The Development of User-Interface and Mobile Interface: A Bibliometric Study 50 Years Using Vos Viewer

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Abstract **– This research employs bibliometric analysis and computational mapping using VOSviewer to study mobile interface research trends. Data from Google Scholar spanning 50 years (1974-2024) identified 30 relevant articles grouped into 4 clusters. Results show mobile interface categorized under 'mobile interface' and 'mobile app', with 'mobile interface' linked to 5 sources, total link strength 6, and 17 occurrences; 'mobile app' linked to 9 sources, link strength 21, and 20 occurrences. Notable publication peaks occurred around 2013, with a decline post-2019. VOSviewer highlights active investigation areas. This study informs researchers and practitioners on mobile interface design, offering insights for future research directions.**

Keywords **– mobile interface, mobile app, user interface, mobile interface development, VOSviewer.**

1. Introduction

The pervasiveness of mobile devices in today's digital environment has completely changed the way people engage with technology on a daily basis. The rising dependence of users on mobile devices for a variety of purposes, include communication, productivity, and entertainment. Mobile devices provide various interaction styles and modes which is creating complexity in the usage of interfaces [1]. Interfaces design in business digital involves creating a more human environment by focusing on improving user experience from the three levels of feeling, cognition, and sense [2], [3]. The mobile interface facilitates convenient information exchange with computers while prioritizing clear visual presentation and effective interaction, particularly on devices like phones [4].

One analytical method, bibliometric analysis, offers a valuable approach to grasp the evolving landscape of mobile interface research. Designers, developers, and researchers can delve into the intricate layers of mobile interface studies by employing bibliographic content and citation analysis from articles published in journals and scientific papers. Through bibliometric analysis, which serves as a form of meta-analysis of research data, insights can be gleaned into the trajectory, trends, and influential works shaping the field of mobile interface design and development.

There have been many studies on bibliometric analysis, such as bibliometrics analysis in social sciences [5], [6], [7], [8], bibliometrics analysis in business and management [9], bibliometrics analysis in medicine [10], bibliometrics analysis in sustainability [11], bibliometrics analysis in human resources [12], bibliometrics analysis in big data [13], market research [14], travel and tourism [15], hospitality management [16], social media [17], green innovation [18], and creative industry [19].

However, there has not been any research that specifically analyzing the trends of research in mechanical engineering education using computational mapping of bibliometric data, especially through the VOSviewer application for examining publications from 1974 to 2024.

DOI: 10.18421/SAR72-12
https://doi.org/10.18421/SAR72-12

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Received: 28 April 2024.
Revised: 03 June 2024.
Accepted: 10 June 2024.
Published: 28 June 2024.

Therefore, this study performed computational research on mapping bibliometric analysis from publications indexed by Google Scholar using the VOSviewer software. This study aims to help developers and designers to find references. Also to help researchers choose appropriate research topics, particularly in the field of mechanical engineering education. It also aims to offer a research roadmap for future attempts.

Mobile interface refers to user interface (UI) of a mobile device or application. It is the way users interact with and navigate through the application or device, typically through touch-based interactions such as tapping, swiping, and pinching. Mobile interfaces are designed to be intuitive and user-friendly, allowing users to easily access and use the features of the application or device. They can include various design elements such as icons, buttons, menus, and text fields. Unlike traditional desktop interfaces, mobile interfaces demand an innovative approach due to the unique constraints and opportunities presented by the mobile platform, including limited screen real estate, computational and power resources, touch-based interactions, and diverse user contexts [20].

In digital business, especially concerning mobile devices and applications, operations can be carried out more effectively and efficiently by implementing mobile interfaces. The design of a mobile interface can greatly impact the user experience and the success of the application or device. That is why understanding the distinction of mobile interfaces is crucial for designers, developers, and researchers alike, as it directly influences user engagement, satisfaction, and overall usability [21], [22], [23].

2. Methodology Section

Google Scholar served as our primary data source for this study due to its open database. Google Scholar has indexed the journals from which the study's articles were taken. Publish or Perish, a reference management tool, was used to gather research data. We also used the Publish or Perish tool to perform a literature review on the selected subject. Publish or Perish can only process a maximum of 1000 paper publications, causing limitations in this article.

There were multiple phases to the research, including:

(i) Gathering publication data using the Publish or Perish program.

(ii) Using Microsoft Excel to process the bibliometric data of the gathered articles.

(iii) Analyzing bibliometric data through computational mapping of publications using the VOSviewer application.

(iv) Evaluating the results of the computational mapping analysis.

Based on publication title criteria, publications containing the keyword "mobile interface" were filtered using the Publish or Perish data search. The utilized articles were released in the years 1974 through 2024. In April 2024, all the data was gathered. The comma-separated value (*.csv) and research information system (.ris) files were utilized to export the gathered articles that satisfied the study's analytical requirements. VOSviewer was also used to create bibliometric maps in order to assess and analyze trends. Next, a mapping was done using the article data from the original database.

Multiple publication mappings were created using VOSviewer by employing network visualization, density visualization, and scatter visualization based on network (co-occurance) among the items. When the bibliometric map was being created, the frequency of a keyword was found to be present at least ten times.

3. Results

Based on the search of the data, 1000 data articles that fit the criteria for the research were found utilizing the application reference manager publish or perish data search. The information was gathered in the form of metadata, which included the name, title, year, journal name, publisher, citation count, article links, and associated URLs for each author. In the VOSviewer examination of this study, several samples of published data are shown in Table 1. The 20 top publications with the most citations were used as the data samples. The average author of the articles used is 2.93, the average number of citations per article is 563.46, the average number of citations per year is 12249.22, and the average number of citations per article is 563464. Additionally, the average h-index for all the articles is 430, and the average g-index is 728.

Table 1. Bibliography paper sequenced by highest to lowest its citation

Authors	Title	Year	Cites
R Brooks	A robust layered control system for a mobile robot	1986	13225
JG Andrews, S Buzzi, W Choi, SV Hanly…	What will 5G be?	2014	9600
JB Goodenough, KS Park	The Li-ion rechargeable battery: a perspective	2013	9056
W Shi, J Cao, Q Zhang, Y Li, L Xu	Edge computing: Vision and challenges	2016	7264
KN Lemon, PC Verhoef	Understanding customer experience throughout the customer journey	2016	6327
RE Voorrips	MapChart: software for the graphical presentation of linkage maps and QTLs	2002	5619
A Bangor, PT Kortum, JT Miller	An empirical evaluation of the system usability scale	2008	4980
S Bhattacharjee	DLS and zeta potential–what they are and what they are not?	2016	3537
PC Verhoef, PK Kannan, JJ Inman	From multi-channel retailing to omni-channel retailing: introduction to the special issue on multi-channel retailing	2015	3502
F Lotte, M Congedo, A Lécuyer…	A review of classification algorithms for EEG-based brain–computer interfaces	2007	3444
KL Schuchardt, BT Didier, T Elsethagen…	Basis set exchange: a community database for computational sciences	2007	3325
M Batty, KW Axhausen, F Giannotti…	Smart cities of the future	2012	3061
J Brooke	SUS: a retrospective	2013	3024
J Lin, W Yu, N Zhang, X Yang…	A survey on internet of things: Architecture, enabling technologies, security and privacy, and applications	2017	2942
S Piry, A Alapetite, JM Cornuet, D Paetkau…	GENECLASS2: a software for genetic assignment and first-generation migrant detection	2004	2914
M Baldauf, S Dustdar…	A survey on context-aware systems	2007	2911
DWF Van Krevelen, R Poelman	A survey of augmented reality technologies, applications and limitations	2010	2722
CD Schwieters, JJ Kuszewski, N Tjandra…	The Xplor-NIH NMR molecular structure determination package	2003	2714
M Chiang, T Zhang	Fog and IoT: An overview of research opportunities	2016	2505
S Osher, RP Fedkiw	Level set methods: an overview and some recent results	2001	2443

The diagram in Figure 1 illustrates the progression of research concerning mobile interfaces as documented in a Google Scholar-indexed journal. According to the data, a total of 1000 publications focusing on mobile interface research were recorded from 1974 to 2024. Since 1978, the landscape of academic publications has been marked by fluctuations, starting with just one paper that year. Subsequent years saw varying numbers of publications: 3 in 1979, 1 in 1980, 3 in 1981, 1 in 1983, 4 in 1985, 1 in 1986, 2 in 1987, 1 in 1988, 1 in 1989, 3 in 1990, 2 in 1991, 4 in 1992, 7 in 1993, 6 in 1994, 8 in 1995, 10 in 1996, 11 in 1997, 15 in 1998, 12 in 1999, 18 in 2000, 20 in 2001, 20 in 2002, 26 in 2003, 39 in 2004, 39 in 2005, 30 in 2006, 29 in 2007, 32 in 2008, 48 in 2009, 46 in 2010, 38 in 2011, 43 in 2012, 77 in 2013, 45 in 2014, 72 in 2015, 67 in 2016, 49 in 2017, 50 in 2018, 42 in 2019, 29 in 2020, 22 in 2021, 11 in 2022, 7 in 2023, and 5 up to April 2024. These figures indicate a peak in research activity on mobile interfaces in 2013 with 77 papers published, followed by a noticeable decline from 2019 onwards. This extensive dataset showcases the evolving trends in scholarly output over the past few decades, with fluctuations in publication numbers reflecting shifts in academic focus and research priorities.

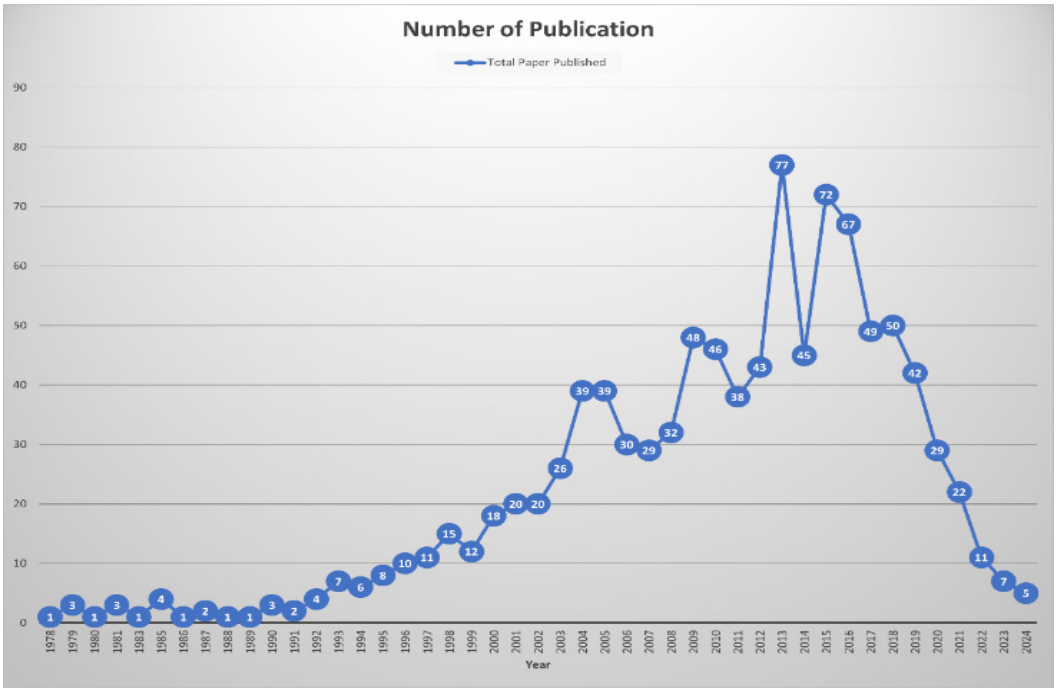

Figure 1. Level of development in mobile interface research

Computational mapping was applied to the article's data. A tool used in computational mapping is VOSviewer. The results of the computational mapping led to the discovery of 30 items. Every item relevant to a mobile interface is divided into 4 clusters via data mapping, which includes:

(i) Cluster 1 has 9 items and marked in app, effectiveness, graphical user interface, gui, mobile app, mobile phase, software, systematic review, and usability.

(ii) Cluster 2 has 8 items and marked in acceptance, architecture, consumer, mobile commerce, mobile computing, mobile learning, mobile user, and rapid growth.

(iii) Cluster 3 has 8 items and marked in augmented reality, concept, developer, iot, overview, rapid development, sensor, and smart phone.

(iv) Cluster 4 has 5 items and marked in customer, mobile banking, mobile interface, model, and service.

Every cluster that is currently in place illustrates the relationships between specific sentences. The label for each phrase is indicated by a colored circle. The frequency of each term determines the size of the circle. The number of times the term appears in the abstract and title is positively connected with the size of the label circle. The label gets larger the more times the word is used. The study investigated three aspects of the mapping visualization: network visualization (Figure 2), density visualization (Figure 3), and overlay visualization (Figure 4).

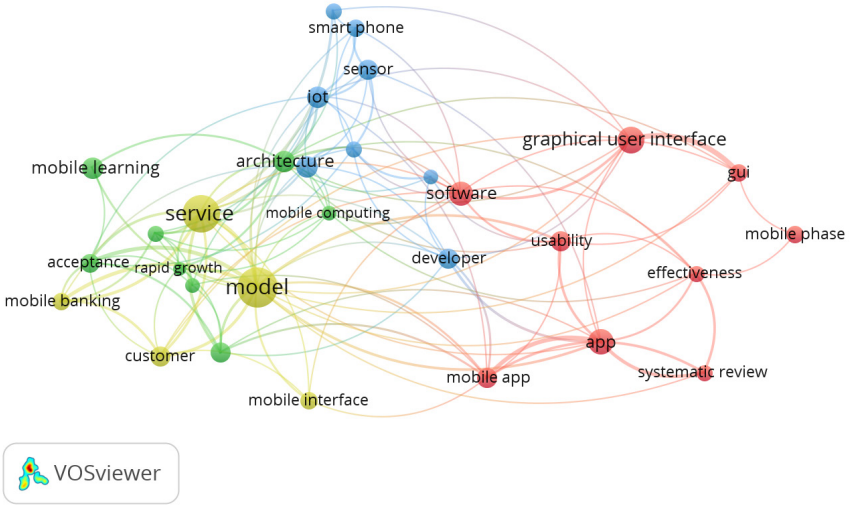

Figure 2. Network visualization of mobile interface keyword

The connection between the concepts is seen in Figure 2. An interconnected network represents the relationship between terms. In Figure 2, every field that is frequently studied and associated with the investigation of mobile interfaces is grouped together.

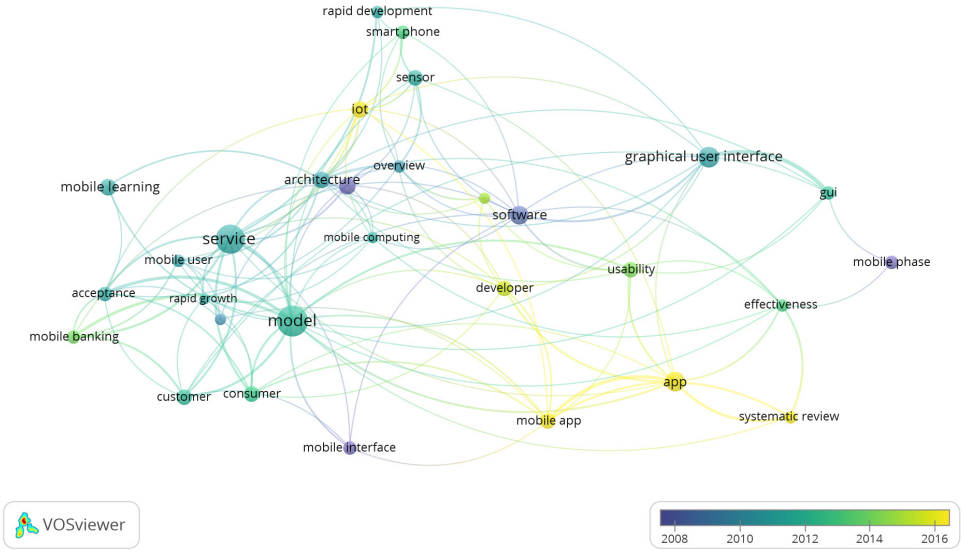

Figure 3. Overlay visualization of mobile interface keyword

Figure 3 displays overlay visualization. According to overlay visualization, the publication year of a phrase is indicated by the color visible on the legend in the bottom left corner. If a phrase is purple like "mobile interface", "software", and "mobile phase", then its publication is around 2008. If it is blue like "mobile commerce" and "overview", then it was published around 2010. If it is blue-green like "service", "model", and "mobile user", then it was published around 2012. If it is green like "usability" and "augmented reality", then it was published around 2014. If it becomes more yellow like "mobile app", "app" and "iot", then it is likely published in 2016.

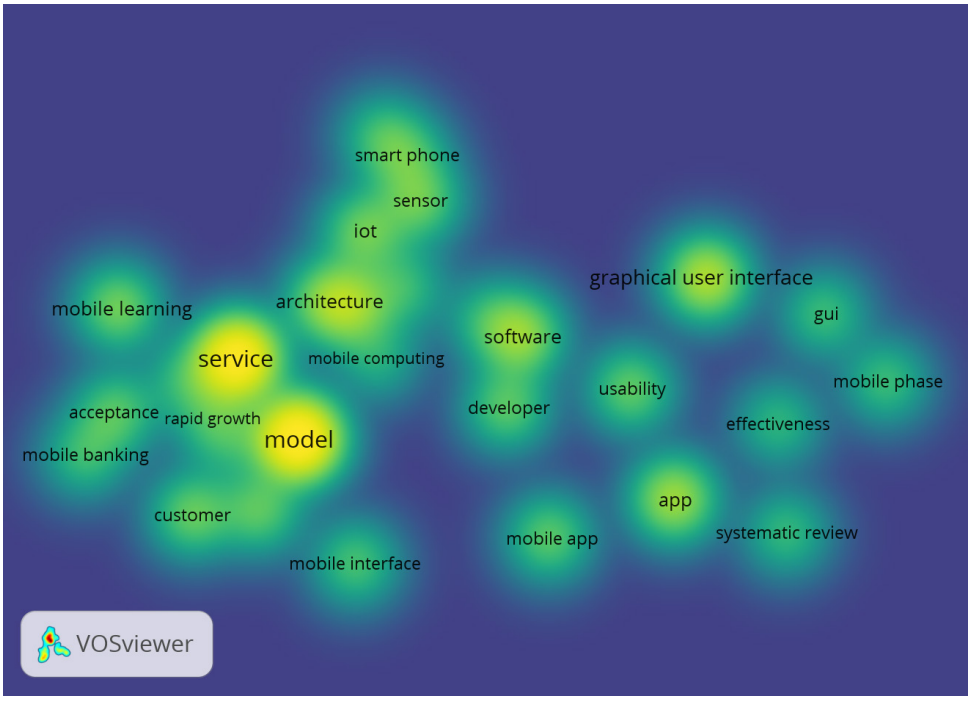

Figure 4. Density visualization of mobile interface keyword

Figure 4 depicts density visualization. According to it, a phrase will appear more frequently if its yellow color is brighter and the circle containing its label is larger in diameter. This indicates that extensive research has been done on the subject.

Conversely, if the color of the phrase fades close to the background color, it means there is not much research on that phrase. According to Figure 4, there has been a lot of research done on service, model, architecture, and graphical user interface. However, topics related to mobile interface have not been extensively researched yet.

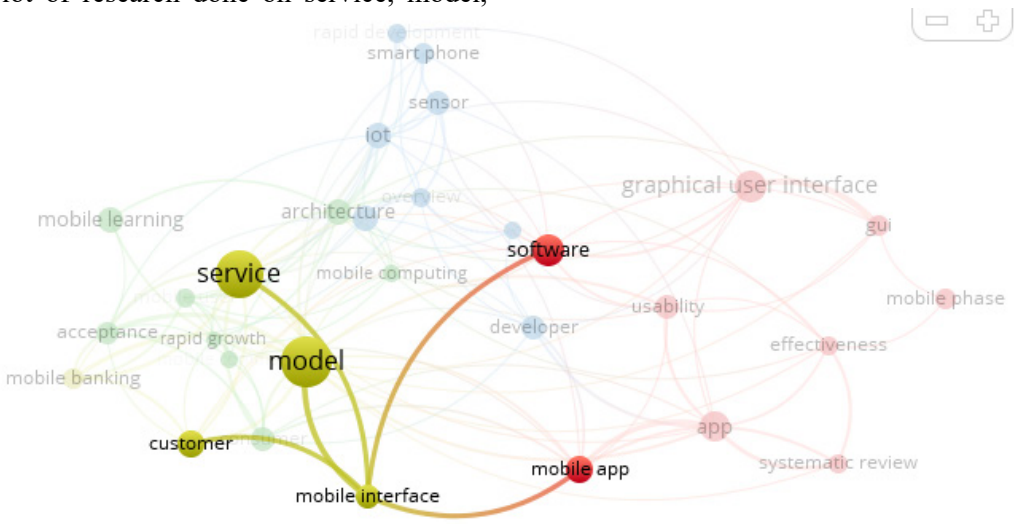

Figure 5. Network visualization of mobile interface term

Figure 5 showcases the network visualization of the mobile interface term, located in cluster 4, with 5 links, 6 total link strength, and 17 occurrences. It displays an interconnected network of concepts linked to mobile interface, customer, model, service, software, and mobile app.

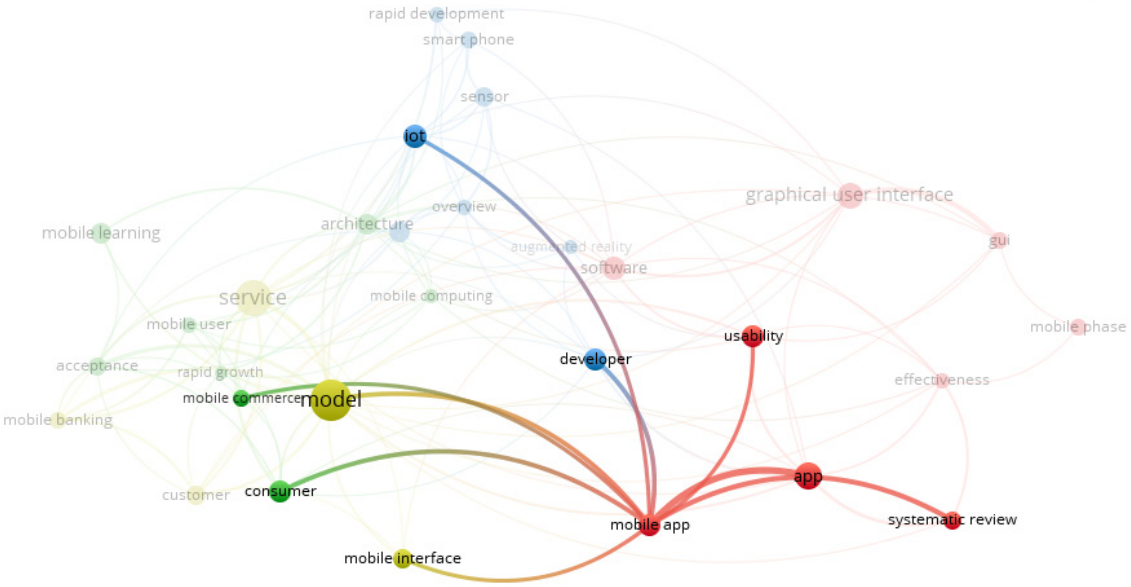

Figure 6. Network visualization of mobile app term

Figure 6 showcases the network visualization of the mobile app term, located in cluster 1, with 9 links, 21 total link strength, and 20 occurrences. It displays an interconnected network of concepts linked to mobile interface, consumer, model, mobile commerce, developer, iot, usability, app, and systematic review.

4. Discussion

The study presents a comprehensive analysis of the trajectory of mobile interface research from 1974 to 2024, utilizing bibliometric analysis and computational mapping. The research reveals a fluctuating trend in scholarly output, with notable peaks and declines over different periods. Particularly, a significant surge in publications around 2013 underscores a heightened interest in mobile interface studies.

This fluctuation in research activity highlights the dynamic nature of the field and suggests potential shifts in academic focus or emerging trends in technology and user behavior.

Insights from computational mapping using VOSviewer have been instrumental in identifying thematic clusters within the mobile interface research domain. The mapping exercise reveals that certain topics like "service" and "model" have garnered extensive research attention compared to "mobile interface". This disparity highlights potential areas for further investigation and underscores the need for deeper exploration into mobile interface design and development. By addressing gaps identified through computational mapping, researchers can enhance the usability, accessibility, and overall user experience of mobile applications and devices.

The bibliometric analysis provides valuable insights into the publication landscape, showcasing the evolution of research interests and priorities over time. Key findings, such as the distribution of publication volumes across different years and the identification of thematic clusters, offer researchers and practitioners a roadmap for navigating mobile interface design and development. Understanding the evolving trends and research priorities in mobile interface design is crucial for designers, developers, and researchers alike. Staying abreast of emerging topics and leveraging computational tools like VOSviewer can provide deeper insights into research trajectories.

Building on the study's findings, future research could focus on bridging the gap in mobile interface research identified through computational mapping. Investigating emerging topics within the thematic clusters, such as "usability" and "graphical user interface", could yield actionable insights for enhancing mobile interface design principles and methodologies. Moreover, exploring interdisciplinary perspectives and incorporating user-centric approaches can further enrich the field of mobile interface research. This approach underscores the importance of leveraging computational mapping to inform future research directions and interdisciplinary collaborations in the dynamic and evolving field of mobile interface design and development.

5. Conclusion

This research employed a bibliometric approach combined with computational mapping analysis using VOSviewer to analyze the evolution of mobile interface studies. Using Google Scholar data retrieved via 'publish or perish', we identified 30 relevant articles from an initial pool of 1000, focusing on keywords like “mobile interface,” “‘user interface,” and “mobile interface development” over the past 50 years (1974 to 2024). Our findings revealed that mobile interface research clusters around terms like “mobile interface” and “mobile app”. The analysis showed that “mobile interface” was linked to 5 different sources with total link strength of 6 and 17 occurences, while "mobile app" had 9 links with a link strength of 21 and 20 occurences. It also showed a notable increase in publications, particularly in the early 2000s and 2013, with a subsequent decline post-2019. Computational mapping highlighted thematic clusters, providing insights for future research. This study contributes valuable insights into mobile interface research evolution, aiding researchers and practitioners in this dynamic field.

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