

Peer-reviewed article

Mapping Ludic Architecture

A Bibliometric Analysis of an Emerging Research Field

Sabiha Sevgi

Assistant Professor, Biruni University, Turkey

<https://orcid.org/0000-0002-1267-6994>

ssevgi@biruni.edu.tr

Aydın Arman

Assistant Professor, Biruni University, Turkey

<https://orcid.org/0000-0003-4931-6535>

aarmanfar@biruni.edu.tr

Keywords

ludic architecture, bibliometric analysis, spatial agency, post-humanist ontology, participatory design



© Author(s). This is an Open Access article released under the terms of CC-BY 4.0

(<https://creativecommons.org/licenses/by/4.0/>).

www.FormAkademisk.org

Abstract

This study maps the academic literature produced between 2000 and 2025 in the field of ludic architecture through bibliometric methods, revealing the transformation of play from a historically peripheral position within architectural discourse into a constitutive ontological actor. A total of 268 publications retrieved from the Web of Science database were analyzed using VOSviewer, to identity temporal trends, geographical distributions, disciplinary relations, co-authorship networks, and conceptual clusters. The findings demonstrate that ludic architecture has evolved into an increasingly institutionalized, multilayered, and interdisciplinary research domain shaped by digital technologies, participatory practices, and post-anthropocentric ontologies. By clarifying how ludic agency has become an epistemic framework in architectural knowledge production, pedagogical approaches, and spatial practices, this study offers the first comprehensive bibliometric mapping of the field.

Introduction

The concept of play has historically occupied a peripheral position within architectural discourse, primarily relegated to the margins of disciplinary concerns and most often merely regarded as a pedagogical tool or a method for enhancing user participation (Stevens, 2007). Yet over the past twenty-five years, a marked transformation has occurred in how play is conceptualized within architecture (Sicart, 2014). This shift has been accelerated by three major developments: the integration of digital technologies into design processes, the expansion of participatory design paradigms, and the incorporation of post-anthropocentric ontologies into architectural theory (Awan et al. 2011). In this context, play is no longer understood merely as a methodological innovation but is increasingly recognized as an ontological actor—one that restructures spatial thinking, renders multiple agencies visible, and reshapes the nature of architectural knowledge production.

This epistemological shift understood here not in a strictly philosophical sense, but as a transformation in the frameworks through which architectural knowledge is produced, legitimized, and transmitted - has laid the foundation for a new research domain that transcends traditional disciplinary boundaries. This domain, which can be defined as ludic architecture, forms a multilayered network of interactions among design education, digital representation, participatory spatial production, critical spatial practices, and post-humanist ontologies. Such multidimensional functionality demonstrates that the role of play within architecture has expanded far beyond an applied technique, triggering a structural transformation within the discipline's knowledge regime (Frichot, 2019).

Despite its increasing visibility, the academic development of ludic architecture has not been comprehensively mapped. Existing studies tend to examine play as a singular theme or application focusing primarily on specific domains such as play in architectural education, digital and game-based design environments, participatory and co-design practices, or performative and experiential spatial approaches (Huizinga, 1955; Schechner, 2013; Caillois, 2001). While these studies provide valuable insights, they often remain limited in scope, addressing isolated aspects of ludic thinking rather than offering a systematic and integrative overview of the field. Furthermore, existing reviews and analytical studies tend to rely on relatively limited datasets or focus on specific subtopics, constraining their ability to capture the broader epistemological and interdisciplinary evolution of ludic architecture.

Consequently, they fail to systematically address the following fundamental questions:

- How does ludic thought expand architectural epistemology?
- Through which conceptual nodes does this transformation materialize?
- Which intellectual communities and networks produce the discourse of ludic architecture?

Therefore, the field requires an empirical visualization of its thematic clusters, conceptual relations, and interdisciplinary interactions. This study aims to fill this gap by providing a bibliometric mapping of the ludic architecture literature published between 2000 and 2025. The study is guided by the following overarching research question: How does ludic architecture restructure architectural knowledge production, pedagogical approaches, and spatial practices?

This main question is supported by the following sub-questions:

- RQ1: What temporal, geographical, and disciplinary patterns characterize research in ludic architecture?
- RQ2: Which conceptual networks and thematic clusters shape the field?
- RQ3: How has the notion of play evolved from a peripheral tool into an epistemic framework?
- RQ4: Which academic communities play a decisive role in shaping the discourse of ludic architecture?

This research provides three original contributions. First, it offers the first comprehensive bibliometric analysis to map the development of ludic architecture over the past twenty-five

years. Second, it renders the concept of ludic agency visible not merely as a theoretical construct but as a tangible intellectual actor within the literary networks. Third, by utilizing both theoretical arguments and methodological evidence, it grounds the evolution of play within a critical, collective, and post-anthropocentric epistemology.

The study analyzes 268 academic publications obtained from the Web of Science database. Using VOSviewer, the temporal distribution, geographical clusters, disciplinary categories, co-authorship networks, and conceptual co-occurrence patterns of these publications were visualized. The findings indicate that ludic architecture has evolved into an increasingly institutionalized, multilayered research ecosystem interwoven through interdisciplinary relationships.

Following this introduction, the literature review systematically presents the historical and theoretical transformation of play in architectural contexts. The methodology section details the data sources and the methodological framework of the bibliometric analysis. The findings section provides an analysis of the field's temporal, geographical, disciplinary, and conceptual networks. The final section discusses the implications of ludic architecture for architectural epistemology and proposes potential directions for future research.

Literature Review and Conceptual Framework

The concept of play, through its integration into architectural practice, has shaped a multilayered field of knowledge. This section systematically examines the anthropological and sociological foundations of play, its manifestations in architectural history, the new dimensions it has acquired through digital transformation, its relationships with participatory and critical practices, and, finally, its reconceptualization within post-humanist ontologies. The literature review reveals that ludic architecture constitutes an interdisciplinary research domain intersecting not only with architecture but also with game studies, design education, digital humanities, performance theory, and new materialism. This multifaceted perspective provides a critical foundation for understanding the epistemological evolution and conceptual diversity of the field, while simultaneously highlighting gaps in the existing literature and the need for bibliometric mapping.

The academic study of play began with Johan Huizinga's seminal 1938 work *Homo Ludens*. Huizinga defined play as a fundamental element of culture, arguing that it is a voluntary activity occurring outside ordinary life, governed by its own distinct rules. This theoretical framework positioned play not merely as a childhood or leisure activity but as a productive principle of human culture. Huizinga introduced the idea of play operating within an autonomous "magic circle" a space that generates rules, meanings, and values distinct from

everyday life. This perspective provides a critical starting point for understanding how play intersects with spatial practices.

Roger Caillois expanded upon Huizinga's work by categorizing games into four types: *agon* (competition), *alea* (chance), *mimicry* (imitation), and *ilinx* (vertigo). Caillois's typology demonstrated that play is not only a cultural phenomenon but also deeply embedded in sociological and anthropological dimensions, linking it to social structures and cultural practices. This theoretical foundation provides a crucial reference for understanding the intersections of play with spatial practices and architectural design. Caillois's categories can be operationalized in architecture to explain different forms of play: design competitions (*agon*), stochastic generative processes (*alea*), role-playing and scenario-based participation (*mimicry*), and sensorial-spatial experiences (*ilinx*) (Caillois, 2001).

While Caillois emphasized the sociological and cultural dimensions of play, the ludological perspective emerging in the late 1990s approached play on a distinct epistemological plane. The field of game studies conceptualized play as a unique mode of thinking and representation, separate from narrative (Frasca, 2003; Aarseth, 1997). Gonzalo Frasca's distinction between simulation and representation offered a new understanding of how games model the world: whereas traditional narratives represent reality, games simulate it, providing opportunities to experience possible states and scenarios (Frasca, 2003). This perspective establishes a critical theoretical basis for understanding the ludic character of digital design tools and parametric modeling systems in architecture. In computational design processes, designers engage with rules, variables, and randomness to develop procedural and generative workflows, effectively redefining design as a simulation practice (Aarseth, 1997).

Tracing the theoretical evolution of play within architectural history reveals deep roots reaching back to Bauhaus philosophy. Johannes Itten's preparatory courses employed play-based exercises that combined material, form, and color experimentation with intuitive and exploratory processes (Itten, 1975). This pedagogical approach demonstrated that, in design education, playful and exploratory processes are as central as rational problem-solving. Itten positioned play not as mere amusement but as an experimental domain for knowledge production, an approach later integrated into Bauhaus philosophy and foundational to modern design education.

In the post–World War II era, the experimental legacy of the Bauhaus merged with technological optimism and visions of radical social transformation, imparting a new political and utopian dimension to the concept of play. In the 1960s and 1970s, groups such as Archigram and other radical architectural movements utilized play to generate architectural

utopias and speculative projects (Sadler, 2005). Projects like Peter Cook's Plug-in City (1964) and Cedric Price's Fun Palace (1961) reconceptualized architecture from fixed, monumental structures into flexible, interactive, and playful systems. These initiatives revealed the critical and speculative potential of play in architecture. The Fun Palace, in particular, was designed as a flexible, programmatically open structure, that allowed users to continually reconfigure the space thereby transforming architecture into a playful interaction platform. Such projects challenged the traditional functionalist paradigm of architecture and redefined space in terms of events, movement, and interaction.

Postmodern architectural theory continued this radical legacy. Bernard Tschumi's *Manhattan Transcripts* (1981) and *Parc de la Villette* (1982–1998) positioned architecture in relation to events, movement, and play. Tschumi linked architectural meaning-making to the structural properties of language while situating play as an integral component of spatial experience (Tschumi, 1996). His concept of the "event" redefined architecture from a static object into a performative field continuously reproduced through users' actions. The folies of *Parc de la Villette*, designed with programmatic openness and functional ambiguity, allowed users to explore and transform space playfully. These projects demonstrated that play in architecture functions not merely as a theme but as a constitutive principle of spatial experience.

From the 1990s onward, the introduction of digital technologies into architectural practice further transformed the epistemological status of play. Parametric design tools (e.g., Grasshopper, Rhino), game engines (Unity, Unreal Engine), and virtual reality environments have enabled new modes of production in both education and professional practice (Ahlquist & Menges, 2011). These tools allow designers to engage with rules, variables, and randomness, thereby developing procedural and generative workflows. In digital design environments, form emerges not solely under the designer's direct control but as a product of algorithmic and parametric interactions, transforming the design process into a playful exploratory practice (Oxman, 2006).

Patrik Schumacher's (2011) *Parametricism* manifesto argued that digital design tools constitute not merely technical innovations but the foundation of a new architectural style (Schumacher, 2011). Critical literature, however, has emphasized the playful nature of these tools, interrogating how parametric systems operate in terms of user interaction, experimentation, and discovery. These debates reveal digital design tools not only as form-generating machines but also as epistemic interfaces that engage designers in playful exploratory processes. In parametric systems, designers define rules but cannot fully control outcomes—this openness and uncertainty transform the design process into a playful domain of experimentation.

Parallel to this technological transformation, participatory design literature began to identify play as a critical tool for democratic spatial production and collective decision-making. Henry Sanoff (2000) and Giancarlo De Carlo (1969) advocated for active user participation, critiquing the hierarchical top-down structure of architecture (Henry, 2000). In this framework, play functions as a strategy that facilitates communication among participants and enables the testing of alternative proposals. Play techniques used in participatory design workshops (such as role-playing, scenario development, physical modeling) allow non-expert participants to contribute to spatial ideation. These methods democratize design language, challenging the monopoly of professional architectural knowledge (De Carlo, 1969).

By the early 2000s, this participatory perspective had evolved into a more radical framework that refined architectural practice. The Spatial Agency project by Jeremy Till, Tatjana Schneider, and Nishat Awan (2011) extended participatory approaches beyond traditional boundaries. The concept of spatial agency demonstrated that architects are not merely building designers but can assume diverse roles as community organizers, activists, and facilitators. In this context, ludic practices emerged as experimental arenas where spatial agency is enacted. From this perspective, play functions not only as a design tool but also as an agent of social and political transformation. Till and colleagues argued for a shift from object-centered to process-centered, relational, and collective practice in architecture—with play positioned at the core of this transformation.

Critical architectural theory has similarly approached play as a tool for resisting hegemonic structures and generating alternative forms of production. Chantal Mouffe's (2013) concept of agonistic pluralism has been used to explain how ludic practices operate through conflict and negotiation. According to Mouffe, democratic politics should be built not on consensus but on agonistic plurality, where competing perspectives coexist legitimately (Mouffe, 2013). This perspective critiques the often idealized quest for compromise in participatory design, foregrounding the conflictual and negotiative character of playful practices. Markus Miessen (2010) further emphasized the confrontational and provocative dimensions of participatory practice, highlighting the political potential of ludic interventions. Miessen's notion of the "nightmare of participation" illustrates that playful practices need not always be harmonious or consensus-driven; instead, they can be critical and disruptive (Miessen, 2010).

Richard Schechner's (2013) performance theory extends this political dimension through corporeality and temporal experience. Schechner argues that performance is not confined to the theater stage but occurs in everyday life—including rituals, protests, and social interactions alike. This perspective, which defines playful practices in architecture through action, embodiment, and temporality, conceptualizes architecture not as a static object but a performative process continuously transformed by user interactions. It emphasizes that

play in architecture is not merely a mental or visual activity but also an embodied and experiential practice (Schechner, 2013).

In recent years, post-humanist and new materialist theories have further expanded the concept of play beyond anthropocentric epistemologies. Tim Ingold's (2013) relational ontology defines space not as fixed objects but as ongoing processes, relations, and flows. Structures are not finished entities but emergent phenomena. In this framework, play is understood as a dynamic field of interaction co-produced by human and non-human actors. Ingold's concept of "correspondence" shows that playful interactions occur not only among human actors but also with materials, environments, and technologies (Ingold, 2013).

Jane Bennett's (2010) vibrant materialism and Bruno Latour's (2005) actor-network theory further extend this post-humanist perspective. Bennett argues that matter is not passive but possesses its own agency, reconceptualizing ludic agency as distributed across humans, digital tools, materials, and environmental conditions (Bennett, 2010). Latour (2005)'s illustrates how human and non-human actors collectively form hybrid networks. This ontological shift explains the evolution of ludic architecture toward a post-anthropocentric epistemology: play is no longer solely a product of the human mind but an emergent phenomenon co-produced by humans, technologies, materials, and environments.

Table 1 presents a framework that illustrates the multilayered epistemological transformation of ludic architecture over approximately a century. The concept of play has evolved from the anthropological context defined by Huizinga and Caillois as a culture-constituting ritual, to a tool for intuitive and material-centered learning in Bauhaus philosophy; in the 1960–1980 period, radical actors such as Archigram, Price, and Tschumi transformed it into speculative and open-ended spatial strategies. From the 1990s onward, the ludology perspective, linked to digital game studies, reconceptualized play according to simulation logic rather than representation, paving the way for the digital transformation of architecture. In the 2000s, generative and rule-based production processes in parametric design further deepened this epistemology. Post-2010, the spatial agency approach repositioned play as a democratic, multi-actor design practice, while post-humanist ontologies emerging after 2015 redefined it beyond anthropocentric boundaries, emphasizing distributed agency, material interactions, and hybrid systems. This historical trajectory demonstrates how ludic architecture has evolved as a thinking regime spanning pedagogical, social, political, and post-humanist/digital paradigms, with play increasingly occupying a central role in architectural epistemology, both as a method and as an ontological principle.

Table 1*The Epistemological Evolution of Ludic Architecture.*

Period	Foundational Concept	Representatives	Ludic Agency Quality	Spatial Display
1938–1950	Play Anthropologist	Huizinga, Caillois	Ritualistic game logic produced by cultural institution	"Magical circle", bounded play-mechanism
1950–1960	Developmental Pedagogy	Bauhaus, Itten	Experiential learning, sensory production	Atelier/studio
1960–1980	Radical Utopia	Archigram, Price, Tschumi, Koolhaas	Speculative, open-ended spatial strategy	Flexible/unprogrammed structures
1990–2000	Ludology/Simulation	Aarseth	World simulation through game logic	Digital game environments
2000–2010	Parametric Design	Schumacher, Zaha Hadid	Generative rules producing production	Algorithmic forms
2010–2015	Spatial Agency	Till, Schneider, Awan	Democratic, multi-actor practice	Participatory workshops
2015–2025	Post-Humanist Ontology	Ingold, Bennett, Latour	Distributed agency, human-nonhuman interaction	Hybrid/emergent systems

In addition to these theoretical developments, bibliometric methods have increasingly been employed as systematic analytical tools in architectural research, enabling the mapping of intellectual structures, citation networks, and thematic clusters across large bodies of literature (Van Eck & Waltman, 2010; Donthu et al., 2021). Several studies have applied these methods to specific subfields of architecture and design. Carvalho et al. (2013) for example, analyzed over 450 publications on technology roadmapping using VOSviewer,

identifying temporal shifts in thematic focus and key contributing institutions (Carvalho, Fleury, & Paula Lopes, 2013). In the domain of sustainable architecture, bibliometric analyses have been used to map the evolution of energy performance and green building discourse, revealing how concepts such as carbon neutrality and passive design have migrated from marginal to mainstream positions in the literature (Ellegaard & Wallin, 2015). Similarly, studies in design pedagogy have employed co-citation analysis to trace intellectual lineages in studio-based and participatory learning environments, uncovering distinct theoretical clusters around constructivist, reflective, and critical pedagogies (Salama, 2015; Luck, 2018). In the context of digital design, bibliometric approaches have illuminated the convergence of computational methods and architectural theory, documenting how parametric thinking and algorithmic design have been absorbed into mainstream discourse over the past two decades (Doğan & Nersessian, 2010). These studies collectively demonstrate that bibliometric analysis offers a methodologically rigorous and empirically grounded framework for making visible the structural transformations within architectural knowledge production one that goes beyond what narrative literature reviews can provide. However, a comprehensive bibliometric analysis in the field of ludic architecture has not yet been conducted. Existing literature reviews tend to address the concept of play through isolated themes (e.g., play space design, gamification and digital simulation) and do not systematically examine the multilayered role of ludic thought within architectural epistemology. Where bibliometric methods have been applied to adjacent subfields, they have remained bounded in scope: studies focusing on gamification in education have typically drawn on samples of fewer than 100 publications and have been confined to learning science journals, without addressing spatial or design dimensions (Donthu et al., 2021). Similarly, bibliometric investigations of participatory design have examined play primarily as a community engagement strategy, leaving its epistemological function within architectural knowledge production unmapped (Luck, 2018). No existing study combines the full breadth of ludic, spatial, pedagogical, digital, and post-humanist dimensions within a single empirical framework. The present research therefore fills this gap by offering the first cross-domain, longitudinal bibliometric mapping of ludic architecture as an integrative research field.

This review indicates that ludic architecture has a long historical trajectory within the discipline but has undergone a particularly radical conceptual and methodological transformation over the past twenty-five years. Play has been reinterpreted in multiple ways: from Huizinga's anthropological definition, to experimental practices in Bauhaus philosophy, to a speculative method in radical architecture, to generative systems in the digital era, to a democratic strategy in participatory design, to a political intervention in critical practices, and finally to distributed agency within post-humanist ontologies (see

Table 1). This multilayered transformation demonstrates that ludic architecture develops not only within the discipline of architecture itself but also through interactions with education, technology, the social sciences, performance studies, and environmental studies.

Accordingly, a bibliometric approach is necessary to render the epistemological, conceptual, and disciplinary evolution of the field visible. Bibliometric analysis enables a systematic investigation of this transformation by empirically mapping the interdisciplinary structure, intellectual networks, and conceptual clusters of ludic architecture. The following methodology section details the data sources, scope, and analytical techniques employed in the study to achieve this aim.

Research methodology

Purpose and Significance of the Research

This study aims to examine the transformation of play within contemporary architectural discourse—from an instrumental strategy into a form of knowledge shaped by multi-agency, relational dynamics, and post-anthropocentric thought. The primary objective is to uncover how the concept of ludic architecture was articulated within the academic literature between 2000 and 2025 and to illuminate how this transformation has influenced architectural knowledge production. The research interrogates the conceptual nodes at which this epistemological shift crystallizes and the intellectual networks through which it circulates.

Historically, the notion of play in architecture has been evaluated as a pedagogical, recreational, or simulation-based tool. However, contemporary theoretical approaches demonstrate that play is not merely a secondary component that supports creative processes, but an ontological actor capable of transforming spatial thinking. By employing bibliometric analysis, this study systematically exposes this paradigmatic shift through a data-driven approach, grounding the largely discursive discussions surrounding ludic transformation in architectural theory within an empirical framework.

The significance of the research lies in its ability to provide a holistic, systematic, and comparative framework concerning the epistemological status of play within the field of architecture. Through bibliometric methods, the conceptual clusters, author networks, and thematic transitions of the ludic architecture literature are mapped, thereby revealing the concrete influence of play on architectural thinking, design pedagogy, and spatial practices. Diverging from existing scholarship, this study approaches ludic agency not merely as a

methodological instrument but as an ontological category that reconfigures the epistemology of architecture itself.

The study's original contribution operates on three levels: first, it constitutes the first comprehensive bibliometric analysis to systematically map the 25-year development of the ludic architecture literature; second, it renders the concept of ludic agency visible as a concrete intellectual actor embedded within literature networks, rather than as an abstract theoretical metaphor; third, it demonstrates the evolution of play into a critical, collective, and post-humanist epistemology, thereby grounding this emergent transformation in architectural theory at both the theoretical and methodological levels. Consequently, the research offers an original contribution to both design education and spatial theory, positioning ludic architecture as a transformative axis within the future epistemologies of architecture.

Data Sources and Scope of Literature

This study covers academic literature published between 2000 and 2025 to map the position of ludic architecture within architectural discourse through a quantitative methodology. The year 2000 was selected as a starting point because it marks the period during which digital transformation and participatory design paradigms became widespread in architecture; extending the analysis to 2025 allows for tracking the integration of post-anthropocentric and relational ontologies into architectural discourse.

The dataset of the research was compiled from academic publications indexed in the Web of Science (WoS) database. WoS was chosen because it systematically archives high-quality publications in international peer-reviewed journals, offers comprehensive indexing standards, and provides reliable citation-network data for bibliometric analyses. Its consistent classification structure and data cleanliness facilitate the extraction of reliable conceptual, thematic, and disciplinary patterns in the field of ludic architecture. For this reason, only the WoS database was used to form a homogeneous, verifiable, and methodologically consistent corpus. This choice is consistent with established practice in bibliometric research, where WoS is widely recognized as a primary data source due to its extensive coverage of peer-reviewed literature and robust citation infrastructure (Zupic & Čater, 2015). The overall methodological framework of the study draws on the systematic bibliometric review approach outlined by Aria and Cuccurullo, which emphasizes transparency in data collection, reproducibility of analytical steps, and the integration of multiple network-based visualization techniques to capture the intellectual structure of a research domain (Aria & Cuccurullo, 2017). The interdisciplinary scope of the analysis is grounded in the argument that emerging fields such as ludic architecture require cross-

disciplinary mapping methods capable of revealing knowledge flows across disciplinary boundaries (Van Eck & Waltman, 2010).

This choice is further supported by the demonstrated utility of co-word and co-citation analyses in tracing paradigm shifts within nascent research domains, as evidenced by applications in design studies and science and technology studies (Zupic & Čater, 2015; Ellegaard & Wallin, 2015). The three-stage screening protocol—comprising title/abstract screening, full-text verification, and duplicate removal—follows the procedural standards recommended for systematic bibliometric reviews (Moher et al., 2009; Donthu et al., 2021), ensuring that the final corpus of 268 publications represents a methodologically defensible and reproducible dataset.

Following the identification of data sources, the search strategy summarized below was employed to define the scope of the study. The dataset was constructed by combining the following keywords using logical operators (AND, OR):

- *Core Terms*: "ludic architecture" OR "ludic design" OR "playful architecture"
- *Conceptual Extensions*: "spatial play" OR "play and space" OR "game-based design"
- *Agency Terms*: "ludic agency" OR "spatial agency" OR "playful intervention"

Only publications in the fields of architecture, interior architecture, urban design, and environmental design were included. The inclusion criteria were as follows:

- The publication must be directly related to spatial production, the design process, or the built environment.
- The concept of play must be addressed within a theoretical discussion beyond its instrumental use.
- Full-text access must be available.

The exclusion criteria were: studies in game theory, education sciences, or digital media that do not contain spatial or design-related content; publications focusing exclusively on gamification-oriented commercial applications; and studio reports that treat play as a methodological tool without offering theoretical reflection.

Data Processing and Analysis Procedure

The records obtained from the literature search were subjected to a three-stage filtering process consistent with the systematic screening protocols recommended in bibliometric

research (Moher, Liberati, Tetzlaff, & Altman, 2009). The initial keyword-based search yielded a total of 412 records from the WoS database. Following the three-stage screening procedure described below, 144 records were excluded based on the inclusion and exclusion criteria, resulting in a final corpus of 268 publications. This filtering process ensured that only publications with a substantive engagement with both spatial/design content and the concept of play were retained for analysis:

- An initial screening of titles and abstracts;
- Verification through full-text review; and
- The removal of duplicate entries and to form the final dataset.

Comparative validation conducted by two researchers ensured data reliability and consistency with the inclusion criteria. In this way, the relevance of the publications included in the analysis was conclusively verified.

The final dataset was analyzed using VOSviewer (v.1.6.20). VOSviewer was selected for its capacity to construct and visualize large-scale bibliometric networks, including co-authorship, co-citation, and keyword co-occurrence structures, and is widely used in systematic bibliometric mapping studies (Van Eck & Waltman, 2010; Aria & Cuccurullo, 2017). The VOS (Visualization of Similarities) mapping technique on which the software is based positions items such that the distance between any two items reflects their degree of relatedness as accurately as possible, enabling the identification of thematic clusters and intellectual communities within the literature (Van Eck & Waltman, 2014). The analytical evaluated the following network configurations:

- *Co-authorship networks*, mapping intellectual communities and collaboration patterns;
- *Co-citation networks*, identifying seminal works that constitute the conceptual foundations;
- *Keyword co-occurrence networks*, visualizing thematic clusters and conceptual transitions.

Through these analytical layers, the representations of ludic architecture in both academic and practical/experimental domains were evaluated holistically. This approach made it possible to reveal the points of articulation and tensions between discourse and practice. The selected dataset and analytical techniques thus allow for a comprehensive mapping of the temporal trends, geographical distribution, disciplinary diversity, and conceptual

orientations of ludic architecture. The findings presented below constitute the empirical cartography of this multi-layered structure.

Findings: A Research Question–Oriented Analysis of Ludic Architecture

This section presents a multi-layered examination of the temporal evolution, geographical distribution, disciplinary diversity, and conceptual clustering within the field of ludic architecture, based on a bibliometric analysis of 268 publications produced between 2000 and 2025. The findings reveal that the position of play within architectural discourse has undergone a marked transformation over the past twenty-five years. Within the architectural literature, play has progressively shifted from being conceived as an instrumental design technique toward becoming visible as a critical epistemic structure that shapes architectural education, redefines digital processes, and distributes spatial agency across diverse actors.

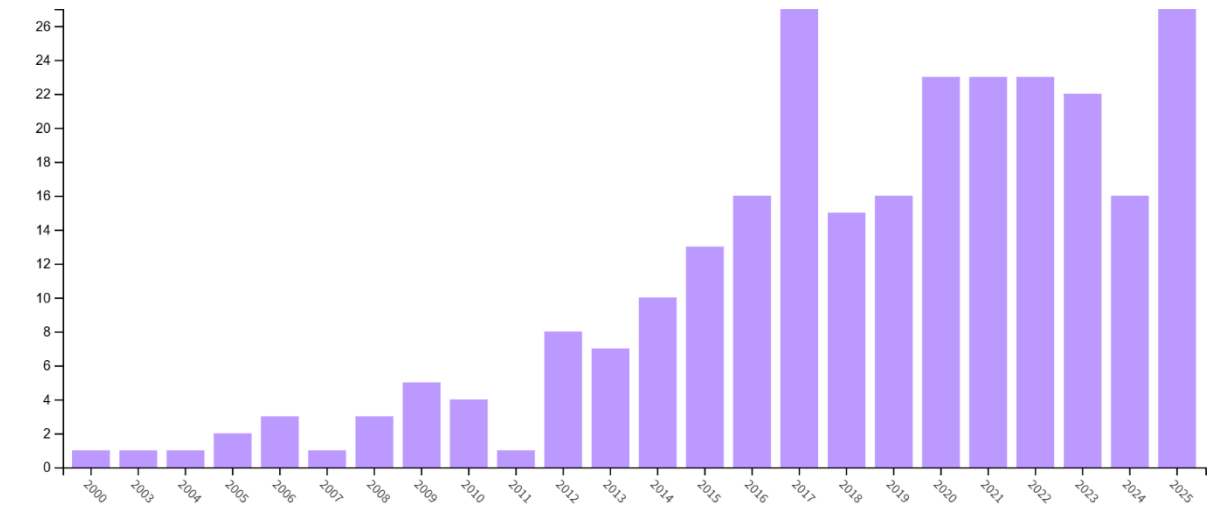
To provide a clearer analytical structure, the findings are organized in direct relation to the research questions guiding the study. Accordingly, the development of ludic architecture is examined sequentially through four key dimensions: temporal, geographical, and disciplinary patterns (RQ1); conceptual networks and thematic clusters (RQ2); the transformation of play into an epistemic framework (RQ3); and the academic communities and networks through which the field is produced (RQ4).

Temporal, Geographical, and Disciplinary Patterns of Ludic Architecture

The temporal distribution of publications demonstrates that ludic architecture evolved from a fragmented and limited area of interest in its early period into a rapidly institutionalizing and expanding research axis, particularly after 2015 (Figure 1). The abrupt increase in 2016 signals that play has become less associated with purely design pedagogy or digital environments, and has instead emerged as an interdisciplinary theme encompassing spatial practices, user interaction, and post-humanist debates. The sustained and consistent production between 2017 and 2025 confirms that ludic architecture has now transformed into a continuous, polycentric, and international research domain. This expansion in temporal trends indicates that ludic architecture cannot be reduced merely to "game-based design"; rather, it presents an emergent research trajectory that redefines the modes of architectural knowledge production, the positionality of the designer-subject, and the ontological framework of spatial experience.

Figure 1

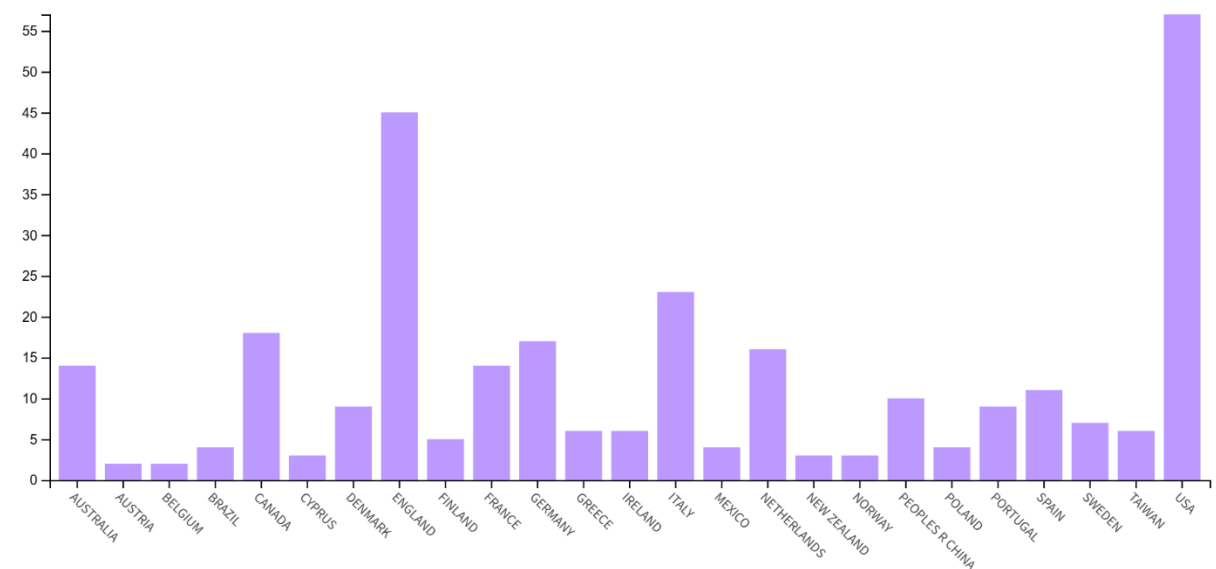
Distribution of Publications by Year in Ludic Architecture Literature (2000–2025).



Completing these temporal trends, the geographical distribution of the ludic architecture literature reveals that how the field has diffused spatially over time. The data reveal that ludic architecture initially developed within a research axis centered in North America and Europe, but has evolved toward a polycentric structure since the mid-2010s.

Figure 2

Distribution of Publications by Country in Ludic Architecture Literature (2000–2025).



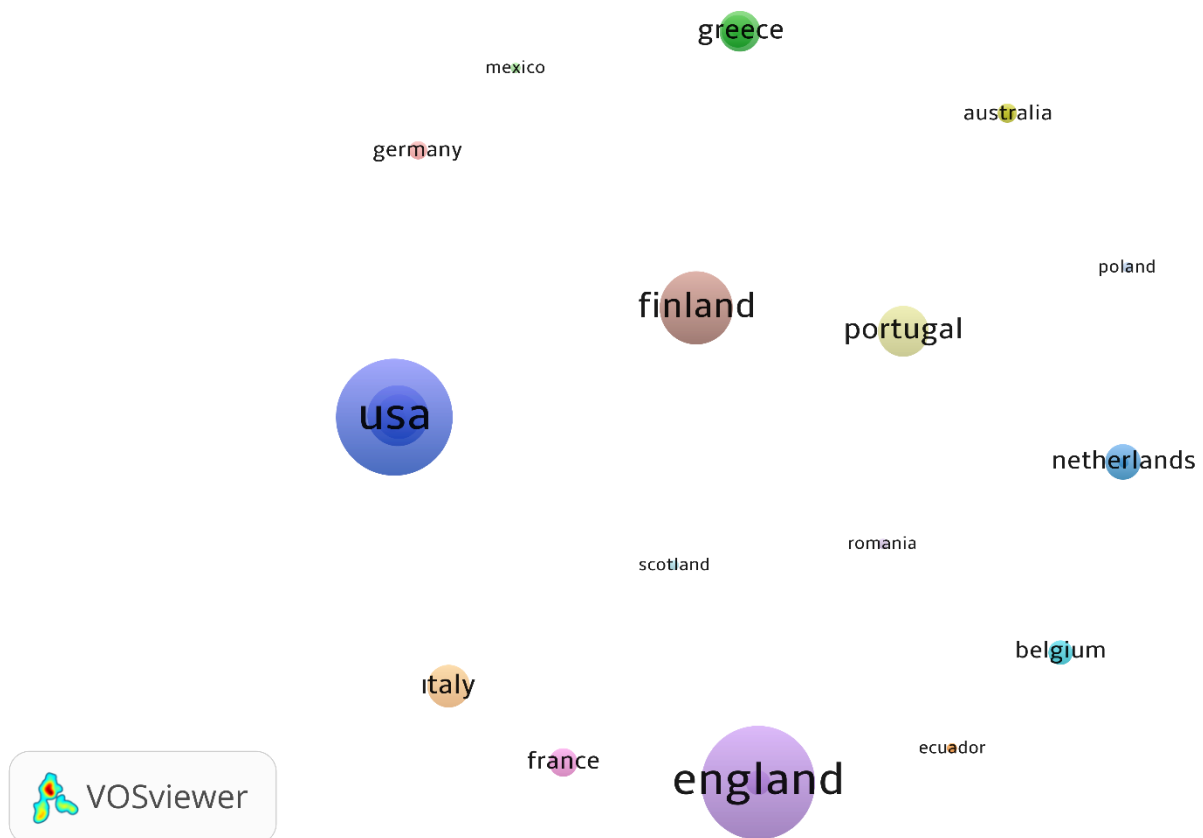
The distribution of publications by country (Figure 2) demonstrates that the United States and the United Kingdom possess by far the highest production rates. These two countries

are followed by Italy, Canada, the Netherlands, France, and Finland. This distribution indicates that the Anglo-Saxon academic tradition has strongly shaped discourses concerning play, digital culture, and architectural education. Consequently the theoretical backbone of ludic architecture has been substantially nourished by this context.

Conversely, it is observed that Northern European countries (such as Finland, the Netherlands, Denmark) are demonstrating an increasingly prominent influence, particularly in the domains of game-based learning, digital representation, and participatory design. Studies conducted in these countries predominantly address the concept of play through experiential learning, interactive systems, and community-oriented design practices, thereby contributing to the emergence of new thematic orientations within the literature.

Figure 3

Country-Based Co-Authorship Network in Ludic Architecture Literature (2000–2025).



Furthermore, countries like Portugal, Spain, and Ireland represent emerging research foci along the Mediterranean and Atlantic axes, boasting rapidly increasing publication numbers in recent years. This indicates that ludic architecture has evolved into a research field that is

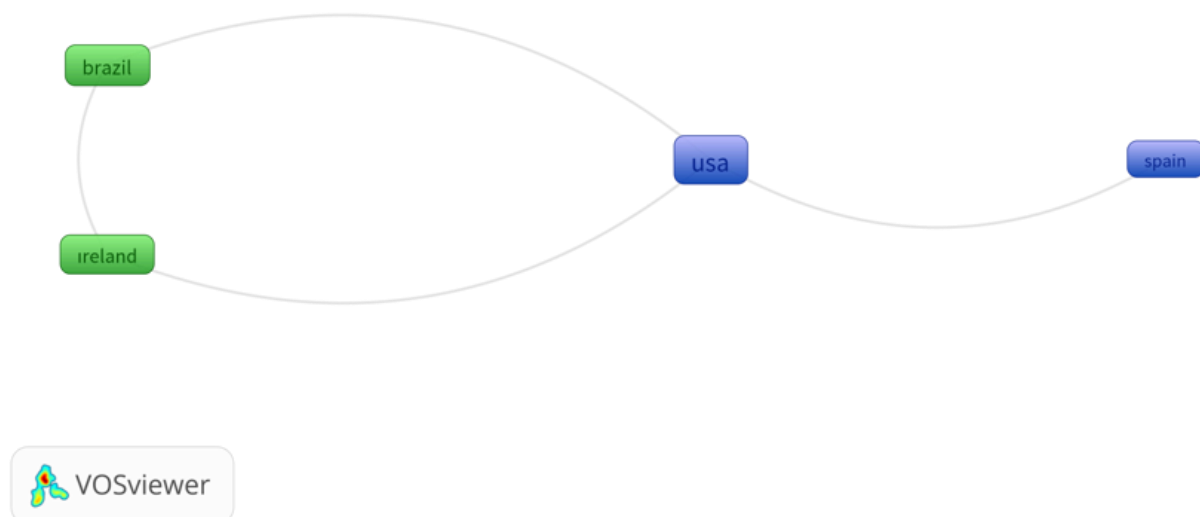
diversifying on a global scale, acquiring new meanings and practices not only within specific academic centers but also across diverse socio-cultural contexts.

Beyond this geographical distribution, the relational structure of the field made apparent through international collaboration networks. The country-based collaboration network generated through VOSviewer (Figure 3) reveals that ludic architecture has developed within a dispersed yet interconnected, decentralized international research ecosystem. The United States and the United Kingdom occupy the center of this network, with these two countries establishing both direct and indirect collaborative ties with European nations such as Finland, the Netherlands, Italy, and Portugal.

Nevertheless, a polycentric model has clearly emerged within the European collaborative structure. This is demonstrated by Finland's production in the domains of game-based learning and digital representation; the Netherlands' participatory design practices; and Italy and Portugal's contributions to the field through cultural studies and critical architectural practices are discernible. The connections established among these countries are concentrated particularly along the axes of game-based pedagogies, digital design processes, and participatory space production; thus, ludic architecture research is organized as a knowledge network that circulates across geographies.

Figure 4

Subnetwork with the Densest Connections in Ludic Architecture Literature.



A more focused examination of this relational structure reveals dense clusters of collaboration between specific countries. The closest subset of the network (Figure 4) demonstrates that the direct connections established by the United States with Ireland, Brazil, and Spain are particularly prominent. These relationships indicate that ludic

architecture research is not confined solely to Europe and North America; rather, new clusters are emerging in Latin America and the Mediterranean regions alike.

This pattern of collaboration demonstrates that ludic architecture has developed not only within the context of spatial production or design pedagogy, but also through a transdisciplinary epistemic network. Researchers from diverse countries enhance the conceptual diversity of the field by redefining play variously through the lens of digital ecologies, community-based negotiation processes, and spatial interpretations of post-humanist thought.

To understand the research universe of ludic architecture, not only the increase in publication numbers but also the disciplinary fields in which these publications are produced constitute a critical indicator. Therefore, the 268 studies in the dataset were evaluated using the category classification system of the Web of Science (WoS) database (Figure 5).

Figure 5

Web of Science Category Distribution of Ludic Architecture Literature.



The analysis reveals that ludic architecture is produced not only within the architectural discipline but also across diverse knowledge domains such as education, psychology, computer science, media studies, and social sciences. Accordingly, the highest number of publications is observed in Education & Educational Research, followed by Computer Science (Interdisciplinary Applications) and Architecture.

This distribution demonstrates that ludic architecture is predominantly positioned within interdisciplinary journals rather than being confined to architecture-specific venues. In other words, ludic architecture has not yet been fully integrated into the mainstream discourse of the architectural discipline; instead, it develops at the intersections of multiple fields, facilitating intensive knowledge exchange across disciplines.

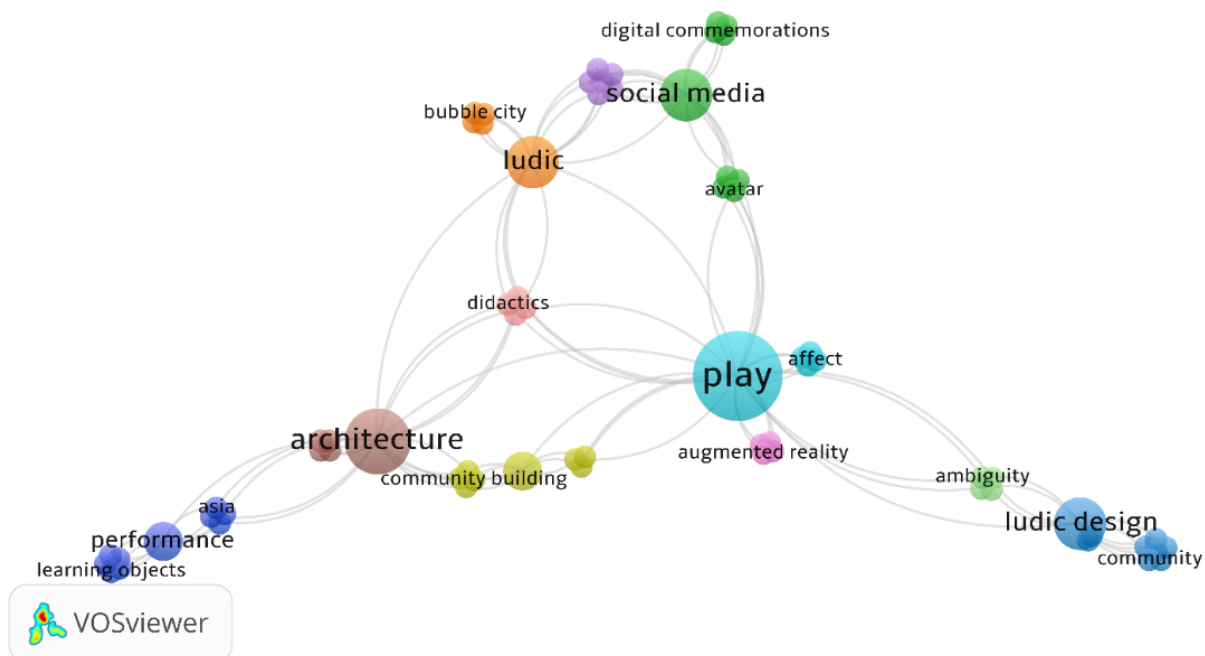
Taken together, these findings demonstrate that ludic architecture has evolved into a globally distributed, polycentric, and interdisciplinary research field shaped by temporal expansion, geographical diffusion, relational connectivity, and disciplinary diversification.

Conceptual Networks and Thematic Clusters

Following the analysis of temporal, geographical, and disciplinary patterns, the conceptual structure of the ludic architecture literature was examined. For this purpose, terms appearing in the title, abstract, and keyword fields of selected studies published between 2000 and 2025 were analyzed by conducting co-occurrence analysis within the VOSviewer software. The unit of analysis was determined as "author keywords," with a minimum co-occurrence threshold of one instance, allowing the inclusion of rare and emerging concepts in the network.

Figure 6

Keyword Co-Occurrence Network in Ludic Architecture Literature (2000–2025).

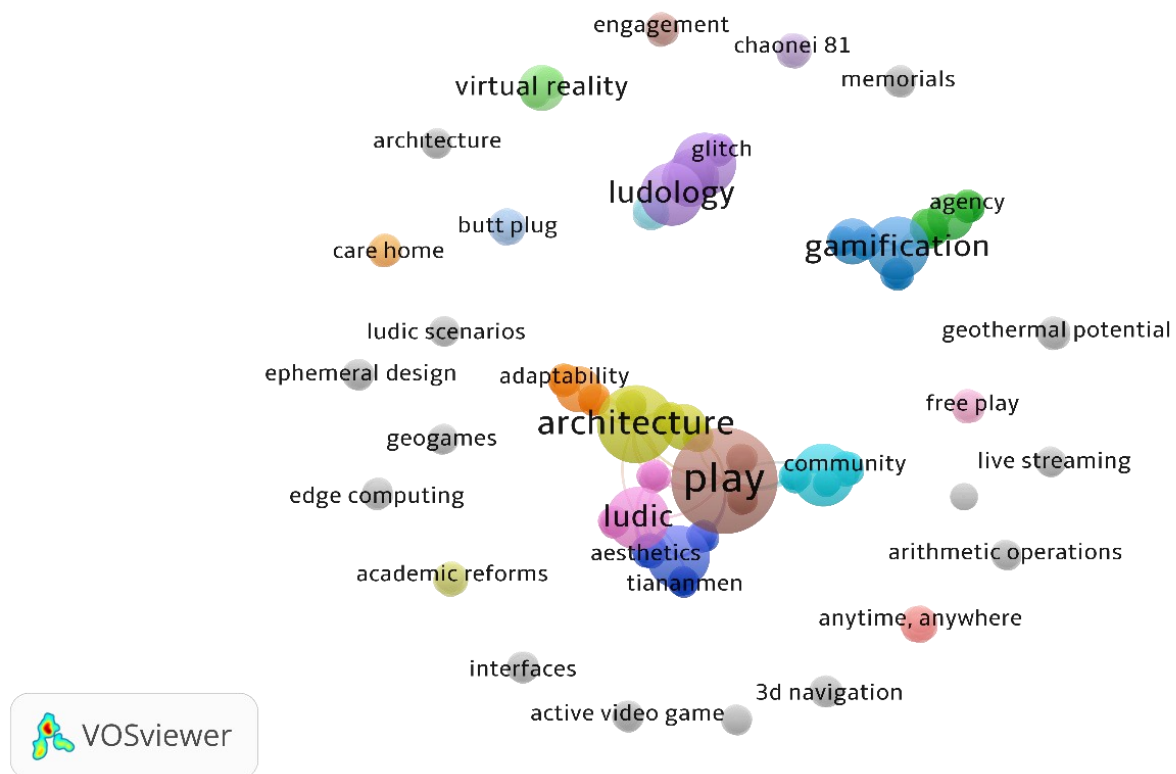


The resulting network structure (Figure 6) demonstrates that three dominant core terms—play, architecture, and ludic—form distinct centers within the conceptual universe of ludic architecture the literature. This triple axis represents both the epistemological and methodological backbone of the field.

As the node with the highest total link strength, play constitutes the semantic center of the entire network. Architecture enables the association of play with spatial thinking and design pedagogy, while the concept of ludic functions as a bridge between these two axes, transposing the concept of play into architectural domain at both theoretical and experiential levels. The network also includes related concepts such as interaction, virtual environments, participation, media, and learning, indicating that ludic architecture operates across multiple epistemic domains.

Figure 7

Thematic Clustering of Ludic Architecture Discourse.



According to the clustering analysis shown in Figure 7, the literature is organized around five main thematic axes. This analysis was conducted using co-word network visualizations, where each color represents a conceptual cluster, and the density of connections among concepts reveals the epistemic orientations of the discourse.

The first cluster is centered on the game-based design approach, formed around concepts such as play, learning, affect, studio, interaction, and education. This cluster reflects the ways in which play is incorporated into architectural education as an experiential tool that transforms learning processes while supporting creative thinking and co-production. The second cluster directly relates to spatial production processes, structured through concepts like architecture, space, community, building, and urban. In this domain, play transforms into a logic of production, enabling participatory, open-ended, and relational approaches to spatial design. The third cluster corresponds to ludic methodologies and critical theory, organized around terms such as ludic, practice, critical, performative, and speculative. This axis positions play not merely as an application tool but as a mode of thinking and a critical instrument within architectural discourse. The fourth cluster is defined by concepts like media, virtual, simulation, participation, and visualization, representing the intersection of play with digital and media ecologies. In this context, play functions as a conceptual interface that reshapes representation and interaction in architectural processes. Finally, the cluster formed around the concepts of gamification, design, agency, and interaction focuses on strategic design approaches. Here, gamification is understood not merely as an aesthetic or entertainment element but as a structuring logic that transforms user participation and decision-making processes.

When these clusters are evaluated together, it becomes evident that ludic architecture is based on a multi-layered and interdisciplinary epistemology. Within this discourse, play functions not only as a metaphor or creative analogy but also as a constitutive model of knowledge production, integrating education, digital processes, spatial thinking, and critical theory. These findings address RQ2 by demonstrating that ludic architecture is structured through interconnected conceptual clusters that form a multi-dimensional and interdisciplinary knowledge system. The conceptual structure identified above provides the basis for understanding the epistemic transformation of play within the field. This established framework provides the conceptual basis for understanding the epistemic transformation of play discussed in the following section (RQ3)

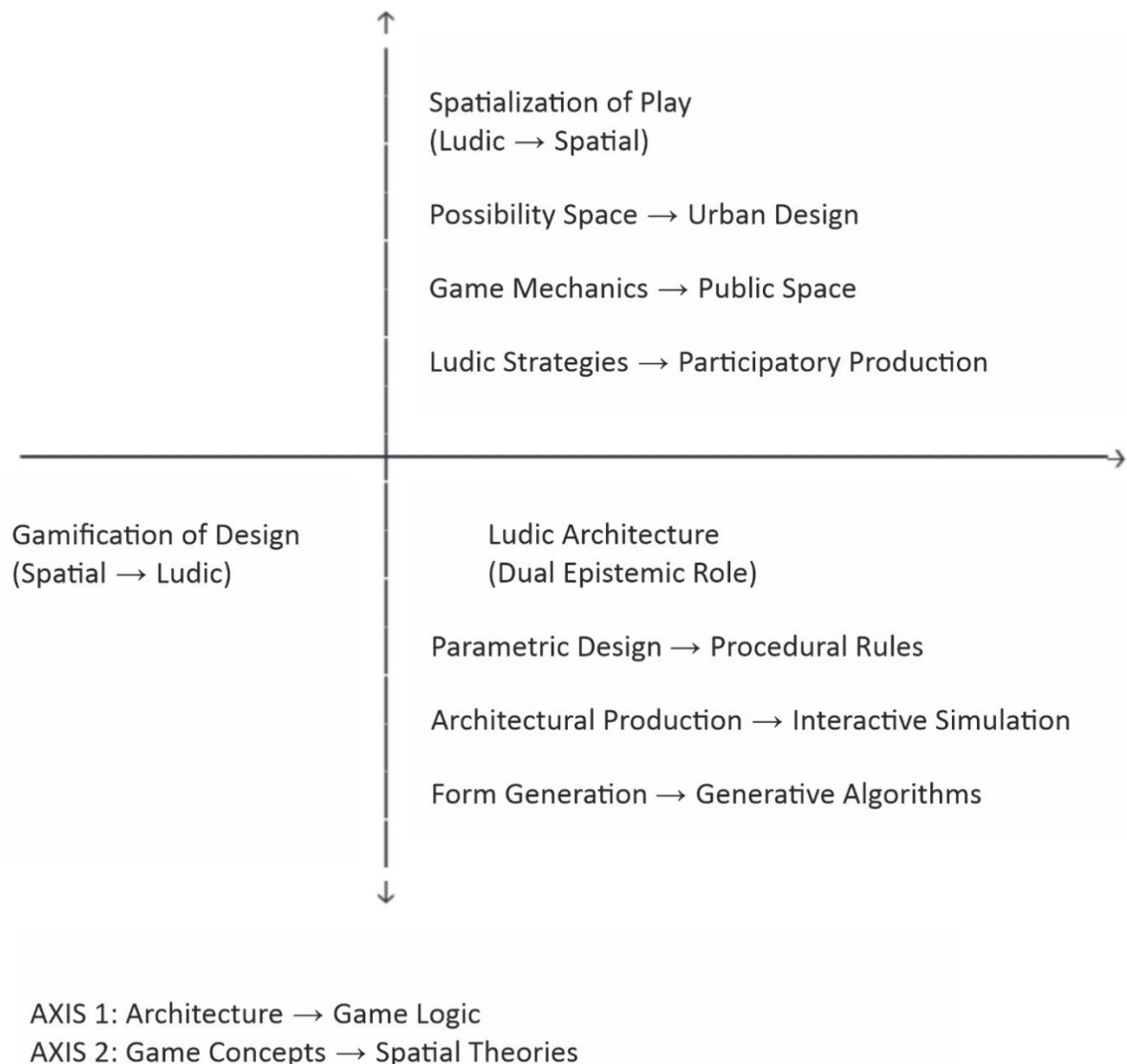
The Transformation of Play into an Epistemic Framework

The findings demonstrate that ludic architecture cannot be understood solely as a thematic field of study, but rather as an emerging conceptual domain within architectural knowledge production. The interdisciplinary distribution identified in the previous section reveals that play operates across multiple domains, including education, computer science, psychology, and spatial design, thereby functioning as a connective structure rather than a singular methodological tool.

These categories demonstrate that ludic architecture interacts not only with traditional design disciplines but also with emerging technological paradigms. Conceptual frameworks such as “cognitive mapping” from psychology, “procedural generation” from computer science, “spatial agency” from geography, and “participatory media” from communication are restructured within architectural design, forming hybrid epistemic configurations. In this context, architecture assumes a dual epistemic role within this ecosystem.

Figure 8

A Dual-Axis Epistemic Model of Ludic Architecture.



This transformation can be articulated through two complementary axes:

- The Gamification of Design: The transformation of architectural production through game logic, including procedural rules in parametric design, interactive simulations, and generative algorithms.

- **The Spatialization of Play:** The translation of play concepts into spatial theories and practices, such as the adaptation of “possibility space” to urban design and the integration of game-based participation strategies into public space production.

As illustrated in Figure 8, these two axes define ludic architecture simultaneously as a practical method and as a theoretical framework. On one axis, play structures design processes through rule-based, procedural, and generative systems; on the other, it reshapes spatial thinking through experiential, participatory, and relational interpretations of space. The intersection of these axes positions ludic architecture as a hybrid epistemic domain that connects technological systems with spatial imagination. This dual structure demonstrates that play is no longer merely an auxiliary or representational component within architectural practice. Instead, it operates as a constitutive principle that reorganizes knowledge production, design structuring, and the conceptualization of spatial experience.

Thus, ludic architecture is positioned as an interdisciplinary research paradigm that enables epistemic permeability across domains such as education, technology, psychology, and the social sciences. Rather than belonging to a single disciplinary framework, it functions as a knowledge system that is continuously transformed through interaction, experimentation, and hybridization. Ultimately, these findings demonstrate that play has shifted from an instrumental design tool to a constitutive epistemic framework that reorganizes architectural knowledge production.

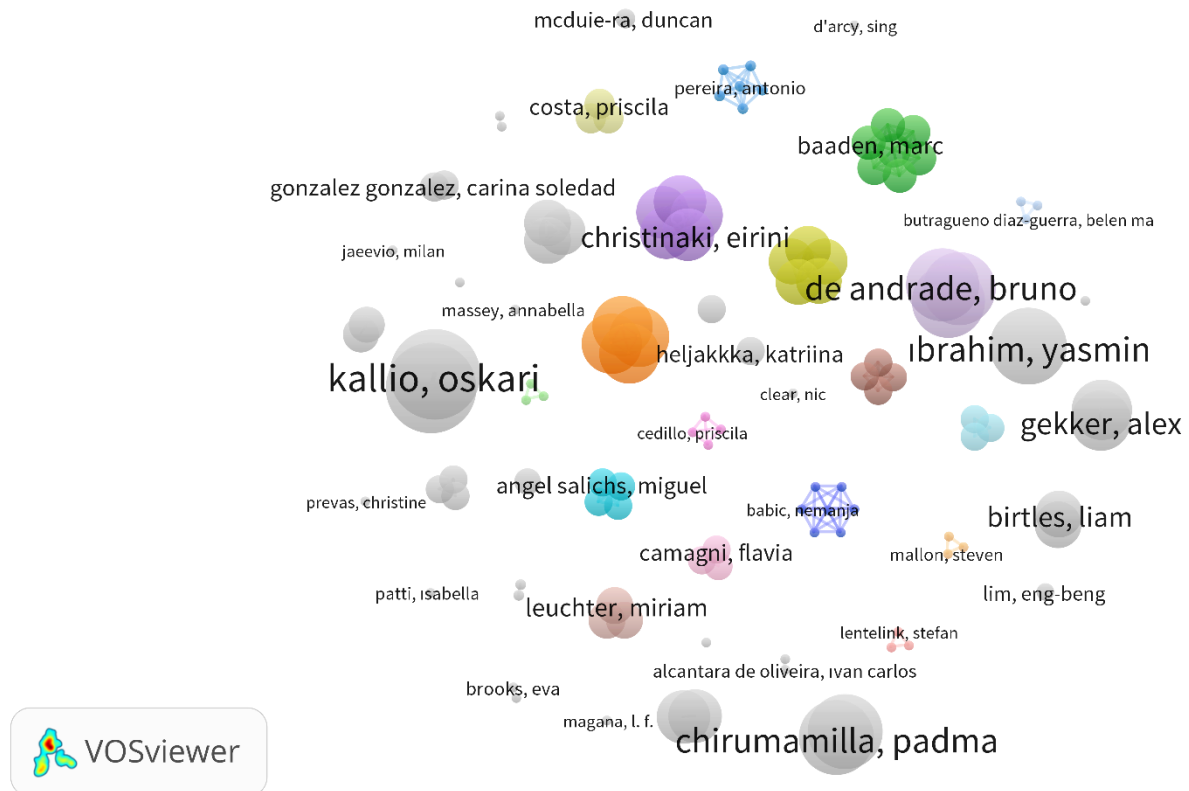
Academic Communities and Knowledge Production Networks

The co-authorship network analysis provides insight into how knowledge production in ludic architecture is organized at the individual researcher level. In this context, co-authorship networks visualize how disciplinary interactions are materialized at institutional and intellectual levels, and how research communities and collaboration patterns shape the production of knowledge within the field.

The resulting network structure (Figure 9) demonstrates that ludic architecture research possesses a highly dispersed and polycentric character. The majority of authors are positioned as singular producers or part of dyadic collaborations, while multiple micro-clusters are distributed across the network without a clearly defined central core. This indicates that the field has not yet formed a distinct or stable “core community,” but rather functions through loosely connected research groups.

Figure 9

Co-Authorship Network in Ludic Architecture Literature (2000–2025).



As is distinctly visible in the visualization, the overall structure of the network possesses an “archipelago topology,” where authors are clustered in small, distant islands. This morphology directly reflects the epistemic nature of ludic architecture:

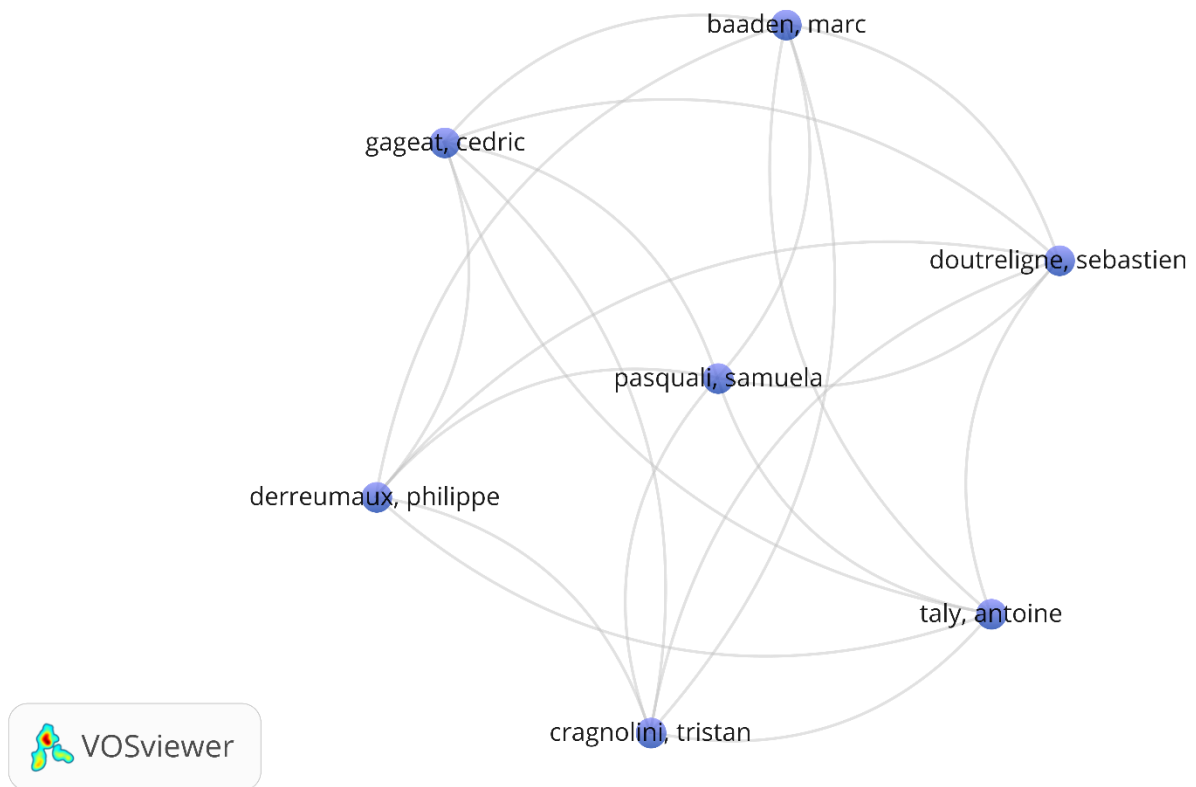
- *Polycentricity*: Parallel research foci emerge from different disciplines rather than a single dominant paradigm
- *Fluidity*: Collaborations are often Project-based and temporary rather than rooted in fixed institutional structures
- *Epistemic diversity*: Heterogeneous knowledge production is distributed across pedagogy, technology, theory, and design practice

The node sizes in the network indicate each author’s total link strength. As observed in Figure 7, researchers such as Chirumamilla, Padma; Kallio, Oskari; Ibrahim, Yasmin; De Andrade, Bruno; Baaden, Marc; Gageat, Cedric; and Christinaki, Eirini possess relatively larger nodes. However, even these actors function as micro-hubs within local clusters rather than forming a dominant central structure.

A more detailed examination of the network reveals densely connected subgroups. As shown in Figure 10, the most densely connected subset represents a tightly interconnected group of authors, forming a localized but highly interactive collaborative structure.

Figure 10

Dense Subgraph with Intensive Connections — Bridge Community in Ludic Architecture (VOSviewer).



This subset possesses a structure that is highly connected but not fully closed, as each node maintains direct or indirect relationships with multiple others. This indicates that the group is organized around shared research trajectories, constitutes an interdisciplinary collaboration cluster and focuses on the technological and computational dimensions of ludic architecture.

This cluster can be interpreted as a “bridge community” within the field, connecting different domains of knowledge production, such as those between architecture and computer science, between pedagogy and digital technologies and between theoretical ludology and applied design practices.

In this context, the dispersed and weakly connected structure of the overall network can be interpreted through the lens of weak ties. As suggested by Mark Granovetter, loosely connected networks enable the circulation of knowledge across otherwise disconnected

communities. The weak ties observed in the ludic architecture network facilitate conceptual hybridization across disciplines, allowing ideas from game studies, architecture, and computational design to intersect.

For instance, the indirect connection of a game theorist (such as Gekker) with architectural researchers enables the integration of concepts “procedural rhetoric” into spatial design discourse. This demonstrates that knowledge production in ludic architecture is not centralized but emerges through distributed and relational interactions.

Taken together, these findings demonstrate that ludic architecture is structured through a decentralized, polycentric, and weakly connected network of research communities. Rather than forming a unified disciplinary core, the field evolves through micro-clusters, bridge communities, and transdisciplinary exchanges. These findings address RQ4 by showing that ludic architecture is produced through dispersed, relational, and interdisciplinary knowledge networks rather than a centralized academic structure.

Discussion and Conclusion

This study has mapped the temporal trends, geographical distribution, disciplinary components, and conceptual orientations of the ludic architecture literature between 2000 and 2025 through bibliometric methods. The findings demonstrate that the field possesses a multi-layered epistemological structure concentrated along pedagogical, digital, and critical-political axes, revealing that ludic architecture is not merely an area of interest but an indicator of a profound transformation in architectural knowledge production.

In relation to the temporal and geographical findings (RQ1), the field gained marked momentum after 2015 and evolved into a polycentric research ecosystem extending beyond the Europe–North America axis toward Asia, Oceania, and South America. This diffusion indicates that play is being reinterpreted across different cultural, pedagogical, and technological contexts, demonstrating that ludic architecture is shaped by a plural and context-dependent knowledge structure.

At the conceptual level (RQ2), ludic architecture is organized around multiple axes. The first axis positions play as a tool for creative, experimental, and speculative design production, supported by the co-occurrence of terms such as "design," "interaction," and "simulation." The second axis emphasizes participatory and social dimensions, structured around concepts like "learning," "children," and "community." The third axis introduces a critical-political dimension through terms such as "agency," "public space," and "activism." Together, these axes demonstrate that ludic architecture constitutes a multi-scalar discursive field that integrates design, collectivity, and critical thinking.

This conceptual structure relates directly to the expanding role of play identified in the findings (RQ3). Rather than functioning solely as a methodological tool, play appears across multiple areas of architectural inquiry, including design education, digital design, participatory practices, and emerging theoretical discussions. The dual movement between the gamification of design and the spatialization of play suggests that play increasingly informs both design processes and ways of conceptualizing spatial experience. In this sense, the findings resonate with broader theoretical discussions that position play as a significant cultural and conceptual dimension of contemporary architectural discourse, extending beyond its traditional instrumental role.

The co-authorship network analysis (RQ4) further reinforces this interpretation. The presence of small clusters connected through weak ties rather than centralized structures reflects the openness, experimental nature, and contingency of the field. In this context, the dispersed structure of ludic architecture can be interpreted through the lens of Mark Granovetter (1983), in which loosely connected networks enable knowledge circulation across different domains and facilitate interdisciplinary hybridization. This interpretation also aligns with discussions in game studies, particularly the work of Alex Gekker (2021), which emphasizes the role of procedural and systemic logics in shaping contemporary cultural and spatial practices.

From a practical perspective, ludic architecture transforms architectural practice. Architects increasingly assume multiple roles including designer, facilitator, activist, educator, and researcher, while collective and network-based organizational forms offer alternatives to traditional hierarchical models.

At the same time, critical limitations must be acknowledged. Issues such as accessibility, digital inequality, and cultural specificity may restrict the universal applicability of play-based approaches, highlighting the importance of low-tech and context-sensitive strategies for inclusive design.

Future trajectories indicate that ludic architecture will increasingly intersect with artificial intelligence, metaverse environments, ecological modeling, and neurodiversity-oriented design. These developments suggest that play is evolving into a framework that reshapes not only design processes but also the ethical and technological agendas of architecture.

In conclusion, ludic architecture emerges as a multi-layered mode of thinking and an epistemological shift that expands architectural knowledge. Play is repositioned not as a supplementary element but as a constitutive and transformative principle that shapes the future of architecture through openness, relationality, and continuous transformation.

Reference

- Aarseth, E. (1997). *Cybertext: Perspectives on ergodic literature*. Johns Hopkins University Press. <https://doi.org/10.56021/9780801855788>
- Ahlquist, S., & Menges, A. (Eds.). (2011). *Computational design thinking*. John Wiley & Sons.
- Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4), 959–975.
<https://doi.org/10.1016/j.joi.2017.08.007>
- Awan, N., Schneider, T., & Till, J. (2011). *Spatial agency: Other ways of doing architecture*. Routledge. <https://doi.org/10.4324/9781315881249>
- Bennett, J. (2010). *Vibrant matter: A political ecology of things*. Duke University Press.
<https://doi.org/10.1215/9780822391623>
- Caillois, R. (2001). *Man, play and games* (M. Barash, Trans.). University of Illinois Press. (Original work published 1958)
- Carvalho, M., Fleury, A., & Lopes, A. P. (2013). An overview of the literature on technology roadmapping (TRM): Contributions and trends. *Technological Forecasting and Social Change*, 80(7), 1418–1437. <https://doi.org/10.1016/j.techfore.2012.11.008>
- De Carlo, G. (2005). Architecture's public. In P. Blundell Jones, D. Petrescu, & J. Till (Eds.), *Architecture and participation* (pp. 3–22). Spon Press.
- Doğan, F., & Nersessian, N. J. (2010). Generic abstraction in design creativity: The case of Staatsgalerie by James Stirling. *Design Studies*, 31(3), 207–236.
<https://doi.org/10.1016/j.destud.2009.12.004>
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285–296. <https://doi.org/10.1016/j.jbusres.2021.04.070>
- Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, 105(3), 1809–1831.
<https://doi.org/10.1007/s11192-015-1645-z>
- Frasca, G. (2003). Simulation versus narrative: Introduction to ludology. In M. J. P. Wolf & B. Perron (Eds.), *The video game theory reader* (pp. 221–235). Routledge.
<https://doi.org/10.4324/9780203700457-11>
- Frichot, H. (2019). *Dirty theory: Troubling architecture*. Spurbuch Verlag.
- Gekker, A. (2021). Against game studies. *Media and Communication*, 9(1), 73–83.
<https://doi.org/10.17645/mac.v9i1.3315>

- Granovetter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological Theory*, 1, 201–233. <https://doi.org/10.2307/202051>
- Sanoff, H. (2000). *Community participation methods in design and planning*. Wiley.
- Huizinga, J. (1955). *Homo ludens: A study of the play-element in culture*. Beacon Press.
- Ingold, T. (2013). *Making: Anthropology, archaeology, art and architecture*. Routledge. <https://doi.org/10.4324/9780203559055>
- Itten, J. (1975). *Design and form: The basic course at the Bauhaus and later*. Van Nostrand Reinhold.
- Latour, B. (2005). *Reassembling the social: An introduction to actor-network-theory*. Oxford University Press. <https://doi.org/10.1093/oso/9780199256044.001.0001>
- Luck, R. (2018). Participatory design in architectural practice: Changing practices in future making in uncertain times. *Design Studies*, 59, 139–157. <https://doi.org/10.1016/j.destud.2018.10.003>
- Miessen, M. (2010). *The nightmare of participation*. Sternberg Press.
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, 6(7), Article e1000097. <https://doi.org/10.1371/journal.pmed.1000097>
- Mouffe, C. (2013). *Agonistics: Thinking the world politically*. Verso.
- Oxman, R. (2006). Theory and design in the first digital age. *Design Studies*, 27(3), 229–265. <https://doi.org/10.1016/j.destud.2005.11.002>
- Sadler, S. (2005). *Archigram: Architecture without architecture*. MIT Press.
- Salama, A. M. (2015). *Spatial design education: New directions for pedagogy in architecture and beyond*. Routledge. <https://doi.org/10.4324/9781315610276>
- Schechner, R. (2013). *Performance studies: An introduction* (3rd ed.). Routledge. <https://doi.org/10.4324/9780203715345>
- Schumacher, P. (2011). *The autopoiesis of architecture: A new framework for architecture* (Vol. 1). John Wiley & Sons.
- Sicart, M. (2014). *Play matters*. MIT Press. <https://doi.org/10.7551/mitpress/10042.001.0001>
- Stevens, Q. (2007). *The ludic city: Exploring the potential of public spaces*. Routledge. <https://doi.org/10.4324/9780203961803>
- Tschumi, B. (1996). *Architecture and disjunction*. MIT Press.

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523–538.

<https://doi.org/10.1007/s11192-009-0146-3>

Van Eck, N. J., & Waltman, L. (2014). Visualizing bibliometric networks. In Y. Ding, R. Rousseau, & D. Wolfram (Eds.), *Measuring scholarly impact: Methods and practice* (pp. 285–320). Springer. https://doi.org/10.1007/978-3-319-10377-8_13

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, 18(3), 429–472.

<https://doi.org/10.1177/1094428114562629>