A General Bibliometric and Conceptual Structure Approach to Global Trends on Artificial Intelligence in Visual Communication and Design Using Scopus Data

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ABSTRACT

This study maps the intellectual and conceptual structure of research on artificial intelligence (AI) in visual communication and design using a structured bibliometric approach. A Scopus CSV export dated 21 May 2026 yielded 2,406 English-language journal articles published between 1999 and 2026. The search strategy required the co-presence of AI-related and visual communication/design-related terms within title, abstract, or keyword fields, thereby embedding topical relevance in the retrieval logic. The dataset comprises 830 sources, 7,136 authors, and 478,085 cited references, with an estimated annual growth rate of 19.82% for the complete-growth window ending in 2025. Performance analysis indicates a sharp acceleration after 2019, with publication peaks in 2024 and 2025, while 2026 is treated as a partial year. Science mapping identifies an interdisciplinary field spanning sustainability, human-computer interaction, design studies, education, geoinformation, communication, and applied computing. Conceptual analysis indicates four broad knowledge streams: generative AI and human-AI creativity support; machine learning and computer-vision applications; visual communication/design education; and domain-specific applications in heritage, cities, health, and sustainability. These structures are interpreted as bibliometric associations rather than causal relationships. The study contributes a reproducible map of the field, clarifies its theoretical fragmentation, and proposes a future research agenda centred on human-AI co-creation, visual meaning, cultural context, ethical governance, and theory-driven evaluation.

Keywords: Artificial intelligence; generative AI; visual communication; graphic design; bibliometric analysis; Scopus; conceptual structure

INTRODUCTION

Artificial intelligence has rapidly become a transformative force in visual communication, graphic design, and communication design. Earlier computational design studies primarily associated AI with pattern recognition, image classification, automation, prediction, and decision support. The diffusion of generative AI, text-to-image systems, multimodal models, and creativity-support tools has shifted attention towards human-AI co-creation, design cognition, authorship, workflow integration, and visual meaning-making. This shift is theoretically important because visual communication is not merely the technical production of images. Images organise attention, construct representational relations, establish modality and salience, and communicate culturally situated meanings (Kress & van Leeuwen, 2021). Accordingly, evaluating AI-generated visual outputs requires consideration of not only technical performance but also communicative intention, audience interpretation, cultural context, and human judgement.

The expansion of AI-related design research is visible in the Scopus corpus analysed in this study. The dataset covers publications from 1999 to 2026 and shows marked acceleration after 2019, coinciding with wider adoption of machine learning, computer vision, generative adversarial networks, transformer-based systems, and generative AI tools. The literature is distributed across sustainability, human-computer interaction (HCI), geoinformation, education, computer science, design studies, communication, and the humanities and social sciences. This breadth demonstrates the interdisciplinary character of AI-related visual research, but it also

produces conceptual dispersion: technical studies often foreground model performance, whereas communication and design scholarship is more concerned with meaning, creativity, user experience, ethics, professional judgement, and cultural interpretation. A critical visual perspective therefore remains necessary because visual materials are produced, circulated, and interpreted within specific technological and social contexts (Rose, 2022).A bibliometric approach is useful for clarifying this fragmented landscape. Bibliometric analysis enables researchers to identify influential sources, productive authors, country-level contributions, citation structures, and conceptual clusters through systematic performance analysis and science mapping (Aria & Cuccurullo, 2017; Donthu et al., 2021). Co-word and thematic techniques are particularly valuable in a fast-moving field where technical vocabularies such as machine learning, neural networks, transformers, and image generation intersect with design-centred concepts such as creativity, visual communication, communication design, user experience, and human-AI collaboration. However, bibliometric proximity should not be treated as causal or theoretical proof. It indicates patterns of association and intellectual organisation that require interpretation against substantive theory and domain scholarship.

This study therefore aims to map global research trends on AI in visual communication and design using a Scopus bibliometric dataset. Specifically, it seeks to: (i) describe the publication trajectory of the field; (ii) identify the most relevant sources, authors, countries, affiliations, and globally cited documents; and (iii) uncover the conceptual structure of the literature through keyword co-occurrence and thematic interpretation. Beyond descriptive mapping, the study connects the identified structures with visual communication theory, human-centred AI, design cognition, and human-AI co-creativity. Its contribution lies in providing a transparent and reproducible overview of the field while distinguishing bibliometric evidence from theoretically informed interpretation and translating observed gaps into specific future research questions and practical interventions.

LITERATURE REVIEW

Artificial Intelligence and Visual Communication

Visual communication is concerned with how visual forms organise information, influence interpretation, and support social meaning. Social-semiotic approaches emphasise that visual composition, salience, framing, modality, and representational choices shape how viewers understand images (Kress & van Leeuwen, 2021), while critical visual methodology foregrounds the contexts, institutions, technologies, and power relations through which images are produced and interpreted (Rose, 2022). AI expands this field by enabling automated image recognition, image generation, layout recommendation, style transfer, visual analytics, and multimodal content analysis. Earlier applications were predominantly technical, focusing on segmentation, recognition accuracy, and feature extraction. More recent research increasingly treats AI as a participant in ideation, concept development, and creative decision-making. This development matters because design quality cannot be reduced to computational accuracy; it also involves semiotic coherence, contextual appropriateness, audience interpretation, cultural sensitivity, and ethical responsibility.

Generative AI, Creativity Support Tools and Design Practice

Generative AI has intensified scholarly attention to creativity-support tools and human-AI co-creation. Text-to-image models can accelerate visual exploration, generate alternatives, and reduce the initial 'blank-page' barrier. At the same time, they introduce risks involving AI literacy, prompt dependency, bias, copyright, homogenisation, professional identity, and displacement of expertise. Recent design scholarship therefore increasingly conceptualises generative AI as an augmentation infrastructure rather than an autonomous substitute for designers. Herath et al. (2026), for example, derive design principles for text-to-image creativity-support tools that emphasise workflow integration and augmentation of human skill, while Fang et al. (2025) conceptualise generative AI-enhanced conceptual design as a collaborative process requiring explicit attention to design stages, interaction modes, and human-AI roles. Empirical work similarly suggests that AI can support problem definition and idea generation while selection and evaluation remain strongly human-led (Chen et al., 2025).

Graphic Design, Communication Design and Human Judgement

Graphic design and communication design depend on culturally situated judgement. Even when AI systems generate technically impressive images, designers remain responsible for interpreting briefs, selecting alternatives, editing outputs, evaluating cultural fit, and aligning visual form with communication objectives. This position is consistent with human-centred AI, which argues that high levels of automation need not eliminate human control, responsibility, and agency (Shneiderman, 2022). Recent experimental evidence also indicates that designers with different levels of experience may benefit from AI in different ways: novice designers may gain support in idea generation, while experienced designers use AI more selectively for refinement and quality enhancement (Wang et al., 2025). The theoretical issue is therefore not whether AI 'replaces' design cognition, but how agency and evaluative judgement are distributed across human-AI workflows.

Bibliometric Approaches to AI-Design Research

Bibliometric analysis has become an established method for mapping fast-growing research domains. Performance analysis identifies publication growth, influential sources, authors, institutions, and countries, while science mapping examines relationships among concepts through co-word analysis, co-citation, collaboration networks, and thematic structures (Cobo et al., 2011; van Eck & Waltman, 2010; Zupic & Cater, 2015). For AI in visual communication and design, bibliometric mapping is particularly appropriate because the field crosses computer science, design, communication, education, arts, sustainability, and HCI. Nevertheless, a bibliometric cluster is not equivalent to a coherent theory. The present study therefore treats clusters as relational structures in the literature and interprets them through established perspectives on visual meaning, human-centred AI, creativity support, and design cognition.

Interpretive Theoretical Framework

Four complementary theoretical lenses guide interpretation of the bibliometric structures. First, social-semiotic visual communication theory treats images as systems of meaning rather than neutral outputs; this directs attention to representation, composition, modality, and audience interpretation (Kress & van Leeuwen, 2021). Second, critical visual methodology emphasises the production, circulation, viewing, and institutional contexts of visual materials (Rose, 2022). Third, human-centred AI foregrounds human control, reliability, responsibility, and the design of systems that amplify rather than displace human capability (Shneiderman, 2022). Fourth, contemporary human-AI co-creative design research conceptualises generative AI as a stage-sensitive collaborator whose contribution differs across problem definition, ideation, selection, evaluation, and refinement (Fang et al., 2025; Chen et al., 2025; Wang et al., 2025). These lenses are not tested as causal models in this bibliometric study. Instead, they provide theoretically defensible interpretive anchors for understanding why particular keyword clusters may matter for visual communication and design research.

METHOD

This study adopts a structured bibliometric analysis consisting of five primary phases: (1) study design, (2) data collection, (3) rule-based relevance control, (4) bibliometric analysis, and (5) knowledge discovery. The procedure follows the logic of performance analysis and science mapping recommended for reproducible bibliometric research (Donthu et al., 2021). Particular attention was given to separating database-defined eligibility from post-hoc subjective judgement so that the corpus-construction process could be replicated from the reported query.

Study Design and Data Collection

The dataset was obtained from Scopus and exported as a CSV file on 21 May 2026. Scopus was selected because the research problem spans communication, design, computer science, HCI, education, geoinformation, sustainability, and applied computing; a multidisciplinary bibliographic database was therefore required. The study maps the internationally indexed scholarly core of this field rather than claiming exhaustive coverage of all professional, local-language, or grey literature. The search used title, abstract, and

keyword fields and combined two concept blocks: an AI block and a visual communication/design block. The complete Scopus query was:

TITLE-ABS-KEY (("artificial intelligence" OR "generative AI" OR "generative artificial intelligence" OR "machine learning") AND ("visual communication" OR "graphic design" OR "communication design" OR "visual design")) AND PUBYEAR < 2027 AND (LIMIT-TO(DOCTYPE, "ar")) AND (LIMIT-TO(LANGUAGE, "English")) AND (LIMIT-TO(SRCTYPE, "j"))

The query architecture required at least one AI-related term and at least one visual communication/design-related term to co-occur in the searchable metadata. This Boolean intersection served as the primary topical eligibility mechanism. The publication-year, document-type, language, and source-type filters further restricted the corpus to English-language journal articles published up to the date of extraction. The unit of analysis was the individual article record, including title, authors, source title, publication year, cited-by count, abstract, keywords, affiliations, references, DOI, document type, and source information.

Data Screening and Relevance Control

The Scopus export contained 2,406 records. All records were classified by Scopus as journal articles and satisfied the Boolean intersection specified above. No post-retrieval record was deleted solely on the basis of subjective topical judgement. This decision should not be interpreted as an absence of screening; rather, screening was primarily rule-based and embedded ex ante in the database query. Requiring the simultaneous presence of AI-related and visual communication/design-related terminology reduces the likelihood that records entered the corpus only because of generic AI terminology. Retaining records that met the predefined query also avoids introducing undocumented researcher discretion into the final corpus. At the same time, the authors acknowledge a precision-recall trade-off: technically oriented studies involving computer vision, visualisation, or computational design may remain when their metadata satisfy the visual/design concept block. Such records are treated as part of the interdisciplinary boundary of the field and are interpreted cautiously rather than assumed to represent communication-design theory directly. The 2026 output is interpreted as a partial publication year because data were extracted in May 2026.

Bibliometric Analysis Tools

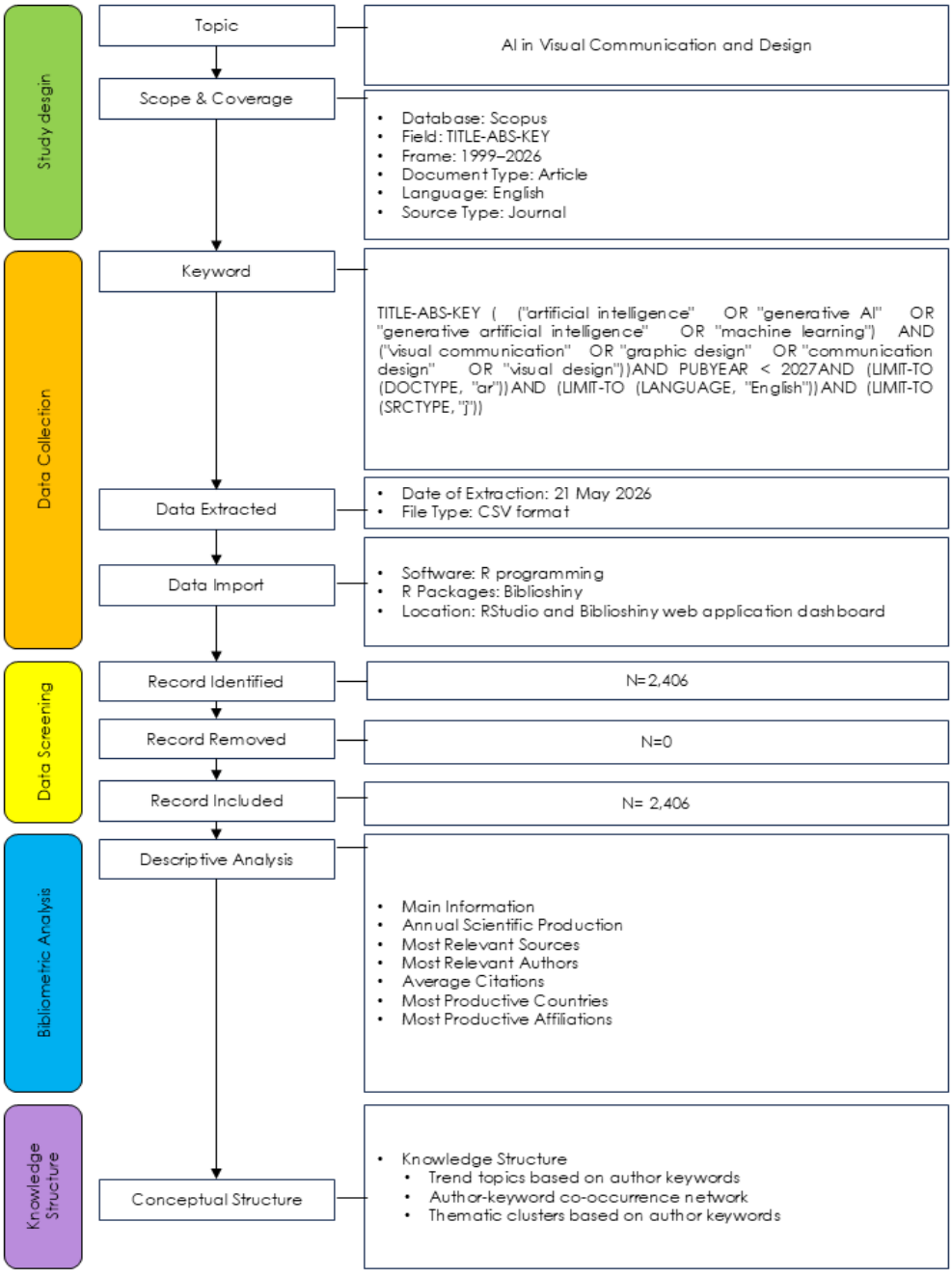
The analysis was organised using an R/bibliometrix-Biblioshiny workflow. Descriptive indicators were calculated from Scopus metadata, including annual scientific production, source productivity, author productivity, citation averages, country production, institutional affiliations, and globally cited documents. Keyword co-occurrence was constructed from author keywords and index keywords, and network-based community patterns were used to interpret conceptual clusters. Thematic interpretation followed a density-centrality logic. Centrality indicates the degree to which a theme is connected with other themes in the network, whereas density indicates the internal development of a theme. These measures are relational properties of the bibliographic network; they should not be interpreted as direct measures of theoretical importance, research quality, or causal influence.

Limitations of Data and Method

This study is limited by database, query, language, and metadata boundaries. First, reliance on Scopus may underrepresent non-indexed design journals, professional design publications, local-language scholarship, grey literature, and some conference-based creative practice. Scopus is therefore treated as a transparent delimitation of the internationally indexed scholarly corpus rather than a complete representation of all knowledge on AI and visual communication. Second, search-string sensitivity creates an unavoidable precision-recall trade-off. A broader query improves recall but may retrieve technically oriented studies that address visualisation or computational design only indirectly; a narrower query may omit relevant studies using alternative labels such as creative AI, computational creativity, image synthesis, multimodal design, or human-AI co-creation. Third, bibliometric co-occurrence and thematic positioning indicate patterns of association, not causal or theoretical relationships. Finally, the 2026 data represent only the first part of the year. Future replications should triangulate Scopus with Web of Science, Dimensions, and specialised design

databases, compare alternative query architectures, and use longitudinal thematic analysis to determine whether low-density/low-centrality themes are genuinely emerging or declining.

Figure 1 Methodological Phases of the Bibliometric Study



Source: Authors' analysis based on the Scopus CSV export.

RESULTS AND DISCUSSION

Descriptive Analysis

Main Information

Table 1 summarises the bibliometric metadata of the 2,406 Scopus-indexed articles analysed in this study. The dataset covers 1999-2026, includes 830 sources, and contains 7,136 unique author name entries. The

annual growth rate for the complete-growth window ending in 2025 is estimated at 19.82%, indicating rapid expansion. The average citation rate is 18.12 citations per document and the average document age is 3.47 years. The large reference base (478,085 cited references) is consistent with an interdisciplinary knowledge structure. These indicators describe the scale and connectivity of the corpus; they do not, by themselves, establish theoretical integration among the disciplines represented.

Table 1 Main Information of Retrieved Articles

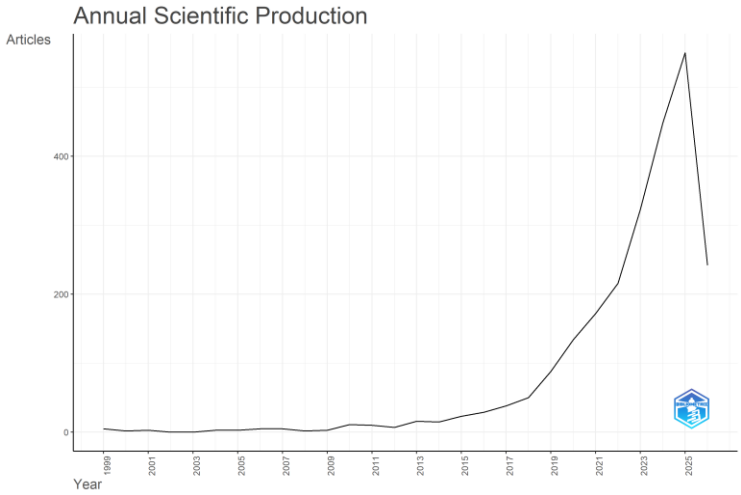
Description	**Results**
Timespan	1999-2026
Sources (Journals, Books, etc.)	830
Documents	2,406
Annual Growth Rate %	19.82
Document Average Age	3.47
Average citations per document	18.12
References	478,085
Keywords Plus / Index Keywords	6,206
Author's Keywords	9,078
Authors	7,136
Authors of single-authored docs	321
Single-authored docs	321
Co-Authors per Document	3.56
International co-authorships %	26.10
Document Type	Article

Source: Scopus. Authors' analysis.

Annual Scientific Production

Figure 2 shows the annual publication trajectory of AI-related visual communication and design research. The field remained relatively small from 1999 to 2012, followed by gradual growth between 2013 and 2018. A clear acceleration is visible after 2019, with output rising from 88 articles in 2019 to 550 articles in 2025. The year 2026 records 242 articles but should not be interpreted as a decline because the dataset was exported in May 2026. The pattern indicates sustained expansion of the indexed literature, but publication volume should be interpreted as growth in research activity rather than evidence of equivalent theoretical maturity.

Figure 2 Annual Scientific Production on Artificial Intelligence in Visual Communication and Design Research

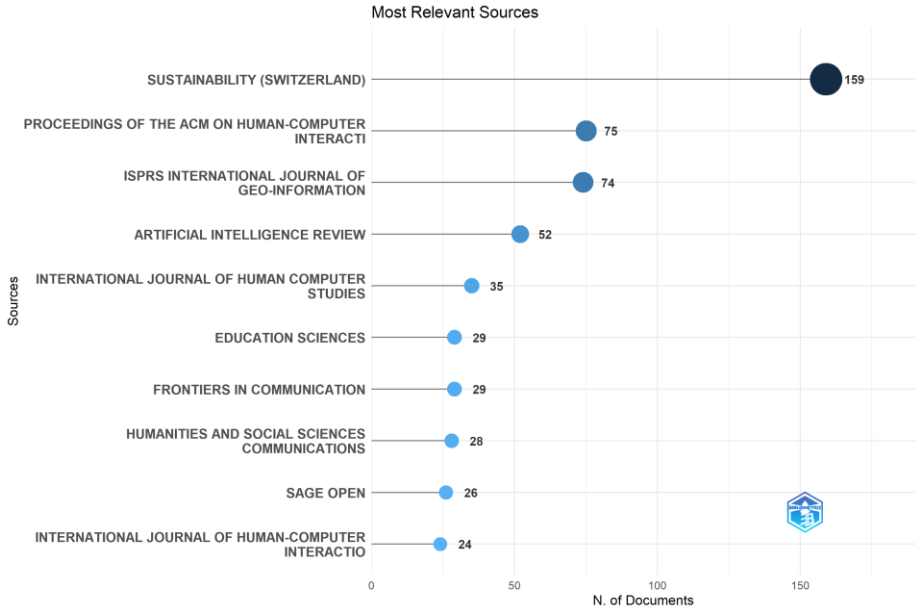


Source: Scopus. Authors' analysis.

Most Relevant Sources

Figure 3 lists the ten sources that published the largest number of articles in the dataset. Sustainability (Switzerland) leads the ranking with 159 articles, followed by Proceedings of the ACM on Human-Computer Interaction and ISPRS International Journal of Geo-Information. The distribution indicates that research captured by the search architecture is not concentrated in design-specific journals. Instead, it spans sustainability, HCI, geoinformation, education, design studies, communication, and interdisciplinary social science outlets. This dispersion is substantively important: it suggests a field organised around multiple application and disciplinary centres rather than a single consolidated visual-communication paradigm.

Figure 3 Top 10 Most Relevant Sources in Publishing Research on AI in Visual Communication and Design



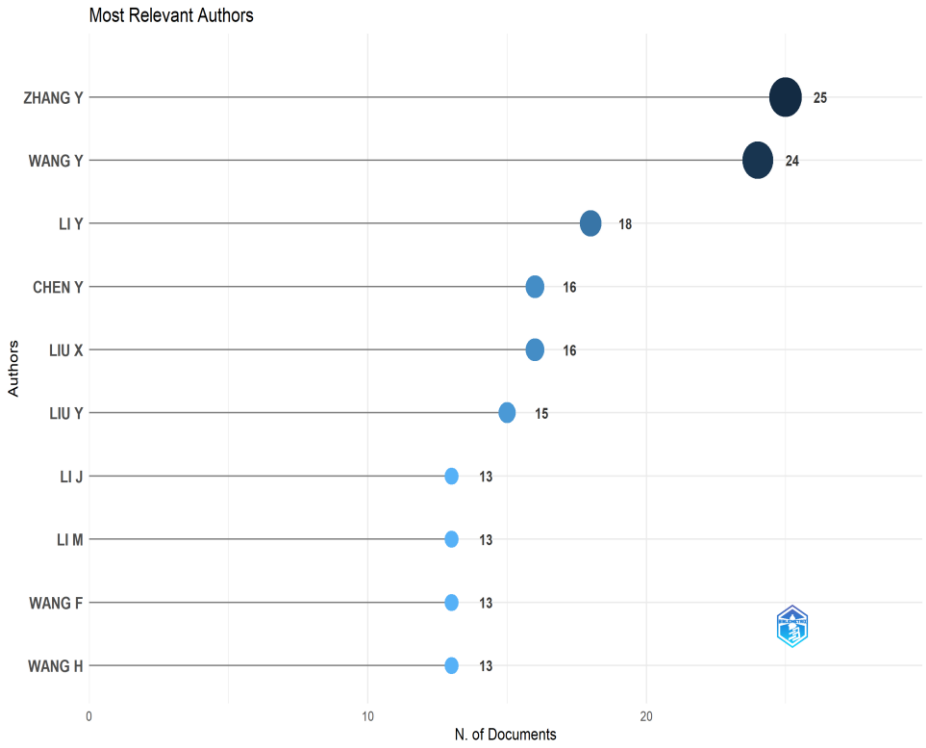
Source: Scopus. Authors' analysis.

Most Relevant Authors

Figure 4 presents the most productive authors based on the number of authored articles in the dataset. The distribution follows a typical bibliometric pattern in which a small group of authors contributes repeatedly while many authors appear only once. The pattern is consistent with a rapidly expanding research area in

which a stable core of recurring contributors coexists with a large peripheral population of occasional authors. Productivity should therefore be interpreted as publication participation within the corpus rather than as a direct measure of intellectual influence, which is better assessed alongside citation and network indicators.

Figure 4 Most Relevant Authors in AI, Visual Communication and Design Research

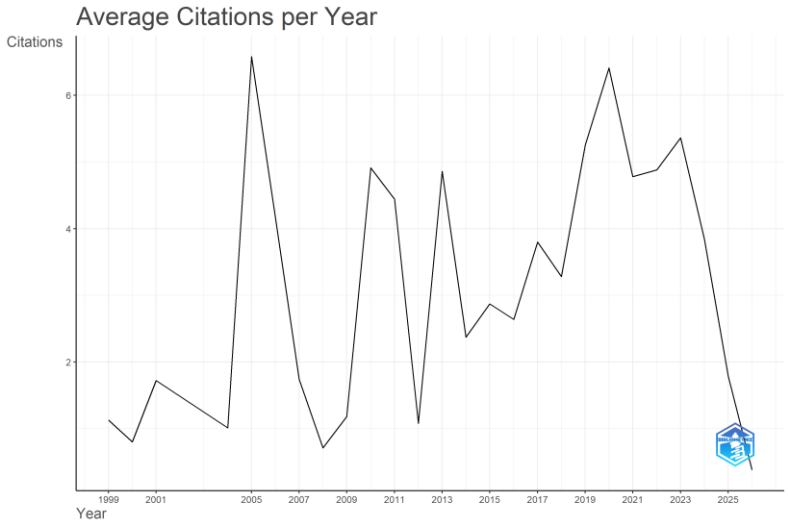


Source: Scopus. Authors' analysis.

Average Citations Per Year

Figure 5 displays average citations per document by publication year. Older studies generally have more time to accumulate citations, whereas recent publications may show lower citation density despite substantially higher output. Peaks in selected years indicate cohorts containing highly cited articles, but year-level averages can be affected by a small number of influential documents. The recent literature on generative AI and multimodal design has also had comparatively little time to accumulate long-term impact. Citation patterns are therefore interpreted as temporal visibility indicators rather than direct measures of conceptual quality.

Figure 5 Average Citations Per Year for AI in Visual Communication and Design Research



Source: Scopus. Authors' analysis.

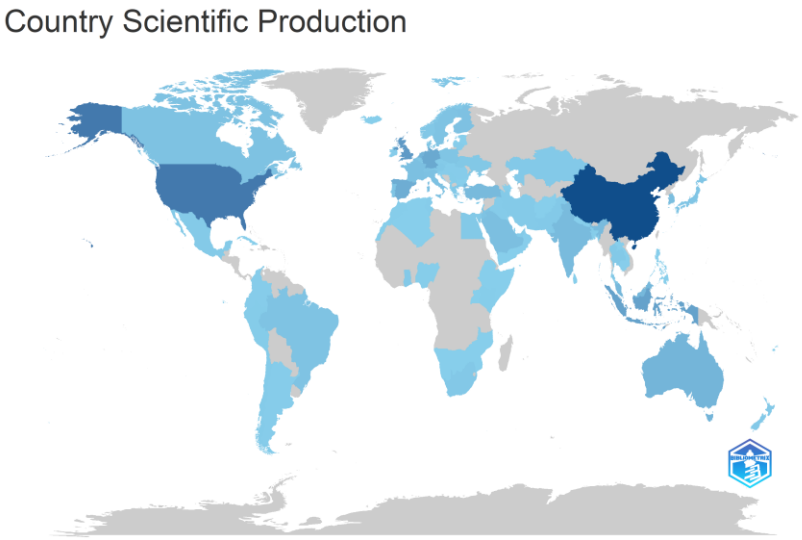
Most Productive Countries

Figure 6 shows country-level scientific production based on affiliation information. China records the highest number of country-affiliated documents (421), followed by the United States and the United Kingdom. Indonesia, Germany, Spain, the Netherlands, Australia, Malaysia, Turkey, and India also contribute substantially. The geographical spread indicates global diffusion of AI-related visual research across Asia, Europe, North America, and Oceania. However, the international co-authorship rate of 26.10% suggests that geographic diffusion has progressed faster than cross-national network integration. Rather than treating this figure simply as 'low', it may reflect the coexistence of nationally situated research communities, locally specific design and educational contexts, language and cultural settings, and discipline-specific collaboration structures. For visual communication research, stronger cross-national collaboration is especially consequential because questions of visual bias, cultural representation, audience interpretation, and AI-generated meaning require comparative evidence across cultural contexts.

International Collaboration and Field Integration

The 26.10% international co-authorship rate provides an additional indicator of the field's organisational maturity. Three interpretations are plausible. First, the corpus contains specialised disciplinary communities - including computer science, education, architecture, geoinformation, HCI, communication, and design - that may develop within established national research systems before forming dense international networks. Second, many AI-design studies are context-dependent and draw on local educational settings, cultural datasets, design industries, urban environments, or language-specific materials, which can favour nationally concentrated teams. Third, the combination of strong publication growth and moderate international co-authorship suggests that the field is expanding globally while remaining only partially integrated across national boundaries. This creates a clear research opportunity for cross-cultural and multi-country studies of visual bias, authenticity, trust, professional practice, and human-AI co-creation.

Figure 6 Countries Scientific Production on AI in Visual Communication and Design Research



Source: Scopus. Authors' analysis.

Most Relevant Affiliations

Table 2 ranks the most frequent affiliation units appearing in the Scopus metadata. The leading entries are associated with computer science, education, design, geography, communication, architecture, psychology, and information systems. The distribution reinforces the interdisciplinary structure identified in the source analysis. It also suggests a dual orientation within the corpus: one stream develops algorithms, computational models, and visual systems, while another examines design practice, communication, learning, interpretation,

and user experience. The coexistence of these streams is productive, but their presence in the same bibliometric field should not be taken to mean that they share equivalent theoretical assumptions.

Table 2 Most Relevant Affiliation Units

Rank	Affiliation unit	Articles	Research focus
1	Department of Computer Science	68	Computer science and AI systems
2	Faculty of Education	35	Education and learning technologies
3	School of Education	27	Education and learning technologies
4	School of Design	23	Design, communication and creative practice
5	Department of Geography	23	Spatial/visual analytics and applied design
6	Department of Communication	22	Design, communication and creative practice
7	School of Architecture	21	Spatial/visual analytics and applied design

Source: Scopus. Authors' analysis.

Most Globally Cited Documents

Table 3 presents the ten most-cited documents in the dataset. Highly cited studies are located at intersections among AI, HCI, communication, education, visual analytics, design, and applied computing. Citation impact is therefore not concentrated in a single disciplinary outlet. At the same time, several highly cited documents are only indirectly connected to visual communication theory. This is analytically informative rather than merely problematic: it reflects the broad computational and applied knowledge base from which contemporary AI-related visual research has developed. Consequently, the conceptual discussion below gives greater interpretive weight to keyword structures and design/communication scholarship than to citation rank alone.

Table 3 Most Globally Cited Documents

Rank	Article (first author, year)	Title	Journal	Total citations	Citations/ year
1	Chan C.K.Y. (2023)	Students' voices on generative AI: perceptions, benefits, and challenges in higher ed...	International Journal of Educational Technology	1577	394.25
2	Egger R. (2022)	A Topic Modeling Comparison Between LDA, NMF, Top2Vec, and BERTopic to Demystify Twit...	Frontiers in Sociology	790	158.00
3	Asgari Taghanaki S. (2021)	Deep semantic segmentation of natural and medical images: a review	Artificial Intelligence Review	756	126.00
4	Vaccari C. (2020)	Deepfakes and Disinformation: Exploring the Impact of Synthetic Political Video on De...	Social Media and Society	718	102.57

5	Anantrasirichai N. (2022)	Artificial intelligence in the creative industries: a review	Artificial Intelligence Review	648	129.60
6	Verbert K. (2013)	Learning Analytics Dashboard Applications	American Behavioral Scientist	542	38.71
7	Zhang Y. (2022)	Real-Time Vehicle Detection Based on Improved YOLO v5	Sustainability (Switzerland)	450	90.00
8	Ifenthaler D. (2020)	Utilising learning analytics to support study success in higher education: a systematic...	Educational Technology Research and Development	400	57.14
9	Alemdag E. (2018)	A systematic review of eye tracking research on multimedia learning	Computers and Education	376	41.78
10	Darvishi A. (2024)	Impact of AI assistance on student agency	Computers and Education	339	113.00

Source: Scopus. Authors' analysis. Note: Citations per year are calculated up to 2026.

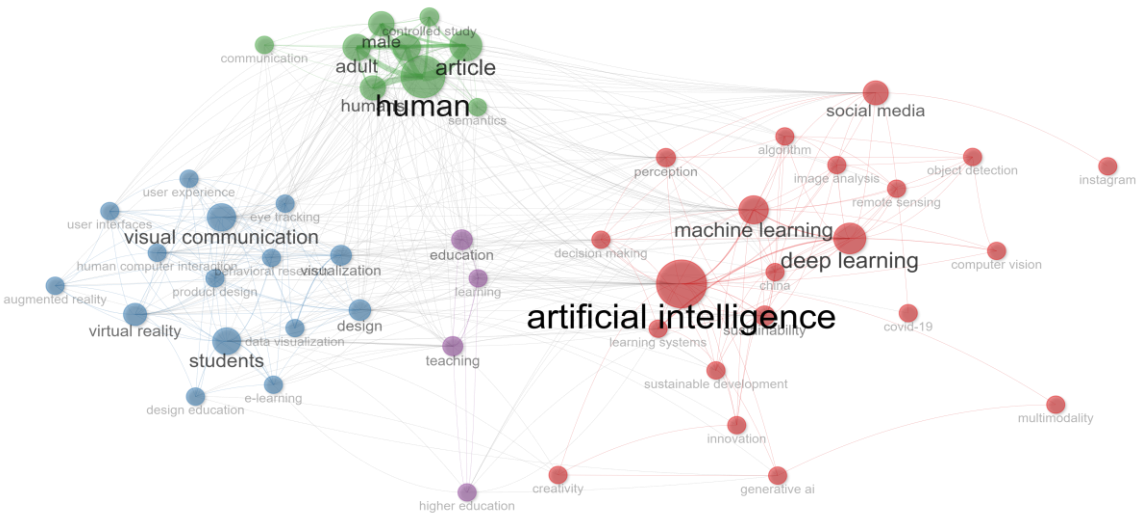
Network Analysis

Keyword Co-occurrence Network

Figure 7 displays the keyword co-occurrence network generated from author keywords and index keywords. Central nodes include artificial intelligence, machine learning, deep learning, design, education, HCI, visualisation, communication, sustainability, and digital technologies.

The clustering pattern indicates several overlapping knowledge domains rather than a single unified paradigm. Importantly, co-occurrence means that terms appear together within bibliographic records; it does not demonstrate that the corresponding concepts have been theoretically integrated. The network is therefore interpreted as an intellectual proximity map that identifies where stronger theory-building may be needed.

Figure 7 Co-occurrence Network of Keywords



Source: Scopus. Authors' analysis.

Thematic Map

Table 4 interprets the major clusters according to a density-centrality logic. Motor themes combine relatively high internal development with strong connectivity to the wider network; niche themes are internally developed but less connected; basic themes are widely connected but less internally developed; and low-density/low-centrality themes are best treated as transitional or under-consolidated. The last category should not be labelled deterministically as either 'emerging' or 'declining' without longitudinal evidence. On this basis, generative AI, machine learning, HCI, and design occupy a structurally prominent position, whereas cultural, ethical, educational, and communication-theoretical dimensions appear less consolidated. These positions are relational bibliometric properties rather than direct measures of scientific value.

Theoretical Interpretation of the Conceptual Structure

The bibliometric structures can be interpreted through four complementary theoretical lenses. First, the generative AI/design cluster is consistent with human-AI co-creativity and creativity-support perspectives. Recent work conceptualises generative AI as a collaborator embedded within distinct stages of conceptual design rather than as an autonomous creative agent (Fang et al., 2025). Experimental evidence further suggests that generative AI is particularly useful in problem definition and idea generation, while idea selection and evaluation remain predominantly human-led (Chen et al., 2025). Likewise, Wang et al. (2025) show that AI support may operate differently for novice and experienced designers. These findings support an augmentation interpretation: computational generativity expands the design space, but human expertise remains central to selection, refinement, and accountable judgement.

Second, the machine-learning/computer-vision stream should be distinguished from communication-centred visual intelligence. Technical systems can classify, segment, detect, or generate images successfully without necessarily explaining how those images communicate socially situated meanings. Social-semiotic visual theory therefore provides a critical bridge between computational performance and communicative interpretation by directing attention to representation, composition, modality, salience, and audience meaning-making (Kress & van Leeuwen, 2021). This distinction helps explain why the field can be technically advanced while remaining theoretically fragmented from a communication perspective. Third, the education and student-related themes can be interpreted through human-centred AI and design-cognition perspectives. Human-centred AI emphasises systems that preserve human control, responsibility, and self-efficacy while exploiting computational capability (Shneiderman, 2022). In design education, this implies that AI literacy should extend beyond prompt production to include critical selection, verification, bias detection, attribution, copyright awareness, and reflective judgement. The objective is not merely efficient image generation but the cultivation of designers who can explain why an output is communicatively appropriate and ethically defensible.

Fourth, the heritage, urban, sustainability, health, and public-communication clusters foreground contextuality. Critical visual methodology emphasises that images acquire meaning through the circumstances of their production, circulation, institutional use, and viewing (Rose, 2022). Consequently, domain-specific AI visualisation research should investigate not only technical usefulness but also cultural representation, inclusivity, authenticity, trust, accessibility, and the consequences of automated visual choices. This is especially important for cross-cultural settings, where apparently high-quality generated images may reproduce representational biases or culturally inappropriate visual conventions.

Future Research Agenda

The combined bibliometric and theoretical interpretation suggests a shift from tool-centred research towards theory-driven investigation of human-AI visual communication. Seven questions are particularly consequential: (RQ1) How does the timing and intensity of generative-AI assistance affect divergent and convergent stages of visual-design cognition? (RQ2) How does human evaluative judgement mediate the relationship between AI-generated alternatives and perceived design quality? (RQ3) How do cultural context and representational diversity shape audience interpretation of AI-generated visuals? (RQ4) Under what conditions does AI literacy improve designers' ability to detect bias, misinformation, copyright risk, and

representational distortion? (RQ5) How does disclosure of AI involvement influence authenticity, credibility, trust, and persuasive effectiveness? (RQ6) How do human-AI collaboration patterns differ among professional designers, students, communication practitioners, and non-specialist users? (RQ7) Does international collaboration increase the cultural diversity and theoretical integration of AI-enabled visual communication research?

These questions also permit theory-building. The bibliometric evidence does not test propositions directly, but the literature supports several propositions for future empirical examination: (P1) AI assistance will contribute more effectively to visual creativity when computational generativity is combined with human contextual judgement than when creative decisions are delegated primarily to AI; (P2) communicative effectiveness of AI-generated visuals will depend on the interaction among visual form, cultural context, audience interpretation, and communicative intention rather than technical image quality alone; (P3) AI literacy will strengthen the relationship between AI-tool use and design quality by improving users' capacity to select, reject, modify, and contextualise outputs; and (P4) human-AI co-creation will produce more defensible outcomes when AI is configured as creativity-support infrastructure and human actors retain accountability for final communicative decisions. Practical interventions follow from these propositions. Communication and design programmes should incorporate AI visual literacy covering prompt strategy, output evaluation, bias detection, copyright, attribution, visual rhetoric, cultural appropriateness, and disclosure. Professional workflows should implement human-in-the-loop review, particularly for public-facing, persuasive, health, educational, or culturally sensitive visuals. Research institutions should encourage cross-national collaboration and culturally diverse evaluation datasets, while design organisations should document when and how AI contributes to creative outputs. These interventions translate the bibliometric gaps into actionable educational, professional, and governance priorities.

Table 4 Thematic Map (Density-Centrality) of Keywords

Quadrant	Position	Cluster(s)	Interpretation
Q1 Motor themes	High density • High centrality	generative AI, machine learning, human-computer interaction, design	Mature and well-connected topics that drive AI-enabled design, visual communication, and creative support research.
Q2 Niche themes	High density • Low centrality	heritage, culture, architecture, urban visualization	Specialised application domains with strong internal development but weaker integration into the central AI-design discourse.
Q3 Transitional themes	Low density • Low centrality	social media, visual communication, visualization, human-computer interaction	Low-density and low-centrality topics whose direction cannot be classified as emerging or declining without longitudinal evidence; they require stronger conceptual consolidation and temporal verification.
Q4 Basic themes	Low density • High centrality	students, virtual reality, education, higher education	Broad foundational themes that connect the field across learning, digital literacy, and design education but require deeper design-specific theorisation.

Source: Scopus. Authors' analysis.

CONCLUSION

This bibliometric study mapped 2,406 Scopus-indexed journal articles on artificial intelligence in visual communication and design published between 1999 and 2026. The findings indicate strong post-2019 expansion, with the highest complete-year output recorded in 2025. Because the 2026 export was obtained in

May, the apparent reduction in that year is not interpreted as a decline. The analysis provides evidence of rapid growth in indexed research activity, while avoiding the stronger claim that publication growth necessarily implies theoretical maturity.

The source, country, and affiliation analyses indicate an interdisciplinary field distributed across sustainability, HCI, geoinformation, education, design, communication, and computer science. This breadth creates opportunities for technical and creative cross-fertilisation but also produces conceptual fragmentation. Many publications emphasise algorithmic performance, computational modelling, or domain-specific systems, whereas fewer explicitly theorise visual meaning, audience interpretation, cultural context, ethics, and professional judgement. The international co-authorship rate of 26.10% further suggests that global diffusion has developed faster than cross-national integration, strengthening the case for comparative and culturally diverse research.

The keyword co-occurrence network and thematic interpretation indicate four broad research directions: generative AI and creativity support; machine-learning/computer-vision applications; design and visual communication education; and domain-specific applications in sustainability, cities, heritage, health, and public communication. These clusters are bibliometric associations rather than causal or fully integrated theoretical domains. Interpreting them through social-semiotic visual communication, critical visual methodology, human-centred AI, and human-AI co-creative design clarifies a central research gap: computational advances are developing faster than theory-driven understanding of how AI-generated visuals are interpreted, trusted, evaluated, and governed.

For scholars, the study provides a reproducible map of the field and a theory-informed agenda for examining visual meaning, creativity, trust, cultural representation, bias, authorship, inclusivity, copyright, and accountability. For design educators, it supports an expanded conception of AI literacy that combines technical competence with critical judgement and ethical reasoning. For practitioners, it supports the treatment of AI as creativity-support infrastructure rather than a substitute for accountable human expertise. Future work should triangulate bibliographic databases, test alternative search architectures, perform longitudinal thematic analysis, and empirically evaluate the proposed research questions and theoretical propositions. The field will benefit most from research that integrates computational innovation with communication theory, design cognition, cross-cultural evidence, and human-centred governance.

Author Contributions

Conceptualization, methodology, formal analysis, visualization, writing - original draft, and writing - review and editing: Mohd Sufiean Hassan and Siti Nurshahidah Sah Allam. Both authors have read and agreed to the submitted version of the manuscript.

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Institutional Review Board Statement

Not applicable. This bibliometric study used secondary bibliographic metadata and did not involve human participants, personal data, or identifiable user-generated content.

Informed Consent Statement

Not applicable.

Data Availability Statement

The bibliometric data used in this study were exported from Scopus. The processed dataset may be made available from the corresponding author upon reasonable request, subject to database licensing conditions.

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Conflicts of Interest

The authors declare no conflict of interest related to this research.

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