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Article

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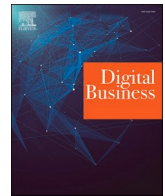
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Research trends in entertainment robots: A comprehensive review of the literature from 1998 to 2024

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ABSTRACT

Entertainment robots, a subset of social robots designed to engage users, constitute a crucial dimension of human–robot interaction. However, current research predominantly focuses on technical advancements, leaving non-technical aspects, such as user experience and emotional engagement, underexplored. This study examines the research trends and gaps in the field of entertainment robots through a bibliometric analysis of 237 academic works published between 1998 and 2024 and a systematic literature review of 26 non-technical studies published since 2016. The bibliometric analysis reveals a decline in publications after 2022 and highlights that most research has been conducted from a technical perspective, while the literature review identifies a lack of understanding of the human-centered aspects of entertainment robots, including emotional responses and long-term engagement. This study emphasizes the need for future research that address these gaps and is aligned with industry needs, particularly highlighting that more research is needed on user-centered designs that enhance human–robot interaction in entertainment contexts.

1. Introduction

The concept of the “social robot” was first introduced by Billard, Dautenhahn, and Breazeal in the early 20th century (Weber, 2008). Social robots are physical entities that operate within a complex and dynamic social environment and are equipped to act in ways that align with their own objectives as well as those of their community (Duffy, Rooney, O’Hare, & O’Donoghue, 1999). These robots are designed to engage with people naturally and interpersonally, often with the aim of creating positive outcomes across various fields, including education, healthcare, quality of life, entertainment, and communication (Breazeal, Dautenhahn, & Kanda, 2016).

Although the concept of social robots was established earlier, very few social robots were available to the general public from the 1990s into the early 21st century. However, with advancements in artificial intelligence (AI) and human–robot interaction (HRI) technologies, social robots began to emerge in the 2010s with applications in education, rehabilitation, therapy, tourism, and entertainment, leading to various studies on these robots (Belpaeme, Kennedy, Ramachandran, Scassellati, & Tanaka, 2018; Giansanti, 2021; Neerincx, Hiwat, & de Graaf, 2021; Nieto, Quesada-Arencibia, García, & Moreno-Díaz, 2014; Rakhymbayeva, Amirova, & Sandygulova, 2021).

The market for social robots and entertainment robots is also experiencing rapid growth. Blue Frog Robotics, a leader in the entertainment robotics market, projects that by 2025, the consumer robotics industry will reach \$41 billion globally, with the entertainment robot sector accounting for \$29 billion (Blue Frog, n.d.). Additionally, another report predicts that the entertainment robot market will grow to \$89.42 billion by 2028, with a compound annual growth rate (CAGR) of 25.5 % (The Business Research Company, 2024).

Despite the significance of entertainment as an application for social robots, most previous research has examined their practical uses, such as in education or therapy, leaving the entertainment aspect largely unexplored. A bibliometric analysis of 3334 social robotics articles revealed that over 90 % could be categorized into eight clusters, including ‘robots as social partners,’ ‘human factors and ergonomics in human robot interaction,’ and ‘robotics for child development,’ but very few focused on entertainment applications (Weber, 2008). Similarly, another bibliometric analysis of social robot interaction design identified five clusters, none of which included entertainment as an application (Wang, Chen, Huo, Mai, & Jia, 2023).

Evidently, the entertainment application of social robots—a widely accepted use—has often been overlooked in research. This oversight has led to a gap between research and industry. Scholars have raised

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concerns about this disparity, attributing it to technical challenges, economic factors, and legal, ethical, and societal issues. (Tulli, Ambrossio, Najjar, & Rodríguez Lera, 2019). This gap may lead to disappointment and dissatisfaction among users (Berzuk & Young, 2023). The disconnect is particularly evident in the entertainment aspect, which serves as a foundation for human–robot relationships (Pollmann, Loh, Fronemann, & Ziegler, 2023). To maintain the essential function of social robots—i.e., engaging with people—it is crucial to bridge the gap between research and industry concerning their applications in entertainment.

In sum, the rapid advancement of AI and HRI technologies has brought social robots to the forefront of various industries, including education, healthcare, and entertainment. Among these applications, entertainment robots as a subset of social robots hold unique potential to enhance human experiences through leisure and emotional engagement. “Entertainment” is broadly defined as the act of capturing and maintaining attention, often evoking emotional responses. Despite the unique potential, research on entertainment robots has largely lagged. Furthermore, most previous studies have focused on technical developments rather than the human-centered aspects which are crucial for interaction and engagement.

This study aims to assess research trends and identify gaps in the field of entertainment robots by conducting a bibliometric analysis and systematic literature review. Specifically, this study emphasizes the importance of understanding the human dimensions of entertainment robots, bridging the disconnect between technological advancements and user needs. Furthermore, the study tries to underline why entertainment robots deserve focused attention compared to other types of robots. By doing so, this study may contribute to the theoretical and practical understanding of entertainment robots in a rapidly evolving industry.

2. Literature review

Robots can be broadly categorized as industrial robots or service robots, as outlined by the International Organization for Standardization (ISO) and the International Federation of Robotics (IFR). Service robots, which are used for non-industrial purposes, are further classified into professional or commercial robots and personal or non-commercial robots. Professional or commercial service robots are typically deployed in a healthcare or hospitality setting, whereas personal robots are typically used for domestic or leisure purposes. Social robots, as a subset of service robots, can fall under either the professional or personal categories as illustrated in Fig. 1.

Social robots differ from autonomous mobile robots in that autonomous robots are typically employed by specialists or used to perform specific tasks, while social robots are designed for interpersonal interaction and are often regarded as partners in fields such as education, healthcare, and entertainment (Breazeal et al., 2016). This distinction highlights a key characteristic of a social robot: their ability to engage with humans naturally and socially. Similarly, service robots, which include social robots, are defined as machines perceived as social entities capable of human interaction (Belanche, Casaló, Flavián, & Schepers, 2020). However, “service robot” is generally a broader term, often encompassing robots with purely functional behaviors and minimal interpersonal interaction; whereas, “social robots” are uniquely designed for rich human interaction and are considered a specialized subset of service robots (Dautenhahn, Ogden, & Quick, 2002, p. 1).

Social robots can be further classified based on their applications, including education, therapy, rehabilitation, and entertainment. However, as a single robot can often serve multiple functions, these classifications are sometimes used interchangeably. In accordance with the IFR’s classification of service robots by application, this study treats entertainment robots as a sub-category of consumer robots designed for social interaction.

Entertainment robots are a subset of social robots that embody the

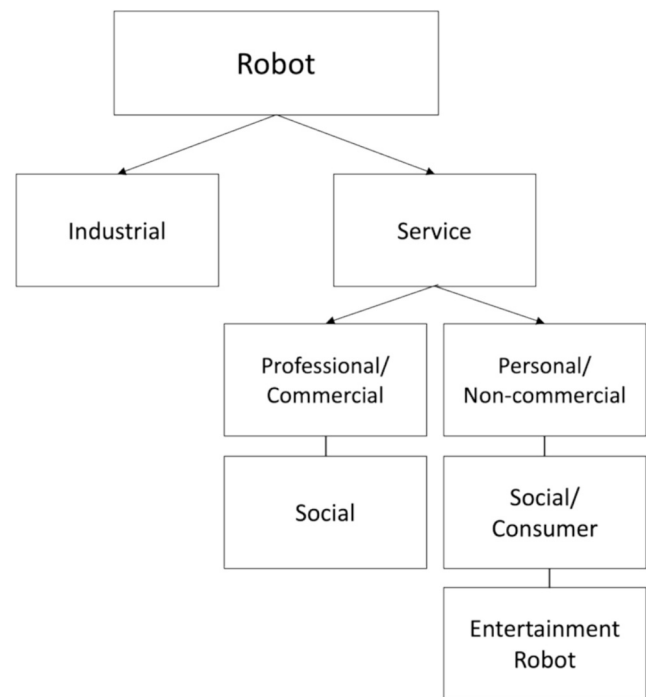


Fig. 1. Classification of Robots.

characteristics of both social robots and service robots. These robots are specifically designed to interact with people for the purpose of providing leisure and entertainment. While the term “entertainment” is broad and can vary across contexts, it generally refers to activities that capture and maintain attention of an audience, whether they are watching or listening. However, despite the increasing relevance in various industries, there is a lack of unified conceptualization of entertainment robots in academic literature. Existing research has largely focused on technological advancements, leaving the entertainment aspect underexplored. This gap has contributed to a disconnect between industry practices and academic research, particularly in defining and operationalizing entertainment within social robotics.

This study addresses the gaps by conducting both a bibliometric analysis and a systematic literature review. The strengths of bibliometric analysis and systematic literature review lie in their complementary nature, enabling a comprehensive examination of research trends and deeper insights into underexplored areas. Bibliometric analysis is particularly valuable for identifying quantitative patterns in research, offering a macroscopic overview of the academic landscape. As the interest in social robotics grew, bibliometric analysis was used by various researchers to capture the comprehensive and unbiased picture of the field. Mejia and Kajikawa conducted bibliometric analysis of social robotics and found eight major clusters regarding social robots (Mejia & Kajikawa, 2017) and Goeldner et al. analyzed publications and patents of care robotics (Goeldner, Herstatt, & Tietze, 2015).

In contrast, systematic literature reviews provide qualitative insights by synthesizing diverse findings and highlighting recurring themes (Donthu, Kumar, Mukherjee, Pandey, & Lim, 2021). Lambert et al. was able to identify the trends and future directions of the field of social robotics by systematically reviewing 10 years of research in the field of social robotics and Góngora Alonso et al. was able to show the acceptance of older people toward social robots through systematic review (Góngora Alonso et al., 2019; Lambert, Norouzi, Bruder, & Welch, 2020).

Together, these approaches “complement each other to ... identify key concepts and themes, uncover research gaps, and set areas for future research” (Cheng, Edwards, Darcy, & Redfern, 2018, p. 1005). In addition, it allows for a balanced perspective that incorporates

technical, human-centered, and societal dimensions. By integrating social science perspectives into traditionally technical fields, these methods uncover how human and societal factors influence the development and adoption of technologies like entertainment robots. This interdisciplinary perspective is critical for bridging the gap between technological innovation and its real-world applications. Accordingly, this paper presents the following research questions.

RQ 1: What are the current trends in academic research on entertainment robots?

RQ 2: What are the possible research gaps in the existing academic research on entertainment robots?

Based on these research questions, the remainder of this paper is organized as the following. First, bibliometric analysis and its results will be outlined, followed by systematic literature review and its results. Finally, based on the findings, a discussion and conclusion section will be presented.

3. Bibliometric analysis

3.1. Methodology

3.1.1. Literature collection process

Bibliometric analysis was utilized to address the research questions by synthesizing and examining previous research on entertainment robots (Donthu et al., 2021). For the analysis, relevant papers on entertainment robots were collected following the process outlined in Fig. 2. Scopus was used to search for literature related to entertainment robots, and it was selected as the primary database for this process because it “indexes a larger number of journals than [PubMed, Web of Science, and Google Scholar]” and “includes a more expanded spectrum of journals” than other databases (Falagas, Pitsouni, Malietzis, & Pappas, 2008, p. 339). Search keywords such as “social robot” or “service robot,” combined with “entertainment,” were used in the search. Conference reviews, notes, and books were excluded, and the search was restricted to titles, abstracts, and keywords. Boolean operators like ‘AND’ and ‘OR’ were applied to identify literature that included both ‘social robot’ and ‘entertainment’ or ‘service robot’ and ‘entertainment’ within the search parameters.¹

The terms ‘social robot’ and ‘service robot’ were searched separately, given their closely related definitions. Additionally, because the literature on entertainment robots is limited, all works that met the search criteria were included without restricting the time frame or subject area. The earliest relevant literature identified was published in 1998. Consequently, this study includes literature published from 1998 to April 2024. After screening for errors and duplicates, 2 studies were excluded, resulting in a final count of 237 studies. Among these, 142 were conference papers, 74 were articles, 12 were book chapters, and 9 were reviews.

3.1.2. Bibliometric analysis

Scopus enables users to extract bibliometric data for each publication, including details such as publication year, authors, title, abstract, and more. With this feature, the bibliometric data were exported into Excel. The analysis and visualization of the data were then performed using Excel and the free software program VOSviewer (van Eck & Waltman, 2010). Each publication was coded based on factors such as co-authorship, funding status, country of affiliation, continent of affiliation, and research area. VOSviewer was specifically used to analyze keyword co-occurrence and co-authorship patterns.

¹ “(TITLE-ABS-KEY (entertainment AND ‘social robot’) OR TITLE-ABS-KEY (entertainment AND ‘service robot’)) AND (LIMIT-TO (LANGUAGE, ‘English’)) AND (EXCLUDE (DOCTYPE, ‘cr’) OR EXCLUDE (DOCTYPE, ‘no’) OR EXCLUDE (DOCTYPE, ‘bk’))”.

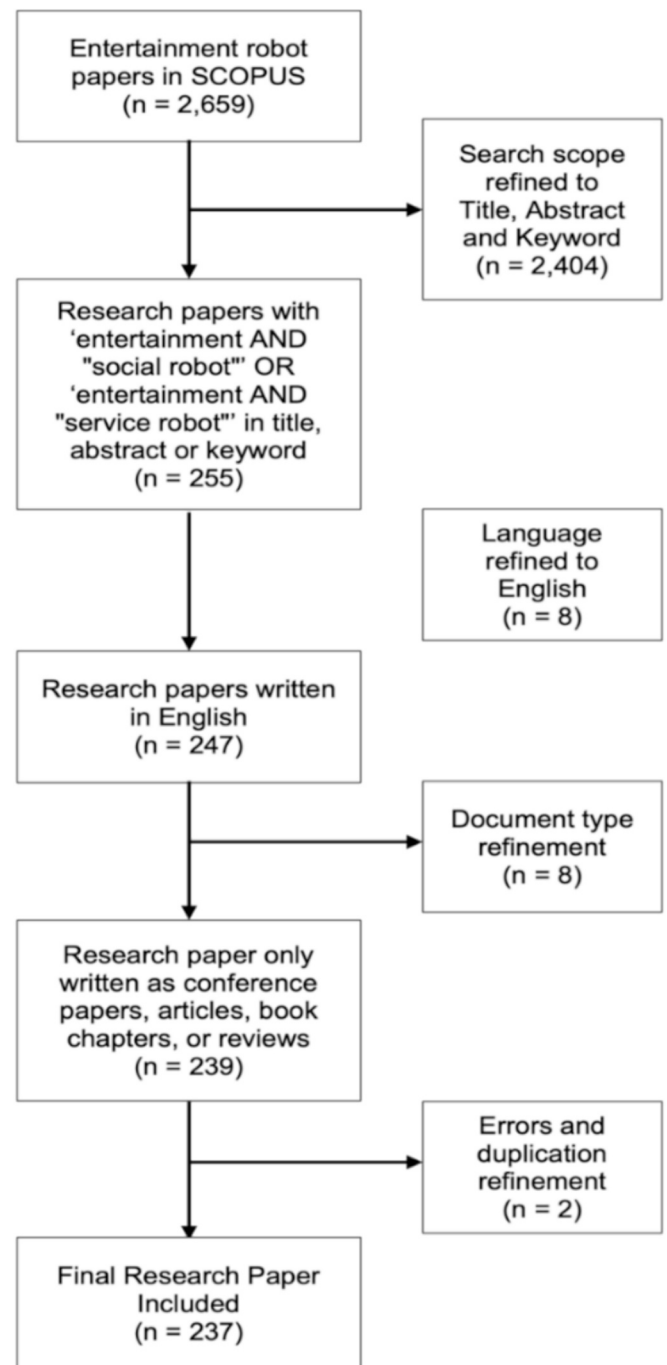


Fig. 2. Paper Collection Process.

3.2. Results

3.2.1. Publication by year

The number of publications over time on a particular topic represents the growing (or diminishing) interest in that specific topic. As depicted in Fig. 3, the number of publications related to entertainment robots has steadily increased since 1998. Between 1998 and 2015, the annual number of publications remained modest, ranging from one to ten papers annually. However, since 2016, there has been a marked increase, with the number of publications peaking at 30 for the year 2021. This rapid growth can be attributed to the development of artificial intelligence (AI), which has significantly impacted the development of entertainment robots, in the mid-2010s. Notably, the progress of entertainment robots has followed the growth of AI. In fact, one of the

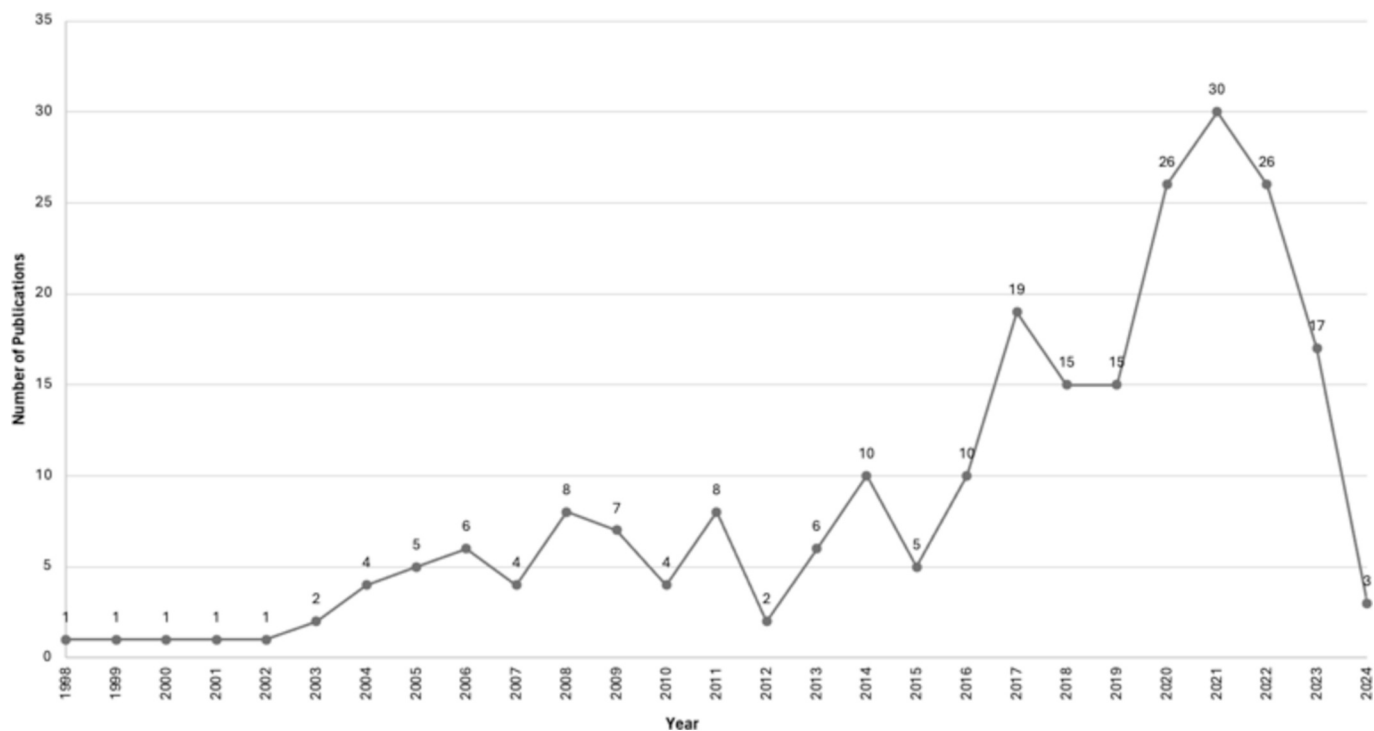


Fig. 3. Publications by Year.

first entertainment robots, AIBO (which stands for ‘Artificial Intelligence RoBOT’), relied on AI. Social robots equipped with AI are capable of interacting with humans both verbally and non-verbally, which enables them to elicit social responses from users (Fosso Wamba, Queiroz, & Hamzi, 2023). Sarrica, Brondi, and Fortunati (2020), who explored both scientific and popular definitions of social robots, also emphasized that AI has enabled social robots to respond to environmental cues. Consequently, the advances in AI technology during the mid-2010s spurred the development of various social robots, including those with entertainment functions, leading to a corresponding increase in publications. This pattern aligns with trends in bibliometric and systematic analyses of social robots across various domains, such as education (Fosso Wamba et al., 2023; Pai, Shetty, Dinesh, Shetty, & Pillai, 2024).

However, despite this growth, there has been a noticeable decline in publications after 2021. This trend may be attributed to several factors, including discrepancies in expectations between users, the market, and companies, as noted by Tulli et al. (2019). In addition, promising companies, including those affiliated with universities, have struggled, which has contributed to a decline in the field. From the late 2010s to the early 2020s, many publications focused on social robots, either through case studies or technological discussions on their integration into various applications. A limited number of studies also explored the role of social robots during the COVID-19 pandemic. Nevertheless, after reaching its peak in 2021, research output has experienced a decline, indicating a possible reduction in industry or academic enthusiasm for entertainment robots.

3.2.2. Authors’ affiliations and affiliated countries

A total of 160 authors contributed to the 237 publications analyzed.

Of these authors, 88.1 % ($n = 141$) participated in one or two publications, while a smaller group of 19 authors contributed to three or more papers. This concentration of productivity among a small number of researchers is consistent with patterns observed in other academic fields, where a select group of authors accounts for the majority of publications (van Nunen, Li, Reniers, & Ponnet, 2018). The bibliometric analysis highlighted the significance of key contributors and institutions in advancing research on entertainment robots. (See Footnote 2).²

It should be noted that the ‘affiliations’ of the authors refer to the academic or research institutions they are associated with, which information can offer key insights into the context in which their research is conducted. These affiliations also highlight geographical imbalances, showing which countries and continents are leading in entertainment robot research. To examine the affiliations, each piece of literature was coded based on the institutions listed. For publications with multiple affiliations, all were included in the coding process. In Fig. 5, the countries are color-coded, with darker shades representing more publications originating from those nations. The top five countries in terms of publication volume are the United States (50 publications), Spain (25), Japan (21), China (20), and Germany and the United Kingdom (14 each). On a continental scale, Europe led the way with 128 publications, followed by Asia with 101 and North America with 56. Table 1 offers a detailed breakdown of these figures by continent and country, revealing that Spain, China, the United States, Australia, and Brazil were the most prolific nations within their respective regions for entertainment robot research.

3.2.3. Fields of study

In this study, the Scopus filter count function was utilized to examine

² The most productive author is Malfaz, followed by Salichs, Castro-González, Breazeal, and Maroto-Gómez. Four of these five authors are affiliated with Charles III University of Madrid, which serves as a central hub for entertainment robot research. Co-authorship analysis confirmed strong collaboration within this group, as shown in the co-authorship network visualization. (See Fig. 4.)

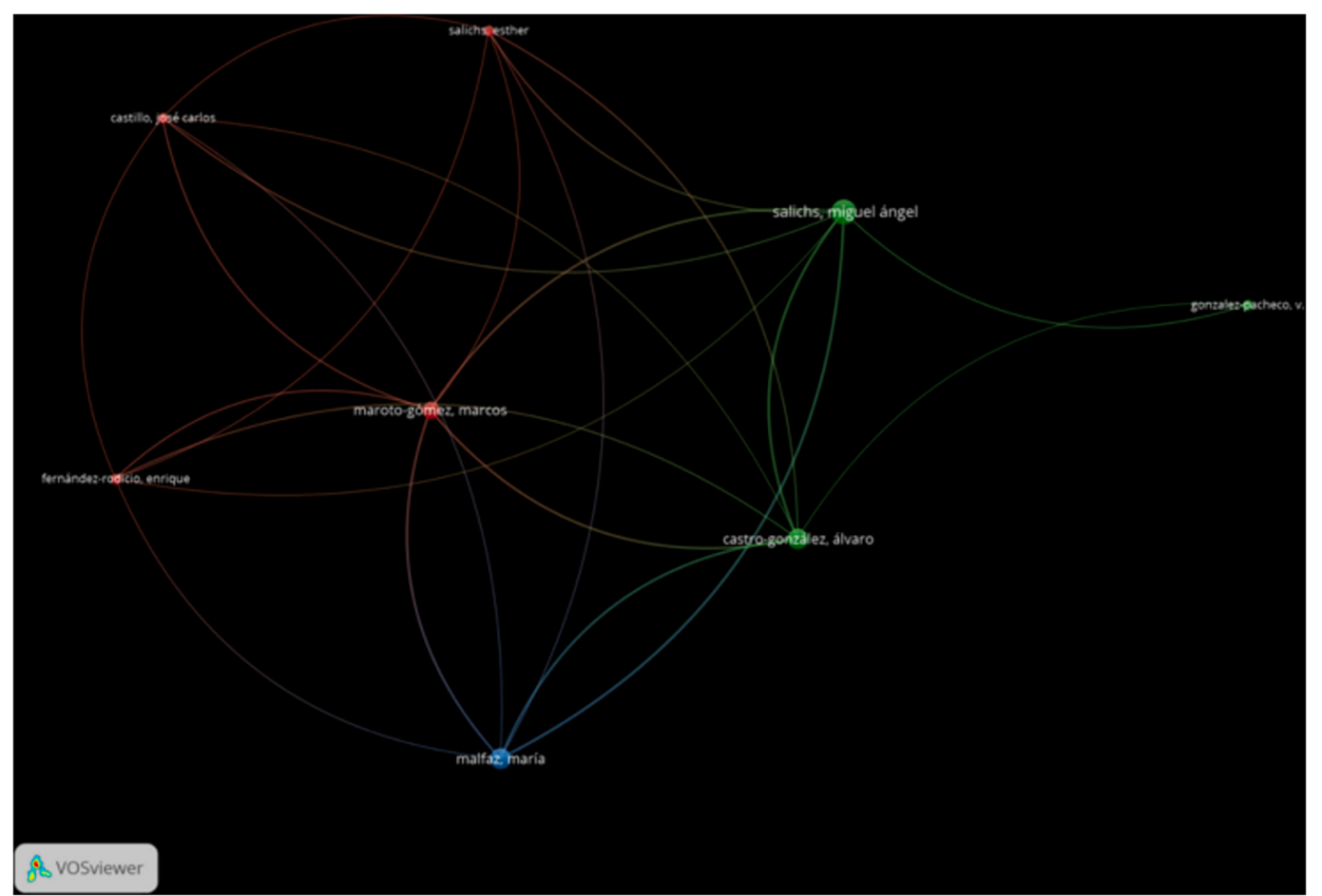


Fig. 4. Co-Authorship.

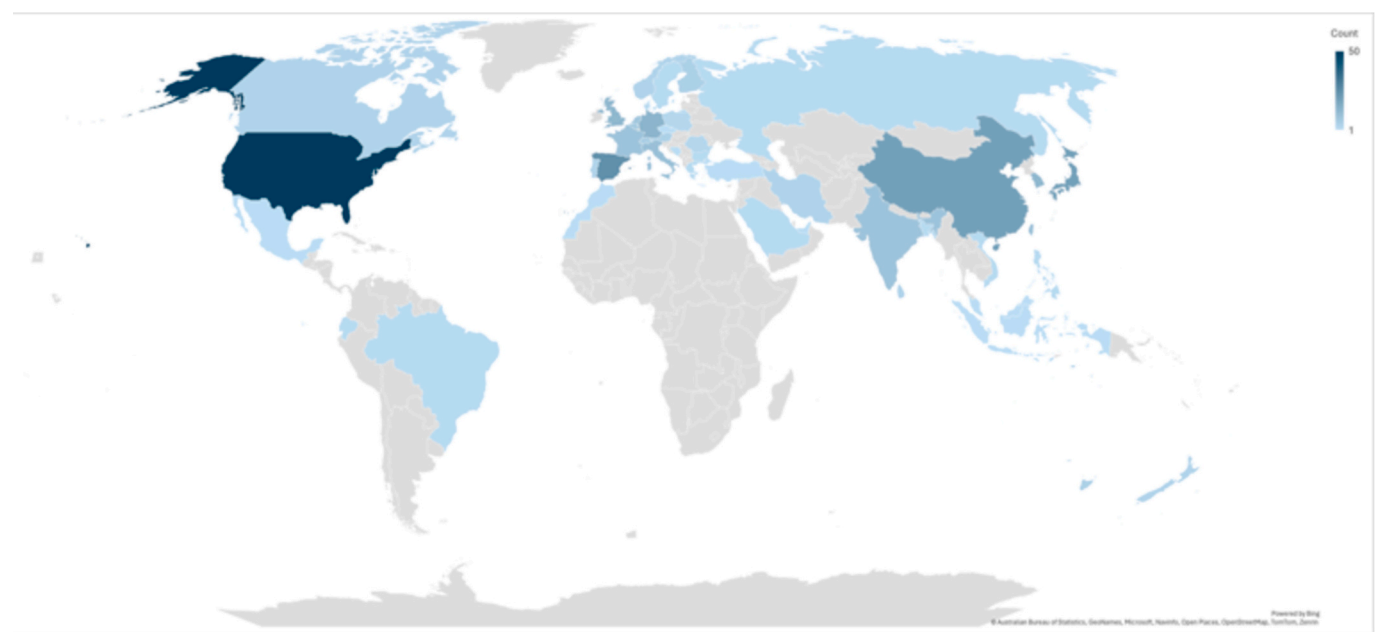


Fig. 5. Authors' Affiliated Countries.

the distribution of fields of study among the collected literature. The majority of publications were concentrated in science, technology, engineering, and mathematics (STEM) disciplines, including computer

science, engineering, and mathematics, and only 68 papers fell under non-STEM categories, even when fields such as health professions and multidisciplinary studies were considered (see Table 2). The bolded non-

Table 1
Authors' Affiliated Countries and Continents.

Continent	Countries (Count)	Count	%
Europe	Spain (25) , Germany (14), United Kingdom (13), Italy (10), France (9), Netherlands (8), Belgium (7), Switzerland (6), Austria (5), Finland (5), Norway (4), Portugal (4), Poland (3), Romania (3), Bulgaria (2), Denmark (2), Greece (2), Sweden (2), Bosnia and Herzegovina (1), Czech Republic (1)	126	42.71 %
Asia	China, Japan (20) , South Korea (13), Taiwan (10), India (9), Iran (4), Sri Lanka (4), Singapore (3), Bangladesh (2), Hong Kong (2), Philippines (2), Russian Federation (2), Saudi Arabia (2), Vietnam (2), Brunei Darussalam (1), Indonesia (1), Malaysia (1), Turkey (1), United Arab Emirates (1)	100	33.90 %
North America	United States of America (50) , Canada (4), Mexico (1)	55	18.64 %
Oceania	Australia (5) , New Zealand (4)	9	3.05 %
South America	Brazil, Ecuador (2)	4	1.36 %
Africa	Morocco (1)	1	0.34 %
Antarctica	N/A	N/A	N/A
Total (Multi-Coded)		295	100 %

Table 2
Fields of Study.

Field	Count (%)
Computer science	199 (42.16 %)
Engineering	107 (22.67 %)
Mathematics	47 (9.96 %)
Social sciences	25 (5.30 %)
Psychology	17 (3.60 %)
Arts and humanities	12 (2.54 %)
Medicine	9 (1.91 %)
Decision sciences	7 (1.48 %)
Health professions	6 (1.27 %)
Physics and astronomy	6 (1.27 %)
Biochemistry, genetics, and molecular biology	4 (0.85 %)
Business, management, and accounting	4 (0.85 %)
Chemical engineering	4 (0.85 %)
Energy	4 (0.85 %)
Materials science	4 (0.85 %)
Neuroscience	4 (0.85 %)
Chemistry	3 (0.64 %)
Environmental science	3 (0.64 %)
Multidisciplinary	3 (0.64 %)
Nursing	3 (0.64 %)
Economics, econometrics, and finance	1 (0.22 %)
Total (Multi-Coded)	472 (100 %)

STEM fields listed in Table 3, which include the social sciences; psychology; arts and humanities; health professions; business, management, and accounting; multidisciplinary studies; and economics; accounted for just 14.4 % of the total publications. This suggests that non-technical aspects, such as psychological and economic factors, may not have received sufficient attention, contributing to the gap between academic expectations and practical outcomes. Given that social robots are designed to interact with users, understanding human behavior is just as important as technological advancement. In particular, some

studies suggest that theories related to human interactions could also be applicable to robots, and psychological phenomena like the tendency for people to react differently to mistakes based on their perception of the individual's capabilities may also influence interactions with robots (Berzuk & Young, 2023).

The Scopus filter count function allows for multi-coding, which means that a single document can be classified under more than one non-STEM field, potentially inflating the numbers. To correct for this, each publication was manually coded according to the filters provided by Scopus. This process revealed that only 45 out of 237 publications, or 18.99 %, belonged to non-STEM fields. Although this percentage is higher than the initial estimate, it still indicates that most of the research has focused on technical perspectives.

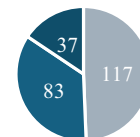
3.2.4. Co-work analysis

Fig. 6 presents the collaboration status of the studies, classifying the collected literature into three groups based on the author affiliations. The first group includes studies where all authors were from the same institution within the same country, representing 49.4 % of the total ($n = 117$). The second group comprises collaborations between authors from different institutions within the same country, accounting for 34.7 % ($n = 83$). The third group includes collaborations between authors from institutions in different countries, which constitutes 15.9 % ($n = 37$). These findings suggest that about half of the research was conducted by authors affiliated with the same institution in the same country, and even when authors were from different institutions, most were from the same country.

With the rapid increase in publications since 2016, it is appropriate to compare the trends between two distinct periods: 1998–2015 (Period 1) and 2016–2024 (Period 2). In both periods, a similar amount of research involved collaboration with non-academic organizations, such as robotics or manufacturing companies. However, the proportion of research involving non-academic organizations was higher in the earlier period, with about 23 % of studies involving such partnerships. This figure dropped to 11 % in the later period, indicating that a larger share of research is now being conducted by academic institutions. Fig. 7 shows the breakdown of research conducted by academic and non-academic organizations. This shift toward academic-led research may also be contributing to the growing divide between research and industry. Because developing and commercializing robots requires market expertise, which is often lacking in university affiliates, it is essential that academic researchers collaborate closely with industry to bridge this gap and ensure that research aligns with practical market needs (Tulli et al., 2019).

3.2.5. Funding

The level of research funding can often reflect the level of public interest in a particular topic. As shown in Table 3, 57.64 % ($n = 147$) of the research analyzed did not receive any external funding. Among the studies that did receive financial support, some were funded by more



- Same Country, Same Affiliation
- Same Country, Different Affiliation
- Different Country, Different Affiliation

Fig. 6. Co-Work Status.

Table 3
Funding Status.

Funding	Count (%)
None	147 (57.64 %)
Public – National/Continental	75 (29.41 %)
Public – University	29 (11.37 %)
Private	4 (1.57 %)
Total (Multi-Coded)	255 (100 %)

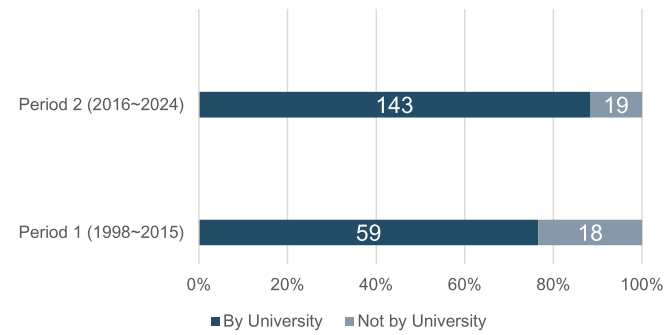


Fig. 7. Proportion of research involving non-academic organizations by period.

than one organization, leading to multiple sources of funding being counted. Out of the 92 funded studies, 75 were supported by national or continental organizations, such as the European Commission and the European Research Council. Additionally, 29 studies received funding from universities, and 4 were backed by private sources. The most active contributors to national or continental funding were the European Union and the European Research Council, followed by organizations in Australia, Brazil, and China.

3.2.6. Keywords analysis

Table 4 presents the 20 most frequently used keywords in the analyzed literature. The top five keywords are “social robots,” “robotics,” “robots,” “human-robot interaction,” and “machine design.” This suggests that entertainment robots are strongly associated with social robots and that human–robot interaction is a key element in their functionality. Other frequently mentioned terms, such as “human-computer interaction” and “artificial intelligence,” further emphasize the importance of interactions between humans and robots in the context of entertainment robots. Additionally, as shown in Table 5, the list includes a variety of robot types, such as agricultural, mobile, anthropomorphic, and educational robots. This diversity reflects the multifunctional nature of social robots, which often serve multiple roles. For instance, it is not uncommon for a social robot to function simultaneously as a companion, assistant, and entertainment provider.

A co-occurrence analysis of all keywords, performed using VOS-viewer and including both author and index keywords, produced similar results (Fig. 8). This analysis was based on bibliographic data from Scopus where, out of 1952 keywords, 53 met the threshold of at least five occurrences. These 53 keywords were then grouped into seven clusters. As displayed in Table 5 and Fig. 8, the first cluster, highlighted in red, includes terms such as “social robot,” “HRI” (human–robot interaction), “man-machine systems,” “social robotics,” and “speech recognition.” These keywords emphasize the interaction between humans and robots, which is a key component of social robots. Additional terms like “face recognition,” “machine learning,” and “deep learning” were also grouped in this cluster, reflecting technologies commonly used in robots to improve their interaction with users.

The second cluster, marked in yellow in Fig. 8, contains keywords

Table 4
Top 20 Most Common Keywords.

Keyword	Count	Keyword	Count
Social robots	126	Man machine systems	31
Robotics	75	Human computer interaction	25
Robots	63	Anthropomorphic robots	22
Human-robot interaction	49	Entertainment	22
Machine design	49	Social robot	21
Intelligent Robots	40	Entertainment robots	20
Human-robot interaction	38	Social robotics	20
Service robots	37	Artificial intelligence	19
Agricultural robots	35	Educational robots	19
Mobile robots	35	Behavioral research	16

Table 5
Keyword Clusters.

Cluster Color (Topic)	Major Keywords
Red (Interaction)	Social robot, HRI, man-machine systems, social robotics, speech recognition
Yellow (Types of robots)	Agricultural robots, anthropomorphic robots, entertainment robot, humanoid Robot
Green (User experience)	Machine design, intelligent robots, service robot, mobile robots, human computer interaction, industrial robots
Blue (Healthcare)	Robot, robotics, economic and social effects, older adults
Purple (Behavioral)	Educational robots, artificial intelligence, entertainment, behavioral research
Turquoise (Robot design)	Robot design
Orange (Social interactions)	Social interactions

Note. HRI = human–robot interaction.

such as “agricultural robots,” “anthropomorphic robots,” “entertainment robots,” and “humanoid robots.” These terms represent different types and applications of social robots, demonstrating that the entertainment aspect has been incorporated across various robot forms. For example, the design of these robots—whether anthropomorphic, humanoid, or zoomorphic—plays a crucial role in entertainment-related interactions. Previous research has highlighted how factors like a robot’s appearance, familiarity, and degree of human-like characteristics can significantly affect people’s interest in and communication with robots (Barnes, FakhrHosseini, Jeon, Park, & Howard, 2017; Kamide, Kawabe, Shigemi, & Arai, 2013).

The third group, highlighted in green in Fig. 8, includes keywords such as “machine design,” “intelligent robots,” “service robots,” “mobile robots,” “human computer interaction,” and “industrial robots.” These terms are closely related to the user experience, which emphasizes how the design of the machine and its applications across different fields can influence how users interact with and perceive robots.

The fourth group, shown in blue in Fig. 8, includes keywords such as “robot,” “robotics,” “economic and social effects,” and “older adults.” Some less frequently mentioned terms include “elderly care,” “patient rehabilitation,” “diseases,” and “children.” These keywords represent healthcare domain where entertainment robots are commonly applied. Social robots with entertainment functions are widely used in healthcare domain, particularly for rehabilitation and care of older individuals and children. While the primary objective of these robots is to improve user well-being, they often provide entertainment either as a core function or as an additional benefit.

The fifth group, represented in purple in Fig. 8, includes keywords such as “educational robots,” “artificial intelligence,” “entertainment,” and “behavioral research.” These terms relate to behavioral aspects of robots, which play a crucial role in the functioning of social robots.

Finally, two smaller clusters were identified, shown in turquoise and orange in Fig. 8, and each contained a single keyword—“robot design” and “social interactions,” respectively. These keywords highlight fundamental aspects of social robotics. As previously discussed, social interaction is a defining characteristic that distinguishes social robots from other autonomous robots, and the design of the robot influences its interaction capabilities. However, in comparison to the large red cluster, which focuses on technical aspects of social robot interaction, these two clusters are much smaller and contain fewer related keywords. This further illustrates the notable gap between research and industry in non-technical areas of study.

4. Systematic literature review

4.1. Methodology

To further identify the current trends in the academic research on entertainment robots, a systematic literature review was conducted. A

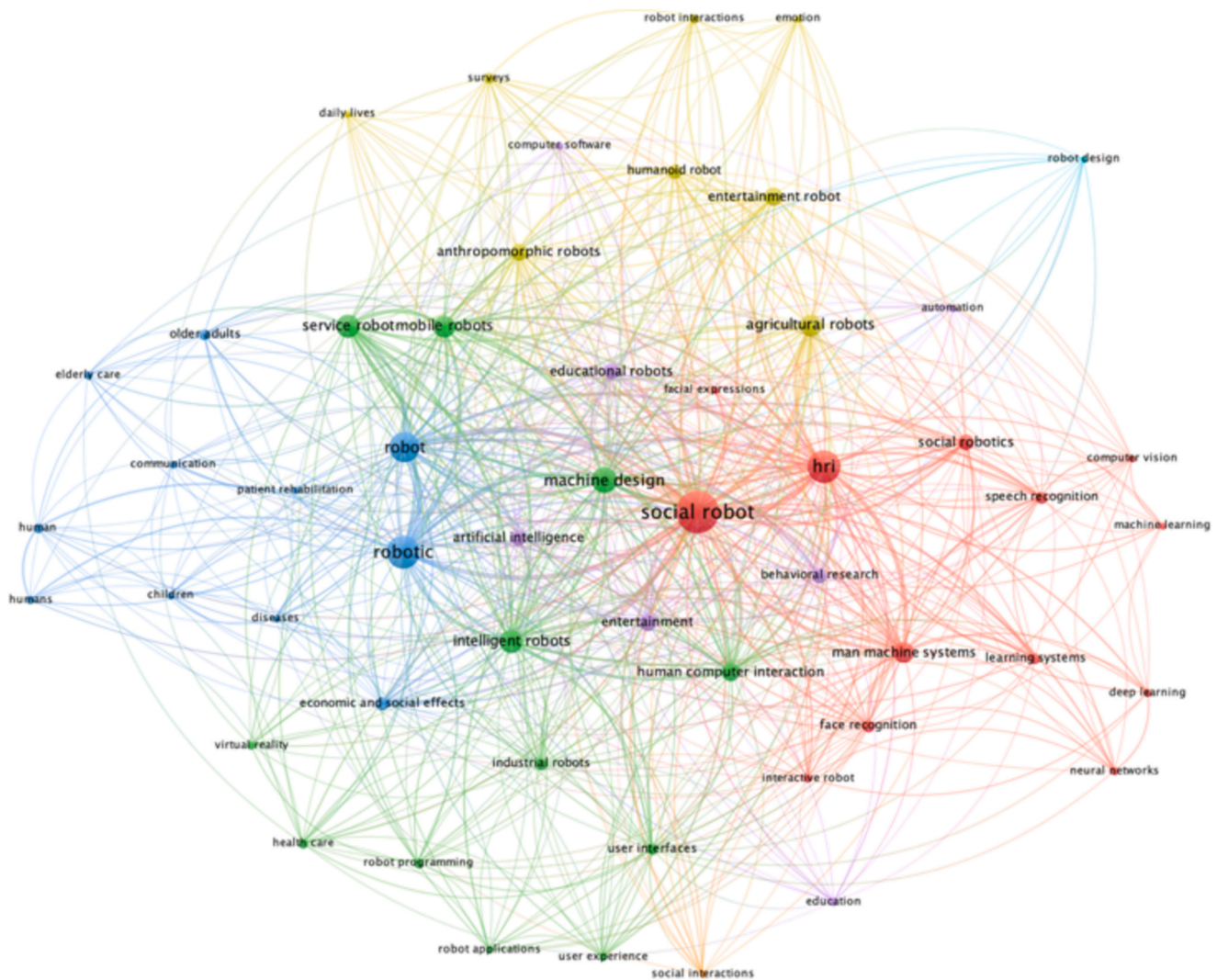


Fig. 8. Co-occurrence Analysis of All Keywords.

systematic literature review “summarizes and synthesizes the findings of existing literature on a research topic or field” (Donthu et al., 2021, p. 287). Of the 237 papers included in the bibliometric analysis, 26 were included in the systematic literature review. To minimize bias and to improve transparency, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adopted for the literature selection. The PRISMA method “ensure[s] that the process of selecting and analyzing papers for inclusion is transparent and provides a clear reference point for others in the field, distinguishing this research from previously published work on similar topics” (Booth, Chaperon, Kennell, & Morrison, 2020, p. 2).

Regarding field of study, only papers written in the arts and humanities; business, management, and accounting; economics, econometrics, and finance; health professions; psychology; the social sciences; and multidisciplinary subject areas were included for further screening. After excluding literature from technical domain, 47 records were retrieved for further screening. 5 literatures were excluded for no access and 10 were excluded after abstract screening for reasons such as written from technical perspective and duplication. Remaining 32 literatures were fully screened and of these 32, another 6 papers were excluded if the literature was published before 2016 or if the focus of the study was technology integrated in social robots. In contrast to the bibliometric analysis, for the systematic literature review, only papers published after 2016 were included because there was a rapid growth in publications after 2016 due to the advancement of AI, as mentioned

earlier. This cut-off was chosen because the advancement of AI around this time significantly increased the volume of publications on entertainment robots. As AI development progressed, it enabled social robots to interact with humans in unprecedented ways. Consequently, a fundamental distinction can be made between social robots with AI capabilities and those without. To accurately capture this shift, only articles published after 2016 were included in this review, resulting in the selection of 26 papers. The process of final literature selection is outlined in Fig. 9.

4.2. Results

4.2.1. Definition of social robots/service robots and entertainment robots

Of the 26 papers, 16 provided definitions of social robots or service robots, and most of these definitions focused on the social aspect of social robots. These definitions included descriptions such as ‘mimicking human behavior,’ ‘social,’ ‘human–robot interaction,’ and ‘human–human interaction.’ On the other hand, some definitions emphasized the diverse functionality of social/service robots by including descriptions of social/service robots performing tasks in diverse locations/applications. Notably, all 16 papers that provided definitions of social robots/service robots included descriptions of their social aspect. When the definitions were multi-coded, only 5 papers provided additional descriptions of social/service robots’ functionality. The list of sources that provided definitions is outlined in Table 6. From these sources, we can

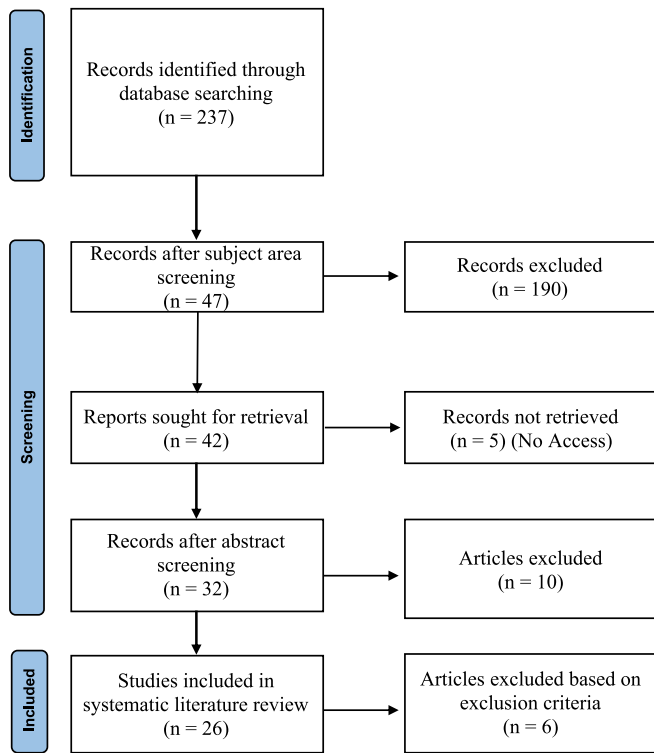


Fig. 9. PRISMA Diagram.

Table 6

Sources that Provide Definitions of Social/Service Robot.

Focus of definition	Source	Count (Multi-Coded)
Social aspect	Andriella, Huertas-Garcia, Forgas-Coll, Torras, & Alenya, 2020; Breazeal et al., 2016; Cao et al., 2023; Celiktutan, Sariyanidi, & Gunes, 2018; Cooney & Sant'Anna, 2017; De Gauquier, Brengman, Willems, Cao, & Vanderborght, 2021; de Jong, Peter, Kühne, & Barco, 2022; Dinesen et al., 2022; Gültekin, 2022; Huisman & Kort, 2019; Joo, Kim, & Hwang, 2023; Kiderle, Ritschel, Mertes, & André, 2023; Salichs et al., 2020; Salimi, Jenabi, & Bashirian, 2021; Steinhäusser et al., 2022; Westlund, Park, Williams, Breazeal, & ACM., 2018	16
Functional aspect	Cooney & Sant'Anna, 2017; Dinesen et al., 2022; Joo et al., 2023; Salichs et al., 2020; Steinhäusser et al., 2022	5

infer that the understanding of social robots does not differ widely from paper to paper. In other words, since the advent of social robots, a consensus has been established that a social robot is a social entity that interacts with human beings and has various applications.

On the other hand, only 3 papers provided definitions of entertainment robots or clarified the meaning of 'entertainment' as it pertains to entertainment robots (see Table 7). Not only were the definitions of entertainment/entertainment robots absent in most of the papers, but the provided definitions were also very loosely defined. For example, Shishehgar, Kerr, & Blake (2018) defined entertainment as an important feature for older adults, Cooney and Sant'Anna (2017) defined it as a fun and humorous act, and Del Vacchio et al. (2020) conceptualized it as a process that focuses on emotions.

This lack of clear definitions is an issue that various researchers have highlighted. Shishehgar himself lamented that very few studies have focused on the entertainment or recreational aspects of social robots,

Table 7

Papers that Define Entertainment/Entertainment Robots.

Study Title (Source)	Definition of Entertainment/Entertainment Robots
A Systematic Review of Research into How Robotic Technology Can Help Older People (Shishehgar et al., 2018)	Entertainment is an important feature for older adults, as a lack of entertainment can lead to poor decision-making, decreased well-being, and negative reactions to risky conditions
Avoiding Playfulness Gone Wrong: Exploring Multi-objective Reaching Motion Generation in a Social Robot (Cooney & Sant'Anna, 2017)	Robots provide entertainment through playful interactions, and playful means fun, happy, and humorous
Social Robots as a Tool to Involve Student in Museum Edutainment Programs (Del Vacchio et al., 2020)	Edutainment is a modern form of entertainment that aims to educate participants without drawing attention to the process by focusing on their emotions

and Cooney and Sant'Anna argued that conceptualizing the meaning of 'playful' requires an understanding of how humans attribute meaning and intentions, which is an extremely complex subject (Cooney & Sant'Anna, 2017; Shishehgar et al., 2018). De Gauquier et al. (2021) also highlighted that the entertainment feature has received very little academic attention with regard to social robots in the retail context. Given this lack of understanding regarding the meaning of 'entertainment,' many entertainment features provided by social robots remain rudimentary, without any real practical use. In the healthcare context, it has even been claimed that in their current stage of development, entertainment robots do not provide practical benefits over cheaper existing technology (Van Aerschoot & Parviainen, 2020).

4.2.2. Context/domain

Given that the word 'entertainment' is used to refer generally to the functionality of social robots, the literature review revealed that entertainment robots have been used in various contexts and domains. The most common use domain was care ($n = 13$), which included elderly care, health care in general, and disability care. There were also 4 papers that focused on the public domain, such as applications in restaurants or store contexts. Only 2 papers examined domestic usage, targeting the general public, and 1 study each explored the usage of social robots in museums and education. Interestingly, 5 papers did not specify the target context or domain but rather conducted their research in a lab environment. Overall, the fact that most papers were conducted in the care context demonstrates that the 'entertainment' feature of social robots is currently being operationalized mainly to entertain those in need rather than for everyday purposes.

4.2.3. Research gap/issues

Many papers identified research gaps and/or issues regarding entertainment robots such as the shortage of research in specific domains or topics despite their importance and differences between academia (expectations) and industry (reality). The identified issues in each study are listed in Table 8 and were clustered into 4 groups.

The most common issue was a lack of studies, reflected in Group 1. Specifically, 13 papers identified insufficient studies as a primary research gap. Interestingly, the shortage of studies on specific topics was also identified in systematic literature reviews. For example, Shishehgar and colleagues (2018), who reviewed 58 papers on robotic technologies in aged care contexts, identified 8 problems associated with older adults and highlighted several studies that addressed each of these problems. In particular, they determined that topics such as 'entertainment,' 'domestic,' and 'fall detection/prevention' were not receiving as much attention as other topics like 'companion' or 'telepresence.' This aligns with the findings of our bibliometric analysis that entertainment, among the many other features of social robots, has not received enough attention from researchers. In addition, many researchers identified a lack of studies related to specific user groups (e.g. specialists, young

Table 8
Identified Issues by Group.

Group	Study	Issue
1 (Lack of studies)	(Joo et al., 2023)	Insufficient studies regarding the experience economy of robot service
	(Shishehgar et al., 2018)	Identified 8 problems of older adults and robotic technologies used to address such problems. Researchers focused on psychological states more than other important aspects
	(Salimi et al., 2021)	Mixed results regarding the usability and effectiveness of robots in therapy of autism spectrum disorder, despite high expectations. More studies are required to fully understand the role of robots in therapy
	(Ma, Yang, Wang, & Song, 2022)	Insufficient studies from a product/service design perspective
	(de Jong et al., 2022)	Insufficient studies regarding children's acceptance of social robots in the domestic context
	(Gültekin, 2022)	Few studies have investigated the views of mental health specialists
	(Cao et al., 2023)	Insufficient studies regarding people's attitudes and expectations about using robots for autism care on the global stage
	(Menne & Schwab, 2018)	Insufficient research on users' emotions and facial expressions toward robots
	(De Gauquier et al., 2021)	Insufficient research regarding the specific placement of the robot
		Entertainment is a functionality that has been insufficiently explored in the retail context
	(Westlund et al., 2018)	Insufficient studies assessing young children's long-term relationships with social robots
	(Salichs et al., 2020)	Some research that examines social robots and older individuals does not use robots specifically designed for older adults
	(Kiderle et al., 2023)	Insufficient research on the use of humor in the dialogue context, despite increased research on entertainment
	(Del Vacchio et al., 2020)	Insufficient studies regarding social robots in the museum environment
	(Shishehgar et al., 2018)	25 % of all the studies were conducted in the USA and Japan.
	(Cooney & Sant'Anna, 2017)	Previous literature has not indicated how robotic motions appear playful without provoking negative perceptions such as obnoxious, untrustworthy, or unsafe.
2 (Lack of human understanding)		Understanding the human perception of playfulness is complex.
	(Celiktutan et al., 2018)	The current capability of social robots is limited, as understanding human interaction and modeling human mechanisms are challenging
	(Andriella et al., 2020)	Current robotic systems are still insufficient in terms of

Table 8 (continued)

Group	Study	Issue
		exhibiting social cues that are understandable by and natural to humans
	(Fernández-Rodicio, Maroto-Gómez, Castro-González, Malfaz, & Salichs, 2022)	Unclear understanding of how emotional processes are evoked in the human brain
	(Waycott, Zhao, Kelly, & Robertson, 2022)	Although a person-centered care approach is crucial, aged care activities are often designed as a one-size-fits-all model
		Technologies should be aligned with people's interests and values
		Organizational and social contexts should be taken into consideration
	(Tozadore et al., 2018)	As a robot loses novelty, user motivation and attention span decrease
3 (Financial issues)	(Bradwell et al., 2022)	The most researched robot pet (Paro) is too expensive. Other Joy for All (JfA) robots are more affordable but have been insufficiently researched
4 (Technological issues)	(Van Aerscht & Parviainen, 2020)	The role of robots in the care domain is still marginal because of R&D and manufacturing. The robots available on the market are only capable of simple tasks and, therefore, research is mostly based on imaginary scenarios or small-scale tests
	(Huisman & Kort, 2019)	More pre-programmed activities are required, as self-composing activities is too complicated

children) or contexts/domains (e.g. museums, retail) (De Gauquier et al., 2021; Del Vacchio et al., 2020; Gültekin, 2022; Westlund et al., 2018). Similarly, as seen in the bibliometric analysis, the majority of the studies regarding entertainment robots were written from a technical perspective, despite the diverse applications of entertainment robots. The lack of research attempting to understand users in different domains from a non-technical perspective could be one possible reason for this common issue.

The second most commonly highlighted issue was a lack of human understanding, which is reflected in Group 2. In this context, a lack of human understanding refers to the insufficient understanding of how humans process emotions or feelings and the lack of understanding of end-users with different cultural and social backgrounds. Comprising Group 2, 7 papers identified a lack of human understanding as an issue. According to Shishehgar et al. (2018), 25 % of the studies they reviewed were conducted in the United States and Japan, which aligns with the results of this study's bibliometric analysis, i.e., that most of the studies were conducted by researchers in just 5 countries. Other researchers highlighted the complexity of understanding what humans perceive as playful, how emotional processes can be modeled, and how human interactions work (Celiktutan et al., 2018; Cooney & Sant'Anna, 2017; Fernández-Rodicio et al., 2022). Taken together, these studies underscore the need to understand how human emotions and feelings work first before being able to build successful human–robot interactions. In addition, many researchers highlighted the possible differences between users with different societal and cultural backgrounds. However, only a few studies have investigated these differences, further exacerbating this issue.

Group 3 (Financial issues) and Group 4 (Technological issues)

comprised 1 and 2 papers, respectively. ‘Financial issues’ here refers to the high cost of current entertainment robots, which serves as a barrier to accessibility for users.

5. Discussion and conclusion

5.1. Discussion and future research directions

This study conducted a bibliometric analysis and a systematic literature review to explore research trends and identify gaps in the field of entertainment robots. The bibliometric analysis demonstrated that most of the reviewed literature was written from a technical perspective, with computer science being the most common subject area. These technical studies mainly examined the advancement of human–robot interaction and of the technologies applied in robots. The keyword co-occurrence analysis generated similar results, with social interaction identified only as a small cluster. However, as social robots are entities that interact with human beings, an understanding of human beings is also an important factor to consider. Ultimately, the lack of research on human factors and the lack of research from a non-technical perspective have led to a discrepancy between research and industry.

In addition, the ratio of research conducted by non-university organizations has decreased by half over time, and most of the reviewed literature was conducted by researchers with the same affiliation. As highlighted by researchers who criticized the discrepancy between industry and the market, designing and selling robots requires cooperative work with industry. Thus, future research should emphasize collaboration between diverse affiliations and fields of study and promote active research between industry and university.

Through systematic literature analysis, this paper was able to identify various research gaps and issues regarding entertainment robots. Although most of the papers presented definitions of social robots, only three attempted to define “entertainment.” While all the papers focused on the ‘social’ aspect when defining the term ‘social robot,’ attempts to define ‘entertainment’ remained shallow, highlighting the lack of a shared understanding of what entertainment robots are. Given such a fragmented understanding of entertainment robots, the term ‘entertainment’ has been inconsistently applied, representing various features of social robots, from serving robots in restaurants to robots in retail service contexts (De Gauquier et al., 2021; Joo et al., 2023). Crucially, entertainment should be addressed and understood differently in different contexts, as its indistinguishable usage of the term hinders our understanding of the ‘how’ and ‘what’ of people’s perceptions of entertainment. The lack of research from a non-technical perspective was a prominent issue, too. Many researchers highlighted the shortage of studies examining human emotions and perceptions, which are critical for successful human-robot interaction. Likewise, cultural and societal differences of end-users were insufficiently addressed, creating barriers to broader adoption and acceptance of entertainment robots in diverse contexts. Finally, technical and financial problems were frequently identified. Current social robots were considered too expensive or technologically underdeveloped to execute sophisticated functions, leading to user dissatisfaction and limiting their practical applications.

5.2. Implications and limitations

This study provides important theoretical implications by addressing the need for a more comprehensive understanding of entertainment robots. The findings highlight the importance of resolving inconsistencies in the conceptualization of entertainment robots by establishing a clear and unified definition. Such clarity is essential for aligning future research efforts and ensuring comparability across studies. Additionally, this study emphasizes the value of incorporating human-centered factors, such as emotional engagement, cultural diversity, and societal perceptions, into research on human–robot

interaction. By shifting the focus beyond technological advancements, the findings encourage future studies to investigate the broader human and societal dimensions of entertainment robots, fostering a more holistic understanding of their potential.

As for future research, we suggest addressing the following four research gaps to reduce the disparity between the expectations and the reality of entertainment robots. First, we need to establish a unified definition. Researchers should attempt to accumulate a consented understanding of “entertainment robots.” While robots’ entertainment applications are employed in various domains and contexts of social robots, this term has been used inconsistently. Providing entertainment to users in different contexts requires different approaches. For example, in the restaurant or retail domains, the presence of robots could be inherently entertaining, as it is not yet a common experience. By contrast, in domestic or everyday use, the entertainment provided must be more sophisticated to ensure a prolonged entertaining experience, as users’ motivation and attention span tend to decrease as robots lose novelty (Tozadore et al., 2018). Second, we also need to expand research on human-centered perspectives. Researchers should explore human emotions, perceptions, and cultural diversity in greater depth to enhance human-robot interaction. Previous research have identified features such as the level of human-likeness, gender, ethnicity, and culture can all affect human–robot interactions (Belanche et al., 2020). However, as seen in the keyword co-occurrence analysis, robot design research has largely focused on narrow perspectives, such as anthropomorphic, humanoid, or zoomorphic approaches. Furthermore, because many of the firms that develop robots originate from a limited number of countries, such products reflect those countries’ cultural characteristics. This could serve as a hindrance to customers of different cultural and societal backgrounds and, therefore, highlights the necessity of adapting these products to different cultures with varying ethnic features (Obaid et al., 2016). Expanding research to address these cultural and geographic differences will help ensure that robots are better adapted to diverse contexts. Additionally, understanding human emotional processes, which vary across cultures, is essential for fostering meaningful human-robot interaction. Conducting more studies on an international level will help address these gaps and provide a foundation for culturally sensitive robot designs. Third, we need to encourage interdisciplinary collaboration. Researchers should prioritize collaboration between academia, industry, and field specialists to align robot development with real-world needs. As highlighted in the systematic literature review, few studies have incorporated specialists’ opinions in their research. For instance, care professionals preferred pre-programmed activities in robots, as creating their own activities was deemed too complicated, even after receiving training (Huisman & Kort, 2019). This indicates that what developers assume to be useful may not align with actual user needs. Therefore, integrating the perspectives of field workers and end-users during the design process is crucial. Additionally, the declining ratio of research conducted by non-university organizations and the lack of collaboration across affiliations must be addressed. Building partnerships between industry and universities can promote innovation and ensure that robots are designed to meet both market demands and user expectations. Fourth, we need to address technical and financial challenges. Researchers should focus on overcoming the technical and financial barriers that limit the functionality and accessibility of entertainment robots. Current entertainment robots are only capable of executing simple, repetitive tasks (Van Aerscht & Parviainen, 2020). One care professional even stated, “Our clients have better hearing than Zora [a care robot],” which highlights the unsatisfying usability of current robots (Huisman & Kort, 2019, p. 10). Additionally, the high costs and limited technological sophistication of these robots have further hindered their adoption. Future research should aim to enhance robot functionality, usability, and affordability. Reducing these barriers will be critical for increasing adoption rates and improving the overall user experience.

From a practical perspective, the findings underline the necessity of

designing robots that prioritize user satisfaction and usability. The study highlights the importance of adapting entertainment robots to the diverse cultural, emotional, and functional needs of end-users. It also emphasizes the need for stronger collaboration between academia, industry, and end-users to ensure that technologies are both practical and aligned with market demands. Addressing technical limitations, such as affordability and usability, is crucial to reducing user dissatisfaction and enabling broader adoption of entertainment robots. By bridging the gap between technical innovation and user needs, this study provides actionable insights for creating robots that resonate with real-world users and deliver meaningful entertainment experiences.

Despite its contributions, this study has several limitations that may influence the interpretation of its findings. First, the data collection relied solely on one database, which may have excluded relevant studies available elsewhere. The focus on specific keywords, such as “entertainment,” could have inadvertently omitted research that used alternative terms to describe similar concepts. Additionally, the exclusion of non-physical robots or those with limited automation may have narrowed the scope of the analysis, potentially overlooking emerging technologies relevant to entertainment robots. These limitations suggest the need for more comprehensive and inclusive approaches in future research. Furthermore, while this study primarily focuses on academic research trends and conceptual gaps, it does not explore the business perspectives related to entertainment robots despite the emphasis on interdisciplinary approach. Future research should explore business models and transitions from business to business (B2B) to business to customer (B2C) markets, given the strong link between research activation and industry development. Addressing these issues could provide practical insights for commercialization and help bridge the gap between technological innovation and market demands.

CRedit authorship contribution statement

Min Hyeok Kang: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Seongcheol Kim:** Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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