

CHAPTER 8

DESIGN WITHOUT DATA? A STUDY OF METHODOLOGICAL TRANSPARENCY IN CONTEMPORARY DESIGN SCIENCE

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ABSTRACT

This study investigated the methodological landscape of contemporary design science by analyzing 7,511 articles published across 10 leading journals in the field. The objective of this study was twofold: first, to ascertain the prevalence of qualitative, quantitative, and other forms of inquiry, and second, to reflect on the implications of methodological choices within design scholarship. The utilization of OpenAlex for the collection of metadata and ChatGPT-4o for the classification of abstracts based on

method-related keywords enabled the study to categorize articles as quantitative, qualitative, mixed methods, or inconclusive. The findings indicated that a mere 5.8% of the articles employed quantitative methods, while 14.28% utilized qualitative methods. Notably, 77.78% of the articles exhibited an absence of clear methodological signals, indicating a deficiency in methodological transparency. The application of topic modeling to inconclusive works revealed a preponderance of research that was conceptual, practice-based, or speculative in nature. These findings lent further credence to ongoing discourse regarding the dearth of methodological transparency and the underutilization of empirical strategies in design. The study's conclusion asserted that enhancing methodological articulation and establishing shared standards fortified the credibility and interdisciplinary recognition of design as a scientific field.

KEYWORDS: design research, research methods, bibliometrics, qualitative research, data-driven design, methodological transparency

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1 INTRODUCTION

The production of scientific knowledge encompasses a broad spectrum of epistemological approaches, which are generally categorized based on the nature of their research methods. In general, methodologies are commonly divided into three categories: quantitative, qualitative, or mixed methods (Creswell & Creswell, 2018). Quantitative research is commonly linked to positivist

frameworks, which prioritize systematic methodologies, numerical data, and the attainment of objective, generalizable results. Conversely, qualitative research aligns with interpretivist traditions, emphasizing unstructured or semi-structured approaches, textual or visual data, and context-dependent interpretation. However, these distinctions can obscure the complex interdependencies between approaches, which, in practice, often overlap or are combined depending on disciplinary norms and research goals (Pilcher & Cortazzi, 2024). Contrary to the notion of these approaches representing diametrically opposed paradigms, they frequently operate in a complementary loop, reinforcing and enriching each other (Greene et al., 1989). Quantitative research frequently identifies general patterns or statistical regularities across extensive datasets, thereby offering a comprehensive understanding of phenomena and directing researchers toward domains that necessitate further investigation. Conversely, qualitative research has been demonstrated to excel at exploring the nuances of specific cases, uncovering contextual factors, subjective meanings, or anomalies that may remain invisible in aggregated data. Insights derived from qualitative inquiry frequently inform the formulation of novel hypotheses or the identification of variables to be tested quantitatively, thereby contributing to the continuous refinement of the research process (Tenny et al., 2025). As Pilcher and Cortazzi (2024) emphasize, this interdependence reflects the blurring of epistemological boundaries and underscores how real-world research often defies binary divisions (Figure 1).

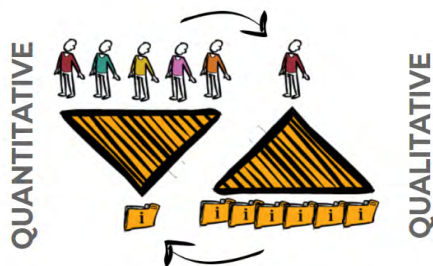


Figure 1. Complementary loop of quantitative and qualitative research. **Note.** Teixeira and Velasco (2024).

This dynamic relationship is particularly evident in fields such as design research, education, and human-computer interaction (HCI), where quantitative studies often measure performance indicators or behavioral patterns, while qualitative methods provide deeper insight into user experience and context (Van Turnhout et al., 2014). In the domain of design research, metrics such as user satisfaction or task efficiency across prototypes have been shown to reveal usability issues (Pinto et al., 2025). These issues often necessitate further study through methods such as interviews or observational techniques, which aim to enhance the comprehension of user responses (Weichbroth, 2019). In the field of education, standardized assessments have been shown to reveal disparities in learning outcomes across large populations. These disparities can be further elucidated through the use of classroom ethnographies, which offer a socio-emotional and cultural perspective on the underlying causes of these disparities (Mejeh et al., 2023). In the field of HCI, the utilization of analytics and A/B testing has emerged as a pivotal method for identifying interface issues. However, it is imperative to recognize the complementarity of think-aloud protocols and contextual inquiries, which unveil the underlying user behaviors and motivations. Across these domains, the interplay between data and interpretation—between breadth and depth—illustrates the evolving integration of research methods. A comprehensive study by Thelwall and Nevill (2021) found that qualitative research methods gained substantial prominence across academic disciplines between 1996 and 2019, signaling a shift toward broader acceptance of interpretive approaches. Notwithstanding the advent of big data and statistical modeling, qualitative methodologies—namely interviews, case studies, and ethnographies—have not only endured but have undergone an expansion in their scope. This tendency was particularly evident in the “social sciences” and “arts & humanities” fields, where qualitative inquiry has gained significant recognition and is actively promoted by journal editors, reviewers, and educators. Despite its continued status as a minority approach within certain scientific disciplines, qualitative research has firmly established itself as a mainstream component of academic scholarship.

Concomitantly, this growing acceptance has redirected attention to concerns regarding research quality and methodological rigor. In contradistinction to quantitative studies, which are

founded on standardized procedures and statistical verification, qualitative approaches are more difficult to reproduce, audit, or validate independently due to their interpretive and contextual nature (Cole et al., 2024; Harris et al., 2019). This inherent challenge in replication poses significant difficulties for the processes of peer review and academic assessment, particularly in instances where methodological procedures are either underreported or inconsistently applied. As Thelwall and Nevill (2021) observe, although qualitative methods—particularly interviews—are becoming more prevalent, their citation impact has diminished in numerous disciplines, potentially indicative of concerns regarding their reliability or scholarly value. To address these issues, journals have begun to adopt structured reporting frameworks, such as the COREQ checklist for interview and focus group studies (Tong et al., 2007), which promote greater transparency, rigor, and coherence in qualitative research practices. In light of these broader developments, it is imperative to investigate whether analogous dynamics are evident in the domain of design research. As a field historically grounded in creative practice, interpretive inquiry, and user-centered exploration, design shares many characteristics with disciplines that have embraced qualitative methodologies (Cross, 2001). However, despite the existence of anecdotal evidence and editorial preferences that appear to indicate a prevailing inclination toward qualitative approaches, there is a conspicuous absence of systematic data that would allow for the confirmation of this perception. If qualitative methods are indeed predominant, then design research may also be vulnerable to the same challenges related to transparency, reproducibility, and evaluative rigor. This concern is further compounded by the existence of adjacent modes of inquiry, such as speculative and critical design (SCD), which function beyond the confines of traditional empirical frameworks. These approaches are often grounded in critical theory and artistic practice, emphasizing conceptual provocation over data collection. This further complicates methodological classification and peer evaluation.

This study is an extension of this premise. It examines over 7,000 articles published in 10 prominent design science journals, and the objective is to determine whether the perceived preference for qualitative research is supported by empirical evidence. The objective of this study is to address the following research question: To what extent does the extant literature on design

science demonstrate a preference for qualitative methods over quantitative ones, and how consistent is this pattern across different journals? By mapping the methodological tendencies in contemporary design research, the study contributes to a clearer understanding of the field's knowledge production practices and highlights opportunities for increased methodological balance and transparency.

2 THEORY

2.1 *Research methodologies: Quantitative, qualitative, mixed, and alternative approaches*

Academic research is commonly structured around three methodological paradigms: quantitative, qualitative, and mixed methods. Quantitative research is rooted in positivist or post-positivist traditions, emphasizing measurement, numerical analysis, and statistical inference to test hypotheses or identify patterns across populations (Babbie, 2016; Creswell & Creswell, 2018). Conversely, qualitative research is predicated on interpretivist or constructivist worldviews, with the objective being to comprehend meanings, behaviors, and experiences through in-depth, context-sensitive approaches such as interviews, observations, and document analysis (Denzin & Lincoln, 2011). Mixed methods research intentionally integrates both paradigms, leveraging the strengths of each to provide a more comprehensive understanding of a research problem (Creswell & Clark, 2018). While these categories are often presented as distinct, in practice, they frequently overlap, reflecting the complexity of real-world inquiry and the increasing recognition of methodological pluralism. In addition to these empirical approaches, some research—particularly in fields such as design, philosophy, and the arts—adopts nonempirical or practice-based formats. These include theoretical or conceptual studies, which aim to develop or critique ideas rather than collect data, and practice-based research, in which creative activity itself becomes a method of inquiry and a source of knowledge (Barrett & Bolt, 2010; Frayling, 1993). Despite their deviation from conventional empirical paradigms, speculative

design, design fiction, and other reflective or critical approaches also play important roles in knowledge production. These inquiries contribute meaningfully to academic discourse by expanding the epistemological boundaries of research.

A considerable number of scholars posit that theoretical, conceptual, and practice-based studies fall within the ambit of qualitative research. However, there is a counterargument positing that theoretical, conceptual, and practice-based research should be regarded as distinct modes of inquiry rather than as subcategories of qualitative research. While these approaches may be considered similar in terms of their interpretive orientation and their lack of reliance on numerical data, they differ in the assumptions they operate under and the types of knowledge they produce. For instance, practice-based research is frequently founded on the process of creative production and the generation of insights through the act of making, as opposed to observation or interaction with participants. As Biggs and Büchler (2007) emphasize, this form of inquiry is epistemologically unique and should not be assessed by the same criteria applied to traditional qualitative or quantitative studies. It is imperative to approach all nonnumerical research as qualitative risks. This approach entails a comprehensive examination of the fundamental differences in research logic and goals, which are often oversimplified in other frameworks. A fundamental distinction can be identified in the absence of empirical data collection or participant involvement, which are hallmarks of most qualitative methodologies. Qualitative research, on the other hand, typically involves the use of interviews, ethnography, or document analysis to understand social phenomena. In contrast, theoretical and conceptual inquiries rely on argumentation, synthesis, or critique without gathering first-hand data. Conversely, practice-based research may entail self-reflection, autoethnography, or artifact generation, without the involvement of external subjects or replicable datasets. As posited by Biggs and Büchler (2007), practice-based research “encompasses a creative output as an integral component of the research process,” thereby situating it beyond the empirical framework of both qualitative and quantitative paradigms.

The epistemological foundations of these approaches further substantiate their distinctiveness. Qualitative research is generally situated within interpretivist paradigms, which seek

to understand meaning from the perspective of human actors. Conversely, theoretical research frequently draws from rationalist or critical traditions, utilizing logic, conceptual analysis, and dialectics as primary methodologies. Practice-based research, as articulated by Borgdorff (2012), is predicated on constructivist and artistic epistemologies, wherein knowledge is interwoven with and manifests through praxis. This diversity of foundations underscores the methodological heterogeneity of nonquantitative inquiry and highlights the limitations of treating them as interchangeable under a single qualitative label. Despite these differences, it is evident that theoretical, conceptual, and practice-based research do not align with quantitative paradigms, which are rooted in measurement, hypothesis testing, and statistical inference. Consequently, while they are distinct from both quantitative and traditional qualitative research, they may nevertheless be subject to similar challenges that confront qualitative methods. These include concerns about reproducibility, transparency, and methodological rigor—particularly when studies lack formal frameworks or clear documentation of procedures. The recognition of these common challenges underscores the necessity for customized evaluation standards that acknowledge the distinct contributions and limitations of each research modality. To better illustrate this discussion, Table 1 is presented to clarify the differences and similarities of the discussed methods.

Table 1. Differences and similarities in methodological characteristics. **Note.** Prepared by authors.

Feature	Quantitative research	Qualitative research	Theoretical/conceptual research	Practice-based research
Data collection	Yes (structured and numerical)	Yes (textual, visual, and contextual)	No	Sometimes (via reflection or logs)

Feature	Quantitative research	Qualitative research	Theoretical/conceptual research	Practice-based research
Human participants	Yes (e.g., surveys and experiments)	Yes (e.g., interviews and observations)	Rare	Rare
Nature of data	Numerical	Textual, visual, and verbal	Argument-based	Creative work + reflective text
Main output	Statistical findings	Thematic or narrative findings	Theories, frameworks, and critiques	Artifacts + reflection/insight
Epistemological roots	Positivism/post-positivism	Interpretivism	Rationalism and constructivism	Constructivism, aesthetics, and critical
Evaluation criteria	Validity, reliability, and replicability	Credibility, transferability, and trustworthiness	Coherence, logic, and originality	Reflexivity and process transparency

2.2 Limited use of data-driven approaches in design research

Despite the growing emphasis on methodological rigor across disciplines, design research continues to demonstrate a relative scarcity of data-reliant studies, particularly those grounded in quantitative or systematically collected empirical evidence. A significant proportion of the field’s scholarly output may persist in being anchored in interpretive, conceptual, or practice-based methodologies. This could be indicative of a predilection for exploration, reflection, and the construction of meaning, as opposed to the testing of hypotheses or the generalization of statistical findings. While this orientation reflects the creative and user-centered foundations of design, it also limits the adoption of methodologies that enable broader pattern identification, replicability,

and comparability across studies (Escudero-Mancebo et al., 2023). One illustrative example of this tendency is sCD. Introduced by Dunne and Raby (2013), sCD repositions design as a discursive practice aimed at questioning prevailing technological and cultural assumptions rather than solving practical problems. This approach emerged as a response to the instrumentalism characteristic of mainstream design practice, proposing instead that design should serve as a tool for reflection, critique, and cultural commentary. The methods employed by this group are primarily conceptual in nature. Designers create fictional scenarios or artifacts with the intention of provoking debate, raising ethical concerns, or reframing societal issues. Consequently, sCD functions beyond the confines of conventional empirical frameworks, eschewing formal data collection and seldom engaging directly with users or environments (Johannessen et al., 2019).

While sCD has expanded the epistemological boundaries of design by legitimizing critique, provocation, and conceptual exploration, its ambiguous methodological status also exposes a broader vulnerability within the field. Design research frequently functions in the absence of a definitive consensus regarding evidentiary standards or methodological rigor, a phenomenon that is particularly evident in studies that do not draw upon empirical data. The multifaceted nature of this phenomenon bestows researchers with methodological flexibility. However, this flexibility can also result in a lack of orientation and observed “lack of rigor,” an issue that has been noted in empirical design studies (Toh et al., 2014). Consequently, projects that eschew formal data collection, whether speculative, conceptual, or artistic, may encounter challenges in communicating their contributions in ways that are auditable, reproducible, or broadly comparable (Timperley et al., 2021). This ambiguity complicates peer review, editorial evaluation, and scholarly dialogue, especially in interdisciplinary settings where expectations around transparency, validity, and impact are shaped by more established research paradigms. Concurrently, design is undergoing a substantial transformation as it increasingly interfaces with technological domains such as UX, CX, service design, and digital product development. Although interaction data are more accessible than ever, they remain underutilized in many traditional design workflows due to methodological misalignment and integration barriers. As Quiñones-Gómez et al. (2025) observe, the integration of

data-driven insights into established design paradigms remains a complex and under-explored area, underscoring the necessity for coherent frameworks that facilitate the integration of data and design. These domains underscore interaction data, behavioral patterns, and performance metrics (Pinto et al., 2025), components that inherently favor data-driven inquiry. As the availability of data increases through digital platforms (Hilbert & López, 2011), there is an increasing expectation for designers and researchers to adopt empirical methods capable of capturing and interpreting this information meaningfully. In light of these arguments, the subsequent section will examine this emerging tension by analyzing the opportunities and responsibilities that accompany data availability in design research and practice.

2.3 *Design in a data-producing society*

The proliferation of digital technologies and interconnected systems has led to an era where data are constantly generated, captured, and stored, thereby transforming the very fabric of modern life (Hilbert & López, 2011). This transition toward a society that produces data offers novel opportunities for understanding user behavior, system performance, and social dynamics—opportunities that remain largely unexplored in conventional design research. As Oppermann and Munzner (2020) suggest, “data-first design studies” reverse the standard model by allowing real-world data to drive design insights and decisions, rather than starting with design questions or assumptions. Design, particularly in its digital and service-oriented manifestations, has become profoundly intertwined with data ecosystems (Velasco et al., 2025). As products evolve into platforms and services transition to digital channels, designers now have access to near real-time, granular, and scalable feedback. Interaction logs, performance metrics, and analytics tools are increasingly being used to guide design decisions. According to Quiñones-Gómez et al. (2025), “data-driven design is a methodology that relies on quantitative and qualitative data to inform and shape design decisions in digital product development,” thereby highlighting this emergent shift in practice. This may encompass a wide range of data, including clickstream data, A/B test results, heatmaps, telemetry, and usage logs. Each of these data sources offers

valuable insights into how users interact with designed systems. These data sources serve to complement qualitative methods and provide evidence that can validate design decisions, reveal usage patterns, and identify opportunities for improvement that may elude purely interpretive approaches. For instance, Ebel et al. (2023) demonstrate how automotive interface telemetry, when visualized and analyzed, can directly inform UX design and drive iterative product refinement.

Notwithstanding this potential, the systematic use of data in design research and practice may remain limited. A considerable number of design projects continue to prioritize experiential and conceptual outputs, while neglecting to consider the potential of behavioral data to inform or evaluate outcomes. Walny et al. (2020) describe how, in data visualization design, even when data are central, design focus often remains on artifact presentation and encoding decisions rather than on structured, behavioral data analysis. The observed discrepancy is indicative of not only epistemological traditions but also a dearth of methodological frameworks and a paucity of literacy in data-driven techniques among design professionals. As design increasingly intersects with areas such as UX, CX, and digital product development—domains where analytics and experimentation are routine—the need for data fluency becomes more relevant (Ebel et al., 2023). This evolving context necessitates a reexamination of the methods by which evidence is defined, gathered, and interpreted in design. As design becomes increasingly intertwined with data-rich environments, it is imperative to understand the methodological foundations of the field. Prior to advocating for greater integration of data-reliant or quantitative approaches, it is imperative to investigate the current state of research practices within the discipline. To provide a foundation for this reflection, the prevalence of methodological paradigms must be mapped, including those of a qualitative, quantitative, or nonempirical nature. By first identifying how design research is currently conducted, the field can meaningfully engage with questions of methodological rigor, evidentiary standards, and the role of data in shaping design knowledge. In this context, the integration of quantitative and computational methods into design represents more than a mere technical evolution; it is, in essence, a contextual response to the epistemic and societal conditions that are characteristic of the digital age.

3 METHODOLOGY

This study employs a data-driven approach to map the methodological orientation of contemporary design research. The investigation commenced with the selection of 10 prominent, active journals in the field of design science. These journals were chosen for their relevance and academic impact, as indicated by metrics such as CiteScore, scimago Journal Rank (SJR), and impact factor, as presented in Table 2. A comprehensive dataset was compiled on May 30, 2025, using the OpenAlex database as a source. This dataset contains metadata from all articles published in the aforementioned journals, resulting in a total sample of 7,511 works. Subsequently, the abstracts of each article were analyzed using ChatGPT-4o to ascertain the presence of keywords indicative of either qualitative or quantitative research methodologies. Articles that lacked sufficient information for classification were labeled as inconclusive, with the understanding that they may represent theoretical, conceptual, or practice-based studies.

Table 2. Sources, relevance, and impact. **Note.** Prepared by authors.

Journal	Year first published	Scope description	CiteScore	SJR	Impact factor
<i>Design Studies</i>	1979	It focuses on developing an understanding of design processes across various domains, including engineering, product design, architectural and urban design, and systems design.	6.7	1.231	3.2

Journal	Year first published	Scope description	CiteScore	SJR	Impact factor
<i>The Design Journal</i>	1998	It covers all aspects of design, providing a forum for design scholars, professionals, educators, and managers worldwide.	1.4	398	0.8
<i>Journal of Design History</i>	1988	It embraces the history of a range of design-related subjects, from furniture to product design, graphic design, craft, fashion, textiles, architectural interiors, and exhibitions.	0.8	166	0.3
<i>International Journal of Design</i>	2007	A peer-reviewed, open-access journal devoted to publishing research papers in all fields of design, including industrial design, visual communication design, interface design, and more.	4.5	876	1.6

Journal	Year first published	Scope description	CiteScore	SJR	Impact factor
<i>Design Issues</i>	1984	The first American academic journal to examine design history, theory, and criticism, provoking inquiry into cultural and intellectual issues surrounding design.	1.3	0.24	0.4
<i>Journal of Engineering Design</i>	1990	It provides a forum for the publication of high-quality, peer-reviewed papers on engineering design, covering design theory, methodology, and practice.	5.2	603	2.5
<i>CoDesign</i>	2005	It focuses on collaborative and participatory design processes across a range of disciplines, including design, arts, and social sciences.	6.1	1.085	2.0

Journal	Year first published	Scope description	CiteScore	SJR	Impact factor
<i>Design and Culture</i>	2009	It explores the cultural significance of design and its impact on society, combining perspectives from design studies, cultural studies, and related fields.	1.8	278	0.7
<i>Design Science</i>	2015	It publishes interdisciplinary research on all aspects of design science, including theory, methodology, and practical applications in engineering, architecture, computing, and other design fields.	5.7	662	2.82
<i>International Journal of Design Creativity and Innovation</i>	2013	It explores creativity and innovation in design, emphasizing multidisciplinary and interdisciplinary approaches to creative processes.	3.1	452	1.2

3.1 Data collection

The dataset examined in this study was retrieved from OpenAlex and comprised metadata for 7,511 academic publications in the field of design science. After the removal of records lacking an abstract from the dataset, a total of 2,052 documents were obtained, constituting the working corpus. The “abstract” field was selected as the primary source for analysis, under the assumption that it would contain methodological information relevant to classifying the research approach adopted in each paper. Four abstracts were excluded from topic modeling due to malformed or corrupted content that failed to yield any usable features for analysis.

3.2 Data analysis

To identify the methodological approach employed by each paper (“quantitative,” “qualitative,” or “inconclusive”), a rule-based classification method was applied to the text of the abstracts. The employment of regular expression pattern matching was instrumental in the identification of keywords commonly associated with quantitative or qualitative research methodologies. In the event that an abstract contained indicators from both categories, it was labeled “both.” In the event that no such findings were present, the result was designated as “inconclusive.” This approach was selected to facilitate rapid, large-scale screening without the need for manual annotation, a process that was further expedited by the implementation of artificial intelligence (AI).

- **Keywords used to identify quantitative methods:** Survey, regression, statistical analysis, quantitative, experiment, data set, dataset, quantitatively, questionnaire, correlation, ANOVA, t-test, descriptive statistics, and sample size.
- **Keywords used to identify qualitative methods:** interview, focus group, ethnography, case study, qualitative, observation, thematic analysis, content analysis, narrative, grounded theory, field notes, and participant observation.

To further understand the content of the abstracts labeled as “inconclusive” (n = 1,596), topic modeling was applied with AI assistance using non-negative matrix factorization (NMF). The abstracts were initially converted into a term-document matrix utilizing TF-IDF vectorization, with the top 1,000 terms identified as the most informative, and stop words in English removed. The NMF algorithm was implemented with five components, which corresponded to five latent topics. The abstracts were then assigned to a topic based on the component with the highest weight. The top 10 keywords per topic were extracted to support the interpretation and labeling of topics. This analysis successfully described the majority of the inconclusive sample.

4 RESULTS

This section presents the findings derived from the classification and analysis of 2,052 articles published in 10 leading design science journals. The initial classification revealed that only a small fraction of works employed quantitative (5.8%) or qualitative (14.28%) methods, while the majority (77.78%) could not be confidently categorized (Table 3).

Table 3. Work classification. **Note.** Prepared by authors.

Classification	Frequency (%)
Quantitative	5.8
Qualitative	14.28
Mixed	2.14
Inconclusive	77.78

To further examine the nature of these inconclusive works, topic modeling was applied to their abstracts, uncovering five dominant thematic clusters that illustrate the methodological diversity—and ambiguity—within contemporary design research. The

results are structured in two parts: (1) the frequency and distribution of methodological classifications, and (2) a qualitative interpretation of themes emerging from the inconclusive subset (Table 4).

Table 4. Inconclusive sample analysis. **Note.** Prepared by authors.

Topic	Frequency (%)	Top terms in topic	Summary
Design research and methodology	26.25%	Design, re-search, practice, process, knowledge, thinking, education, paper, framework, methods	These papers discuss design as a research discipline, often referencing conceptual or pedagogical frameworks without specifying methods.
Conference/event meta-data	6.52%	2019, scissors, pp, dundee, running, 13th, bleacher, valentine, cruickshank	This topic includes event references, likely representing metadata from conference proceedings rather than substantive content.
Web/indexing artifacts	5.83%	Search, doi, icon, author, university, org, https, issues, institute, site	These records are probably noise—scraped metadata, broken abstracts, or entries containing only web or reference boilerplate.
Product design and engineering	24.12%	Product, products, development, method, process, engineering, based, model, use, user	These abstracts discuss technical aspects of product or system design, possibly in engineering contexts, but without mentioning how the research was conducted.

Topic	Frequency (%)	Top terms in topic	Summary
Digital and social innovation	37.03%	Social, new, people, paper, cultural, innovation, digital, public, service, objects	This theme focuses on digital transformation, cultural change, or public service innovation, often theoretical or reflective in tone.
Topic not identified	0.25%	N/A	No topic could be identified in these papers.

Table 3 presents a summary of the distribution of methodological classifications across the sample. A total of 119 articles (5.8%) were identified as quantitative, while 293 articles (14.28%) were classified as qualitative. The majority of articles (1,596, or 77.78%) were classified as inconclusive, indicating an absence of clear references to methodological frameworks typically associated with empirical studies. This distribution indicates that, while empirical research is present in design science, it is not yet the predominant approach. The preponderance of inconclusive articles lends credence to the notion that a significant portion of the field's research remains anchored in interpretive, conceptual, or practice-based methodologies, which do not depend on explicit methodological indicators discernible through keyword analysis. In light of the inconclusive findings from Table 4, it is evident that the predominant cluster pertains to the domain of design education, with a particular emphasis on pedagogical methodologies, the attainment of learning outcomes, and the development of curricula. These subjects frequently prioritize the cultivation of reflective and experiential knowledge over formal empirical validation. The second most prominent theme involves sustainability and social innovation, areas that are often explored through speculative or value-driven approaches that defy easy classification. Other clusters include design theory and methodology, user-centered processes, and emerging technologies. These other clusters may involve conceptual work or practice-based inquiry without explicit methodological articulation. Conference/event metadata and web/indexing artifacts were identified as likely

noise and deemed irrelevant for the purposes of this research, as they do not contribute to the methodological orientation or thematic content of the articles. Furthermore, four papers in the dataset could not be reliably assigned to any thematic cluster, suggesting insufficient or ambiguous abstract content for topic modeling.

5 DISCUSSION

The findings presented in this study offer a comprehensive overview of the methodological landscape in contemporary design science literature. Of the 2,052 articles that were subjected to analysis, a negligible proportion were classified as quantitative (5.8%) or qualitative (14.28%), with a minimal number employing mixed methods (2.14%). Most notably, the majority (77.78%) were classified as “inconclusive,” exhibiting a lack of clear methodological markers traditionally associated with empirical studies. This finding resonates with persistent concerns articulated within the domain of design theory, particularly concerning the epistemological foundations of the field and the frequently ambiguous nature of its knowledge production practices (Cross, 2001). This methodological opacity appears to confirm the dominance of interpretive, conceptual, or practice-based traditions within design research—traditions that frequently resist classification using empirical criteria. As Pilcher and Cortazzi (2024) contend, design scholarship functions at the nexus of numerous epistemological paradigms, where the distinctions between empirical, speculative, and artistic modes of inquiry are permeable. However, the limited availability of empirical transparency presents significant challenges, particularly in light of the mounting calls for methodological rigor and auditability across various disciplines (Cole et al., 2024; Harris et al., 2019). The observed discrepancy between qualitative and quantitative studies within the identifiable subset—where qualitative works appear almost three times more common—further reinforces the perception that design scholarship tends to privilege interpretive over generalizable analysis. This phenomenon, however, does not inherently pose any significant challenges. In fact, it can be viewed as a reflection of the historical emphasis that design has placed on user-centered, contextual, and reflexive knowledge creation.

However, as Van Turnhout et al. (2014) observe, this orientation may inadequately prepare the field for engagement with evidence standards and evaluative frameworks that are increasingly dominant in adjacent domains, such as HCI and service design.

The application of topic modeling to the 1,596 inconclusive articles provides further insights. The largest cluster, “digital and social innovation” (37.03%), corresponds to domains that are typically associated with reflective, ethical, and societal concerns. These works generally address emergent challenges using speculative, conceptual, or value-driven perspectives, consistent with the principles of sCD (Dunne & Raby, 2013). While such contributions are valuable, they may not meet traditional academic standards of evidence and reproducibility. The second most prevalent category, “design research and methodology” (26.25%), encompasses works that delve into the foundational principles, conceptual frameworks, and pedagogical dimensions of design as a discipline. These papers frequently engage with abstract or philosophical discussions about design thinking and research practice, but they do so without specifying data sources or procedural details. This further reinforces the prevalence of conceptual or exploratory work in the field. The third cluster, “product design and engineering” (24.12%), demonstrates engagement with technical systems and user-centered tools, yet exhibits minimal methodological transparency. This phenomenon may be indicative of a practice-based reporting style, which prioritizes the presentation of evidence over the exposition of underlying principles. Alternatively, it could be attributed to the influence of engineering disciplines, where methodological descriptions are implicit but not explicitly articulated.

6 CONCLUSION

This study reveals that design science embraces a diverse array of knowledge-making strategies, many of which diverge from conventional empirical norms. As design increasingly interfaces with data-rich domains such as UX, CX, and digital product development, this lack of methodological articulation may hinder its ability to communicate contributions effectively within broader scientific discourses. Furthermore, the dearth of shared evidentiary standards jeopardizes the marginalization of entire

subfields—such as speculative or conceptual design—whose value is arduous to assess using conventional academic metrics. The findings indicate that a considerable proportion of design research either evades or exhibits an absence of the methodological transparency that is generally anticipated in other disciplines. While reflective, speculative, and conceptual approaches are integral to the field, their growing prevalence underscores the need for more precise criteria to distinguish between modes of inquiry and evaluate their scholarly merit. In the absence of a more precise methodological articulation, there is a risk that design research may be misclassified, misunderstood, or undervalued, particularly in fields where empirical grounding is widely regarded as the gold standard of credibility. This methodological opacity is indicative of a discipline that is deeply rooted in exploration, practice, and reflection—forms of inquiry that resist facile classification and rarely conform to the reproducibility and auditability standards of the natural and social sciences. As design becomes increasingly intertwined with technology, reliance on systematic evaluation and data fluency grows. Consequently, the credibility and relevance of design will be contingent on the development of stronger methodological clarity and accountability. In this context, this study serves as a preliminary step toward elucidating the methodological composition of design research. By mapping the distribution of empirical and nonempirical approaches, the study contributes to ongoing efforts to rethink what constitutes valid evidence in design—and how diverse modes of inquiry can be recognized, validated, and integrated into a more inclusive and methodologically reflective research culture.

Notwithstanding its contributions, this study is not without limitations. First, the classification system was dependent on automated keyword analysis in abstracts. While this method is scalable and efficient, it has the potential to overlook methodological nuances or frameworks that are discussed exclusively in full texts. Second, although topic modeling offers insight into the inconclusive subset, it remains an interpretive tool, subject to subjective interpretation. Third, the keyword sets utilized may not fully encompass the range of terms associated with qualitative or quantitative research, potentially leading to underrepresentation. Furthermore, the expansion of the dataset to encompass a more extensive array of works and a wider spectrum of publication types would enhance the generalizability of the findings. A

further structural limitation is evident in the strategy employed for journal selection. In the absence of a formal taxonomy of design science, the focus on 10 prominent journals—though methodologically justifiable—may introduce epistemological bias. These publications may include a disproportionate representation of particular subfields or methodological preferences, thereby constricting the breadth of the analysis. This may reveal a more extensive issue: the field could benefit from the development of a widely accepted taxonomy that defines its epistemic boundaries, paradigms, and methodological standards. The implementation of such a framework has the potential to enhance clarity, facilitate comparative research, and establish comprehensive evaluation criteria across the discipline. In essence, the mapping of methodological tendencies presented herein establishes a foundational framework for subsequent investigations into the epistemological dynamics of design research. Subsequent studies could build on this work by refining classification methods (e.g., through manual coding or supervised machine learning), increasing the scope of analysis, and exploring correlations between method and research impact. It is imperative to enhance methodological transparency and cultivate a unified lexicon of inquiry to ensure the advancement of the rigor, relevance, and recognition of design as a scientific discipline.

Conflict of interest

The authors declare that there are no conflicts of interest.

Contribution statement

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Statement of data consent

The datasets generated during the development of this study have been deposited in Google Drive and are accessible at:

<https://drive.google.com/drive/folders/1On8ZsrT8uVDzOC1xqMEB-cqjHh1o1UoU?usp=sharing>.

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