Original Article

Exploring the Landscape of Digital Nudging: A Comprehensive Bibliometric Analysis Using VOSviewer

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Abstract

In recent years, digital nudging, which is based on human-computer interaction and behavioural economics, has received much attention as a means to influence users' behaviour in digital environments. There has been a notable proliferation of scholarly investigations within diverse academic disciplines related to the concept of digital nudge and its implementation in real-life contexts. However, there remains a significant gap in the comprehensive understanding of the current state of research on digital nudging and its future directions. This article offers an extensive bibliometric analysis of the digital nudging literature by examining 1,713 publications sourced from the Scopus database, covering the period from 2008 to mid-2023. This study outlines trends in digital nudging publications, identifies the most pertinent sources and highlights frequently used keywords. A bibliometric analysis using VOSviewer was subsequently performed to uncover thematic clusters. The co-authorship network analysis of authors and countries, the co-occurrence of specific keywords and author-level co-citation analysis reveal notable patterns and themes within the field of digital nudging. This study serves as a valuable resource for gaining a comprehensive understanding of recent research developments in digital nudging.

Keywords

Digital nudge, choice architecture, bibliometric analysis, Scopus, VOSviewer

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Introduction

The term nudge was coined by behavioural economist Richard Thaler and law professor Cass R. Sunstein in their book 'Nudge'. They define the concept of nudge as 'any element of choice architecture that predictably influences people's behavior without eliminating any options or significantly altering their economic incentives' (Thaler & Sunstein, 2008). Studies in psychology and behavioural economics have demonstrated that numerous psychological factors impact individuals' decision-making processes, whether they are aware of it or not (Thaler et al., 2013). Decisions are often heavily influenced by the context in which they are made, meaning that the environment plays a significant role (Thaler & Sunstein, 2008). With the expansion of the digital economy, an increasing number of decisions are being made through digital platforms, such as screens (Weinmann, Schneider & Brocke, 2016). The decision environment is important here because decisions in the digital sphere are strongly influenced by the design of the user interface like the website or the mobile app. Digital nudging becomes important in online shopping because customers can't physically see or touch products. As a result, other elements of the website like pictures, graphics and videos play a crucial role (Tomar, 2023). The decision made by a user is affected not only by their logical thinking as a human being, but also by the way the choice environment is designed, in which information is provided. (Weinmann, Schneider & Brocke, 2016).

A growing number of studies on nudge have been conducted, including systematic reviews and meta-analyses. But research on nudging on digital context is only on its nascent phase. Despite the fact that research into digital nudge is currently a hot topic, there is still a lack of analysis on the connections between the composition, development and collaboration of the body of existing knowledge and the identification of promising areas for future study. This article employs bibliometric analysis to explore the field of digital nudges, focusing on publication trends from 2008 to mid-2023, the most commonly featured journals and keywords and the leading research disciplines and thematic clusters in nudge studies. It also highlights areas of digital nudging that need further investigation and outlines potential directions for future research. The findings will benefit behavioural scientists, researchers, decision makers and higher education institutions by identifying research hotspots and emerging trends in nudging, guiding their future research endeavours.

This article is structured in the following way: The second section introduces the key concepts of digital nudging. The third section outlines the strategies used for data extraction and literature analysis. The fifth section displays the key results of the bibliometric analysis. The sixth section discusses the gaps in current research and potential avenues for future studies. The eighth section summarises the analysis outcomes, while the ninth section wraps up the study. Finally, the tenth section addresses the constraints and limitations of the research.

Theoretical Framework

Digital Nudging

Thaler and Sunstein (2009) introduce the concept of nudging as a way to influence human behaviour by deliberately designing choice environments, based on principles from behavioural economics. However, human decisions are never made in isolation; instead, they occur within a context where various visible and hidden factors can exert influence (Thaler, Sunstein & Balz, 2010). Decision architects are responsible for designing these environments, and they have the power to alter them by subtly guiding or nudging individuals towards making better choices. The concept of nudging is rooted in behavioural economics, which, through empirical research, has shown that people often make irrational decisions and behave irrationally due to social, emotional and cognitive influences (Thaler & Sunstein, 2009).

Nudges are interventions in choice environments that either exploit certain heuristics and biases or aim to counterbalance them. According to the concept of libertarian paternalism, nudges should be easy to avoid, beneficial to the decision-maker and should preserve the individual's freedom of choice (Thaler & Sunstein, 2009). Hansen (2016) defines a nudge as any effort to systematically influence a person's judgment, choice or behaviour that meets two criteria: (1) it is enabled by cognitive limitations, biases, routines and habits in both social and individual decision-making, which can hinder people from acting rationally in their own stated interests; and (2) it functions by leveraging these very limitations, biases, routines and habits as key elements of the influence attempt.

The dual process theory, which suggests that individuals use two separate cognitive systems – reasoning and intuition – to assess information during decision-making, helps explain this phenomenon. These systems differ in the level of mental effort they require. In certain situations, people depend on the reason-based System 2, which is slower, more effortful, deliberate and controlled, while in other instances, they rely on the intuitive or perceptual System 1, which is fast, automatic, effortless and emotionally driven (Stanovich & West, 2000). Most empirical studies in this field find that daily activities are predominantly intuitive, relying on System 1 (Kahneman 2003; Kahneman 2011). According to Kahneman (2011), individuals generally do not need substantial cognitive effort for routine tasks such as using digital services (Constantiou et al. 2014), meaning System 2 is only marginally engaged in everyday activities. System 1 employs heuristics, or mental shortcuts, to minimise the amount of information processed, thereby facilitating and accelerating the decision-making process (Bazerman & Moore 2008).

In recent years, digital nudges have become more prevalent due to the growing number of decisions made in digital environments. While the concept of nudging is originated in political science and behavioural economics, it is also applicable in the digital realm. This is commonly known as a ‘digital nudge’. Digital nudging involves utilising a digital platform – such as a website or mobile app – to influence decisions made in both digital and physical contexts.

When discussing digital nudging, it refers to the subtle use of design, informational and interactive elements to steer user behaviour in digital settings, without limiting the individual's freedom to choose. Digital environments often depend on automated processes and basic heuristics for decision-making, which simplifies the process but can also increase the likelihood of poor decisions. Digital nudging is a method that alters people's digital surroundings to affect their decision-making process and the resulting choices. The design features that influence decisions can vary widely and generally rely on different psychological mechanisms related to decision-making.

Methodology

Index Database

With technological advancements and ongoing investments in scientific research, bibliometric analysis has emerged as a solution to the limitations of traditional narrative literature reviews in evaluating academic contributions, assessing study merits and determining research trends in the face of a growing volume of literature. Bibliometric analysis offers a thorough and accurate way to understand the interconnectedness of journal citations and summarise the most recent advancements in ongoing or emerging research topics by analysing and examining enormous amounts of scientific data. This quantitative analysis of literature is becoming more common across many disciplines due to improvements in the accessibility and usability of bibliometric software and scientific databases. It provides a trustworthy and impartial approach, free from individual subjectivity and other outside influences, making it a widely accepted theory.

Table 1. Criteria Table.

Criteria	Reject	Accept
Search Date: 30-06-2023		6560
Database: Scopus		
Search Term: 'digital' OR 'online' OR 'on-line' OR 'on-screen' OR 'web-based' OR 'computer-based' OR 'user interface' OR 'UI' OR 'interface design' OR 'image' OR 'colour' OR 'color') AND ('persuasive systems' OR 'choice architecture' OR 'nudge' OR 'behavioral economics' OR 'behavioural economics' OR 'persuasive tech' OR 'gamification').		
Subject Area: Social Sciences, Business Management and Accounting, Decision Sciences, Psychology, Arts and Humanities, Economics, Econometrics and Finance	3479	3081
Document Type: Articles and Review	1131	1950
Language: English	119	1831
Year: 2008 to 2023	7	1824
Publication Stage: Final	111	1713

The bibliometric analyses in this review were carried out using the Scopus database (Baas et al., 2020). To identify relevant literature on digital nudging, a broad search was conducted using the terms 'digital nudging' and 'online'. As shown in Table 1, from the initial search, eight publications were closely reviewed to help refine and identify relevant keywords for the study. The initial search resulted in 6,560 publications. Only articles and review articles published from 2008 (till mid-2023) were selected as the concept of nudging gained significant popularity in the year 2008. After applying different inclusion and exclusion criteria as shown in Table 2, finally a total of 1713 publications were selected for the analysis.

General Descriptive Statistics

This section presents the general descriptive results of the analysis related to digital nudging, highlighting publication trends and major sources. It also specifies the inclusion and exclusion criteria used by the author to collect data from the Scopus database.

Retrieve Design Criteria

Findings

Article Publication Trends in the Field of Digital Nudging

The number of publications on digital nudge research is presented in Figure 1 which depicts the development from year 2008 to mid-2023. The increasing growth trend is supported by an increase in the number of articles published. When examining the average annual number of publications, the observed

Table 2. Inclusion and Exclusion Criteria Table.

Inclusion Criteria
Articles related to Social Sciences, Business Management and Accounting, Decision Sciences, Psychology, Arts and Humanities, Economics, Econometrics and Finance
Only articles and review articles
Published between 2008 and June 2023
Published data only
Exclusion Criteria
Book chapters
Conference articles
Conference review
Languages other than English
Articles in progress

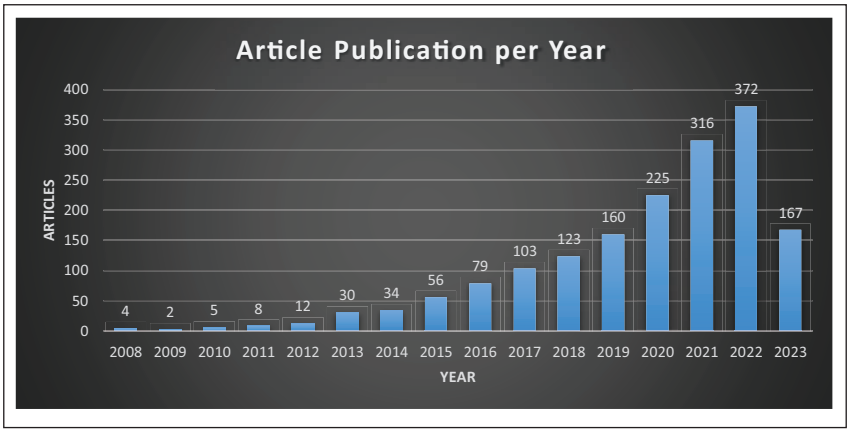

Figure 1. Annual Scientific Production.

Table 3. Most Relevant Sources.

Sources	Articles
Sustainability (Switzerland)	56
Computers in Human Behavior	35
Frontiers in Psychology	32
Computers and Education	27
International Journal of Emerging Technologies in Learning	23
Appetite	22
Education and Information Technologies	20
Education Sciences	18
Computer Applications in Engineering Education	16
Behaviour and Information Technology	15

research trend can be categorised into two distinct phases. First phase is before 2016. Before 2016, nudge research saw moderate growth during this time, with fewer than 100 publications published year. During this period, the average number of publications was about 25 per year. Second phase starts after 2016 with a rapid increasing trend which is continuing till the mid-2023. The decreasing trend (2023) in the graph is because the data is collected till mid-2023 only (6 months).

Most Relevant Sources

Nudge theory is generally applicable to decision-related studies. We discovered that publications on nudge-related research appear in a variety of journals, which point to a considerable advancement in the field. Table 3 shows the top 10 most relevant sources in the field of digital nudging. The data in the figure shows that

all the sources are related to technology as the area is in digital context. Economic journals are not the most productive, despite the fact that the concept of digital nudge has evolved from behavioural economics. Human psychology and behaviour-related sources have gained high positions in the respective list.

Bibliometric Analysis

Bibliometric analysis entails the study and interpretation of citations from scholarly works using different frameworks, tools and techniques. As a result, various metrics have been created to analyse the intellectual structure of broad academic disciplines and to evaluate scientific publications, research activities and scholars in a comprehensive manner (Rani & Salanke, 2023). To show the bibliographic data visually, we used VOSviewer to examine the connections between different elements being analysed. Our current research involved conducting several types of analyses, including co-authorship, co-occurrence, bibliographic coupling and co-citation analysis. We chose VOSviewer for this study because it can generate maps using network data, bibliographic data and textual information, and it is also versatile in supporting multiple file formats. Specifically, we employed a .CSV file containing bibliographic details of the articles for visualization purposes in VOSviewer.

Word Cloud

Word clouds are a type of data visualisation where the magnitude of each word represents its frequency or importance in a textual representation. When creating a word cloud from a text, the more frequently a word appears, the bigger it is

Figure 2. Word cloud.

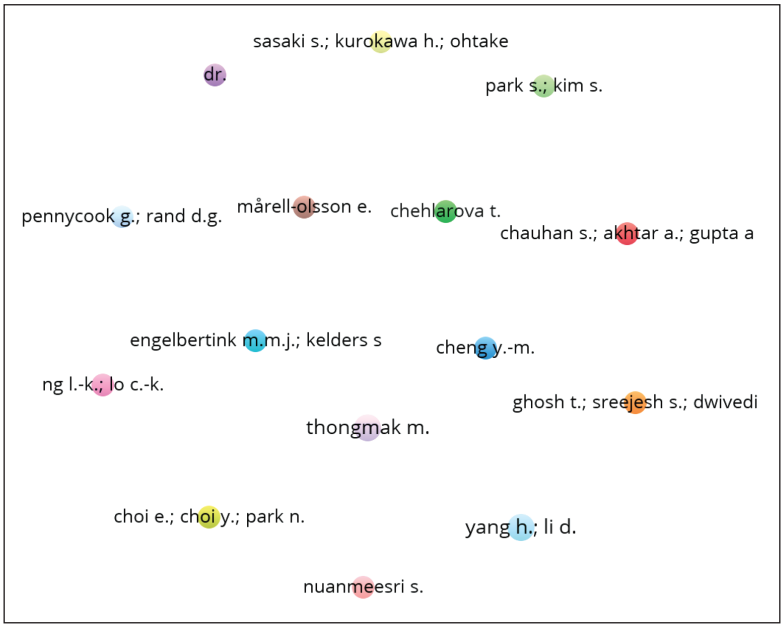

Figure 3. Co-authorship Network of Authors.

displayed in the word cloud making it more prominent in the visual presentation. Figure 2 shows the word 'human' appeared to be the most frequently used one (223 times) followed by the word 'gamification' with (214 times). Next following words include 'male', 'female', 'humans' and 'adult'. This is because the main aim of digital or technology mediated nudges is to influence the human behaviour and psychology.

6.2 Co-authorship Network Analysis of Author and Countries

The co-authorship network highlights the level of collaboration among authors, institutions and nations, resulting in a synergistic impact. Collaborative research not only generates innovative scientific outcomes but also improves the quality of research articles. Researchers frequently collaborate and contribute jointly to the development of scientific articles, which enhances both the quantity and quality of scientific output. The network analysis was performed using VOSviewer. As depicted in Figure 3, the co-authorship network consists of authors who have worked together on a minimum of two research articles. In total, 28 authors are organised into 14 clusters, each distinguished by a unique colour. The most substantial co-authorship network involves Thongmak M., Yang H. and Li D., who have collaborated on three documents. Additionally, Pennycook G. and Rand D.G. have co-authored three articles with 246 citations.

The co-authorship network in Figure 4 displays the connections between author-affiliated countries that have published at least two articles together between 2008 and mid-2023. To ensure a diverse range of countries, a minimum

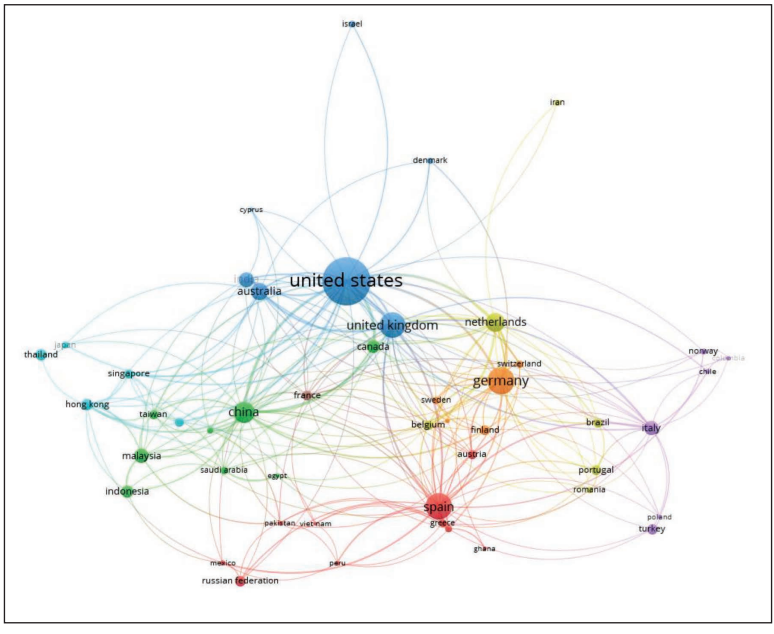

Figure 4. Co-authorship of Author Affiliated Countries.

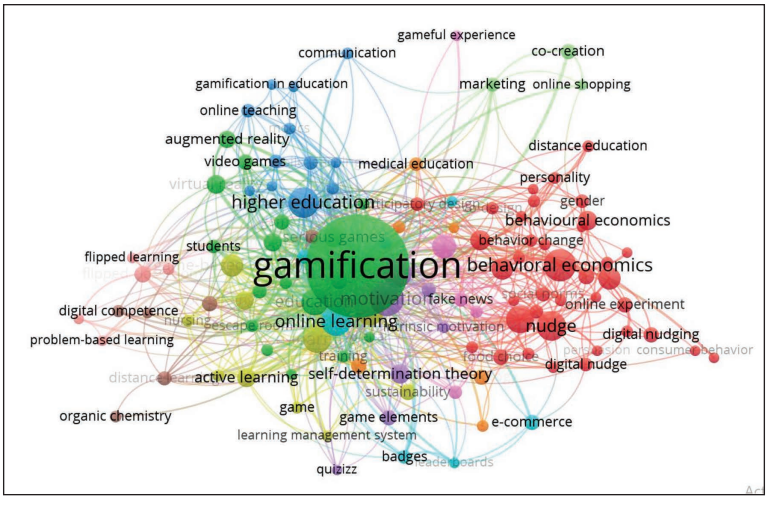

Figure 5. Co-occurrence of Author's Specific Keywords.

of 10 citations per country were set as the threshold limit, resulting in a total of 51 countries. The USA shows the highest total link strength among all the countries. There are no connections between certain countries, such as Hungary and the Philippines. However, there is a strong collaboration network between countries like the USA, Germany, the UK, the Netherlands, China and Spain.

Keyword Occurrence Network

We performed an author keyword analysis to identify the dominant thematic understanding among scholars. This analysis focused on getting a deeper understanding of the current research trends in the field of digital nudging. To study the most frequently used author keywords, we used VOSviewer version 1.6.19 to create a keyword co-occurrence network. We started with a list of 1713 articles and extracted a total of 3494 keywords. To create the co-occurrence network of the most frequently used author keywords, we limited the keywords to at least five occurrences, resulting in 117 keywords. In total, 117 keywords out of the 3494 met the criteria. The frequently used author keywords co-occurrence network is shown in Figure 5. The map reveals that the concept of 'gamification' was the primary focus of study, with 492 occurrences, followed by 'motivation' with 52 occurrences. The analysis resulted in 117 keywords grouped into 11 clusters, each cluster represented by a different colour. Author keywords analysis offers some useful insight. Firstly, most of the studies have done in the field of education to identify the learning intention among students or e-learners. Secondly, studies focusing on behaviour change, consumer behaviour, customer experience and personality in the context of e-commerce or online shopping are also growing.

Co-citation Analysis at the Author Level

We conducted co-citation analyses at the author level, and to be eligible for inclusion, an author must have been cited at least 30 times. We also used VOSviewer with the full counting method to analyse co-citation patterns, and out of the 80,236 authors, 300 authors met the threshold of 10 minimum citations. Through co-citation analysis of the cited authors, we identified six clusters, which are represented by different colours in Figure 6. This figure displays the co-citation pattern of the 300 authors who were cited at least 30 times by the studies in our sample. Cluster 1, depicted in red, comprises the work of 112 highly cited authors, making

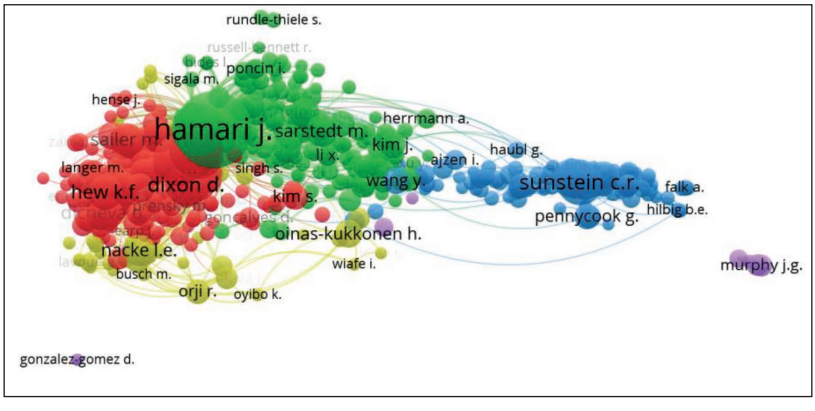

Figure 6. Co-citation of the Cited Authors.

it one of the largest clusters. Of the 112 authors, Ryan R.M. and Dixon D. are the most highly cited in the field of digital nudging. Cluster 2, in green, includes 93 authors, with Sunstein C.R., Pennycook G. and Acquisti A. being the most prominent. Cluster 3, in blue, consists of 74 authors and Hamari J. and Koivisto J. are the most highly cited. Cluster 4, in yellow, features 16 authors, including Nacke L.E., Orji R. and Tondello G.F. Cluster 5, also in yellow, comprises 3 authors, with Murphy J.G., Mackillop J. and Bickel W.K. being the most prominent. Cluster 6, in black, includes just 2 authors, with Rundle-Thiele S. and Dietrich T., being the most highly cited.

Unexplored Avenues in Current Research and Prospects for Future Research Directions

After doing a thorough evaluation of the literature, we found that while there has been ongoing advancement in the body of knowledge, there are still significant gaps in the body of knowledge that are limiting current research. We suggest a few directions for further investigation into digital nudging.

1. Dominance of experimental studies

   A review of a substantial body of literature indicates that most studies employed experimental research designs, either through laboratory experiments or by constructing dummy websites (Eigenbrod & Janson, 2018; Huang et al., 2018; Koch, 2020; Marx & Germies, 2021; Meske et al., 2020; Sharma & Cheng, 2021; Kesseli, 2021). There is a noticeable absence of descriptive and analytical research in the field of digital nudging. Future researchers should investigate more sophisticated statistical methods to improve the prediction of human behaviour and psychological processes.

2. Lack of studies measuring long-term effectiveness and sustainability

   Many studies on digital nudging focus on short-term behavioural changes. Longitudinal studies are needed to better understand the long-term impacts of digital nudging interventions. Exploring whether the impact of nudges persist over time or diminish after repeated exposure will provide insights into the sustainability of these interventions.

3. Effectiveness and generalisability

   Many investigations into digital nudging have been carried out in controlled environments or specific contexts. Future studies should aim to evaluate how effective and applicable digital nudges are across various populations, cultures, settings and dimensions. Besides the known aspects like nudge type and context of application, factors such as personality traits and prior social media usage also impact the efficacy of nudges (Schär, 2023). Exploring how different demographic variables – such as age, gender, socio-economic status, personality and emotions – affect the effectiveness of digital nudges will provide valuable insights.

4. Sampling limited to younger users

   The results from these studies highlight the growing appeal among younger individuals, particularly targeting university and college students. Nonetheless, because of the small sample sizes, these results cannot be generalised to huge population. It is recommended that future research endeavours consider individuals across different age groups and with diverse educational backgrounds in order to obtain a more comprehensive understanding.

5. Lack of studies in developing countries

   The present review highlights that majority of the studies have predominantly focused on developed countries such as the USA, the UK and Germany. The application of digital nudges and its effects needs to be studied in the context of developing countries like India, China etc too.

6. Measurement and evaluation

   Developing robust measurement tools and evaluation frameworks for digital nudging interventions is crucial. Future research should focus on the development of standardised metrics to assess the effectiveness and impact of digital nudges. This includes developing reliable methods to measure behavioural outcomes, such as engagement, adherence and sustained behaviour change.

Discussion

This section provides a summary of our current study and showcases the results of the four research questions that were introduced in the introduction. The findings for each of the four questions are listed below:

i. RQ (1) addresses the trends in research publications in the area of digital nudging from 2008 to mid-2023. The findings clearly indicate that research on digital nudging has gained significant momentum and is expected to experience rapid growth, particularly since 2020. Before 2016, the average number of publications was about 25 per year. But after that, a rapid uptake of about 170 average publications per year can be seen and the increasing trend is still continuing.
ii. The findings of RQ (2) highlighted the most relevant sources and keywords. The analysis reports that sustainability (Switzerland) journal has emerged as the most pertinent source with 46 articles. Also, the keyword 'human' appeared to be the most frequently used keywords in this area.
iii. The results of Research Question (RQ) 3 were obtained through conducting co-authorship network analysis, keyword occurrence analysis and co-citation network analysis. The co-authorship network of authors indicates that Thongmak M., Yang H. and Li D. have the strongest co-authorship network with three co-authored documents. The co-authorship of author-affiliated countries reveals that the USA has the highest total link strength

among all nations, with no linkages between countries such as Hungary and the Philippines. On the other hand, a strong collaboration network exists among countries like the USA, Germany, the UK, the Netherlands, China and Spain. Keyword occurrence network analysis resulted in a total of 117 keywords grouped under 11 clusters. It shows that most of the studies have done in the field of education to identify the learning intention among students or e-learners. Secondly, studies focusing on behaviour change, consumer behaviour, customer experience and personality in the context of e-commerce or online shopping are also growing.

The author-level co-citation analysis yielded six clusters, with the work of Ryan R.M. emerging as the most frequently cited source, followed by Dixon D., the most frequently cited author in the field of digital nudging.

v. To address RQ (4), various research gaps were identified in the body of knowledge that are limiting current research and suggested directions for future research.

Conclusion

This article offers a thorough overview of current direction of digital nudging research. The 1713 publications that were collected from Scopus were analysed using a bibliometric analysis of digital nudge to examine the publication trend, countries, authors and keyword co-occurrence. The findings indicate that, beyond the realm of behavioural economics, digital nudge research have been applied to a number of other fields. Since 2016, especially after 2020, there have been a lot of digital nudge publications, and this trend is predicted to continue. In the digital world, there is a greater need to contribute to the improvement in the well-being of those being nudged through decision-making and interface design. The study encountered several limitations in its attempt to enhance our comprehension of digital nudges from a broad perspective. Primarily, the analysis was confined to the data obtained from Scopus publications. While Scopus is known for predominantly including reputable data sources, it is not guaranteed that the data are flawless or encompass all relevant studies. As a result, it is advisable for future researchers to explore additional databases such as Web of Science, SpringerLink, EBSCO, JSTOR and others to ensure comprehensive coverage of crucial journal indexes and varying time periods. This study has another limitation whereby only publications in the English language were chosen for the analysis. Notwithstanding the aforementioned limitations, our article presents an all-encompassing review of the research on digital nudging, offering significant advantages to both scholars and professionals. The comprehensive nature of our work will facilitate the expansion and progression of research in this field, benefiting academia and practitioners alike.

Limitations

The structured literature review concentrated on the ongoing research in digital nudging, aiming to provide a broader understanding of the field. However, the

study encountered some limitations. Firstly, it only included articles from Scopus, a database known for its reliable sources but not exhaustive in coverage. Future researchers are encouraged to utilise additional databases such as WoS, SpringerLink, EI and EBSCO to ensure a more comprehensive inclusion of relevant journals and time frames. Secondly, the analysis was restricted to English-language publications, which limited its scope and inclusivity. Incorporating sources in other languages could offer a fuller perspective on the topic. Lastly, the study focused on identifying general aspects and themes within digital nudging without delving into specific areas or dimensions. This indicates a need for more detailed research on various domains and aspects in future studies.

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