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Forty years of the theory of planned behavior: a bibliometric analysis (1985–2024)

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Abstract

The goal of the study is a comprehensive and systematic analysis of the literature and research landscape of the TPB between 1985–2024. This paper presents a comprehensive bibliometric study of the Theory of Planned Behavior (TPB) literature over the past forty years (1985–2024), analyzing 14,461 articles and 542,479 citations published in the Web of Science Core Collection. Utilizing performance analysis and science mapping techniques, the study leverages bibliographic coupling, co-citation, keyword co-occurrence analysis, and a temporal assessment of the field across six distinct periods (1985–1999; 2000–2004, 2005–2009; 2010–2014; 2015–2019; and 2020–2024). Employing VOS Viewer software for visualization, this research maps the evolution, intellectual structure, and networks of relationships in the TPB field for the first time. The results highlight significant patterns and interdisciplinary connections, identifying the most influential publications, authors, journals, and institutions. A distinguishing feature of the study is the identification of thematic clusters based on multiple criteria and a triangulation analysis of these clusters. Additionally, the study investigates the most influential articles within the six periods and provides an evolutionary phase-wise analysis of TPB. Another highlight is the detailed guidance on future research avenues, which are actionable and based on a rigorous assessment of the most cited articles from 2020 to 2024. The study makes a significant contribution to the ongoing research conversations on the trajectory and growth of TPB across various disciplines.

Keywords Bibliometric study · Theory of planned behavior · VOS viewer · Bibliographic coupling · Co-citation analysis · Keyword co-occurrence analysis

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1 Introduction

The theory of planned behavior (TPB) is the pre-eminent social psychology theory that explains and predicts human intentions, behaviors, and individual-level decision-making in diverse interdisciplinary domains and contexts (Ajzen 2020). The TPB posits that behavioral intentions, influenced by attitudes, subjective norms, and perceived behavioral control, are the primary determinants of actual behavior (Ajzen 1991). In the prestigious Web of Science (WoS) Core Collection database, the productivity of the field of TPB is evident, and from one paper published in 1985, the total number of papers annually published in TPB grew to 1564 articles in 2024, registering a compounded annual growth rate of 23.1% over forty years. The influence of the field of TPB is significant, and from the first citation received in 1986, the cumulative citations in the field of TPB have grown to 542,479 in 2024, with an average count of 13,561 citations per year over forty years. The interdisciplinary diffusion of the TPB is evident from recent articles. For example, the year 2022, saw the publication of TPB articles in knowledge-sharing behavior among academics (Hosen et al. 2022), telecardiology usage intention (Jiar et al. 2022), ethical purchase intentions of Generation Z (Djafarova and Foots 2022), microfinance adoption in rural areas (Purwanto et al. 2022), utilization of counseling centers by international students (Yee and Ryan 2022), the intention of the public to avoid products containing microplastics (Borriello et al. 2022), long-term use of hypnotics by insomnia patients (Yang et al. 2022), hand hygiene behaviors among hospital nurses (Sin and Rochelle 2022), travel intentions during COVID-19 (Pratiwi et al. 2022), entrepreneurial intentions to establish businesses (Hanage et al. 2022), farmers' land abandonment behavior (Chen 2022), faculty barriers to mentoring freshmen (Huart et al. 2022), service-oriented behavior among employees (Tsai et al. 2022), COVID-19 vaccination intentions (Dou et al. 2022), and hikers' pro-environmental behavior in national parks (Sun et al. 2022).

1.1 Rationale for the study

Given its widespread application, it is surprising that there has been no effort to analyze quantitatively and objectively the scientific output of the field of TPB, examine the evolution of its intellectual structure, and visualize the relationships defining the sustained rise of the TPB (Donthu et al. 2021). Only two studies till 2024 focused on a narrow application of the TPB within individual domains, outlining the need for a comprehensive bibliometric analysis that maps the entire TPB research landscape. The first one focused on the application of TPB in environmental science (Si et al. 2019), and the second one focused on the adoption of TPB in knowledge-sharing studies (Fauzi et al. 2024). A search of the Web of Science (WoS) Core Collection database indicates multiple reviews of the Theory of Planned Behavior (TPB) exist.

While these reviews are useful for understanding the effectiveness of TPB across various domains, a closer analysis reveals that they primarily focus on the application of TPB rather than the theory itself. In many cases, TPB is incidental and serves as a supporting framework for exploring specific topics rather than being the main subject of analysis.

For example, the most cited review article in the field of TPB conducted a meta-analysis that revealed that a significant amount of variance in intention and behavior was explained by the TPB but was limited to a set of 185 articles published till 1997 (Armitage and Conner 2001) and did not analyze the intellectual structure of the field, the diffusion of the TPB across disciplines, and the relationships among articles, authors, journals, and institutions that were at the forefront of TPB research. This gap is evident in multiple reviews in the field of TPB, for example, in the domain of solid-state waste management for the use of refuse as fuel in developing countries (Galavote et al. 2024), a monograph that reviewed the evidence concerning causes of unhealthy risk-taking behaviors in adolescents (Reyna and Farley 2006), and a content analysis that was not focused on the TPB but on the evolution of the trends and themes of organic food consumption globally (Pant et al. 2024).

The absence of a comprehensive bibliometric analysis that maps the structure of the research field of the TPB is lacking, and its evolution and development over time has not been objectively assessed to date and points to the need for a comprehensive bibliometric study (Block and Fisch 2020). Previous studies have noted the need for systematic bibliometric evaluations to identify research patterns and guide future research directions (Aliyev et al. 2019; Ozturk 2021).

Apart from a holistic understanding, there is no discussion on the current state of the TPB, nor is there an agenda for future research in the field of TPB, and all these reasons point us to the urgent need for a bibliometric analysis that leverages the tools of co-citation analysis, bibliographic coupling, and co-occurrence analysis to identify the gaps, thematic clusters and conducts a temporal analysis of the leading authors, journals, institutions, and articles that have influenced the field of TPB over time and specifically identifies promising research avenues and potential interdisciplinary applications (Block et al. 2020; Kumar et al. 2020).

1.2 Research questions

The research questions for the study are developed to achieve the goal of a comprehensive and systematic analysis of the literature and research landscape of the TPB between 1985–2024.

1. What is the intellectual structure and dynamics of research in TPB?
2. How has the field of TPB evolved over the past forty years?
3. Who are the most influential authors, articles, institutions, and journals?
4. What are the networks and relationships between the articles?
5. What are the promising and specific future research avenues?

1.3 Proposed analysis and organization of the paper

To address the research questions, we map the field of TPB through an analytical representation of the evolution of articles and highlight the important authors, journals, articles, and institutions (Sect. 3). Next, we undertake a period-wise investigation of the article and citation distribution patterns and a detailed analysis of the most cited influential articles in each of the six periods to map the evolutionary phases of the TPB over time (Sect. 4). The bibliometric analysis is conducted using Visualization of Similarities (VOS) viewer software, which presents graphical patterns of associations and is effective in constructing and generating bibliometric maps of a large number of articles (Van Eck and Waltman 2010), leveraging bibliographic coupling (Kessler 1963) and co-citation methods (Small 1973). Section 5 consists of a co-occurrence analysis of author keywords, co-citation analysis at the journal and author level, bibliographic coupling at the article level, and identification of thematic clusters through these bibliometric techniques and concluding with a temporal analysis of authors, author keywords, institutions, and journals over forty years. The last section of the study is Sect. 6, which undertakes a comprehensive analysis of the most cited articles in each of the immediate past 5 years and the research trends in each year and leads to the future research avenues section and an assessment of the limitations of the study.

2 Methods

2.1 Literature review and identification-screening-selection of articles

Consistent with the best practices in identifying academic papers in a field of research, a systematic literature review is conducted as a first step in the process (Block et al. 2020; Ozturk 2021). The Web of Science database was selected as a research database as it is the world's leading inter-disciplinary citation database with more than 3400 journals across 58 disciplines from 1900 to the present, with more than 122 million cited references, and is the most widely used database used by researchers in the field of management (Zupic and Čater 2015; Butt et al. 2021). Further, the Web of Science Core Collection has advanced functionalities to facilitate citation and co-citation analysis, bibliographic coupling, and keyword occurrences that are useful in identifying thematic clusters and charting the temporal evolution of the field. Its user-friendly interface enables users to transfer data in formats that easily integrate with other visualization software, including the Visualization of Similarities software (VOS Viewer) that has been used for the present paper.

The article selection process framework used for the current study is visualized in Fig. 1. As the research objective was to map the field of TPB and identify its evolution forty years after its emergence in 1985, the search was conducted for the forty years 1985–2024. The search string used to source articles was "theory of planned behavior" or "theory of planned behaviour." The authors arrived at these two search terms because, depending on their preference for a specific English style, authors

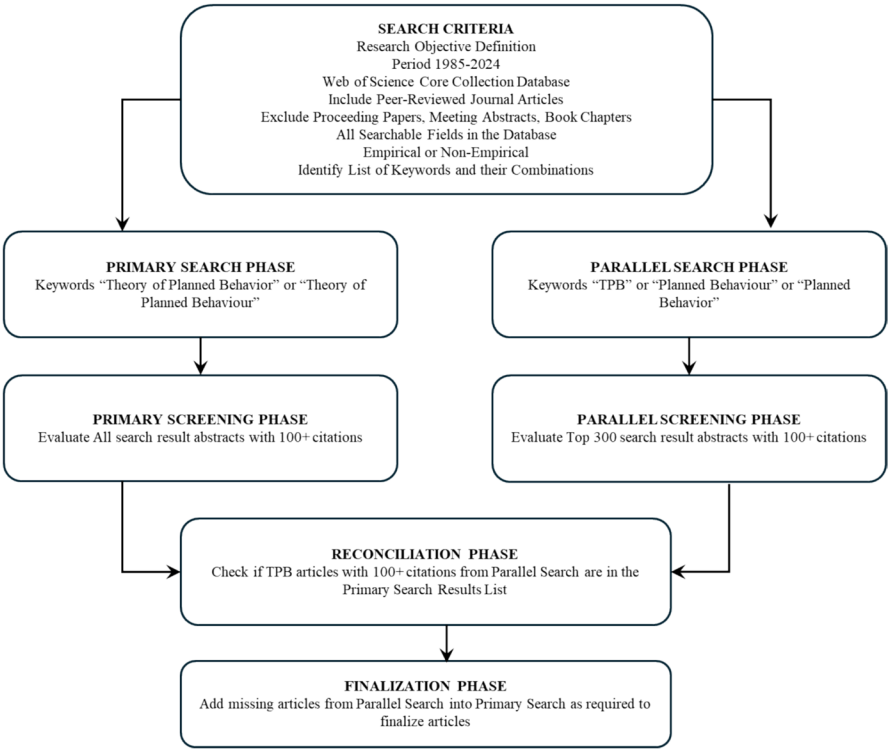

Fig. 1 Article selection process framework for the bibliometric study

would use the word "behavior" (US English) or "behaviour" (UK English). The authors experimented with a variety of search words related to the TPB, such as perceived behavioral control, attitudes, behavioral intention, subjective norms, and planned behavior, but the results were not exhaustive and relevant to the TPB.

To ensure comprehensive coverage, the "all"-field search tag was utilized in Web of Science to initiate search anywhere in the full record, including but not limited to the source title, abstract, author keywords, and keywords plus. The keywords plus feature in WoS include additional keywords and phrases from the titles of the cited references in an article and enhances the retrieval of articles that may not have been discovered using only author-provided keywords. Only articles are included in the bibliometric study to ensure that only high-quality, peer-reviewed academic scholarship is included because they are more likely to be peer-reviewed and are viewed as validated knowledge (Ozturk 2021). The search period was for all papers published till December 31, 2024. From the retrieved search results, the authors evaluated the 976 most highly cited articles with more than or equal to 100 citations to ensure that they were within the scope of TPB and that all of them were retained. Another parallel search was conducted with the search terms "planned behavior" or "planned behavior" and the results were

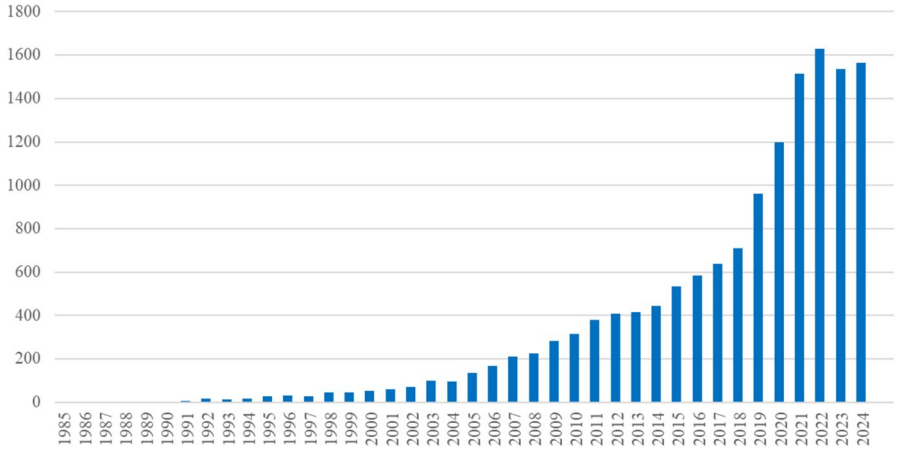

Fig. 2 Articles published per year in the period 1985–2024 in the field of TPB

ranked in the order of citations received. The list of the top 300 most cited papers was compared with the list of the results generated by the earlier search, and it was found that only four papers from the parallel search of the top 300 cited articles were missing from the primary search. The primary search results were deemed comprehensive for the study, as evidenced by a 98.67% overlap with the parallel search, with only 4 out of the 300 most cited articles missing in the primary search results. The high percentage demonstrates the robustness of the initial search methodology. Figure 2 presents the total number of articles published per year in the field of TPB.

A total of 14,461 articles were retained that received 542,479 citations in the Web of Science Core Collection database, averaging 37.51 citations per article. The h-index of the papers citing the TPB is 255, which indicates that of the 14,461 papers in the field of TPB in the WoS database, 255 papers have received at least 255 or more citations.

2.2 Bibliometric analysis

The study of bibliographic sources using quantitative techniques is termed the discipline of bibliometrics (Broadus 1987). Bibliometrics is a proven approach to unearthing statistical patterns and multi-level associations within a particular field (Vallaster et al. 2019). Bibliometrics utilizes bibliographic data, including information that uniquely identifies a published paper, such as the title, authors, institution affiliation, journal, publisher, date, keywords, subject terms, country of origin, and related data (Pritchard 1969). Given the large number of papers published in the field of TPB, bibliometrics' versatility is particularly appropriate for an in-depth analysis of topical perspectives and research conversations reflecting the main topics, the most influential papers, journals, authors, and institutions, and their temporal evolution over time.

In bibliometric studies, it is common to use the metric of the number of publications as an indicator of productivity, the metric of the number of citations as an indicator of influence, and the h-index, which is defined as the threshold X number of publications that have received at least X or greater number of citations, thereby incorporating productivity and influence in the same metric (Garfield 1955; Hirsch 2005; Ding et al. 2016). In order to provide readers with more flexibility and options in choosing metrics that address their needs, the bibliometric study provides information on cites per paper, cites per year, number of articles at various citation thresholds, and citing articles as indicators of scholarly impact (Merigó et al. 2015).

Apart from an overall analysis of the entire period (1985–2022), the study also analyzes the temporal evolution of the field over six periods (1985–1999, 2000–2004, 2005–2009, 2010–2014, 2015–2019, and 2020–2024). These periods were chosen to reflect significant phases in the development and application of the TPB. The paper leverages VOS Viewer's graphical computing and mapping capabilities to generate bibliographic coupling, co-citation, co-authorship, and co-occurrence maps of author keywords. These visualizations provide a comprehensive and intuitive understanding of the key contributors and thematic clusters within the field (Van Eck and Waltman 2010).

3 Mapping the field of TPB

This section provides an analytical representation of the evolution of articles in the field of TPB over the past forty-years (1985–2024), along with the most important authors, journals, articles, and institutions.

3.1 Evolution of the field of TPB based on the annual number of articles

The annual count of articles published indicates the increase and growth of the TPB over the past forty years (1985–2024). The number of articles published per year from 1985 to 1999 remained less than 50 and showed a sustained increase beyond 100 articles per year from 2005 onwards. The period from 2010 showed a nearly two-fold increase in the number of articles published per year from 203 per year for the period 2005–2009 to 393 per year for the period 2010–2014. The next major increase happened in the period 2020–2024, when the average number of articles published per year increased to 1489 per year. The highest number of articles published during the forty years is 1630 articles in 2022. The phenomenal growth in the TPB can be judged from the fact that the average number of articles per year since 1985 is 362 papers. In terms of numbers, while there was a slight dip in the number of articles per year in 2023 and 2024, the total share of articles published in the last 5 years (2020–2024) was 7444, which is 51% of the total number of 14,461 articles published in the TPB till 2024. The analysis indicates that the research in the field of TPB remains highly active and the dynamic and sustained evolution is evident over the forty years.

Table 1 Important articles in the field of TPB

R	Title	Author	Y	TC	C/Y
1	The Theory of Planned Behavior	Ajzen, I	1991	49,002	1484.91
2	User Acceptance of Information Technology: Toward a Unified View	Venkatesh, V; Morris, MG; Davis, GB; Davis, FD	2003	19,414	924.48
3	Efficacy of the Theory of Planned Behaviour: A Meta-Analytic Review	Armitage, CJ; Conner, M	2001	6179	268.65
4	Perceived Behavioral Control, Self-Efficacy, Locus of Control, and the Theory of Planned Behavior	Ajzen, I	2002	4393	199.68
5	Understanding Information Technology Usage—A Test of Competing Models	Taylor, S; Todd, PA	1995	4361	150.38
6	Prediction of Goal-Directed Behavior—Attitudes, Intentions, and Perceived Behavioral-Control	Ajzen, I; Madden, TJ	1986	3252	85.58
7	Competing Models of Entrepreneurial Intentions	Krueger, NF; Reilly, MD; Carsrud, Al	2000	2784	116.00
8	The Theory of Planned Behavior: Reactions and Reflections	Ajzen, I	2011	2400	184.62
9	Nature and Operation of Attitudes	Ajzen, I	2001	2381	103.52
10	Twenty years after Hines, Hungerford, and Tomera:: A new meta-analysis of psycho-social determinants of pro-environmental behaviour	Bamberg, S; Möser, G	2007	2312	136.00
11	Extending the Theory of Planned Behavior: A Review and Avenues for Further Research	Conner, M; Armitage, CJ	1998	2036	78.31
12	The Theory of Planned Behavior: A Review of its Applications to Health-Related Behaviors	Godin, G; Kok, G	1996	1991	71.11
13	Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior	Mathieson, K	1991	1951	59.12
14	What is an Adequate Sample Size? Operationalising Data Saturation for Theory-Based Interview Studies	Francis, JJ; Johnston, M; Robertson, C; Glidewell, L; Entwistle, V; Eccles, MP; Grimshaw, JM	2010	1857	132.64
15	Development and Cross-Cultural Application of a Specific Instrument to Measure Entrepreneurial Intentions	Liñán, F; Chen, YW	2009	1856	123.73
16	Using the Internet to Promote Health Behavior Change: A Systematic Review and Meta-Analysis of the Impact of Theoretical Basis, Use of Behavior Change Techniques, and mode Of Delivery on Efficacy	Webb, Tl; Joseph, J; Yardley, L; Michie, S	2010	1654	118.14
17	Understanding and Predicting Electronic Commerce Adoption: An Extension of the Theory of Planned Behavior	Pavlou, PA; Fygenson, M	2006	1525	84.72

Table 1 (continued)

R	Title	Author	Y	TC	C/Y
18	Prospective Prediction of Health-Related Behaviours with the Theory of Planned Behaviour: A Meta-Analysis	Mceachan, RRC; Conner, M; Taylor, NJ; Lawton, RJ	2011	1408	108.31
19	Do Entrepreneurship Programmes Raise Entrepreneurial Intention of Science and Engineering Students? The Effect of Learning, Inspiration and Resources	Souitaris, V; Zerbinati, S; Al-Laham, A	2007	1217	71.59
20	A Comparison of the Theory of Planned Behavior and the Theory of Reasoned Action	Madden, TJ; Ellen, PS; Ajzen, I	1992	1199	37.47

R, citation rank; Y, publication year; TC, total citations; C/Y, citations per year since publication year

3.2 Important articles in the field of TPB

The importance of an article is directly reflected in the number of citations it receives over time (Garfield 1955; Block and Fisch 2020). Table 1 presents the list of the 50 most cited papers in TPB, and its interdisciplinary impact is evident from the multiple research domains that are featured in Table 1. The seminal contribution of Ajzen's articles is evident as they are featured five times in the top 10 most cited articles of all time in the TPB. The most influential article established TPB as a foundational model for understanding intention and behavior by incorporating perceived behavioral control along with attitudes and subjective norms as predictors (Ajzen 1991). The article has received 49,0002 citations (which is 9% of the 542,479 citations received by all the 14,461 articles in the field of TPB). The other articles of Ajzen featured in the top 10 most cited articles include a clarification of the perceived behavioral control construct and differentiating it from other psychological variables like self-efficacy, and locus of control which was the fourth most cited article with 4393 citations (Ajzen 2002), and exploring the interplay between attitudes, personality traits, and behavioral intentions within the TPB framework which was the sixth most cited article with 3252 citations (Ajzen and Madden 1986). The other two articles by Ajzen in the top 10 most cited articles included one that addressed criticism of the TPB and clarified the limits of predictive validity and the boundaries of the TPB and ranked eight on the list with 2400 citations (Ajzen 2011) and another article that conducted a comprehensive review of research on attitudes including additional moderators in the attitude-behavior relationship and received 2381 citations and ranked ninth on the most cited list of articles in TPB (Ajzen 2001).

The second most influential article in the list received 19,414 citations and made a seminal contribution that validated the potential of the TPB by integrating it with the technology acceptance model (TAM) and proposing the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al. 2003). The versatility of the article and its proposed UTAUT framework led to its widespread use in the field of information systems and technology adoption and predicting user acceptance and usage behaviors. The seventh most cited article received 2784 citations and provided fresh insights into the application of the TPB and factors influencing entrepreneurial intention and behavior led to its subsequent emergence as a leading psychological theory in the field of entrepreneurship (Krueger et al. 2000). The other two articles ranked third and tenth in the list of most cited articles, received 6179 and 2312 citations respectively and were both meta-analysis studies focusing on the efficacy of TPB across multiple studies (Armitage and Conner 2001) and provided insights into the psychosocial determinants of pro-environmental behavior (Bamberg and Möser 2007).

3.3 Important journals in the field of TPB

The list of the top 20 important journals is presented in Table 2 and ranked by the number of articles published in the field of TPB. The table also contains information on the impact factor and 5-year impact factor of the journals, the total number of

Table 2 Important journals in the field of TPB

R	Publication	IF	5-IF	TP	TC	TC/TP	H	≥200	≥100	≥50	≥1
1	Sustainability	3.3	3.6	576	9301	16.15	46	1	11	43	503
2	Frontiers in Psychology	2.6	3.3	206	2595	12.60	24	1	1	8	184
3	Journal of Cleaner Production	9.8	10.2	184	12,436	67.59	64	11	40	76	176
4	International Journal of Environmental Research and Public Health	4.6	4.7	173	2922	16.89	29	0	3	11	170
5	Transportation Research Part F Traffic Psychology and Behaviour	3.5	4.1	133	5380	40.45	42	3	13	27	123
6	PLOS One	2.9	3.3	133	2574	19.35	22	2	3	6	110
7	BMC Public Health	3.5	3.9	127	2287	18.01	27	2	3	8	114
8	Psychology Health	2.4	3.2	121	7451	61.58	41	3	15	35	121
9	Journal of Applied Social Psychology	2.2	2.6	113	17,468	154.58	57	17	39	59	113
10	British Food Journal	3.4	3.4	109	4270	39.17	32	5	6	15	94
11	British Journal of Health Psychology	3.5	5	96	5122	53.35	45	1	14	40	94
12	Heliyon	3.4	3.9	91	528	5.80	11	0	0	2	68
13	Journal of Islamic Marketing	3.1	3.5	86	1256	14.60	21	0	0	4	69
14	Appetite	4.6	4.5	80	5317	66.46	39	5	15	32	77
15	Accident Analysis and Prevention	5.7	5.9	77	4231	54.95	34	4	13	26	76
16	Computers in Human Behavior	9	9.5	73	6453	88.40	44	6	18	40	73
17	Journal of Environmental Management	8	7.9	62	3993	64.40	29	8	17	25	56
18	Sage Open	2	2.3	59	563	9.54	13	0	1	2	36
19	Resources Conservation and Recycling	11.2	12.1	57	6995	122.72	37	12	21	34	57
20	Journal of Retailing and Consumer Services	11	11.2	57	3986	69.93	30	4	7	19	54

R, rank; TC, total citations; TP, total publications; TC/TP, citations per publication; H, h-index; ≥200, ≥50, ≥25, ≥1, Threshold number of publications equal to or greater than 200, 50, and 1 citation; IF, impact factor 2024; 5-IF, 5 year impact factor; impact factors were taken from Clarivate analytics

articles, and citations by those articles in the journal till 2024. The average citation per article and the h-index are followed by the threshold number of publications in TPB in the journal that received equal to or greater than 200, 100, 50, and 1 citation. Thus, the citation structure of articles in TPB in the journal provides a conceptual basis for assessing the influence of the journal. All the journals in the list have impact factors ranging from 2 for Sage Open to 11.2 for Resources Conservation and Recycling. The highest number of 576 articles have been published in Sustainability (IF 3.3, 5-IF 3.6) and received 9301 citations for an average of 16.15 per published article in TPB in the journal. The h-index of the journal is 46, indicating that 46 articles have received at least 46 or more citations in the journal. The citation structure of the journal indicates that 1 article received 200 or more citations, 11 articles received 100 or more citations, and 43 articles received 50 or more citations. The list of top 10 journals includes three journals that predominantly publish in environment and sustainability, two journals that publish in the field of social psychology, two journals from public health, and one journal each in food, transportation, and multiple disciplines. The presence of high-impact factor journals in diverse research domains like Resources Conservation and Recycling (IF 11.2, 57 articles, 122.72 citations per article), Journal of Retailing and Consumer Services (IF: 11. 57 articles, 69.93 cites per article), Journal of Cleaner Production (IF:9.8, 184 articles, 67.59 cites per article), Journal of Cleaner Production (IF: 9.8, 184 articles, 67.59 cites per article), Computers in Human Behavior (IF: 9, 73 articles, 88.40 cites per article), underscore the TPB's interdisciplinary influence in leading journals in areas such as sustainability, environment, public health, social psychology and green marketing. It is surprising to note that there is only one journal devoted to publishing in the field of social psychology that is on the list, the Journal of Applied Social Psychology (IF: 3.5, 113 articles, 154.58 cites per article) and most of the other journals are in diverse research domains as noted above including public health, food, transportation, exercise science, among others. The snapshot of leading journals in TPB reflects the migration of emphases from social psychology to the application of the TPB in diverse disciplines over time. The analysis suggests the TPB's expanding relevancy and applicability in diverse contexts and domains that have contributed to its long standing influence among psychological theories of intention-behavior over the past forty years.

3.4 Important authors in the field of TPB

The list of the top 20 authors in Table 3 has published 1106 articles and received 151,985 citations. The influence of these authors on the field of TPB can be gauged from the fact that they have received 28% of the 542,579 citations received by articles in the field of TPB while having a share of 7% of all the 14,461 articles published in the TPB. The table ranks the authors by the number of articles published and includes their total citations received by the authors, their h-index, citations per publication, and the number of publications that received equal to or greater than 200, 100, and 50 citations. This citation structure provides a conceptual basis for assessing each author's influence in the field of TPB.

Table 3 Important authors in the field of TPB

R	Author	University	Country	TP	TC	H	TC/TP	≥200	≥100	≥50
1	White, KM	Queensland U Tech	Australia	110	5642	36	51.29	6	12	27
2	Rhodes, R	U Victoria	Canada	105	4997	45	47.59	2	9	37
3	Hagger, MS	U California, Merced	USA	94	5611	43	59.69	1	18	37
4	Conner, M	U Leeds	UK	92	18,777	57	204.10	15	40	61
5	Courneya, K	U Alberta	Canada	81	4597	43	56.75	1	11	37
6	Hamilton, K	Griffith U	Australia	77	1811	25	23.52	0	2	9
7	Godin, G	Laval U	Canada	56	4695	23	83.84	4	6	13
8	Armitage, CJJ	U Manchester	UK	47	12,802	35	272.38	8	21	29
9	Mullan BA	Curtin U	Australia	47	1798	25	38.26	0	2	13
10	Ong, AKS	Mapua University	Phillipines	43	396	10	9.21	0	0	2
11	Ajzen, I	U Massachusetts	USA	43	68,210	36	1586.28	20	30	36
12	Han, H	Sejong U	South Korea	39	4563	26	117.00	6	10	14
13	Chatzirantis, NLD	Curtin U	Australia	37	3589	28	97.00	1	14	24
14	Blanchard, CM	Dalhousie U	Canada	37	1387	20	37.49	0	3	8
15	Sheeran, P	U North Carolina Chapel Hill	USA	35	6030	30	172.29	12	21	27
16	Hyde, MK	U Queensland	Australia	34	1263	21	37.15	0	3	7
17	Grimshaw, J	U Ottawa	Canada	34	3890	23	114.41	2	5	10
18	Jeihooni, AK	Shiraz University	Iran	32	132	7	4.13	0	0	0
19	Legare, F	U Laval	Canada	32	694	17	21.69	0	0	3
20	Ranmayah, T	Universiti Sains Malaysia	Malaysia	31	1101	16	35.52	1	2	6

R, rank; TP, total publications; TC, total citations; H, h-index; TC/TP, citations per publication; ≥200, ≥100, ≥50, threshold number of publications equal to or greater than 200, 100, and 50 citations

The top 20 ranked productive authors list is dominated by authors from Canada, Australia, the USA, and the UK, with 6. 5, 3, and 2 authors, respectively. White, KM (110 papers, 51.29 cites/paper) from Queensland University of Technology is the most productive author. Rhodes, R (105 papers, 47.59 cites/paper) from the University of Victoria is ranked second. Hagger, MS (94 papers, 59.69 cites/paper) from the University of California, Merced is ranked third. The fourth and fifth-ranked productive authors are Conner, M (92 papers, 204.10 cites/paper) from the University of Leeds and Courneya, K (81 papers, 56.75 cites/paper), respectively. Ajzen, I (43 papers, 1586.28 cites/paper) from the University of Massachusetts is ranked eleventh on the list and stands out for his extraordinary impact, with a total of 68,210 citations, which is equivalent to 45% of the 151,986 citations received by the top 20 productive authors in the TPB, and he has an h-index of 36 further emphasizing his foundational influence on TPB research. Ajzen work is well accepted, with 20 papers receiving 200 or more citations, 30 papers receiving 100 or more citations, and 36 papers receiving at least 50 citations. On the cites/paper criteria, Ajzen is ranked first with 1586.28 cites per paper, followed in chronological order by Armitage, CJ (272.38 cites/paper), Conner, M (204.10 cites/paper), Sheeran, P (172.29 cites/paper), and Han, H (117.29 cites/paper). Armitage, CJ from the University of Manchester, has published 35 papers, with eight papers receiving 200 or more citations and 21 papers receiving 100 or more citations; and Conner, M from the University of Leeds has published 92 papers, with 15 of them receiving 200 or more citations and 40 papers receiving 100 or more citations. Apart from the dominance of authors from Australia, Canada, the UK, and the USA, there is one author each from the Philippines, South Korea, Iran, and Malaysia who comprise the list of 20 productive authors.

3.5 Important institutions in the field of TPB

The list of the most productive institutions is presented in Table 4. The institution is the author's affiliation when publishing the paper. Thus, an author who changes institutions may have papers published in different institutions. These institutions are ranked by their contributions to TPB research, including total publications, total citations, h-index, and citations per publication. The table also includes the number of publications that received equal to or greater than 200, 100, and 50 citations, as well as their rankings in the Academic Ranking of World Universities (ARWU) and the Quacquarelli and Symonds (QS) University Ranking.

Table 4 lists the top 20 most productive and influential institutions in TPB, and it includes five institutions from Australia: Queensland University of Technology (206 papers, 43 h-index, 34.65 cites/paper), Griffith University (166 papers, 37 h-index, 28.82 cites/paper), Curtin University (121 papers, 36 h-index, 40.68 cites/paper), University of Queensland (105 papers, 37 h-index, 62.11 cites/paper), and Monash University (86 papers, 21 h-index, 20.77 cites/paper), which are ranked first, third, seventh, tenth and seventeen on the list. The list also includes four institutions from Canada: Laval University (166 papers, 33 h-index, 47.66 cites/paper), the University of Alberta (126 papers, 48 h-index, 44.71 cites/paper), the University of Victoria

Table 4 Important institutions in the field of TPB

R	Institutions	Country	TP	TC	H	TC/TP	≥200	≥100	≥50	ARWU	QS
1	Queensland U Tech	Australia	206	7138	43	34.65	6	13	38	42	222
2	Laval U	Canada	166	7911	33	47.66	7	11	23	301–400	433
3	Griffith U	Australia	166	4782	37	28.81	3	8	28	201–300	300
4	U Leeds	UK	133	20,427	58	153.59	16	43	71	151–200	86
5	U Sheffield	UK	128	20,804	62	162.53	21	49	75	101–150	96
6	U Alberta	Canada	126	5634	48	44.71	1	11	45	92	110
7	Curtin U	Australia	121	4922	36	40.68	4	11	22	201–300	193
8	U Victoria	Canada	117	5933	46	50.71	4	12	41	301–400	359
9	Maastricht U	Netherlands	105	4941	30	47.06	1	8	18	201–300	278
10	U Queensland	Australia	105	6522	37	62.11	9	18	32	201–300	50
11	Hong Kong Poly U	China	105	5200	38	49.52	7	14	25	151–200	65
12	U Sains Malaysia	Malaysia	101	2394	24	23.70	2	3	14	401–500	143
13	Chinese Academy Sciences	China	94	5744	40	61.11	5	20	36	–	–
14	U Ottawa	Canada	94	5644	34	60.04	2	8	20	201–300	237
15	U Putra Malaysia	Malaysia	89	1983	24	22.28	1	5	9	701–800	123
16	U Kentucky	USA	88	1608	26	18.27	0	1	8	301–400	701–750
17	Monash U	Australia	86	1786	21	20.77	1	2	11	75	57
18	U Aberdeen	UK	80	5000	34	62.50	1	8	24	201–300	220
19	U Nottingham	UK	79	3862	38	48.89	1	8	30	101–150	114
20	U Florida	USA	79	3398	27	43.01	1	7	16	94	188

R, rank; TC, total citations; TP, total publications; H, h-index; TC/TP, citations per publication; ≥200, ≥100, ≥50, threshold number of publications equal to or greater than 200, 100, and 50 citations; ARWU, Academic Ranking of World Universities; QS, Quacquarelli and Symonds University Ranking

(117 papers, 46 h-index, 50.71 cites/paper), and the University of Ottawa (94 papers, 34 h-index, 60.04 cites/paper), which are ranked second, sixth, eighth, and fourteen, respectively. Apart from institutions from Australia and Canada, there are four institutions from the UK, two each from China, the USA, and Malaysia, and one institution from the Netherlands. In terms of influence per paper, the University of Sheffield, UK (128 papers, 62 h-index, 162.53 cites/paper), and the University of Leeds (133 papers, 58 h-index, 153.59 cites/paper) are top ranked with 21 and 16 papers receiving at least 200 citations in the database. The presence of institutions from various countries highlights the global reach of the TPB and its widespread influence in the field of intentions and behavior. The diffusion of the TPB from the USA to Canada, the UK, Australia, China, Malaysia, and the Netherlands can be observed from the list (Table 5).

Table 5 Top 5 articles in each time period

Top 5 articles (1985–1999)			Top 5 articles (2004–2009)		
Reference	Year	Citations	Reference	Year	Citations
Ajzen, I	1991	49,027	Venkatesh et al	2003	19,424
Taylor and Todd	1995	4363	Armitage and Conner	2001	6181
Ajzen and Madden	1986	3253	Ajzen, I	2002	4395
Conner and Armitage	1998	2036	Krueger et al	2000	2784
Godin and Kok	1996	1991	Perugini and Bagozzi	2001	1126
Top 5 articles (2005–2009)			Top 5 articles (2010–2014)		
Reference	Year	Citations	Reference	Year	Citations
Liñán and Chen	2009	1858	Francis et al	2010	1857
Pavlou and Fygenson	2006	1526	Webb et al	2010	1654
Souitaris et al	2007	1217	McEachan et al	2011	1410
Luarn and Lin	2005	945	Han et al	2010	1141
Lee, MC	2009	938	Bulgurcu et al	2010	1050
Top 5 articles (2015–2019)			Top 5 articles (2020–2024)		
Reference	Year	Citations	Reference	Year	Citations
Paul et al	2016	1156	Ajzen, I	2020	1062
Marangunic and Granic	2015	1006	Bae and Chang	2021	435
Yadav and Pathak	2016	823	Yuriev et al	2020	432
Schmid et al	2017	822	Han, H	2021	343
Kautonen et al	2015	746	Guidry et al	2021	340

Citation counts retrieved on December 31, 2024

4 Investigating the articles in the field of TPB

4.1 Investigation of the period-wise article distribution pattern

To get a granular understanding of the growth and evolution of the field of TPB over the past forty years and as older articles have a greater probability of being cited, we divide the forty-year time frame into periods. The practice of analyzing specific periods within a longer time frame has precedence in the field of bibliometrics (Block et al. 2020). We develop a sound rationale for the time classification based on the growth rate of articles and the annual number of articles published in the field of TPB and identify six time periods (1985–1999, 2000–2004, 2005–2009, 2010–2014, 2015–2019, and 2020–2024). Figure 3 illustrates the number of articles published annually and their percentage of the total articles published till 2024. The first period from 1985 to 1999 marked the foundational years and early development of the TPB with 229 articles that comprise 1.6% of all articles published till 2024 but laid the groundwork for the development of the field. The second period, 2000–2004, saw 378 articles being published, and the adoption and initial validation of TPB gave it additional traction. The third period, 2005–2009, marked a significant growth and expansion of the TPB, with 1018 published articles reflecting mainstream acceptance of TPB as researchers applied it to different contexts and disciplines. The fourth period, 2010–2014, with 1963 articles, saw a period of extensions to the TPB and its consolidation in the academic community, further illustrating its robustness in understanding intentions and behavior. The fifth period, 2015–2019, with 3429 articles, showed a substantial increase in the annual number of articles and demonstrated its versatility and relevance to the field. The sixth period, 2020–2024, saw a 118% increase in the number of articles published to 7444 articles and highlighted the

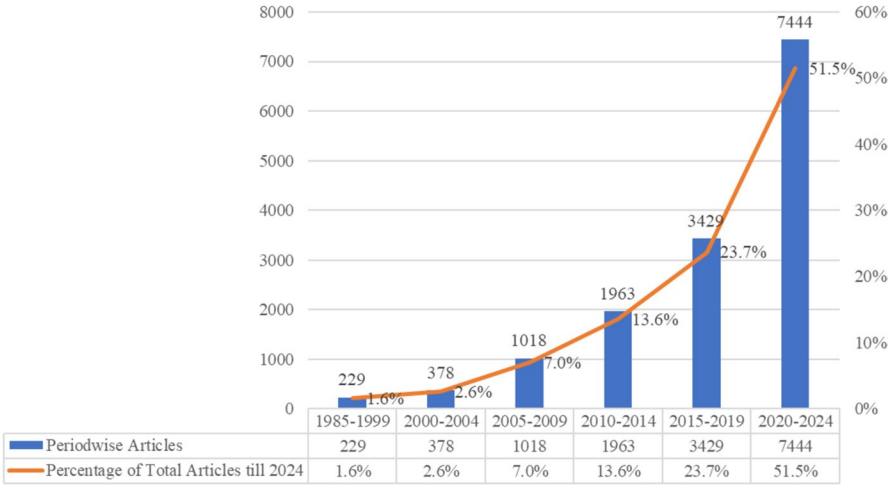

Fig. 3 Articles published in each period and as a percentage of total articles published till 2024 in the field of TPB

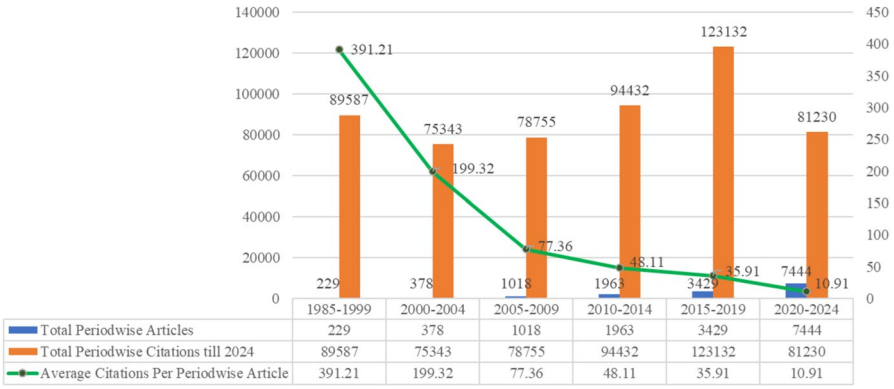

Fig. 4 Total and average citations received till 2024 by articles in each period in the field of TPB

recognition of TPB as a critical framework for understanding human behavior. It is interesting to note that during the six periods, the average number of articles published per year grew astronomically, with a 100-fold increase from 15 articles in the first period (1985–1999) to 1488 articles in the most current sixth period (2020–2024).

4.2 Investigation of the period-wise citation distribution pattern

The graph in Fig. 4 provides valuable insights into the impact and recognition gained by TPB research over different periods. The distribution of citations for each period is analyzed, and the results indicate the growing acceptance and usage of TPB across a wide range of disciplines and contexts. The early phase of TPB research (1985–1999) shows 229 articles with a total of 89,587 citations, resulting in an impressive average of 391.21 citations per article. This high average indicates the foundational importance and substantial influence of early TPB studies. During the second period (2000–2004), there were 378 articles with 75,343 total citations, averaging 199.32 citations per article, highlighting the continued relevance and validation of TPB. The third period (2005–2009) saw a notable increase in publications, with 1018 articles, accumulating 78,755 citations. The average citation per article was 77.36, reflecting the broadening application of TPB across various fields. The fourth period (2010–2014) saw the publication count increase to 1963 articles, receiving 94,432 citations. The average number of citations per article was 48.11, driven by the diversification and expansion of TPB research into new areas and contexts. In the fifth period (2015–2019), 3429 articles were published, gathering 123,132 citations. The average citations per article decreased to 35.91, indicating a significant increase in research volume while maintaining substantial influence and relevance. The most recent period (2020–2024) shows a dramatic surge with 7444 articles, and the average number of citations per article was 10.91, totaling 81,230 citations. The decrease in the

average number of citations received in recent periods is attributed to the large number of articles published over time and the fact that older articles have a greater likelihood of being cited as they are around for a longer period than newly published articles. Figure 4 reflects the exponential growth in TPB research activity and its widespread influence, as evidenced by the citation distribution over the six periods.

4.3 Investigation of period-wise analysis of the most influential articles

Within each period, we focus on the top 5 most influential articles that have received the highest number of citations and investigate their impact on the field's evolution in the TPB.

4.3.1 Most cited articles published during 1985–1999

In the first fifteen-year period (1985–1999), the most cited article is the seminal paper that introduces the TPB as an extension of the theory of reasoned action by incorporating the construct of perceived behavioral control to account for situations where individuals do not have complete volitional control over the behavior (Ajzen 1991). The article received 49,027 citations by publications in the WoS core collection as of December 19, 2024. The second most influential paper, with 4363 citations, compared the technology acceptance model and variations of the TPB to understand information technology usage and found support for the decomposed TPB model and shaped the trajectory of technology adoption research since its publication thirty years ago (Taylor and Todd 1995). The third most influential article, with 3253 citations, empirically tested the extended TPB and found support that perceived behavioral control significantly predicted the intentions and goal attainment of college students and validated the addition of perceived behavioral control in the TPB (Ajzen and Madden 1986). The fourth most cited article in the period received 2036 citations and conducted a review of the TPB and recommended the inclusion of additional variables such as belief salience, moral norms, self-identity, and affective belief to enhance the TPB (Conner and Armitage 1998). The paper also discussed the potential of incorporating the TPB into a dual-process model and expanding it to include volitional process. The fifth most cited paper with 1991 citations reviewed the application of TPB in health-related behaviors and found that the TPB performed well in explaining intentions, with attitude towards the action and perceived behavioral control being significant predictors (Godin and Kok 1996). The authors also noted the variations in the effectiveness of the TPB across different types of health-related behaviors.

4.3.2 Most cited articles published during 2000–2004

The second period (2000–2004) marked the diffusion of the TPB into the domains of health and wellness, addiction, information technology, and entrepreneurship.

The most cited article published in the period, with 19,424 citations, proposed the unification of the theory of acceptance and use of technology that integrated concepts from the TPB and technology acceptance model to predict better technology acceptance and usage intentions and behaviors (Venkatesh et al. 2003). The authors identified performance expectancy, effort expectancy, social influence, and facilitating conditions as key determinants of user acceptance and subsequent usage of technology. The unified model has been extensively applied in various fields that require technology adoption and serves as a perfect example of the extendibility of the TPB. The second most influential article in the period, with 6181 citations, conducted a meta-analytic review of the TPB from 185 independent studies and found that the TPB accounted for 27% of the variance in behavior and 39% of the variance in intention and also noted the weakness of the subjective norm construct in the TPB (Armitage and Conner 2001). The article offered support for the TPB and played a pivotal role in building the foundation for future research in the TPB. The third most influential article from the period received 4395 citations and reflected the ongoing discourse in the field about how self-efficacy and locus of control interact with perceived behavioral control within the TPB framework and how they have differentiated roles (Ajzen 2002). The fourth most cited article in the period received 2784 citations and compared the TPB with other behavioral models to understand entrepreneurial intentions and found that perceptions of feasibility and desirability impacted intentions (Krueger et al. 2000). The paper played a pivotal role in the field of entrepreneurship and built a theoretical basis for understanding intentions. The fifth most influential paper received 1126 citations and extended the TPB by incorporating desires and anticipated emotions into the model, made the argument for their crucial role in goal-directed behaviors, and provided further support for the TPB while broadening the scope of the TPB by highlighting the significance of emotional and motivational factors in predicting intentions and behavior (Perugini and Bagozzi 2001).

4.3.3 Most cited articles published during 2005–2009

The next set of five most cited articles in the period 2005–2009 made a significant contribution to the TPB as they demonstrated the applicability of the TPB across various fields, including electronic commerce, mobile banking, internet banking, and education. The most influential article from this period received 1858 citations and developed an entrepreneurial intention questionnaire analyzed its psychometric properties, and found evidence for the role of culture in explaining motivational perception and intention to engage in entrepreneurship (Linan and Chen 2009). The second most influential article from the period received 1526 citations and integrated trust and technology adoption variables into the TPB framework, enhancing the explanatory power of the model and highlighting the significance of perceived usefulness, ease of use, and trust in predicting electronic commerce adoption. The third most influential article, with 1217 citations, tested the effect of entrepreneurship programs on the entrepreneurial attitudes and intentions of students and found that the programs influenced attitudes and entrepreneurial intentions (Souitaris et al. 2007). The fourth most important article in the period, with 945 citations, used

constructs from the TPB such as trust-based (perceived credibility) and resource-based (perceived self-efficacy and perceived financial cost) and extended the technology acceptance model in predicting user intentions to adopt mobile banking (Luarn and Lin 2005). The fifth most cited article published in the period received 938 citations and integrated the technology acceptance model with the TPB to explore factors such as perceived benefit and risk facets (financial, security/privacy, performance, social, and time) affecting internet banking adoption (Lee 2009). The article provided guidance on the factors shaping consumer intentions and presented a comprehensive model that combines positive and negative factors.

4.3.4 Most cited articles published during 2010–2014

A focus on methodological rigor and a pronounced focus on health-related behaviors, environmental sustainability and new applications in the field of information security and employee compliance characterize the five most influential articles in the period. The most prominent article published in the period received 1857 citations, addressed the methodological question concerning adequate sample sizes for qualitative interview-based TPB studies, and provided guidelines for operationalizing data saturation in generating results that are reliable and valid (Francis et al. 2010). The study significantly influenced methodological approaches in qualitative research in the TPB. The second most important article from the period had 1654 citations and was a meta-analysis that examined the prediction of health-related behaviors using the TPB (McEachan et al. 2011). The analysis validated the predictive power of the TPB in the health domain and reinforced the role of the three TPB variables in designing effective health behavior interventions. The third most influential article published in the period received 1141 citations and applied the TPB to explain customers' intentions to visit green hotels and showed that attitude, subjective norms, and perceived behavioral control positively affected the intention regardless of customers' engagement in eco-friendly activities (Han et al. 2010). The article extended the application of the TPB to the tourism and hospitality industry. The fifth most important article from the period has 1.050 citations and examines the factors influencing employees' compliance with information security policies using the TPB framework and finds support for rationality-based beliefs and information security awareness in predicting employee compliance behavior (Bulgurcu et al. 2010). The article demonstrated the robustness of the TPB in addressing a timely and emergent topic of information security compliance and associated employee behaviors leading to the design of effective awareness and intervention programs.

4.3.5 Most cited articles published during 2015–2019

The most influential articles from the period represent significant contributions to the application of TPB across diverse fields of green marketing, public health, entrepreneurship, and consumer behavior. The most important paper published in the period extended the TPB and found it to have higher predictability than the original TPB and the theory of reasoned action when it came to consumers' intention to purchase green products and served to validate the TPB in green marketing

settings (Paul et al. 2016). The second most cited paper from the period, with 1006 citations, consolidated the extensive body of research on the technology acceptance model that has its roots in the TPB and the TRA classified 85 publications in leading journals and provided insights on the research area overlaps among intention and behavior models (Marangunić and Granić 2015). The third most influential article in the period had 823 citations used the TPB to understand young consumers' intention towards buying green products and found that additional constructs such as environmental concern and environmental knowledge improved the predictive utility of the TPB (Yadav and Pathak 2016). The fourth most cited article from the period received 822 citations and conducted a systematic review of the vaccination intention literature and identified key factors contributing to vaccine hesitancy, such as perceived risks and benefits, social influences, and individual attitudes (Schmid et al. 2017). The guidance provided by the literature review gained traction during COVID-19 pandemic studies relating to vaccination intention. The fifth most important article had 746 citations and demonstrated the robustness of the TPB in predicting business, startup, and subsequent behavior based on longitudinal survey data and addressed the weakness in existing TPB research on entrepreneurial intention that focused on cross-sectional studies and limited samples (Kautonen et al. 2015).

4.3.6 Most cited articles published during 2020–2024

The five most influential articles during the period are predominantly in two areas: COVID-19 and environmental sustainability. The most influential article, with 1062 citations, provided a comprehensive review of the key components of the TPB and also addressed questions on topics related to differences between the TPB and TRA, perceived behavioral control and self-efficacy, and, most notably, the author outlined the criteria to be followed for incorporating additional predictors in the TPB (Ajzen 2020). The second most cited article from the period had 435 citations and examined the effect of COVID-19 affective and cognitive risk perception on behavioral intention toward a specific type of tourism (Bae and Chang 2021). The third most influential article from the period received 432 citations, was a scoping review that analyzed 126 publications on pro-environmental behaviors using the TPB and emphasized the importance of evaluating indirect variables and reporting the amount of explained variance (Yuriev et al. 2020). The fourth-ranked article from the period received 343 citations, introduced a special issue on environmental and sustainable behavior, and provided a review of the prominent intention models that have been utilized in the tourism and hospitality industry (Han 2021). The fifth-ranked article published in the period received 340 citations and explored the psychosocial predictors of willingness to get a future COVID-19 vaccine under two conditions: standard vaccine approval and emergency use authorization (Guidry et al. 2021).

Table 6 Evolutionary phase analysis in each period

Time period	Evolution phase	Evolutionary trend	Industry spotlight	Research emphasis	Research opportunity
1985–1999	Nascent phase	Initial emergence of TPB, introduction of perceived behavioral control, differentiation from TRA, early applications of original TPB across some behaviors	Social Psychology and Health	How do attitudes, subjective norms, and perceived behavioral control influence behavior intentions? How to differentiate TPB from TRA?	Validate the core constructs of TPB in diverse contexts. Explore additional constructs to enhance predictive power and applicability
2000–2004	Formative phase	Development of TPB, comparison with other intention-behavior models, extensions with other models (TAM, UTAUT), meta-analytic studies and reviews	Information Technology, Health Informatics, Entrepreneurship	How can TPB be integrated with other models like TAM to better predict technology acceptance, health and entrepreneurship behaviors?	Investigate deeper integrations of TPB with behavioral models. Expand meta-analytic reviews to consolidate broader findings for the future
2005–2009	Expansion phase	Contextual studies introducing antecedents to the three components of the TPB, introduction of cross-cultural factors, extended models proposed with new constructs	Electronic Commerce, Mobile Banking, Entrepreneurship	What are the contextual factors and demographic factors that influence entrepreneurial intentions and predict user adoption of mobile and internet banking?	Explore TPB's role in culturally diverse settings. Apply TPB to novel and practical contexts reflecting emerging technological trends
2010–2014	Refinement phase	Emphasis on methodological rigor, sample size guidance and statistical techniques, improving reliability and validity of TPB, confirmation of TPB's predictive power and variance analysis	Health Interventions, Environmental Conservation and Information Security	What sample sizes are adequate for TPB-based qualitative research? How effective are internet-based interventions in promoting health behavior change?	Enhance methodological rigor for TPB studies. Conduct longitudinal and meta-analytic studies to validate TPB constructs further
2015–2019	Maturation phase	Diffusion and growth of TPB in green behavior, environment sustainability, public health, technology adoption, validation through longitudinal studies	Green Marketing, Technology Adoption and Public Health	How do environmental concerns influence green product purchase intentions? What factors predict influenza vaccination behavior?	Investigate the impact of environmental concerns on consumer behavior. Extend TPB's reach to new areas such as sustainability and health crises

Table 6 (continued)

Time period	Evolution phase	Evolutionary trend	Industry spotlight	Research emphasis	Research opportunity
2020–2024	Integration phase	Large-scale acceptance of TPB in addressing global challenges such as COVID-19, routine extension of TPB, guidelines for incorporating additional predictors to TPB outlined	COVID-19, Environmental Sustainability. Tourism and Hospitality	How do risk perceptions influence behavioral intentions during a pandemic? What are the predictors of willingness to get a COVID-19 vaccine under emergency use authorization	Adapt TPB to address emerging global challenges like pandemics. Provide criteria for incorporating variables into TPB. Focus on comparing application of TPB in different contexts

The table has been developed on the analysis of the most cited papers in each time period and highlights the prominent trends, research, and industries

TAM, technology acceptance model; TRA, theory of reasoned action, UTAUT, unified theory of acceptance and use of technology

4.4 Evolutionary phase analysis over six periods

The evolution of the field of TPB over six periods is presented in Table 6 and provides a comprehensive overview of the development and application of the TPB from 1985 to 2024. The table also highlights trends, identifies research emphases, spotlights disciplines of interest in each period, and provides valuable guidance to researchers to identify research opportunities and position their work.

4.4.1 Nascent phase (1985–1999)

During this nascent phase, TPB emerged as an extension of the Theory of Reasoned Action (TRA), with the introduction of perceived behavioral control. Foundational research, primarily in social psychology and public health, established the core constructs, and the period also saw the initial adoption of the TPB in diverse contexts. These early studies enabled the academic community to explore behavioral intentions and position the TPB among other behavior theories. One key research emphasis was understanding how perceived behavioral control influenced intentions and behaviors and its value to the field.

4.4.2 Formative phase (2000–2004)

The formative phase marked the diffusion of TPB into new domains such as health, information technology, and entrepreneurship. Comparisons with other intention-behavior models like TAM and UTAUT and meta-analytic reviews consolidated TPB's findings and improved its predictive power. This period demonstrated TPB's versatility, offering academics a nuanced understanding of technology acceptance and health behaviors. Among the research emphases of the phase include the analysis of factors influencing technology acceptance and usage intentions and comparative analysis of the TPB.

4.4.3 Expansion phase (2005–2009)

In the expansion phase, TPB research incorporated contextual and cross-cultural factors, extending its applicability to electronic commerce, mobile banking, and education. Integrating constructs such as trust and perceived usefulness extended the TPB in technology adoption. Academics benefited from applying TPB in culturally diverse settings and emerging technological contexts, enhancing its global relevance. The research emphasis of the period was on the factors that influence the drivers of intention and behaviors and their applicability in different contexts.

4.4.4 Refinement phase (2010–2014)

The refinement phase emphasized methodological rigor, focusing on sample size guidance and statistical techniques to improve reliability and validity. Research confirmed TPB's predictive power in health interventions, environmental conservation,

and information security. The academic community gained insights into designing effective TPB-based studies, and their robustness in addressing complex behavior change interventions. The phase focused on questions at the intersection of public health and the environment, providing clarity on research methods and statistical techniques.

4.4.5 Maturation phase (2015–2019)

During the maturation phase, TPB's diffusion continued in green behavior, public health, and consumer behavior. Longitudinal studies validated its predictive utility, particularly in green product purchase intentions and vaccination behaviors. This phase reinforced TPB's applicability to contemporary issues like environmental concerns and health crises, providing empirical evidence for effective interventions. The factors driving consumer intentions to purchase sustainable products and contributing to vaccine hesitancy formed the research emphasis.

4.4.6 Integration phase (2020–2024)

The integration phase saw TPB widely adopted to address global challenges such as COVID-19 and environmental sustainability. Research provided guidelines for incorporating additional predictors, emphasizing TPB's adaptability. The academic community leveraged TPB to understand risk perceptions during pandemics and predictors of vaccine willingness, showcasing its relevance in real-world crises and expanding its theoretical and practical horizons. The research emphasis highlighted the versatility and proficiency of the TPB in addressing behavioral issues relating to COVID-19.

5 Bibliometric analysis

The paper uses VOSviewer software to construct and develop bibliometric maps. While many bibliometric mapping techniques are used, they can be classified as distance-based or graph-based (Van Eck and Waltman 2010). There are advantages and disadvantages to both distance and graph-based maps. VOSviewer is graph-based and uses its mapping technique. The VOSviewer is utilized because it provides the versatility of labeling items that do not overlap. Further, the maps are more even and interpretable than distance-based maps, as the relations between items in VOS Viewer are generated not based on distance but on the lines connecting them (Van Eck et al. 2010). Consistent with the practices in bibliometrics that are aligned with the goals of the paper, VOS Viewer is used to generate maps as a part of co-citation, co-occurrence of author keywords, and bibliographic coupling (Merigó et al. 2018; Andrade-Valbuena et al. 2019; Rialp et al. 2019).

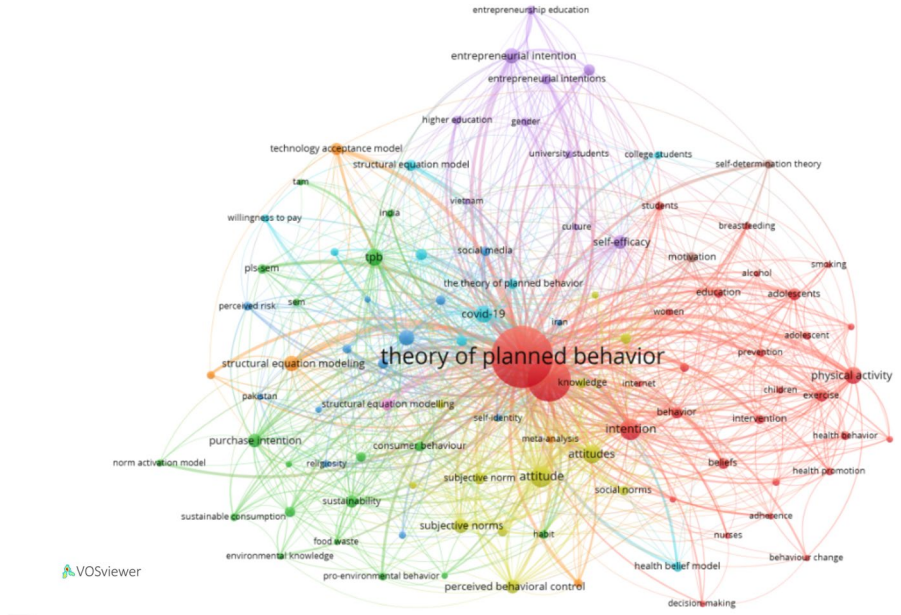

Fig. 5 Co-occurrence of keywords

5.1 Co-occurrence analysis of keywords

We utilize VOSviewer to identify the frequently used author keywords in the 14,461 articles in our sample. Consistent with prior guidelines, the minimum threshold was set at fifty occurrences, and a hundred of the most representative connections were considered for the co-occurrence analysis (Merigó et al. 2018). The co-occurrence of keywords is presented in Fig. 5. The co-occurrence network of keywords, as presented in Fig. 5, reveals several key clusters and themes. The central keyword, "theory of planned behavior," is prominently displayed at the center of the network, indicating its significance. Various other keywords are connected to it through lines, representing their co-occurrence in the literature. The clusters are color-coded, with larger nodes signifying more frequently occurring keywords and links indicating the strength of their co-occurrence relationships.

The keywords used in the identification of the articles, country names, statistical terms, research methods, and the common constituents of the TPB, such as belief, perceived behavioral control, attitude, behavior, and intention, are excluded, and thematic clusters based on co-occurrence of keywords analysis are presented in Table 7. The largest cluster is the Health and Wellness cluster, and it highlights a significant focus on health behavior research, particularly concerning physical activity, adolescent health, and intervention strategies. The prominence of these keywords indicates ongoing research interest in understanding and promoting healthy behaviors across different age groups and demographics. The second most prominent cluster is Sustainability and Environment, and it underscores the growing

Table 7 Thematic clusters based on co-occurrence of keywords analysis (1985–2024)

Cluster I: health behavior and wellness			Cluster II: sustainability and environment			Cluster III: technology and social perception		
Author keyword	Oc	Co	Author keyword	Oc	Co	Author keyword	Oc	Co
Physical Activity	338	284	Purchase Intention	222	182	Technology Acceptance Model	294	285
Adolescents	259	208	Sustainability	192	156	Trust	131	111
Exercise	173	159	Environmental Concern	131	109	Social Media	111	91
Intervention	111	93	Consumer Behaviour	150	200	Perceived Risk	98	84
Health Behavior	92	75	Pro-Environmental Behavior	85	70	Religiosity	69	56
Health Promotion	86	69	Sustainable Consumption	82	67	Climate Change	65	51
Prevention	80	58	Norm Activation Model	62	61	Self-Identity	64	62
Children	73	64	Food Waste	60	54			
Breastfeeding	66	56	Organic Food	59	56			
Women	63	47	Recycling	59	55			
Cluster IV: theoretical foundations			**Cluster V: entrepreneurship education and intention**			**Cluster VI: health behavioral models and testing**		
Author keyword	Oc	Co	Author keyword	Oc	Co	Author keyword	Oc	Co
Attitude	978	899	Entrepreneurial Intention	440	415	Covid-19	349	286
Subjective Norms	427	417	Self-Efficacy	219	189	Motivation	129	107
Perceived Behavioral Control	338	332	Entrepreneurship	165	150	Health Belief Model	112	109
Knowledge	116	109	Education	115	93	Theory Of Reasoned Action	99	98
Social Norms	114	101	Students	108	95	Self-Determination Theory	94	91
Adoption	78	61	Higher Education	104	87	Risk Perception	90	70
Survey	66	51	Entrepreneurship Education	100	91	Protection Motivation Theory	90	89
Behavioural Intention	65	55	Gender	94	79	Willingness To Pay	87	65
			University Students	83	69	College Students	80	68
			Culture	54	43			

Keywords used for identification of articles, abbreviations of theory of planned behavior and country names are excluded for the purpose of the analysis

Oc, author keyword occurrences; Co, author keyword co-occurrence links

importance of environmental sustainability and consumer behavior towards green practices. The emphasis on keywords such as sustainability and recycling reflects the increasing focus on promoting sustainable consumption and waste management practices. The third most prominent cluster is Technology and Social Perception, which intersects technology adoption and social perception, highlighting the role of trust, social media, and perceived risks in shaping behaviors. The presence of keywords like climate change and self-identity indicates research exploring the broader social and psychological dimensions of technology acceptance. The fourth most prominent keyword cluster is Theoretical Foundations, which focuses on TPB's core theoretical constructs, the TPB's extension and development, and their application in understanding and predicting behavioral intentions. The frequent occurrence of keywords like attitude, subjective norms, perceived behavioral control, and social norms underscores TPB's continued development, evolution, and relevance in behavioral research and its foundational role in studying intention and behavior. The fifth cluster is Entrepreneurship Education and Intention, and the author's keywords highlight research on entrepreneurship education, self-efficacy, and cultural

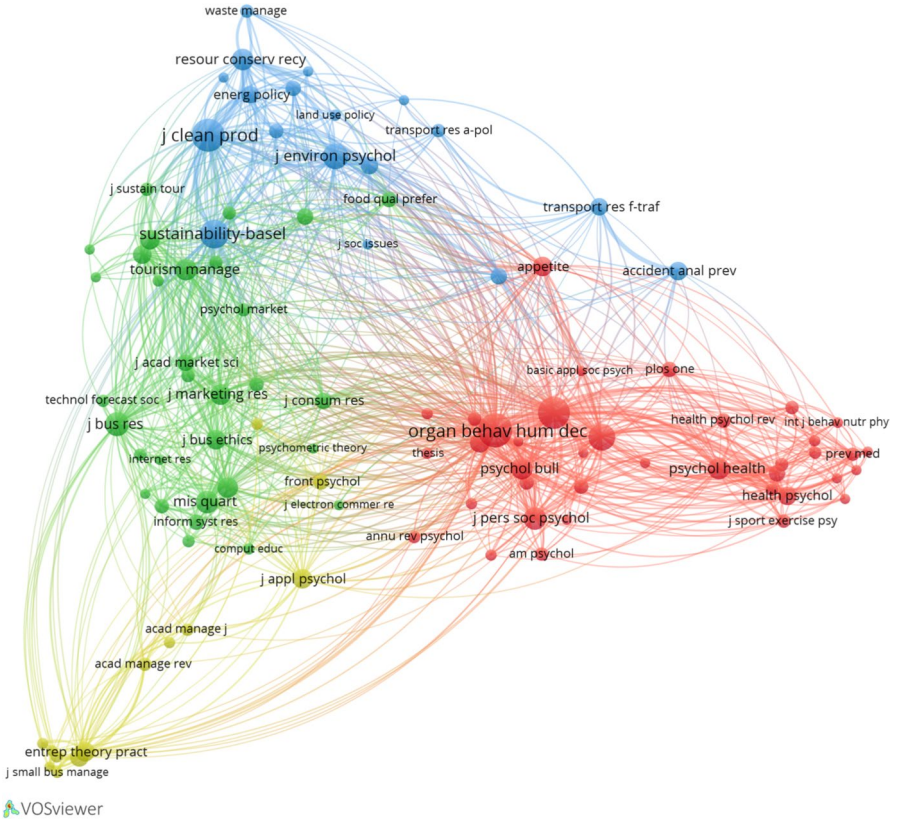

Fig. 6 Co-citation analysis at the journal level

influences on entrepreneurial intentions among students. It indicates a growing interest in understanding how educational and cultural factors shape entrepreneurial behaviors and intentions. The sixth and final cluster is Health Behavioral Models and Testing, with the most frequent co-occurring authors' keywords of COVID-19, motivation, health beliefs model, self-determination theory, protection motivation theory, and theory of reasoned action. This cluster indicates a focus on health behavioral models, especially in the context of the COVID-19 pandemic, and the presence of keywords related to risk perception, willingness to pay, and motivation highlight research exploring the factors influencing health behaviors during the pandemic.

5.2 Co-citation analysis

Co-citation analysis is a technique that identifies how often authors and journals are cited together and is a proven technique to identify thematic clusters in the field of bibliometric studies (Block et al. 2020). The co-citation analysis was conducted using VOSviewer to map the relationships in the TPB literature.

5.2.1 Co-citation analysis at the journal level

The graphical representation of the co-citation of journals in TPB is presented in Fig. 6 for the overall period 1985–2024. Co-citation of journals refers to a situation where two journals are frequently cited together in the reference lists of subsequent articles. The co-citation indicates a close relationship or thematic similarity between the journals, as researchers within a particular field often reference them together. As an example, if multiple articles cite works from Journal A and Journal B together, it suggests that the research published in these two journals is often related or complementary. The co-citation map for Fig. 6 (1985–2024) focuses on a threshold of two hundred citations and shows the one hundred connections that are co-cited most often. The lines between the journals indicate the strength of the co-citation links, and the distance between the journals indicates the relatedness between the journals. Figure 6 provides the structure of the TPB research for the overall period (1985–2024). The four thematic clusters of journals are indicated in Table 8. Four prominent thematic clusters can be identified from the VOSviewer analysis. The largest cluster, Health and Social Psychology includes top journals such as Organizational Behavior and Human Decision Processes, Journal of Applied Social Psychology, British Journal of Social Psychology, Journal of Business Research, and Journal of Personality and Social Psychology. This cluster focuses on the intersection of health and social psychology, highlighting research on human decision processes, social behavior, and health-related behaviors. The prominence of journals like Organizational Behavior and Human Decision Processes and Journal of Applied Social Psychology indicates significant interest in understanding how social and psychological factors influence health behaviors. The second most prominent cluster, Consumer Behavior, Marketing, Tourism, and Technology, features journals such as MIS Quarterly, Tourism Management, Journal of Marketing Research,

Table 8 Thematic clusters based on co-citation analysis of journals (1985–2024)

Cluster I: health and social psychology		Cluster II: consumer behavior, marketing, tourism and technology		Cluster III: sustainability and environment		Cluster IV: entrepreneurship and small business	
Journals	C	Journals	C	Journals	C	Journals	C
Organ Behav Hum Dec	12,133	MIS Quart	5846	J Clean Prod	11,446	Entrep Theory Pract	4345
J Appl Soc Psychol	10,842	Tourism Manage	4935	Sustainability-Basel	8730	J Appl Psychol	4099
Brit J Soc Psychol	7685	J Marketing Res	4577	J Environ Psychol	7003	J Bus Venturing	3683
J Bus Res	6025	Comput Hum Behav	4542	Resour Conserv Recy	5202	Front Psychol	2605
J Pers Soc Psychol	5571	J Bus Ethics	4431	Accident Anal Prev	3657	Acad Manage Rev	1949
Psychol Bull	5184	J Retail Consum Serv	4160	Transport Res F-Traf	3570	Int Entrep Manag J	1781
Psychol Health	4971	Int J Hosp Manag	3601	Environ Behav	3403	Acad Manage J	1698
Appetite	4410	J Consum Res	3171	Energ Policy	3257	J Econ Psychol	1410
Health Psychol	3749	Brit Food J	3130	Int J Env Res Pub He	3076	J Small Bus Manage	1402
Brit J Health Psych	2866	J Acad Market Sci	2848	J Environ Manage	2751	Int J Entrep Behav R	1369
Plos One	2792	Food Qual Prefer	2826	Ecol Econ	2335	Educ Train	1355
Pers Soc Psychol B	2384	Inform Syst Res	2498	Waste Manage	2080	J Manage	1343
Health Psychol Rev	2293	Inform Manage-Amster	2430	Transport Res A-Pol	2048	Small Bus Econ	1241
J Exp Soc Psychol	2262	J Marketing	2105	Land Use Policy	1350		
J Sport Exercise Psy	2049	J Consum Mark	2046	Renew Sust Energ Rev	1278		
Am Psychol	2034	Int J Consum Stud	1908	J Soc Issues	1250		
Prev Med	1977	Psychol Market	1892	Transport Res D-Tr E	1207		
Soc Sci Med	1894	J Sustain Tour	1878	Sci Total Environ	1196		
Bmc Public Health	1889	Manage Sci	1811				
Health Educ Res	1711	Technol Forecast Soc	1726				
Annu Rev Psychol	1699	Int J Inform Manage	1607				
Am J Health Promot	1649	Ann Tourism Res	1407				

Table 8 (continued)

Cluster I: health and social psychology		Cluster II: consumer behavior, marketing, tourism and technology		Cluster III: sustainability and environment		Cluster IV: entrepreneurship and small business	
Journals	C	Journals	C	Journals	C	Journals	C
Psychol Rev	1579	Bus Strateg Environ	1323				
Comput Educ	1552	Int J Contemp Hosp M	1309				
Pers Indiv Differ	1532						

Created using VOSviewer based on a sample of N = 14,461 articles; Books and Proceedings excluded from the analysis

C, citations

Computers in Human Behavior, and Journal of Business Ethics. This cluster underscores the importance of consumer behavior, marketing, tourism, and technology in TPB research. Journals like MIS Quarterly and Journal of Marketing Research highlight the focus on understanding consumer behavior in digital and physical environments, while Tourism Management reflects the application of TPB in tourism studies. The third major cluster, Sustainability and Environment, includes journals such as the Journal of Cleaner Production, Sustainability, Journal of Environmental Psychology, Resources Conservation and Recycling, and Accident Analysis and Prevention. This cluster emphasizes the growing focus on sustainability and environmental behavior. Journals such as the Journal of Cleaner Production and Sustainability are central to research on environmental practices, resource conservation, and sustainable behaviors, reflecting the increasing importance of sustainability in TPB research. The fourth and last cluster, Entrepreneurship and Small Business highlights research related to entrepreneurship, small business management, and applied psychology. Top journals in this cluster include Entrepreneurship Theory and Practice, Journal of Applied Psychology, Journal of Business Venturing, Frontiers in Psychology, and Academy of Management Review. Journals like Entrepreneurship Theory and Practice and Journal of Business Venturing strongly focus on understanding entrepreneurial intentions and behaviors, particularly in small businesses and startups.

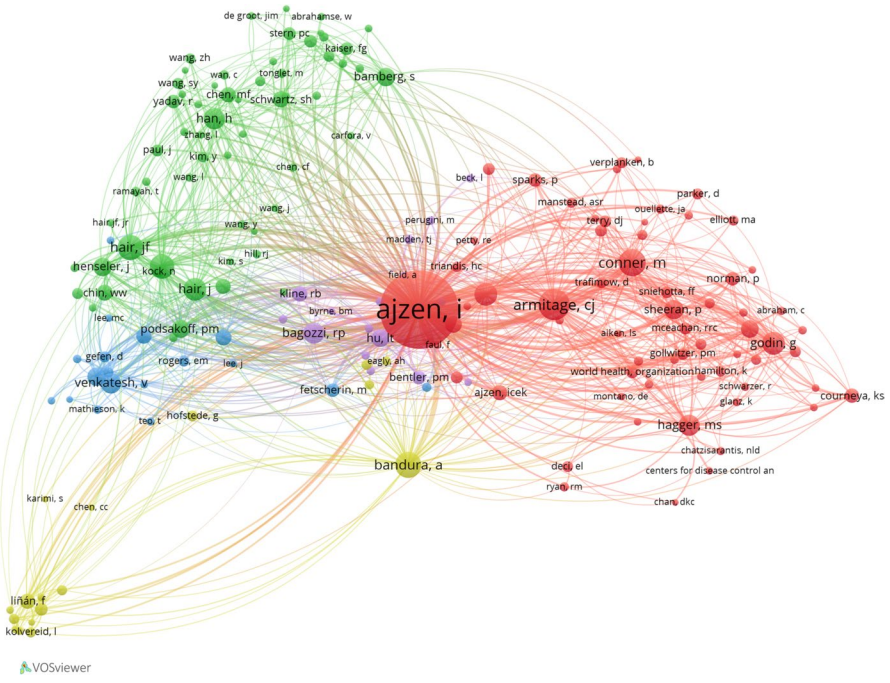

Fig. 7 Co-citation analysis at the author level

Table 9 Thematic clusters based on co-citation analysis of authors (1985–2024)

Cluster I: health behavior and social psychology		Cluster II: environment and sustainability behavior		Cluster III: technology adoption and information systems		Cluster IV: entrepreneurial intentions and behavior		Cluster V: psychometric and research methodologies	
Author	C	Author	C	Author	C	Author	C	Author	C
Ajzen I	28,873	Hair JF	3131	Venkatesh V	1997	Bandura A	3364	Bagozzi RP	2183
Armitage CJ	4601	Fornell C	2952	Davis FD	1719	Liñán F	1087	Hu LT	1459
Conner M	3424	Han H	2134	Nunnally JC	1220	Krueger NF	743	Kline RB	1078
Godin G	2588	Bamberg S	1610	Taylor S	1092	Hofstede G	565	Bentler PM	891
Fishbein M	2531	Henseler J	1603	Fetscherin M	907	Kautonen T	536	Rivis A	698
Hagger MS	2101	Podsakoff PM	1522	Rogers EM	637	Preacher KJ	533	Webb TL	493
Sheeran P	1836	Schwartz SH	1285	Gefen D	636	Kolvereid L	521	Madden TJ	450
Rhodes RE	1581	Chin WW	1243	Pavlou PA	526	Fayolle A	514	Eagly AH	409
Cohen J	1404	Chen MF	1156	Sheppard BH	472	Hayes AF	462	Cronbach LJ	388
Courneya KS	1044	Anderson JC	1122	Bhattacherjee A	394	Chen CF	341	Bollen KA	387
Sparks P	883	Yadav R	916	Mathieson K	374	Autio E	304	Perugini M	386
Norman P	866	Stern PC	841	Teo T	355	Zhao H	291	Byrne B	372
McEachan RRC	730	Kaiser FG	773	Lee J	301	Bird B	272	Browne MW	370
Sniehotta FF	723	Steg L	756	Hsu CL	300	Karimi S	266	Beck L	369
Terry DJ	718	Paul J	695	Hsu MH	287			Joreskog KG	341
Cialdini RB	700	Thogersen J	626	Agarwal R	279			Byrne BM	316
Gollwitzer PM	696	Wang SY	603	Lee MC	272			Fidell LS	313
Baron RM	671	Ringle CM	588					Weinstein ND	293
Michie S	637	Kock N	528					Marsh HW	281
Trafimow D	637	Kim Y	495					Field A	266
Verplanken B	629	Wang ZH	491						
Sutton S	611	Yazdanpanah M	477						

Table 9 (continued)

Cluster I: health behavior and social psychology		Cluster II: environment and sustainability behavior		Cluster III: technology adoption and information systems		Cluster IV: entrepreneurial intentions and behavior		Cluster V: psychometric and research methodologies	
Author	C	Author	C	Author	C	Author	C	Author	C
Parker D	591	Klöckner CA	440						
Deci El	575	Tonglet M	426						
Triandis HC	542	Ramayah T	408						
Manstead ASR	525	Wan C	407						
Elliott M	516	Schultz PW	388						
Hamilton K	487	Wang L	372						
White KM	483	Fielding KS	370						
		Sarstedt M	369						

Created using VOSviewer based on a sample of N = 14,461 articles; Books and Proceedings excluded from the analysis

C, citations

5.2.2 Co-citation analysis at the author level

Co-citation of authors is a bibliometric technique used to analyze the frequency with which other subsequent publications cite two authors together. When two authors are frequently cited together in the reference lists of other academic papers, it suggests a link that may be conceptual or methodological between their works. From an academic perspective, co-citation analysis of authors helps us to identify influential authors, map the intellectual structure of a research field like the TPB, and uncover thematic clusters, showing us which topics of analysis are closely related. The co-citation map for authors uses a threshold of 175 co-citations and retains the 100 top author co-citation links, which is presented in Fig. 7. The five thematic clusters of related authors are indicated in Table 9. The largest cluster is Health Behavior and Social Psychology, dominated by influential authors such as Ajzen I, Armitage CJ, Conner M, Godin G, and Fishbein M. These authors have significantly contributed to understanding health behaviors and social psychology. Ajzen I and Fishbein M's prominence underscores TPB's foundational role in this area, particularly in examining how attitudes, social norms, and perceived behavioral control influence health-related intentions and behaviors. The second largest cluster is Environment and Sustainability Behavior. Key authors in this cluster include Hair JF, Fornell C, Han H, Bamberg S, and Henseler J. This cluster focuses on environmental behavior and sustainability, with research exploring the factors that influence pro-environmental behavior, sustainable consumption, and resource conservation. The presence of authors like Hair JF and Fornell C highlights the application of advanced statistical methods in analyzing environmental behaviors. The third largest cluster is Technology Adoption and Information Systems and features authors such as Venkatesh V, Davis FD, Nunnally JC, Taylor S, and Fetscherin M. It highlights research on technology adoption, information systems, and the psychological factors influencing users' acceptance of new technologies. The prominence of Venkatesh V and Davis FD reflects their substantial contributions to the Technology Acceptance Model (TAM) and related frameworks. The fourth cluster is on the theme of Entrepreneurial Intentions and Behavior. Prominent authors in this cluster include Bandura A, Liñán F, Krueger NF, Edwards AL, and Morris MH. This cluster centers on entrepreneurial intentions and behavior, with research focusing on self-efficacy, entrepreneurial motivations, and the psychological determinants of entrepreneurial actions. Bandura A's work on self-efficacy is particularly influential in understanding how personal beliefs impact entrepreneurial intentions. The last thematic cluster is highly specialized and is Psychometric and Research Methodologies. The cluster is represented by authors such as Bentler PM, Kenny DA, Parker RLJ, Campbell JL, and Wilcoxon F. These authors have significantly contributed to developing and applying psychometric and research methodologies. Their work on structural equation modeling, factor analysis, and reliability testing has been critical in ensuring the robustness and validity of TPB research. It also points to the attractiveness of TPB for research methodologists and statisticians.

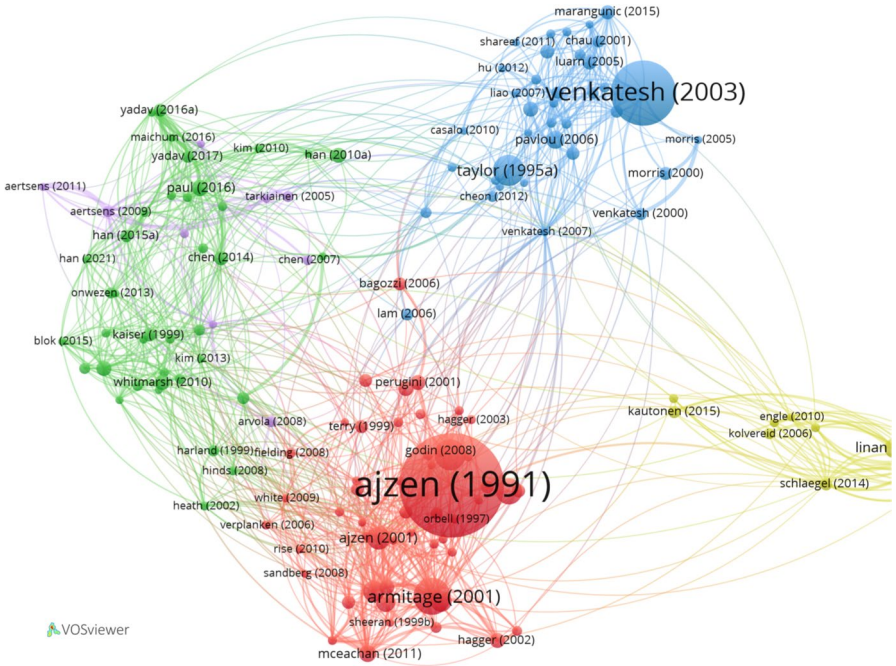

Fig. 8 Bibliographic coupling at the article level

5.3 Bibliographic coupling

Bibliographic coupling provides insights into the citation behavior and structure of a field like the TPB. Bibliographic coupling is a bibliometric technique used to identify relationships between documents based on the number of references they share. When two articles cite a common third article in their bibliographies, they are considered bibliographically coupled. This method is valuable for identifying clusters of related research articles and uncovering thematic structures within a field of study. The fractional counting method is utilized for the bibliographic coupling exercise. The fractional counting method is preferred for bibliographic coupling as it assigns a fractional weight to each of the publication's co-authors and avoids overestimating the impact of papers with many authors. Consequently, each publication has the same overall weight compared to full counting, which inflates the weight of a publication to the number of co-authors (Mutz and Daniel 2019). The fractional counting method is used to get a clear picture of productivity and reduce the bias towards papers with more co-authors.

5.3.1 Bibliographic coupling at the article level

We undertook a bibliographic coupling of articles to explore the interconnectedness of research within the Theory of Planned Behavior (TPB) literature. This

Table 10 Thematic clusters based on bibliographic coupling of articles (1985–2024)

Cluster I: health behavior and social psychology (52 articles)		Cluster II: environment and sustainability behavior (38 articles)		Cluster III: technology acceptance and information systems (37 articles)		Cluster IV: environmental intentions and behavior (14 articles)		Cluster V: consumer behavior and green marketing (9 articles)	
Author	Citations	Author	Citations	Author	Citations	Author	Citations	Author	Citations
Ajzen (1991)	49,002	Paul (2016)	49,002	Venkatesh (2003)	19,414	Linan (2009)	1856	Aertsens (2009)	634
Armitage (2001)	4393	Han (2010A)	6179	Taylor (1995A)	4361	Souitaris (2007)	1217	Arvola (2008)	588
Ajzen (2002A)	3252	Whitmarsh (2010)	4393	Pavlou (2006)	1525	Kautonen (2015)	745	Tarkiainen (2005)	569
Ajzen (1986)	2396	Klockner (2013)	3252	Bulgurcu (2010)	1050	Schlaegel (2014)	672	Chen (2007)	469
Ajzen (2001)	2036	Chen (2014)	2396	Marangunic (2015)	1005	Kolvereid (2006)	545	Nuttavuthisit (2017)	426
Conner (1998)	1991	Yadav (2016A)	2036	Luarn (2005)	945	Zellweger (2011)	414	Yadav (2016B)	360
Godin (1996)	1654	Kaiser (1999)	1991	Lee (2009)	943	Linan (2011)	407	Yazdanpanah (2015)	345
Webb (2010)	1408	Han (2015A)	1654	Morris (2000)	856	Kautonen (2013)	393	Al-Swidi (2014)	331
Mceachan (2011)	1126	Yadav (2017)	1408	Herath (2009)	771	Rauch (2015)	382	Aertsens (2011)	315
Perugini (2001)	1064	Bamberg (2003B)	1126	Rai (2002)	744	Newman (2019)	381		
Albarracín (2001)	1060	De Leeuw (2015)	1064	Venkatesh (2001)	727	Moriano (2012)	364		
Ajzen (2020)	1057	Bamberg (2007)	1060	Venkatesh (2000)	685	Zhang (2014)	341		
Hagger (2002)	849	Onwezen (2013)	1057	Lam (2006)	678	Maresch (2016)	328		
Rivis (2003)	794	Harland (1999)	849	Chau (2001)	667	Engle (2010)	320		
Terry (1999)	792	Oreg (2006)	794	Yi (2006)	646				
Bamberg (2003A)	783	Greaves (2013)	792	Cheon (2012)	563				
Ajzen (2002B)	783	Kaiser (2005)	783	Chau (2002)	558				
Carrington (2010)	774	Heath (2002)	783	Quintal (2010)	545				
Beck (1991)	773	Kim (2010)	774	Wu (2005)	509				
Ajzen (1992)	768	Yuriev (2020)	773	Kamble (2019)	499				
Bagozzi (2006)	676	Hinds (2008)	768	Wang (2016)	482				

Table 10 (continued)

Cluster I: health behavior and social psychology (52 articles)		Cluster II: environment and sustainability behavior (38 articles)		Cluster III: technology acceptance and information systems (37 articles)		Cluster IV: environmental intentions and behavior (14 articles)		Cluster V: consumer behavior and green marketing (9 articles)	
Author	Citations	Author	Citations	Author	Citations	Author	Citations	Author	Citations
Sutton (1998)	669	Botetzagias (2015)	676	Ifinedo (2012)	471				
Godin (2008)	558	Sreen (2018)	669	Hsu (2004)	459				
Hardeman (2002)	530	Moser (2015)	558	Venkatesh (2007)	421				
Fielding (2008)	484	Gao (2017)	530	Lee (2010)	406				
Cordano (2000)	475	Yadav (2016B)	484	Shih (2004)	402				
Hausenblas (1997)	473	Klockner (2010)	475	Hsieh (2008)	401				
Baranowski (2003)	434	Maichum (2016)	473	Liao (2007)	395				
Fishbein (2008)	407	Russell (2017)	434	Ryu (2003)	374				

Created using VOSviewer based on a sample of N = 14,461 articles; Books and Proceedings excluded from the analysis; Most cited articles highlighted

C, citations

analysis helps to identify clusters of articles that share common references, revealing key thematic areas and influential works within the field. To obtain an accurate and interpretable snapshot of the bibliographic coupling of articles, we used a threshold of 300 citations and retained 150 connections in the VOSviewer map (Fig. 8). The five thematic clusters identified in the bibliographic coupling exercise are presented in Table 10. The largest cluster is Health Behavior and Social Psychology, which comprises 52 articles focusing on health behavior and social psychology. Prominent articles in this cluster include works by Ajzen, Conner, Armitage, Fishbein, Godin, Webb, McEachan, Perugini, and Albarracín. These articles explore the psychological factors influencing health-related behaviors, such as physical activity, dietary habits, and smoking cessation. The emphasis on attitudes, social norms, and perceived behavioral control reflects the foundational role of TPB in understanding health behaviors. The second largest cluster is Environment and Sustainability Behavior, with 38 articles centered on environmental behavior and sustainability. Key authors in this cluster include Paul, Han, Whitmarsh, Klockner, Chen, Yadav, and Kaiser. These articles investigate the determinants of pro-environmental behaviors, such as recycling, energy conservation, and sustainable consumption. The focus on environmental attitudes, perceived behavioral control, and social norms highlights the application of TPB in promoting sustainable practices. The third largest cluster is Technology Acceptance and Information Systems, which features 37 articles related to technology acceptance and information systems. Influential authors whose works are cited in this cluster include Venkatesh, Taylor, Pavlou, Bulgurcu, Maranguinic, and Luarn. These articles examine the psychological factors influencing the acceptance and use of new technologies, including the role of perceived ease of use, perceived usefulness, and social influence. The Technology Acceptance Model (TAM) and its extensions are frequently referenced in this cluster, along with the Unified Theory of Acceptance and Use of Technology (UTAUT). The fourth cluster is Environmental Intentions and Behavior and comprises 14 articles examining environmental intentions and behavior. Key authors in this cluster include Lian, Souitaris, Kautonen, Schlaegel, Kolverid, Zellwegger, and Rauch. The fifth thematic cluster is Consumer Behavior and Green Marketing. This small cluster contains nine articles focused on consumer behavior and green marketing. Notable articles include works by Aertsens, Arvola, Tarkianen, Chen, Nuttavuthisit, Yadav, and Yazdanpanah. These studies explore the factors influencing consumer decisions about green products, sustainable consumption, and eco-friendly practices. The emphasis on attitudes, perceived behavioral control, and social norms underscores the relevance of TPB in understanding green consumer behavior.

5.4 Triangulation analysis of thematic clusters

Our study used four different bibliometric methods to generate thematic clusters through (1) author keyword co-occurrence, (2) co-citation of journals, (3) co-citation of authors, and (4) bibliographic coupling of articles. By triangulating the findings from co-citation, keyword occurrence, and bibliographic coupling, we

Table 11 Overview of thematic clusters identified from bibliometric methods (1985–2024)

Cluster rank	Cluster basis on bibliometric method			
	Bibliographic coupling of articles	Co-citation of authors	Co-citation of journals	Co-occurrence of author keywords
1	Health Behavior and Social Psychology	Health Behavior and Social Psychology	Health and Social Psychology	Health Behavior and Wellness
2	Environment and Sustainability Behavior	Environment and Sustainability Behavior	Consumer Behavior, Marketing, Tourism and Technology	Sustainability and Environment
3	Technology Acceptance and Information Systems	Technology Adoption and Information Systems	Sustainability and Environment	Technology and Social Perception
4	Environmental Intentions and Behavior	Entrepreneurial Intentions abd Behavior	Entrepreneurship and Small Business	Theoretical Foundations
5	Consumer Behavior and Green Marketing	Psychometric and Research Methodologies		Entrepreneurship Education and Intention
6				Health Behavioral Models and Testing

can confirm the consistency and overlap of the identified clusters. Triangulation enhances the validity of our findings and provides a holistic perspective on the TPB research landscape. Table 11 presents the four sets of thematic clusters to provide a comprehensive view of TPB research, highlighting the major themes across different analytical methods and revealing how these themes intersect and complement each other.

Some themes are prominent across three or more analysis methods; the most prominent is Health Behavior and Social Psychology, underscoring their significance within TPB research. The alignment of this cluster highlights the strong foundation TPB provides in understanding health behaviors and social psychological factors. Similarly, Environment and Sustainability Behavior is another prominent theme across different methods, emphasizing the importance of studying environmental behaviors and sustainability practices through the TPB lens. The third theme of entrepreneurial intentions and behavior is not as prominent as the other two themes mentioned but appears in all thematic clustering methods, indicating specialized areas of TPB application. The themes of Technology Acceptance and Information Systems, Consumer Behavior, and Green Marketing are well-represented, particularly in bibliographic coupling and keyword occurrence analyses. These themes reflect the evolving research interests in understanding how technology and consumer behavior influence TPB applications. Including Psychometric and Research Methodologies as a thematic cluster highlights TPB research's methodological advancements and rigor. The cluster indicates its critical role for s essential for ensuring the reliability and validity of findings in this field. Theoretical Foundations, identified in keyword occurrence, underscore the importance of continued theoretical development and refinement in TPB.

5.5 Temporal analysis of authors, keywords. institutions, and journals

Temporal analysis is conducted to understand the development and dynamics of a research field over time. We can identify trends, shifts in research focus, and emerging themes by examining how key elements such as authors, keywords, institutions, and journals evolved. The temporal analysis offers insights into the changing landscape of a field, highlighting significant contributions and guiding future research efforts. We employed bibliometric techniques and tools to extract, analyze, and visualize data from scholarly databases to create the tables. By using VOSviewer and other bibliometric software, we mapped the temporal evolution of author keywords (Table 12), authors (Table 13), institutions (Table 14), and journals (Table 15) within the TPB literature. The data was grouped into six periods based on the rationale presented earlier in the paper to highlight trends and shifts over the years. To balance the content, structure, and analysis in our paper, we only present the highlights of the temporal analysis in this section.

Table 12 presents the temporal analysis of author keywords, capturing the evolution of research themes in the field of TPB. From 1985 to 1999, the focus was primarily on health-related behaviors, with keywords like "Adolescents," "Exercise," and "Physical Activity" being most common. The keywords indicate an

Table 12 Most common author keywords in six time periods: occurrence and co-occurrence analysis

1985–1999			2000–2004			2005–2009		
Author keyword	Oc	Co	Author keyword	Oc	Co	Author keyword	Oc	Co
Adolescents	5	3	Exercise	19	17	Physical Activity	47	38
Exercise	5	5	Adolescents	8	5	Adolescent	42	37
Physical Activity	5	5	Self-Efficacy	8	8	Exercise	32	27
			Physical Activity	5	2	Consumer Behaviour	14	5
			Smoking Cessation	5	4			
2010–2014			2015–2019			2020–2024		
Author keyword	Oc	Co	Author keyword	Oc	Co	Author keyword	Oc	Co
Physical Activity	86	71	Entrepreneurial Intention	141	132	Covid-19	349	297
Adolescents	45	36	Physical Activity	85	68	Entrepreneurial Intention	254	245
Entrepreneurial Intention	43	37	Adolescent	68	60	Purchase Intention	176	142
Exercise	41	37	Self-Efficacy	64	57	Sustainability	152	128
Consumer Behaviour	28	20	Consumer Behavior	48	45	Technology Acceptance Model	119	107
Theory Of Reasoned Action	25	24	Entrepreneurship	46	45	Physical Activity	110	88
Self-Efficacy	24	19	Exercise	42	35	Self-Efficacy	108	90
Technology Acceptance Model	21	18	Education	36	28	Entrepreneurship	96	84
Students	20	17	Purchase Intention	36	30	Environmental Concern	94	84
			Students	34	29	Social Media	85	71

Keywords used for identification of articles, components and abbreviations of the theory of planned behavior, common statistical terms and country names are excluded for the purpose of the analysis

Oc, author keyword occurrences; Co, author keyword co-occurrence links

Table 13 Most cited authors from six time periods

R	1985–1999			2000–2004			2005–2009		
	Author	TP	TC	Author	TP	TC	Author	TP	TC
1	Conner M	17	4325	Conner M	21	9005	Rhodes RE	36	1962
2	Ajzen I	12	56,567	Courneya KS	18	1640	Courneya K	27	1443
3	Bamberg S	9	213	Armitage CJ	15	7692	Hagger MS	22	2086
4	Sparks P	8	1134	Sheeran P	14	2939	White KM	21	1776
5	Courneya KS	8	853	Rhodes RE	11	1058	Godin G	19	1393
6	Sheeran P	7	1609	Abraham C	9	1106	Chatzisarantis NLD	18	1823
7	Norman P	7	567	Hagger MS	7	990	Armitage CJ	18	1740
8	Armitage CJ	6	3155	Orbell S	7	770	Conner M	17	1769
9	Manstead A	5	1192	Biddle SJH	6	926	Blanchard CM	16	781
10	Schmidt P	5	75	Venkatesh V	6	21,838	Grimshaw J	16	1436
R	2010–2014			2015–2019			2020–2024		
	Author	TP	TC	Author	TP	TC	Author	TP	TC
1	White KM	44	1783	White KM	34	774	Ong AKS	43	396
2	Rhodes RE	27	1234	Hagger MS	30	1387	Jeihooni AK	29	105
3	Mullan B	22	1046	Hamilton K	30	668	Prasetyo YT	29	639
4	Godin G	19	725	Rhodes RE	20	453	Hamilton K	28	472
5	Hamilton K	18	527	Conner M	16	1254	Nadlifatin, Reny	28	397
6	Hyde MK	16	489	Ramayah T	15	512	Han, Heesup	24	884
7	Courneya KS	16	526	Mullan BA	14	508	Hagger MS	23	487
8	Legare F	15	397	Kim Y	13	426	Al Mamun A	20	114
9	Plotnikoff RC	14	533	Moriano JA	11	432	Sujood	17	173
10	Conner M	12	2207	Pakpour AH	10	269	Gumasing MJ	16	31

Abbreviations: R = Rank; TC = Total citations; TP = Total publications

early emphasis on understanding health and exercise behaviors within the TPB framework. In the following periods, there was a diversification of research themes, with keywords such as "Self-Efficacy," "Smoking Cessation," "Entrepreneurial Intention," "Technology Acceptance Model," and "Covid-19" emerging, reflecting broader applications of TPB in various contexts. Table 13 highlights the temporal analysis of authors, showcasing the evolving contributions of key researchers in the TPB literature. From 1985 to 1999, influential authors such as Ajzen I and Conner M laid the foundational work for TPB research. In subsequent periods, the focus on health behaviors remained strong, with authors like Courneya KS, Rhodes RE, White KM, and Hagger MS making significant contributions. The analysis shows a gradual shift in research themes, with more recent periods highlighting research on psychological factors, health behaviors, and the application of TPB in various domains. Table 14 provides the temporal analysis of institutions, highlighting the evolving contributions of key universities in TPB research. From 1985 to 1999, the University of Massachusetts Amherst and the

Table 14 Most productive institutions in each time period

R	1985–1999			2000–2004			2005–2009		
	University	TP	TC	University	TP	TC	University	TP	TC
1	U Leeds	17	4325	U Sheffield	33	10,947	U Victoria	37	2215
2	U Sheffield	17	2428	U Leeds	23	9221	U Alberta	36	1829
3	U Mass Amherst	11	53,314	U Alberta	18	1657	U Ottawa	32	2157
4	U Giessen	11	338	U Victoria	12	1491	U Aberdeen	32	1345
5	U Quebec	10	615	U Sussex	12	1434	U Sheffield	28	2816
6	Laval U	8	2479	U Essex	11	1337	Queensland U Tech	27	1968
7	U Manchester	7	3489	Laval U	10	642	U Nottingham	21	2157
8	U Calgary	7	721	U Bergen	9	510	U Leeds	21	1958
9	U Montreal	7	165	U Minnesota	8	20,244	Laval U	21	1442
10	U Queensland	6	1576	U Birmingham	8	455	Maastricht U	20	1211
R	2010–2014			2015–2019			2020–2024		
	University	TP	TC	University	TP	TC	University	TP	TC
1	Queensland U Tech	55	2125	Griffith U	70	1942	HK Poly U	66	1438
2	Laval U	46	1401	Queensland U Tech	65	2104	Griffith U	66	1032
3	U Aberdeen	31	3111	Curtin U	60	2309	Mapua U	65	730
4	Maastricht U	31	598	Laval U	39	1271	U Putra Malaysia	64	1169
5	U Alberta	30	1106	U Sains Malaysia	34	1245	U Kebangsaan Malaysia	61	614
6	U Victoria	29	1019	U Kentucky	34	849	Chinese Acad Sci	57	1592
7	U Sheffield	27	3750	Chinese Acad Sci	32	3479	U Sains Malaysia	55	608
8	U Ottawa	27	2638	Monash U	30	706	Queensland U Tech	55	539
9	Curtin U	27	2134	U Leeds	29	1956	Sejong U	49	1532
10	U Sydney	27	1192	U Queensland	29	1357	U Malaya	47	455

R, rank; TC, total citations; TP, total publications

University of Leeds were prominent contributors. Later, institutions such as the University of Sheffield, University of Victoria, Queensland University of Technology, and Griffith University emerged as leading contributors. The analysis also reveals a growing global research presence, with institutions like the Hong Kong Polytechnic University, Mapua University, and U Putra Malaysia becoming significant contributors in recent years. Table 15 presents the temporal analysis of journals. From 1985 to 1999, psychology journals were prominent, like the Journal of Applied Social Psychology and the British Journal of Social Psychology. More recent periods saw the rise of journals such as the Journal of Business Research, Sustainability, and the Journal of Cleaner Production, reflecting the

Table 15 Most cited journals from six time periods

1985–1999			2000–2004			2005–2009		
Journal	C	TLS	Journal	C	TLS	Journal	C	TLS
Org Beh Hum Decision Proc	49,002	147	MIS Quarterly	20,141	3	Brit J Soc Psych	2701	91
J Appl Soc Psych	6874	285	Brit J Soc Psych	8833	124	J Appl Soc Psych	2382	51
Info Systems Res	6608	9	J Appl Soc Psych	6535	60	Comp Hum Beh	2245	29
Brit J Soc Psych	3325	119	J Bus Venturing	2784	1	MIS Quarterly	2071	16
J Exp Soc Psych	3252	118	Annual Rev Psych	2396	29	Entrep Theory Practice	1856	1
Amer J Health Promotion	2027	60	Psych Health	1855	66	Transport Res F Traffic Psych	1844	31
Personality Soc Psych Bulletin	1683	61	Health Psych	1784	46	J Bus Venturing	1762	2
Psych Health	964	101	Brit J Health Psych	1764	77	Brit J Health Psych	1756	104
J Personality Social Psych	806	84	Current Psych	1265	16	J Env Psych	1692	9
J Env Psych	797	1	J Sport Exer Psych	1134	26	Brit Food J	1549	9
2010–2014			2015–2019			2020–2024		
Journal	C	TLS	Journal	C	TLS	Journal	C	TLS
J Env Psych	3075	30	J Cleaner Production	7835	463	Sustainability	5216	2584
Psych Health	2999	95	Sustainability	4070	371	J Cleaner Production	4271	1355
Tourism Mgmt	2189	38	Resources Conser Recycling	4013	229	Intl J Env Res Public Health	1826	758
J Bus Ethics	2130	33	Comp Hum Beh	2574	78	Frontiers Psych	1758	899
J Medical Internet Res	2084	24	J Env Psych	2571	194	Resources Conser Recycling	1498	566
Intl J Hospitality Mgmt	1932	19	J Retailing Consumer Services	2319	112	J Retailing Consumer Services	1306	396
Accident Analysis Prevention	1882	60	Tourism Mmgt	1921	113	J Bus Res	1134	286
J Appl Soc Psych	1535	62	Transport Res F Traffic Psych	1844	86	Hum Beh Emerging Tech	1124	485
Comp Hum Beh	1523	24	Ecological Eco	1618	96	Brit Food J	1057	497
Comp Education	1454	14	J Env Mgmt	1560	83	Current Issues Tourism	998	226

Created using VOSviewer based on a sample of N = 14,461 articles; Books and Proceedings excluded from the analysis

C, citations; TLS, total link strength

Table 16 Top cited articles in each year (2020–2024)

Article details	Y	TC
Digital Health Innovation: Exploring Adoption of COVID-19 Digital Contact Tracing Apps, Sharma et al. (2024)	2024	129
How do digital natives perceive and react toward online advertising? Implications for SMEs, Lim et al. (2024)	2024	24
Factors Affecting Public Transportation Use during Pandemic: An Integrated Approach of Technology Acceptance Model and Theory of Planned Behavior, Saeidi et al. (2024)	2024	21
Drivers of generative AI adoption in higher education through the lens of the Theory of Planned Behaviour, Ivanov et al. (2024)	2024	21
Crowdfunding small businesses and startups: a systematic review, an appraisal of theoretical insights and future research directions, Camilleri et al. (2024)	2024	20
Changes in travel behaviors and intentions during the COVID-19 pandemic and recovery period: A case study of China, Fan et al. (2023)	2023	69
Integrating the norm activation model and theory of planned behaviour to investigate farmer pro-environmental behavioural intention, Savari et al. (2023)	2023	50
Revenge buying after the lockdown: Based on the SOR framework and TPB model, Liu et al	2023	46
Modeling EFL teachers' intention to integrate informal digital learning of English (IDLE) into the classroom using the theory of planned behavior, Liu et al. (2023)	2023	39
Pro-environmental behavior on electric vehicle use intention: Integrating value-belief-norm theory and theory of planned behavior, Lee et al. (2023)	2023	39
Understanding farmers' intention and willingness to install renewable energy technology: A solution to reduce the environmental emissions of agriculture, Elahi et al. (2022)	2022	283
Perceived Behavioral Control Moderating Effects in the Theory of Planned Behavior: A Meta-Analysis, Hagger et al. (2022)	2022	104
Transforming consumers' intention to purchase green products: Role of social media, Nekmahmud et al. (2022)	2022	100
Correlates of COVID-19 vaccination intentions: Attitudes, institutional trust, fear, conspiracy beliefs, and vaccine skepticism, Seddig et al. (2022)	2022	98
Investigating the relationship between educational support and entrepreneurial intention in Vietnam: The mediating role of entrepreneurial self-efficacy in the theory of planned behavior, Maheshwari et al. (2022)	2022	90
Consumer behavior and environmental sustainability in tourism and hospitality: a review of theories, concepts, and latest research, Han et al. (2021)	2021	343
Willingness to get the COVID-19 vaccine with and without emergency use authorization, Guidry et al. (2021)	2021	340
Predicting intention to receive COVID-19 vaccine among the general population using the health belief model and the theory of planned behavior model, Shmueli et al. (2021)	2021	225
An assessment of consumers' willingness to utilize solar energy in China: End-users' perspective, Irfan et al. (2021)	2021	206
Integrating health behavior theories to predict American's intention to receive a COVID-19 vaccine, Chu et al. (2021)	2021	199
The theory of planned behavior: Frequently asked questions, Ajzen et al. (2020)	2020	1062
The effect of coronavirus disease-19 (COVID-19) risk perception on behavioural intention towards 'untact' tourism in South Korea during the first wave of the pandemic, Bae et al. (2020)	2020	435
Pro-environmental behaviors through the lens of the theory of planned behavior: A scoping review, Yuriev et al. (2020)	2020	432
Technology acceptance theories and factors influencing artificial Intelligence-based intelligent products, Sohn et al. (2020)	2020	244
Impact of the perceived risk from Covid-19 on intention to travel, Sánchez-Cañizares et al. (2020)	2020	242

Table 16 (continued)
Y, year; TC, total citations

diversification of research themes towards consumer behavior, technology adoption, and environmental sustainability.

6 Conclusions

6.1 Investigating current research trends in the post-pandemic period 2020–2024

The period from 2020 onwards was unique regarding challenges such as the COVID-19 pandemic and increased focus on climate change, environmental sustainability, and public health. To get a closer insight into the research trends shaping the TPB, we investigate the most influential articles in the most recent 5 years, 2020–2024. We assess how TPB is being applied to address contemporary issues and its relevance in real-world contexts, which allows us to pinpoint groundbreaking studies and methodologies shaping TPB's future direction and serve as a foundational work for future investigations. The top 5 most cited articles investigated in each of the 5 years (2020–2024) are outlined in Table 16, along with the citations received by them till 2024.

6.1.1 Investigating research trends for 2024

The most cited article in 2024 has 129 citations and explores the adoption intention of COVID-19 digital contact tracing apps (Sharma et al. 2024). The article's highlight was a conceptual framework that incorporated other factors with the TPB, like procedural fairness, protection motivation, and cultural dimensions. The findings highlighted how privacy concerns shape user attitudes and intentions. The second most cited article in 2024 received 24 citations and leveraged constructs from two behavioral models (uses and gratification and technology acceptance models) and utilized them as antecedents to the three factors influencing intention in the TPB (Lim et al. 2024). The novel contribution of the article was the finding that digital natives, as a self-assured generation are not easily influenced by online advertising in their online product purchase intentions. The third most cited article in 2024 in TPB analyzes public transportation use during the COVID-19 pandemic, integrating the technology acceptance model and TPB, and finds robust support for both theories (Saeidi et al. 2024). The study identifies the mediating role of perceived ease of use and perceived usefulness in shaping intentions to use public transportation. The fourth most cited paper from 2024 explores generative AI adoption in higher education, highlighting how perceived benefits and positive attitudes shape the adoption of GenAI tools in academic settings (Ivanov et al. 2024). The fifth-ranking article in 2024 from the WoS core collection received 20 citations and identifies the critical gap in crowdfunding platform usage for leveraging behavioral theories like TPB

to explore the trade-off between risks and rewards associated with crowd-financing (Camilleri and Bresciani 2024).

6.1.2 Investigating research trends for 2023

The most important article from 2023 with 69 citations was a mixed study that found support for the constructs in TPB for domestic travel intentions in the recovery period of the COVID-19 pandemic and noted the shift in travel preference towards natural and uncrowded destinations due to altered risk perceptions (Fan et al. 2023). The second most important article from 2023, with 50 citations, integrates the norm activation model and TPB to predict farmer pro-environmental behaviors and underscores the importance of awareness of consequences and social norms in sustainable farming practices (Savari et al. 2023). The third most important article in 2023, with 46 citations, investigates the phenomenon of revenge-buying behavior in the COVID-19 post-lockdown period (Liu et al. 2023). Using the stimulus-organ-response (SOR) framework and TPB, the study identifies psychological drivers such as perceived scarcity, perceived susceptibility, and social influence regarding the lockdown that stimulate anxiety and induce revenge-buying behavior. The fourth most important article in 2023, with 40 citations, examined the intention of teachers to incorporate digital learning of foreign languages into the formal curriculum context and found support for all three factors of the TPB (Liu and Wang 2023). The fifth most important article from 2023, with 39 citations integrates value-belief-norm theory and TPB to develop a holistic comprehension of consumers' purchase decision of electric vehicles (Lee et al. 2023). The results indicate that value-based constructs like altruistic and biospheric values positively influence awareness of consequences, while egoistic values exert a negative influence.

6.1.3 Investigating research trends for 2022

The most important article from 2022, with 283 citations, used an extended model of TPB to find support for farmers' intention to install renewable energy water pumps (Elahi et al. 2022). The study also compared the results of the extended TPB with the original TPB and theory of reasoned action (TRA) and found it to perform better. The authors employed a novel parametric econometric approach to estimate the determinants of farmers' willingness to bear additional costs for green electricity and estimated the willingness to increase with education and lack of access to electricity. The second most important article published in 2022 with 104 citations was a study that meta-analytically tested the moderating effect of perceived behavioral control on the attitude-intention, subjective norm-intention, and intention-behavior relationships in the health behavior domain (Hagger et al. 2022). Perceived behavioral control was found to moderate the intention-behavior relationship but not attitude-intention and subjective norm-intention relationships. The third most important article from 2022, with 100 citations, expanded the TPB with additional moderating-mediating variables of green thinking, social media usage, and social media marketing and examined consumers' green product purchasing intentions

(Nekmahmud et al. 2022). The purchase intention of consumers' was found to be positively influenced by social media that was included in the expanded TPB. The fourth most important article from 2022, with 98 citations, studied the COVID-19 vaccination intentions of adults and found support for the attitude to get vaccinated and did not find support for normative and control beliefs as predictors of vaccination intentions (Seddig et al. 2022). While positive attitudes were supported by trust in science, negative attitudes were associated with acceptance of conspiracy theories and vaccination skepticism. The fifth most influential article published in 2022 received 90 citations and explores the mediating role of entrepreneurial self-efficacy and the three drivers of intention in the TPB on the relationship between educational support and entrepreneurial intentions (Maheshwari and Kha 2022). The results found no evidence of a direct relationship but found an indirect positive effect mediated by three components of TPB and entrepreneurial self-efficacy.

6.1.4 Investigating research trends for 2021

The most important article published in 2021 with 343 citations introduced the special issue on environmental sustainability and consumer behavior and presented arguments for using a set of prominent behavioral theories, including the TPB, to understand environmentally sustainable consumption and behavior in the tourism and hospitality industry (Han 2021). The second most influential article published in 2021 that received 340 citations used the TPB and health belief model and identified susceptibility to the virus, education, insurance, scoring high on subjective norms, and having a positive attitude towards the vaccine among the significant predictors of COVID-19 vaccine uptake intentions (Guidry et al. 2021). The third most important article, published in 2021 with 225 citations, developed a unified model incorporating predictor variables from the health belief model and TPB, along with demographic and health-related factors (Shmueli 2021). The findings indicated that those who received the seasonal influenza vaccine the previous year and were more educated demonstrated a higher intention to receive the COVID-19 vaccine. The fourth most influential article published in 2021 received 206 citations and examined the factors influencing the consumers' willingness to utilize solar energy for household purposes and augmented the TPB by incorporating factors such as perception about self-effectiveness, belief of solar energy benefits, and perception of neighbors participation (Irfan et al. 2021). The study confirmed the positive effects of the additional factors on consumers' willingness to utilize solar energy but notably found no evidence of neighbors' participation in consumers' intentions. The fifth article from 2021, with 199 citations, integrates multiple health behavior theories to explore vaccination intentions and study the sociophysiological factors influencing the intention to receive the COVID-19 vaccine (Chu and Liu 2021). Disease exposure resulted in higher vaccine uptake intention through the mediation of fear. Safety concerns negatively influenced vaccine intentions, and perceived community benefits were positively associated with vaccination intention.

6.1.5 Investigating research trends for 2020

The top article published in 2020 received 1062 citations and was authored by Icek Ajzen, who introduced the TPB in 1991 and addressed the theoretical and practical issues encountered concerning the TPB (Ajzen 2020). The article addressed why intention did not predict behavior consistently and highlighted the key differences between perceived behavioral control and locus of control. The second most influential TPB article to be published in 2020 with 435 citations, examined the impact of COVID-19 risk perceptions on intentions towards untact tourism (limits physical interaction as a customer service strategy) and highlighted the role of affective and cognitive risk perceptions in shaping travel behaviors during the pandemic (Bae and Chang 2021). Affective risk perception negatively influenced behavioral intention, while cognitive risk perception was found to have a positive influence. The third most significant article published in 2020 had 432 citations and provided a scoping review of pro-environmental behaviors through the TPB lens (Yuriev et al. 2020). The fourth most important paper published in 2020 received 244 citations and used multiple theoretical frameworks, including TPB, the technology acceptance model, the unified theory of acceptance and use of technology model, and the value-based adoption model to explain the acceptance of artificial intelligence-based products (Sohn and Kwon 2020). The authors concluded that the value-based adoption model provided the best prediction for modeling user acceptance and confirmed that highly innovative artificial intelligence-based products were more influenced by interest in technology than other utilitarian aspects. The study also found that enjoyment and subjective norms significantly influence purchase intentions. The fifth most influential article published in 2020 received 242 citations and analyzed the influence of perceived risk on intention to travel during the COVID-19 pandemic for an at-risk group (Sánchez-Cañizares et al. 2020). While the risk perception had a negative influence on perceived behavioral control and attitude towards traveling, the influence of travel intention on the willingness to pay was not significant, indicating that the relationship was indirect and pointed to other variables influencing the relationship.

6.2 Future research avenues

The analysis of the most recent research trends in the most recent 5-year period (2020–2024) leads us to conclude that despite its widespread application, there remain significant gaps and emerging trends that necessitate further exploration. This section outlines the future research directions that will not only extend the applicability of TPB but also meaningfully contribute to addressing current and future societal challenges. The list of ten specific research avenues in this section is not meant to be exhaustive but rather reflective of the tremendous research potential that TPB has in multiple disciplines and contexts.

6.2.1 Multi-faceted emotional responses and behavioral outcomes

While emotional responses have been studied in the TPB, but not in a multifaceted way. Events like lockdowns, climate shutdowns, and other forced isolations cause various negative emotions that influence behaviors differently. Investigating the impact of multifaceted negative emotions, such as anxiety, depression, and boredom, on behaviors will provide richer insights into their influence on behavioral intentions and outcomes. Longitudinal studies to track changes over time will be essential to understand how these emotions evolve and affect behavior.

6.2.2 Artificial intelligence adoption

TPB has been applied to technology adoption and technology usage, but models including artificial intelligence-specific variables are not common. Understanding artificial intelligence (AI) adoption and usage behaviors can inform strategies for their mainstream implementation. Future research should expand the study of AI adoption by incorporating a broader range of variables, including strengths, benefits, weaknesses, and risks of AI technologies. Developing comprehensive models that integrate theories like Diffusion of Innovation, TAM, and UTAUT and utilizing machine learning techniques to enhance predictive accuracy will be critical.

6.2.3 Social-psychological predictors of green energy adoption

Green energy adoption has been studied in the TPB, but more focus on social-psychological predictors is needed. Understanding social-psychological factors can improve the adoption of sustainable technologies. Future research should determine the social-psychological predictors and policies that influence the adoption of green energy technology in various groups, cultures, and organizations. Exploring the role of perceived behavioral control and other moderators in this process and conducting field experiments to test interventions will provide valuable insights.

6.2.4 Online versus offline behavioral patterns

While TPB has been applied to online and offline behaviors, a specific focus on consumer behavior during supply chain disruptions that are increasingly common is lacking. Understanding consumer behavior variations in different contexts helps in adapting marketing and supply chain strategies. Future research should study the variations in consumer behaviors across online and offline shopping contexts, particularly in response to supply chain disruptions. Longitudinal assessments will be needed to observe changes in revenge buying behavior post-lockdown while examining moderators such as socio-economic status and access to digital infrastructure will offer comprehensive insights.

6.2.5 Neural mechanisms in behavioral research

As a large part of consumer purchasing is done online and on mobile devices and tablets, understanding neural mechanisms in decision-making is vital. While the field of TPB has seen some research in that direction, more advanced techniques like EEG (electroencephalography) and fMRI (functional magnetic resonance imaging) are required. Understanding neural mechanisms provides deeper insights into cognitive processes underlying behavior. Utilizing sophisticated data collection methods, such as EEG, fMRI, and eye-tracking, will help better understand the neural mechanisms underlying responses to online advertising and other behavioral stimuli. Integrating neuroimaging techniques with TPB research will provide deeper insight into these processes.

6.2.6 Vaccination and public health interventions

While the past decade has seen multiple studies on vaccination intentions, the use of TPB in designing public health policies and interventions is an important gap that needs to be addressed. Effective public health policies can address vaccine hesitancy and improve vaccination rates. Conducting nationally representative population surveys to understand vaccine hesitancy across different demographics will provide valuable insights. Further, the role of prior experience in vaccination impacting future intentions and behaviors is a research opportunity of vital importance. The same holds for factors like health policies, free or insured vaccinations, and psychological and socio-economic moderators, which hold substantial research promise.

6.2.7 Observed behavior versus stated intentions

The focus in existing TPB research has predominantly been on stated intentions as compared to observed behavior and observing actual behavior provides a more accurate understanding of behavioral patterns. Future research should enhance external validity by investigating actual behaviors in natural contexts rather than relying solely on behavioral intentions. Surveying consumers who have made actual purchases or adopted behaviors to provide more representative.

6.2.8 Machine learning and AI applications

The integration of machine learning (ML) with TPB has gained some traction, and the use of advanced AI applications, such as deep learning and neural networks, can significantly enhance the predictive power of TPB. Future research should investigate how ML and AI can intersect with TPB to predict and analyze behavioral intentions and outcomes. The ability to analyze complex and non-linear relationships within the data with greater accuracy will impart more versatility and predictive strength to applying TPB in diverse contexts. Using predictive analytics and big data approaches will also be beneficial in further refining the models and expanding their applicability.

6.2.9 Cross-cultural, mixed-methods driven causal models

There is a need for cross-cultural validation in TPB research and understanding how cultural, economic, social, and policy factors influence intention and behavior. Multi-level analyses that account for individual and country-level factors will provide deeper insights into how these differences impact intention and behavior. Mixed-methods analysis that has more sophisticated combinations of advanced statistical techniques can unlock learnings from complex and large datasets and will be beneficial to the field of TPB. Similarly, causal models that incorporate the temporal order, longitudinal perspective, time lag between intention and behavior, and the dynamic changes that impact the intention-behavior linkage are vital and needed for the design of interventions in health, environment, and sustainability.

6.2.10 Circular economy and food waste management

While TPB has been widely applied in environmental and sustainability research, there is a significant gap in focusing specifically on food waste management. Reducing food waste and promoting circular economy systems are vital for achieving sustainability goals. Future research should investigate how coordinated actions in the 4Ps of green marketing (product, price, place, and promotion) can effectively reduce food waste and enhance circular economy practices. Additionally, examining the role of social media marketing in influencing consumer behavior towards sustainable practices will provide valuable insights.

6.3 Limitations

Despite the comprehensive analysis and extensive bibliometric review of the field of TPB over the forty years from 1985 to 2024, we acknowledge certain limitations to provide a balanced perspective and highlight areas for improvement in future research. First, the reliance on bibliometric data from specific databases, such as the Web of Science, may have excluded relevant studies not indexed in these databases. Although we believe this exclusion does not alter our study's overall results or recommendations, considering multiple databases would have provided some marginal benefit in terms of scoping comprehensiveness. Second, while the analysis covers various disciplines and contexts, it may not fully capture the depth and nuances of research conducted in niche areas or emerging fields. For instance, the application of TPB in the circular economy and the assessment of AI and ML within TPB research may not be represented.

Additionally, the interpretation of bibliometric data is inherently limited by the quality and completeness of the metadata provided by the sources. We analyzed 976 articles in the search results with 100 or more citations for their relevancy and conducted a parallel search to reconcile the primary search results for their inclusion. While we used the most relevant and accepted techniques for bibliometric study,

employing advanced text-mining and content analysis techniques to evaluate all the articles for their inclusion would have been beneficial.

Future studies should consider these factors to enhance further the robustness and comprehensiveness of bibliometric studies of prominent theories like TPB. We earnestly hope that our endeavor in bibliometric study of the field of TPB over the forty years 1985–2024 motivates other researchers to focus on other theories in their areas and research domains.

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Declarations

Competing interests None.

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