of evaluation:

- Number of article citations since its publication; and
- Number of citations the authors received in the combined list of references compiled from every article in the portfolio (1485 references in total, from 37 articles).

Figure 6 contains a graph tracking both dimensions and featuring the articles that stood out after analysis. All 37 articles are represented in the graph. The lower left quadrant—articles by authors with less prominence— is where most articles are distributed (34 in total). Their citation numbers are low, and they have been written by authors rarely cited by authors of the other articles in the portfolio. They represent articles of lesser academic relevance. In the diametrically opposite quadrant are the two articles of greatest academic relevance, one by Helen Perks and her colleagues,[48] and the other by Claudio Dell'Era and Roberto Verganti.[49] These works are notable for their citation frequency within the article sample and for their authors' prominence. The upper left quadrant, intended to host the group of articles of comparatively greater academic relevance, contains no items. The lower right quadrant features the one article less frequently cited, but written by two prominent authors: Margaret Bruce and Barny Morris.[50]

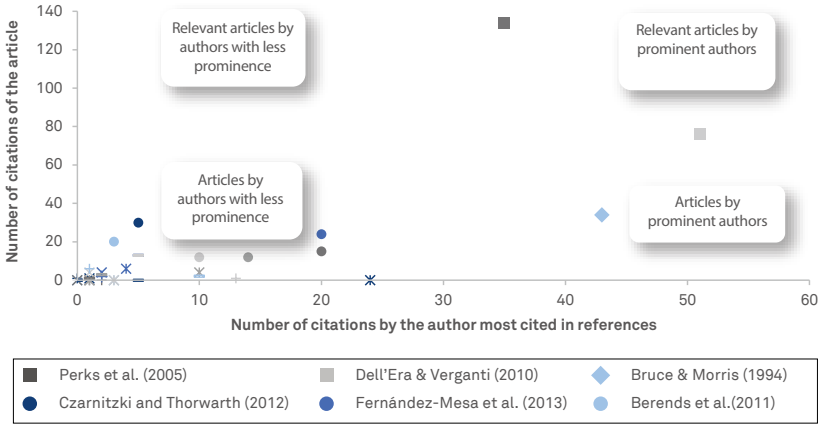

Figure 6
Distribution of articles by academic relevance. © 2021 by authors.

at https://www.lancaster.ac.uk/media/lancaster-university/content-assets/documents/fhm/dhr/chir/NSsynthesisguidanceVersion1-April2006.pdf.

40 Jorge Eduardo Tasca et al., "An Approach for Selecting a Theoretical Framework for the Evaluation of Training Programs," *Journal of European Industrial Training* 34, no. 7 (2010): 637, https://doi.org/10.1108/03090591011070761.

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41 Piccarozzi et al., "Industry 4.0," 4.

42 Shannon Scott-Findlay and Carole A. Estabrooks, "Mapping the Organizational Culture Research in Nursing: A Literature Review," *Journal of Advanced Nursing* 56, no. 5 (2006): 498–513, DOI: https://doi.org/10.1111/j.1365-2648.2006.04044.x.

43 Uwe Flick, *Introducing Research Methodology: A Beginner's Guide to Doing a Research Project* (London: SAGE Publications, 2011), 34.

44 Beall's List of Potentially Predatory Journals and Publishers (website), accessed April 29, 2021, https://beallslist.net/.

45 "State of the Art through Systematic Review (StArt)," LaPES: Laboratório de Pesquisa em Engenharia de Software, accessed April 28, 2021, http://lapes.dc.ufscar.br/tools/start_tool.

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46 Piccarozzi et al., "Industry 4.0," 5.

47 Borja de Mozota, *Design Management*.

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48 Perks et al., "Empirically Derived Taxonomy."

49 Dell'Era and Verganti, "Collaborative Strategies."

50 Bruce and Morris, "Managing External Design Professionals."

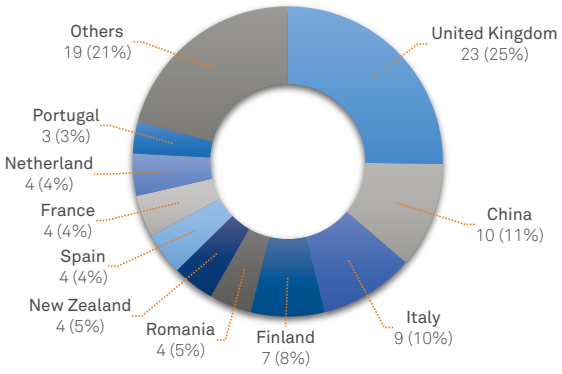

Figure 7
Number of authors (expressed as a percentage) by geographic origin. © 2021 by authors.

51 Borja de Mozota, *Design Management*.
52 Ibid.

Geographic Distribution of Authorship

We used the country of the author's institutional affiliation at the time of publication for this metric. Figure 7 illustrates the preponderance of authors from the United Kingdom.

This characteristic seems logical, since design management originated in Great Britain in the 1960s with the work of Michael Farr[51]—although at the time, the term referred to the management of the client/agency relationship. Brigitte Borja de Mozota[52] points out that it was also in Great Britain that a greater awareness of the critical role design could play in industry and the economy emerged thanks to a joint effort, led by Peter Gorb, between the Royal College of Art in London and the London Business School Department of Design Management.

Thematic Analysis of the Literature

An in-depth analysis of the 37 articles in the portfolio enabled us to classify each according to the topics addressed and ascertain their key contributions to the literature (Table 1).

Table 1 **Main topics divided by the number of articles in which they were found.**

#	Main Topics	Nº Papers	%	References
1	Design function organization	12	33%	(Abecassis-Moedas and Benghozi, 2012; Abecassis-Moedas and Pereira, 2016; Berends et al., 2011; Bruce and Morris, 1994; Capra and Bernardes, 2013; Czarnitzki and Thorwarth, 2012; Dell'Era and Verganti, 2010; Filippetti and D'Ippolito, 2017; Gulari and Fairburn, 2013; Hemonnet-Goujot, Manceau, and Abecassis-Moedas, 2019; Perks, Cooper, and Jones, 2005; Yao and Guo, 2009)
2	Design management integration	10	27%	(Chen, Liu, and, Qiao, 2009; Gerlitz, 2016a; Gerlitz, 2016b; Ellman et al., 2018; Gill, 2009; Kramoliš, 2016; Magistretti et al,. 2019; Na, Choi, and Harrison, 2017; Qian and Deserti, 2013; Wormald and Evans, 2009)
3	Design management capabilities	7	18%	(Acklin, 2013; Braga, 2017; Ceptureanu et al., 2016; Fernández-Mesa et al., 2013; Manzakoğlu, and Er 2018; Moultrie et al., 2001; Rojas and Roldán, 2016)
4	Tools and methods	5	14%	(Fukuda, 2016; Kokotovich and Killen, 2016; McBeth, Tennant, and Neailey, 2006; Li et al., 2012; Whybrew et al., 2001)
5	Managing design projects	3	8%	(Gašović and Salai, 2012; Kess et al., 2009; Roy and Potter, 1990)
	Total	37	100	

Design Function Organization

The first topic that emerged from this analysis was internal design function. Margaret Bruce and Barny Morris[53] classify the design function as purely internal design expertise, purely external design expertise (outsourced), and a mixture of both. Based on this taxonomy, the most significant contributions in this area sought to investigate the impacts, contributions, advantages, and challenges inherent in various industrial contexts, including design-centered industrial firms,[54] the luxury fragrance and cosmetics industry,[55] manufacturing,[56] fashion triads (manufacturer, designer, retailer),[57] and the footwear industry.[58]

Internal design expertise refers to existing design resources and capability inside the organization, located in a design department.[59] The strength of an internal approach to design management is that internal designers will be quite familiar with the company's modes of production, marketing campaigns, and culture.[60] Since they are intimately aware of the company's practices,[61] and physically located on site, they can readily address problems arising from the product development process. Likewise, an internal design team can more easily and strategically align their activities with other departments of the company.[62] This familiarity, ease, and proximity to the development process can lead to shorter delivery times and reduced development costs, and fosters improved product performance.[63] Internal design emerges as superior to external design when it comes to incremental innovation as well.[64] However, the main risk of relying on internal designers is the possibility that inertia,[65] complacency,[66] and stagnation[67] may set in, due to company politics, culture, market standards, or poor intra-organizational relations.[68] This automatically leads to less creative and less efficient design teams, lacking in innovative ideas, who tend to produce obsolete and uninspired work, or suffer other limitations to their innovation capability.[69]

External design expertise refers to design competency drawn from outside the company, who selects designers to carry out the design activities the company requires.[70]

Despite the popularity of this trend, Bruce and Morris[71] argue that organizational approaches to managing external design expertise are carried out on an ad hoc basis and are quite broad, as they depend on the client's previous experience and managers' personal preferences. Shanliang Yao and Qinghong Guo[72] classify external design expertise into five categories: design companies, agencies, or consultants; freelance designers; universities and research institutions; rivals; and companies upstream and downstream in the supply chain. The key factor in the relationship between client and design supplier is compatibility between the two parties. Bruce and Morris[73] outline three dimensions of compatibility: personal characteristics, expertise (needed/required), and collaborative approach. "Successful relationships," they state, "tend to be characterized by high levels of trust and respect, rapport and involvement, as opposed to relationships that have not worked, where lack of communication is the main factor of failure."[74]

According to our review, the main benefits to utilizing external design capability are its capacity to introduce new ideas, and high levels of innovation, renewal, and creativity. External designers are relatively autonomous,

53 Bruce and Morris, "Managing External Design Professionals."

54 Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure"; Dell'Era and Verganti, "Collaborative Strategies"; Andrea Filippetti and Beatrice D'Ippolito, "Appropriability of Design Innovation across Organisational Boundaries: Exploring Collaborative Relationships between Manufacturing Firms and Designers in Italy," *Industry and Innovation* 24, no. 6 (2017): 613–32, DOI: https://doi.org/10.1080/13662716.2016.1263888.

55 Aurélie Hemonnet-Goujot, Delphine Manceau, and Céline Abecassis-Moedas, "Drivers and Pathways of NPD Success in the Marketing-External Design Relationship," *Journal of Product Innovation Management* 36, no. 2 (2019): 196–223, DOI: https://doi.org/10.1111/jpim.12472.

56 Berends et al., "External Designers"; Bruce and Morris, "Managing External Design Professionals"; Dirk Czarnitzki and Susanne Thorwarth, "The Contribution of In-House and External Design Activities to Product Market Performance," *Journal of Product Innovation Management* 29, no. 5 (2012): 878–95, DOI: https://doi.org/10.1111/j.1540-5885.2012.00935.x.

57 Abecassis-Moedas and Benghozi, "Efficiency and Innovativeness."

58 Andréa Capra and Maurício Moreira e Silva Bernardes, "Investigation of Internal and External Design Teams during the Product Development Process in Footwear Companies," in *Proceedings of the 19th International Conference on Engineering Design (ICED13): Design for Harmonies*, vol. 3, ed. Udo Lindemann et al. (Glasgow, UK: The Design Society, 2013),1–10, available at https://www.designsociety.org/publication/34895/.

59 Bruce and Morris, "Managing External Design Professionals."

60 Czarnitzki and Thorwarth, "In-House and External Design."

61 Margaret Bruce and Rachel Cooper, *Marketing and Design Management* (London: Thomson Business Press, 1997).

62 Bruce and Morris, "Managing External Design Professionals"; Czarnitzki and Thorwarth, "In-House and External Design"; Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure"; Capra and Bernardes, "Investigation"; Abecassis-Moedas and Benghozi, "Efficiency and Innovativeness."

63 Abecassis-Moedas and Benghozi, "Efficiency and Innovativeness"; Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure."

64 Perks et al., "Empirically Derived Taxonomy."

65 Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure."

66 Bruce and Morris, "Managing External Design Professionals."

and therefore not affected or constrained by company policies and culture or institutional barriers that can restrict the creative process.[75] This is particularly relevant for radical product innovations where design is a key differentiating factor that requires a high degree of imagination and creativity.[76] In addition, external designers have complementary knowledge that enables companies to continually update their product development approaches and methods, complements internal design expertise, and enables the organization to create solutions that they could never achieve on their own.[77] According to Hans Berends and his colleagues,[78] product design processes evolve more iteratively when external designers are more involved, because small companies tend to restrict their vision and quickly converge on a solution. Designers contribute complementary, divergent capabilities that enable the organization to pursue multiple design directions and achieve more successful product designs. Finally, using external design expertise to propel the organization's first innovation project mitigates the risks associated with introducing novelty into company operations, facilitates design integration at a higher hierarchical level, creates more flexibility, favors design team coordination, and allows more control over project costs.[79] Collaboration with external designers is, however, also associated with a fear of information leakage and the increased risk of unintended spillover effects.[80] In addition, relying primarily on external design expertise may not automatically lead to greater competitive advantage, as competitors may be using similar external resources.[81] External designers can even slow down the design process, especially when a project moves from ideation to development, because they may not be familiar with the company's existing practices or their technological expertise.[82] This raises the question of how much information an external designer should receive.[83]

The benefits and risks of internal design expertise versus external design expertise have been widely researched and discussed in the literature. A case study of fashion triads (manufacturer, designer, retailer) by Celine Abecassis-Moedas and Pierre-Jean Benghozi[84] demonstrates that internal design affords greater efficiency (incremental innovation), while external design affords greater innovativeness (radical innovation). Similarly, Helen Perks and her colleagues[85] note that among UK manufacturing companies that develop radical new products, some make extensive use of external design resources, while others have hybrid design teams. Finally, Dirk Czarnitzki and Susanne Thorwarth[86] argue that external design is not superior to internal design.

When internal and external design expertise are blended together, the external designer is hired to provide additional resources to the internal design team and ensure that the project is completed on time, or to introduce novelty, or to provide specific knowledge.[87] Since there is no general consensus about whether internal or external design capability is the most efficient strategy for SMEs, companies often adopt a hybrid strategy.[88] Hybridization seems to overcome certain problems and enhance the positive aspects of each of the approaches mentioned above. It allows companies to diversify their knowledge and product portfolio[89] by combining innovation and efficiency,[90] and adds value to products,[91] both of which are particularly

67 Czarnitzki and Thorwarth, "In-House and External Design."
68 Bruce and Morris, "Managing External Design Professionals"; Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure."
69 Abecassis-Moedas and Benghozi, "Efficiency and Innovativeness"; Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure"; Bruce and Morris, "Managing External Design Professionals"; Czarnitzki and Thorwarth, "In-House and External Design."
70 Bruce and Morris, "Managing External Design Professionals."
71 Ibid.
72 Shanliang Yao and Qinghong Guo, "Study on the Enterprise Design Management of External Cooperation," in *Proceedings of the 2009 International Symposium on Computational Intelligence and Design (ISCID 2009)*, vol. 2, ed. Yongchwan Tang and Jonathan Lawry (New York: IEEE, 2009), 207–9, DOI: https://doi.org/10.1109/ISCID.2009.199.
73 Bruce and Morris, "Managing External Design Professionals."
74 Ibid., 596.
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75 Abecassis-Moedas and Benghozi, "Efficiency and Innovativeness"; Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure"; Czarnitzki and Thorwarth, "In-House and External Design"; Bruce and Morris, "Managing External Design Professionals"; Dell'Era and Verganti, "Collaborative Strategies."
76 Abecassis-Moedas and Benghozi, "Efficiency and Innovativeness"; Czarnitzki and Thorwarth, "In-House and External Design."
77 Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure"; Dell'Era and Verganti, "Collaborative Strategies."
78 Berends et al., "External Designers."
79 Capra and Bernardes, "Investigation."
80 Bruce and Morris, "Managing External Design Professionals"; Czarnitzki and Thorwarth, "In-House and External Design"; Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure."
81 Czarnitzki and Thorwarth, "In-House and External Design."
82 Bruce and Morris, "Managing External Design Professionals"; Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure."
83 Bruce and Morris, "Managing External Design Professionals," 587.
84 Abecassis-Moedas and Benghozi, "Efficiency and Innovativeness."
85 Perks, Cooper, and Jones, "Empirically Derived Taxonomy."
86 Czarnitzki and Thorwarth, "In-House and External Design."

relevant to design centered industries. Celine Abecassis-Moedas and Joana Pereira[92] note that design centered industries with internal design teams often hire external designers to enhance brand and product reputation by association, introduce a different perspective of the product/innovation landscape inside the organization, or provide their staff with exposure to other approaches. However, the integration of internal and external professionals must be carefully managed to guarantee that they are really working together. "The tension between fear of giving away commercially sensitive information and the need to build an open and trusting relationship is particularly acute," according to Bruce and Morris.[93] Coordination problems with internal designers and other departments can occur, particularly if external design professionals are responsible for the innovative component of the design process, and the internal team is responsible for integrating the new design or performing less attractive design activities. In addition, the organization may suffer from "not invented here" syndrome—the credibility gap that sometimes appears when a designed product is very different from the company's vision.[94]

Design Management Integration

Most of the articles related to integrating design management are dedicated to investigating the attitudes, benefits, and challenges inherent in its implementation, from a more upstream view at the intersection of design and strategy (strategic design management) to a more downstream view related to project management and design processes (operational design management).[95] One article refers to SMEs for which industry 4.0 represents a challenge, proposing design management as the central domain of intelligent and sustainable companies.[96] Through her case study with project-based SMEs, Laima Gerlitz[97] demonstrates that innovation is essential to a company's competitiveness and growth, and that innovations are, in turn, driven by design. An organization driven by an incremental design process is able to generate and exploit its capacity to develop innovative products, services, and processes. Her study also reveals that, surprisingly, innovation does not only evolve in line with R&D, but also as the result of intelligent combinations of resources, activities, and capabilities from the technological, commercial, and design functions. Jea Na and his colleagues[98] developed a framework that presents the influences of design on innovation. The framework defines three levels of intervention (strategic, functional, and operational). It establishes which design practitioner/decision maker is likely to be directly responsible at each level, how much decision making influence they may have, the functions and contexts potentially affected by these decisions, and the underlying competencies required for good decision making. This framework provides organizations with a tool to understand, evaluate, and prioritize areas for improvement to increase their capacity for innovation.

Design Management Capabilities

Design management is defined as a high-order construct[99] composed of five first-order factors[100] (basic skills, specialized skills, collaboration, organizational change, and innovation skills) that are all of equal importance

87 Bruce and Morris, "Managing External Design Professionals."
88 Ibid.; Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure."
89 Dell'Era and Verganti, "Collaborative Strategies."
90 Abecassis-Moedas and Benghozi, "Efficiency and Innovativeness."
91 Capra and Bernardes, "Investigation."
92 Abecassis-Moedas and Pereira, "Reputation, Perspective, and Exposure."
93 Bruce and Morris, "Managing External Design Professionals," 587.
94 Czarnitzki and Thorwarth, "In-House and External Design."
95 Laima Gerlitz, "Integrating Design Management Concept in Entrepreneurial Practices: Evidence from the Cross-Border Project," in *9th International Scientific Conference: Business and Management 2016* (Vilnius: Vilnius Gediminas Technical University, 2016), 1–10, DOI: https://doi.org/10.3846/bm.2016.07; Xiaobo Qian and Alessandro Deserti, "Matching the Innovation of Products with Organizational Change: Introducing Design Knowledge into Chinese Furniture Manufacturing Companies," in *2013 IEEE Tsinghua International Design Management Symposium*, ed. Jun Cai et al. (New York: IEEE, 2013), 303–11, DOI: https://doi.org/10.1109/TIDMS.2013.6981251; Asko Ellman et al., "Re-use Of Engineering Design Rationale in Finnish SME Project Based Industry," in *DS '92: Proceedings of the DESIGN 2018 15th International Design Conference*, ed. Dorian Marjanović et al. (Glasgow, UK: The Design Society, 2018), 1825–32, DOI: https://doi.org/10.21278/idc.2018.0363; Jan Kramoliš, "The Attitude of Czech Companies towards Design—Comparative Study of 2012 and 2014," *Marketing and Management of Innovations*, no. 2 (2016): 11–21, available at http://mmi.fem.sumdu.edu.ua/en/journals/2016/2/11-21; Wormald and Evans, "Integration of Industrial Design."
96 Laima Gerlitz, "Design Management as a Domain of Smart and Sustainable Enterprise: Business Modelling for Innovation and Smart Growth in Industry 4.0," *Entrepreneurship and Sustainability Issues* 3, no. 3 (2016): 244–68, DOI: https://doi.org/10.9770/jesi.2016.3.3(3).
97 Gerlitz, "Integrating Design Management."
98 Jea Hoo Na, Youngok Choi, and David Harrison, "The Design Innovation Spectrum: An Overview of Design Influences on Innovation for Manufacturing Companies," *International Journal of Design* 11, no. 2 (2017): 13–24, http://www.ijdesign.org/index.php/IJDesign/article/view/2637/776.

when providing the skills and conducting the activities traditionally associated with design. Anabel Fernández-Mesa and her colleagues,[101] Claudia Acklin,[102] and Bilgen Manzakoğlu and Özlem Er[103] argue that since each factor imparts a certain degree of competence reconfiguration, they all act as dynamic capabilities. Dynamic capability is understood as the company's ability to integrate and reconfigure its internal and external resources to handle environmental changes.[104] Dynamic capabilities enable "organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die."[105] According to Renato dos Santos and his colleagues,[106] design management as a dynamic capability is based on three previously aquired design foundations: learning, skills, and coordination. Design learning entails acquiring knowledge and practices and spreading them throughout the organization. Design skills represent a collection of techniques and knowledge that generate creativity and innovation. Design coordination is the ability to coordinate activities and practices required for good design. Only one of the articles investigates design management as a dynamic capability from the point of view of design coordination.[107] The remaining articles investigate dynamism from the point of view of design learning, suggesting that as the creation of knowledge arises from learning, then organizational learning capability is a precursor to its design management capability. Some of these articles focus, for example, on developing frameworks and models to describe and measure the process of knowledge absorption and improve design management skills.[108] For example, Acklin[109] proposes a design management absorption model to measure the integration of design knowledge in SMEs with little or no prior design experience. The model is based on the absorptive capacity construct created by Shaker Zahra and Gerard George,[110] which distinguishes between potential capacity, the ability to acquire and assimilate knowledge, and realized capacity, the ability to transform and explore new knowledge. Whereas potential capacity makes a company predisposed to learning, realized capacity allows the company to take advantage of potential capacity. Acklin[111] also divides design management capabilities between strategic and operational. Strategic design management capabilities are linked to potential capacity, while operational capabilities are linked to realized capacity. According to the author, this distinction reveals how the design management absorption model relates to SMEs that are powerfully controlled by owners playing the role of gatekeeper, determining whether design knowledge is useful or not. Other articles propose design management as a dynamic capability that plays a mediating role between organizational learning capability and product innovation performance.[112] Anabel Fernández-Mesa and her colleagues'[113] study of Italian and Spanish SMEs from the tile industry clearly states, for example, that "organizational learning capability enhances product innovation through the mediation of design management capability." Similar results were found by Sebastian Ceptureanu and his colleagues[114] in the context of Romanian clothing industry SMEs.

Tools and Methods

In terms of tools and methods, one article[115] pointed out that when

99 Fernández-Mesa et al., "Design Management Capability," 550.

100 Peter Dickson et al., "Managing Design in Small High-Growth Companies," *Journal of Product Innovation Management* 12, no. 5 (1995): 406–14, DOI: https://doi.org/10.1016/0737-6782(95)00056-9. –

101 Fernández-Mesa et al., "Design Management Capability."

102 Acklin, "Absorption Model."

103 Manzakoğlu and Er, "Design Management Capability Framework."

104 David J. Teece, Gary Pisano, and Amy Shuen, "Dynamic Capabilities and Strategic Management," *Strategic Management Journal* 18, no. 7 (1997): 509–33, DOI: https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z; Fernández-Mesa et al., "Design Management Capability"; Renato dos Santos et al., "Design Management as Dynamic Capabilities: A Historiographical Analysis," *European Business Review* 30, no. 6 (2018): 707–19, DOI: https://doi.org/10.1108/EBR-11-2016-0147.

105 Kathleen M. Eisenhardt and Jeffrey A. Martin, "Dynamic Capabilities: What Are They?," *Strategic Management Journal* 21, no. 10-11 (2000): 1107, DOI: https://doi.org/10.1002/1097-0266(200010/11)21:10/11<1105::AID-SMJ133>3.0.CO;2-E.

106 Santos et al., "Dynamic Capabilities: A Historiographical Analysis," 107.

107 James Moultrie et al., "Better by Design — Development of a Framework to Guide Design Improvement in SMEs," in *Design Applications in Industry and Education*, ed. S. Culley et al. (Bury St. Edmonds, UK: Professional Engineering Publishing Limited, 2001), 3–10, available at https://www.wiley.com/en-gb/Design+Applications+in+Industry+and+Education-p-9781860583575.

108 Acklin, "Absorption Model"; Mariana Fonseca Braga, "The Choice of Design. From Businesses' Conditions to Businesses' Attitudes," *The Design Journal* 20, no. sup1 (2017): S635–46, DOI: https://doi.org/10.1080/14606925.2017.1353011; Manzakoğlu and Er, "Design Management Capability Framework."

109 Acklin, "Absorption Model."

110 Shaker A. Zahra and Gerard George, "Absorptive Capacity: A Review, Reconceptualization, and Extension," *The Academy of Management Review* 27, no. 2 (2002): 185–203, DOI: https://doi.org/10.2307/4134351.

111 Acklin, "Absorption Model."

112 Miguel David Rojas López and Felipe Zapata Roldán, "Capacidades de Innovación para la Gestión del Diseño en PYME

de Empaques Plásticos Flexibles," *Revista de Ingeniería*, no. 41 (2014): 15–21, DOI: https://doi.org/10.16924/riua.v0i41.455.

113 Fernández-Mesa et al., "Design Management Capability," abstract, 547.

114 Sebastian Ion Ceptureanu et al., "Capabilities of SMEs in the Romanian Clothing Industry/Capabilitatile IMM-urilor din industria de îmbrâcaminte din România," *Industria Textila* 67, no. 4 (2016): 265–69, available at http://www.revistaindustriatextila.ro/images/2016/Textila_nr_4_2016.pdf#page=47.

115 Vasilije Kokotovich and Catherine P. Killen, "Enhancing Design Project Review Board Effectiveness through a Visual Collaborative Approach," in *Cooperative Design, Visualization, and Engineering: CDVE 2016 Lecture Notes in Computer Science*, vol. 9929, ed. Yuhua Luo (Cham: Springer, 2016), 118–25, DOI: https://doi.org/10.1007/978-3-319-46771-9_16.

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116 Ibid.

117 Shuichi Fukuda, "Diverse Scope Coordination in Design Management," in *PLM 2016: Product Lifecycle Management for Digital Transformation of Industries, IFIP Advances in Information and Communication Technology*, vol 492, ed. Ramy Harik et al. (Cham: Springer International, 2016), 559–66, DOI: https://doi.org/10.1007/978-3-319-54660-5_50.

118 Christine McBeth, Charles Tennant, and Kevin Neailey, "Developing Products in the Global Environment Using Digital Technology — A Case Study," in *2006 IEEE International Technology Management Conference* (New York: IEEE, 2006), DOI: https://doi.org/10.1109/ICE.2006.7477098.

119 Bo Li et al., "Research on FMEA in the Special Vehicle Enterprises Design Management," in *Future Computer, Communication, Control, and Automation: Advances in Intelligent and Soft Computing*, vol. 119, ed. Tianbiao Zhang (Berlin: Springer Verlag, 2012), 437–47, DOI: https://doi.org/10.1007/978-3-642-25538-0_62; K. Whybrew et al., "Use of Design Tools and Methodologies for Rapid Product Development in the New Zealand Manufacturing Industry," in *Design Applications in Industry and Education*, ed. S. Culley et al. (Bury St. Edmonds, UK: Professional Engineering Publishing, 2001), 27–34, available at https://www.wiley.com/en-gb/Design+Applications+in+Industry+and+Education-p-9781860583575.

120 Pekka Kess et al., "Learning about Design and Development: The Roles of Industrial Design and Concurrent Engineering," *International Journal of Innovation and Learning* 6, no. 6 (2009): 659–71, DOI: https://doi.org/10.1504/IJIL.2009.026650; Roy and Potter, "Managing Design Projects."

analyzing several project proposals at a time, decisions need to be made simultaneously at the macro level, with a strategic perspective encompassing the entire project portfolio, and at the micro level, in detail. However, for decision makers it can be extremely difficult to absorb the amount of market, financial, technical, aesthetic, ergonomic, and other information needed for global project analysis. Vasilije Kokotovich and Catherine Killen[116] explore the synergies between research and practices in the field of project portfolio management and the disciplines of design innovation and design management. They propose a new, collaborative, visual tool to help SME project decision makers consider an extensive range of factors (economic, psychological, legal, institutional/political, human/social, technological, and environmental). The model ties together network-based, non-hierarchical relationships that enable users to capture the complexity of a given decision making context. Shuichi Fukuda[117] also seeks to structure design decision-making but at the operational level. He focuses on how to structure design scope coordination in a way that facilitates negotiations among diverse project team members, so that everyone might converge on a commonly shared goal, and achieve a fruitful collaboration. Project management, to Fukuda, includes considering the work scope (how to run the project) and the product scope (which product to produce). And although there is meticulous discussion about performance in each area, there is no discussion about how to structure this performance. Today's rapid diversification, customization, and complexity in product engineering means that creating solutions and solving problems is not possible without the involvement of several specialists from different areas. And, hence, mitigating differences and reaching a final goal acceptable to all involved becomes paramount. To this end, the author proposes the Lazy Evaluation method, an approach from the field of artificial intelligence, useful for decision making and negotiation between members of the project teams. Still in the operational domain, the remaining articles focus on collaborative tools to allow projects to be shared and reviewed remotely,[118] or to otherwise assist design project realization.[119]

Managing Design Projects

Lastly, the articles on managing design projects address the initial design project process by exploring, on the one hand, the problems at the root of project failure[120] and on the other, by explaining key activities and methods and how they can and should be carried out.[121] The earliest decisions associated with preliminary design activities are related to the initiation of a design project, which requires effective methods for sourcing, briefing, and evaluation.[122]

Design sourcing means the decision to use internal or external design expertise, or a mix of both. A complete assessment must be made, including the benefits and risks of each approach, the company's resources, and the skills needed for the project. If the choice is to use external design expertise, the question of references, recommendations, and how to find the right partner(s) is one of the great challenges. Buying design skills requires some skill itself.[123] The company must also be prudent with regard to its relationship

with design professionals. A good practice is to appoint a manager to oversee this relationship and ensure that the proposed design solutions are properly integrated into the company's strategic vision and trajectory.[124] We co-authors[125] have been leading research institutions and industrial innovation and research projects for over 20 years. In our experience, effective management and integration of the company and the external consultancy, and establishing a strong, trusting relationship between the two, is the most central factor determining a project's success or failure.

A comprehensive and clearly-written design brief is a prerequisite for any successful design project, and one of the main components of successful design management. Robin Roy and Stephen Potter[126] find that inadequate briefing is one of the problems strongly associated with project failure (19% incidence). It is the company's responsibility to prepare the design brief[127] used as a reference by the project team. In successful companies, the brief tends to be written by a group of people representing different key areas, and not by an individual. It includes not only cost and performance requirements, but also details related to the target market, users, competitors, production restrictions/limitations, and so on. Another relevant factor is the importance of discussing, analyzing, and agreeing on the brief in concert with the design professionals/project team.[128] "The brief is viewed as evolutionary until a product specification is mutually agreed by the team."[129]

There is no specific way to elaborate and write a design brief, nor are there any rules that govern the content of design briefs. Milan Gašović and Suzana Salai[130] suggest that the design brief should contain the following

- A **project goal**, specifying performance benchmarks such as reducing costs, improving reputation, or increasing sales. It defines and summarizes the role of design and the proposed impact the project will have on the business.
- **Company information**, outlining the organization's history, size, competitive positioning, business strategy, global product and service configurations, and so on.
- **Project information** defining the project's development stages, such as analysis, design, production, cost estimation, and duration. Design information includes conceptual, technical, and market data, estimated time to complete each step of the design process, and more.

Any design project must establish a list of appropriate evaluation criteria and a process to apply these criteria.[131] It is good practice to communicate the evaluation process and criteria to everyone involved in the project.[132] Design process oversight and evaluation can occur in different ways at different levels within an organization.[133] At the strategic level (top management), for example, design performance can be evaluated against design strategy. At the tactical level (functional management), design can be evaluated against the plans, to assess whether the objectives defined for the process and the products were achieved. Finally, at the operational level (design function), evaluation becomes more specific, relating to assessment of a concept in relation to the design brief, use in the market, design effectiveness, and so on.[134] According to Gašović and Salai,[135] in addition to a project's management and

121 Suzana Salai and Milan Gašović, "Managing Initial Design Projects," in *International Symposium on Machine and Industrial Design in Mechanical Engineering (KOD 2012)*, ed. Siniša Kuzmanović (Balatonfüred: University of Novi Sad, 2012), 85–90, available at http://www.kod.ftn.uns.ac.rs/images/proceedings/kod2012.pdf.

122 Bruce et al., "Effective Design Management"; Bruce and Morris, "Managing External Design Professionals"; Salai and Gašović, "Managing Initial Design Projects."

123 Bruce et al., "Effective Design Management."
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124 Salai and Gašović, "Managing Initial Design Projects."

125 F. Jorge Lino and A. Barata da Rocha, "A Successful Model of Cooperation Between a Public University and Industrial Companies Through a Hybrid Public/Private R&D Institute," in *Proceedings of the ASME 2010 10th Biennial Conference on Engineering Systems Design and Analysis*, Volume 2 (New York: ASME, 2010), 831–40, DOI: https://doi.org/10.1115/ESDA2010-24883; A. Barata da Rocha and F. Jorge Lino Alves, "A Relação Universidade-Indústria: Um Caso de Transferência Da Tecnologia Em Engenharia Mecânica e Gestão Industrial," in *Proceedings CLME '2008 - 5º Congresso Luso-Moçambicano de Engenharia, IICEM - 2º Congresso de Engenharia de Moçambique*, ed. J. F. Silva Gomes et al. (Porto: Edições INEGI Pesquisar, 2008), 943–44, available at https://repositorio-aberto.up.pt/handle/10216/69534.

126 Roy and Potter, "Managing Design Projects."

127 Salai and Gašović, "Managing Initial Design Projects."

128 Roy and Potter, "Managing Design Projects."

129 Bruce and Morris, "Managing External Design Professionals," 591.

130 Salai and Gašović, "Managing Initial Design Projects."

131 Cooper and Press, *The Design Agenda*.

132 Ibid.; Salai and Gašović, "Managing Initial Design Projects."

133 Cooper and Press, *The Design Agenda*.

134 Bruce et al., "Effective Design Management"; Cooper and Press, *The Design Agenda*.

135 Salai and Gašović, "Managing Initial Design Projects."

evaluation instruments, observing the principles that guide project control and management are also important. They include feedback, proper control of the organizational structure in the project team, self-control, and direct control. Feedback is related to the implementation and initiation of controls based on input from the project team. Project organizational control means achieving consistency with the company hierarchy, and managing specialists, ranges of activities, and so forth. The principle of self-control implies that each individual consciously controls the results they achieve. Compliance with this principle means ongoing communication to the responsible manager about personal results. Direct control is direct managerial access to project team results at the various stages of the design process.

Implications for Research and Practice

At the heart of the SME product development process are complex sets of design management parameters and dependencies that require careful consideration (Figure 8). Each of the five aspects of design management comes with a set of relevant subtopics directly or indirectly related to each other. Their connections become even more intricate once we consider the sub-connections that also occur between the subtopics of different aspects—all of which combines to create a complex web of interdependencies. For example, in the "Managing Design Projects" group, the "Project Design" subtopic is sub-connected to the "Design Coordination" and "Design Skills" subtopics of the "Design Management Capabilities" group (marked with a dotted yellow line). To exemplify this complexity, and render it visible, we have chosen to depict potential connections and sub-connections among

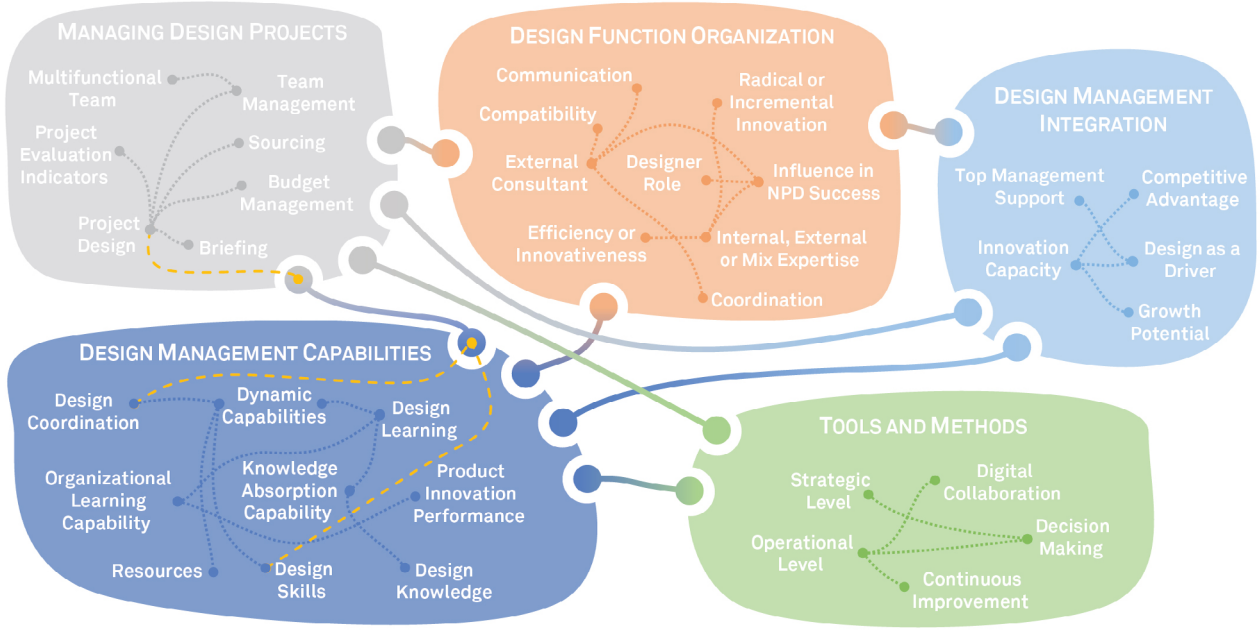

Figure 8
Map of the main topics and parameters for design management during the product development process in the context of SMEs.

136 Perks et al., "Empirically Derived Taxonomy."
137 Dell'Era and Verganti, "Collaborative Strategies."

subtopics using a single, continuous, graded line between groups. Many more sub-connections exist, attesting to the complexity inherent in the relationships among all these aspects of design management.

Involving external expertise places the design function beyond the company's remit, which may have severe consequences on product development management. How to structure and discern this complex web of connections, sub-connections, and parameters during the formulation of a systematic methodological approach to design management inside SMEs emerges (from the present research) as a relevant line of investigation with considerable practical implications.

Conclusions

Given the increasing academic interest in design management, our objective was to survey and characterize the international scientific literature on design management inside SMEs. From a theoretical standpoint, this article provides several contributions.

First, using a well-structured and replicable methodology, we present a procedure for selecting highly relevant articles for systematic review. Our method and approach to design management literature analysis proved appropriate and original. Other literature reviews can be updated and extended under the same methodological matrix, and further research should be carried out to cover all accessible sources of literature on design management in the context of SMEs. This is relevant since we are aware that the three databases chosen do not cover all accessible sources of literature on design management in the context of SMEs. There are influential design management journals that are not indexed by these three databases — for example, *Design Management Review*.

The bibliometric analysis revealed that design management of the SME product development process is a research domain in its infancy, with multiple research opportunities and gaps. The works of Helen Perks, Rachel Cooper, and Cassie Jones,[136] and Claudio Dell'Era and Roberto Verganti[137] are of significant academic relevance.

Design function organization, design management integration, and design management capability (at the strategic and functional level) were core topics, whereas managing design projects (operational level) received little attention. This distribution may be related to the fact that the character of design management is still under debate, including whether it has a design or management perspective. This leads to different definitions of design management, and different visions of its execution. These visions may originate upstream, at the intersection of design and strategic management (strategic design management), and downstream, where project management and design process come together (operational design management). The parameters of design management involved in the SME product development process are complex, as are the connections between them. Creating a structured, sequential, and organic methodology to visualize this complexity has several relevant practical implications. Our future research objective is to do precisely this.

Although much of the literature in this systematic literature review emerged over the last 20–30 years, there has been a great deal of early work in this area published independently as reports or monographs because there were relatively few journals or conference outlets for this topic. Furthermore, some of our findings rely on papers that are now quite old, which suggests an opportunity to challenge some of these earlier findings.

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There are no conflicts of interest involved in this article.

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Appendix A: Keywords for Database Search

Appendix A1 **Research axes — keywords and synonyms**

Research Axes	Keywords and Synonyms
Design Management	Design Management;
SMEs	Small and medium-sized enterprises; Small and medium-sized firms; SME; SMEs; SME's;
External Design	External Design; External Designer; External Designers;
Product Development	New Product Development; NPD; Product Development; Product Design;

Appendix A2 Keyword Combinations and Strings for Database Search

#	Research Axis Combinations	Search Strings
1	Design Management + SME's + External Design + Product Development	TITLE-ABS-KEY ("Design Management") AND ("Small and medium-sized enterprises" OR "Small and medium-sized firms" OR SME OR SMEs OR SME's) AND ("External Design" OR "External Designers" OR "External Designer") AND ("New Product Development" OR NPD OR "Product Development" OR "Product Design")
2	Design Management + SME's + External Design	TITLE-ABS-KEY ("Design Management") AND ("Small and medium-sized enterprises" OR "Small and medium-sized firms" OR SME OR SMEs OR SME's) AND ("External Design" OR "External Designers" OR "External Designer")
3	Design Management + SME's + Product Development	TITLE-ABS-KEY ("Design Management") AND ("Small and medium-sized enterprises" OR "Small and medium-sized firms" OR SME OR SMEs OR SME's) AND ("New Product Development" OR NPD OR "Product Development" OR "Product Design")
4	Design Management + External Design + Product Development	TITLE-ABS-KEY ("Design Management") AND ("External Design" OR "External Designers" OR "External Designer") AND ("New Product Development" OR NPD OR "Product Development" OR "Product Design")
5	SME's + External Design + Product Development	TITLE-ABS-KEY ("Small and medium-sized enterprises" OR "Small and medium-sized firms" OR SME OR SMEs OR SME's) AND ("External Design" OR "External Designers" OR "External Designer") AND ("New Product Development" OR NPD OR "Product Development" OR "Product Design")
6	Design Management + SME's	TITLE-ABS-KEY ("Design Management") AND ("Small and medium-sized enterprises" OR "Small and medium-sized firms" OR SME OR SMEs OR SME's)
7	Design Management + External Design	TITLE-ABS-KEY ("Design Management") AND ("External Design" OR "External Designers" OR "External Designer")
8	SME's + External Design	TITLE-ABS-KEY ("Small and medium-sized enterprises" OR "Small and medium-sized firms" OR SME OR SMEs OR SME's) AND ("External Design" OR "External Designers" OR "External Designer")
9	External Design + Product Development	TITLE-ABS-KEY ("External Design" OR "External Designers" OR "External Designer") AND ("New Product Development" OR NPD OR "Product Development" OR "Product Design")

Note: The term "TITLE-ABS-KEY" indicates a search on the title, abstract, and keywords of the article.

Appendix B: Number of Papers Obtained for Each Research Axis Combination per Database

#	Research Axes Combinations	Databases		
		Scopus	Web of Science	Science Direct
1	Design Management + SME's + External Design + Product Development	0	0	0
2	Design Management + SME's + External Design	0	0	0
3	Design Management + SME's + Product Development	8	5	1
4	Design Management + External Design + Product Development	4	5	1
5	SME's + External Design + Product Development	2	1	0
6	Design Management + SME's	20	20	1
7	Design Management + External Design	6	7	1
8	SME's + External Design	3	3	0
9	External Design + Product Development	22	20	5
	Total	65	61	9