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Quantitative evaluation of the production and trends in research applying the structural equation modelling method

Francisco Javier Blanco-Encomienda and Elena Rosillo-Díaz

Abstract

There are various statistical methods serving to analyse data and test hypotheses. The structural equation modelling method is nonetheless one of the most widespread as it allows to estimate complex causal relationships between different variables. Moreover, has been greatly promoted since the emergence of new information and communication technologies. This paper presents a quantitative study of the performance and evolution of research applying structural equation modelling in Social Sciences. SciMAT software has served for the bibliometric analysis. The results indicate that the thematic areas revealing the greatest relevance throughout the last three decades (1990–2019) are behaviour and health. This contribution of this study is that it offers a comprehensive view of the status quo and predicts further research trends.

Keywords: Scientific information, Structural equation modelling, Quantitative methods, Social Sciences.

1. Introduction

Statistical analysis tools have been applied to research for decades. They have evolved from common techniques such as simple linear regression analyses (Bollen 1989), through the analyses of variance, multivariate analyses of

variance and multiple regressions, until attaining the most recent and popular methods such as structural equation modelling enabling application of both analytical and path approaches (Morrison, Morrison, and McCutcheon 2017).

Structural equation modelling stems from the need to render linear regression models more flexible. This method, considered a hybrid of path and factor analyses (Weston and Gore 2006), is a complex data analysis technique that permits researchers to examine the interrelationships between different variables and test hypothetical relationships between constructs.

The foundation of structural equation modelling method was laid by the development of the path analysis method by Wright (1918, 1921, 1934). However, structural equation models did not receive much attention until they were reintroduced in the 1960s by authors such as Blalock (1961), Duncan (1966) and Jöreskog (1967). Jöreskog (1973), credited with the development of the first structural equation model resorting to computer software, was a turning point for this type of research. The development of different software since then has enabled application of structural equation model methods to very intensive analyses involving large datasets to attempt to resolve complex and unstructured problems (Tarka 2018).

The development of structural equation modelling stems from two approaches: a) the covariance-based structural equation modelling (CB-SEM) and b) the partial least squares structural equation modelling (PLS-SEM). Each is characterised by different underlying philosophies, estimation objectives and distributional assumptions (Gefen, Rigdon, and Straub 2011). Thus, while CB-SEM serves to minimise the discrepancies between the estimated and sample

covariance matrices and requires coming to multivariate normality assumptions, PLS-SEM serves to estimate the partial model relationships in an iterative sequence of ordinary least squares regressions, relaxing the multivariate normality assumptions (Shiau and Chau 2016).

CB-SEM is the most common approach to structural modelling from its outset. However, PLS-SEM is also a useful approach that is increasingly applied to examine structural equation models (Hair, Risher, Sarstedt, and Ringle 2019; Khan et al. 2019). Although the PLS-SEM method over the years has remained in the shadows of CB-SEM, it has of late been emancipated (Shiau, Sarstedt, and Hair 2019) and become a well-established tool for multivariate analysis methods (Hair, Black, Babin, and Anderson 2018).

The structural equation modelling method in recent decades has been widely applied by researchers from different fields, in particular in Social Sciences. It has served the disciplines of psychology (Klainin-Yobas et al. 2016; Myers, Ntoumanis, Gunnell, Gucciardi, and Lee 2018; Valente, Valera-Pertegas, and Guàrdia-Olmos 2019), social work (McFadden, Campbell, and Taylor 2015; Park 2019; Travis, Lizano, and Mor Barak 2016), education (Koç, Turan, and Okursoy 2016; Marks, Sibley, and Arbaugh 2005; Supriadi and Mutrofin 2020; Tarhini, Hone, and Liu 2014; Usluel, Askar, and Bas 2008), business (Chen, Gu, Cai, and Yang 2019; Chong and Monroe 2015; Guerrero, Rialp, and Urbano 2008; Hsu et al. 2012; Ringle, Sarstedt, Mitchell, and Gudergan 2020; Sarstedt, Ringle, Smith, Reams, and Hair 2014; Sila 2020), tourism and hospitality (Ali, Kim, Li, and Cobanoglu 2018; Han and Ryu 2009; Nunkoo, Ramkissoon, and Gursoy 2013; Usakli and Kucukergin 2018; Yoon, Gursoy,

and Chen 2001) and marketing (Hair, Sarstedt, Ringle, and Mena 2012; Petrescu 2013).

The number of publications applying this method has increased exponentially due to the great advances in technology and the broad access to software such as LISREL, SmartPLS or AMOS. This has, in fact, yielded an overload of information in the databases (Huggett 2013) requiring researchers to be able to digest the data, to development means of performance and impact analyses (Li, Ma, and Qu 2017).

The need to analyse the immense scientific information gathered in databases has given rise to the discipline of bibliometrics (Castillo-Vergara, Alvarez-Marin, and Placencio-Hidalgo 2018). This new branch identifies the main research themes of a certain field and pinpoints the authors, countries and institutions yielding the greatest number of publications (Capobianco-Uriarte, Casado-Belmonte, Marín-Carillo, and Terán-Yépez 2019). It also offers clues to identify emerging thematic areas (Terán-Yépez, Marín-Carrillo, Casado-Belmonte, and Capobianco-Uriarte 2020). This type of quantitative study focused on academic production enables the grouping of analogous concepts. Bibliometric surveys can in fact be broken down into two procedures: analyses of the yield or performance and scientific mapping (Cobo, López-Herrera, Herrera-Viedma, and Herrera 2012). Thus, these surveys serve as a guide to define the state of research in specific fields (Rey-Martí, Ribeiro-Soriano, and Palacios-Marqués 2016).

However, despite the acceptance of the structural equation model by academia as a research tool, no study has delved into its scientific evolution and impact.

Thus, the aim of this study is to carry out a bibliometric survey by means of a performance analysis and scientific mapping to quantitatively evaluate the production. The intention is likewise to examine the trends in research applying the structural equation modelling method to Social Sciences, and to identify the main themes and new areas of interest. This consisted of a co-word analysis carried over the span of the last three decades, a timeframe marked by the surge of this statistical method.

2. Methodology

2.1. Bibliometric analysis

The bibliometric analysis obtained its results through a combination of scientific mapping and performance analyses garnered from secondary sources (Cobo, López-Herrera, Herrera-Viedma, and Herrera 2011). This method offers researchers relevant information to assess scientific activity as it allows scrutinising a field of research, identify different general and specific themes, and determine their thematic evolution (López-Robles, Otegi-Olaso, Porto-Gómez, and Cobo 2019; Rey-Martí et al. 2016). These techniques are experiencing an increase in use by researchers to assess the production, evolution and quality of scientific research (Gómez-Jauregui, Gómez-Jauregui, Manchado, and Otero 2014; Martínez, Cobo, Herrera, and Herrera-Viedma 2015).

2.2. Dataset

The substantial technological advances of recent times have led to the creation of various databases on the World Wide Web offering researchers the option to carry out searches of specific themes. These databases, notably the Web of Science (WoS), Scopus and Google Scholar, enable citation analyses that cover most scientific fields (Falagas, Pitsouni, Malietzis, and Pappas 2008). The current study chose to collect the data by means of the WoS database due to its advantages over Scopus and Google Scholar (Norris and Oppenheim 2007). This choice was likewise founded on the fact that this database includes the largest volume of documents in the realm of Social Sciences (Martínez et al. 2015).

The bibliographic records identified in this study span the years from 1990 to 2019 as publications of this type do not exist prior to 1990. Furthermore, the evolution of information and communication technology, compounded with the growth of the World Wide Web, has led to a great transformation of the scientific-academic field (Huggett 2013) yielding an exponential excess of information. The analysis of bibliographic contents from the periods before and after the introduction of these technological advances is therefore of interest despite the fact that only a small number of publications appeared in first years of the decade of the 1990s. This offers the possibility to examine the impact of these new technologies on academic performance, as well as to identify the thematic trends at each of the phases applying structural equation modelling.

The keywords serving for the search were "Structural Equation Modelling," "Structural Equation Modeling," "Structural Equation Model," "Structural

Equation Models," and "SEM" using the Boolean operator “or” in the topic field, while the research area was “Social Sciences.”

The search yielded a total of 5,720 documents which after deleting those duplicated or containing irrelevant data (López-Robles et al. 2019) was reduced to 5,518. The information compiled includes the publication's author/s, title, abstract, keywords, citations, references and source.

The entire study was divided into four periods: a) 1990–2003, b) 2004–2009, c) 2010–1014 and d) 2015–2019. The first is characterised by a modest number of publications (356) resorting to structural equation modelling and covers the phase prior to the inception and introduction of the technological advances. The second, marked by a slight increase (615), corresponds to the adoption and adaptation of the new technological tools. The third and fourth periods with respectively 1,488 and 3,059 correspond with an exponential increase of publications applying the structural equation modelling (Figure 1).

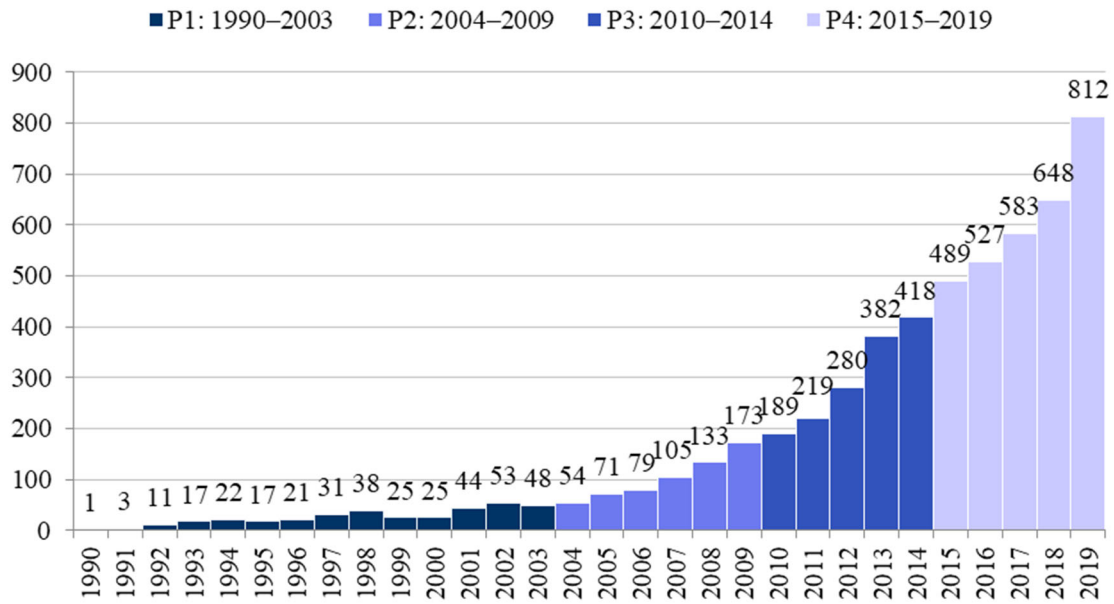

Figure 1. Distribution of the number of publications by year.

2.3. Tools serving for the analysis

Although different bibliometric analysis software is available, this study resorted to the WoS Analyze Results to glean the data on scientific performance and the SciMAT software, developed by Cobo et al. (2012), to generate the scientific maps and visualise their evolution.

It was necessary to normalise the keywords at the study's outset. This meant changing those in in plural form to singular and unifying those with close conceptual links (Cobo et al. 2011). Moreover, all the words related to structural equation modelling were removed in order to identify the thematic areas this method was applied. This meant that the 16,769 keywords obtained originally through the software dwindled to 6,908 word groupings for the final analysis.

After determining the periods of study, the SciMAT was configured for the analysis as follows: a) a single word was chosen as the unit of analysis, b) a co-occurrence analysis was designed to generate networks, c) an equivalence index was selected to measure the similarity of the standardised networks, d) the simple enter algorithm was applied to detect clusters, and e) the citations and h-index served to measure quality and impact (Castillo-Vergara et al. 2018; Hirsch 2005).

This led to plotting strategic diagrams which illustrate the evolution of the most representative themes based on centrality and density. Centrality is represented by the horizontal axis which reflects the consistency of the link between the themes of a certain field of study. In addition, the more a specific theme increases, the greater its connection with others which expands its relevance to the evolution of particular field of research (Xie, Zhang, and Duan 2020).

Density, in turn, is depicted by the vertical axis and indicates the degree of association of keywords within a given theme. As the connections within a distinct theme increase, their links and degree of maturity narrow.

A strategic diagram is a two-dimensional chart that plots the different themes into four quadrants (Cobo et al. 2011). Motor themes that are relevant to the structure of a research field occupy the top right quadrant. The top left quadrant plots the highly developed and isolated themes pertinent to the field that remain nonetheless irrelevant to the current state and are not research renters. The bottom left quadrant displays the emerging and declining themes that are marginal to research and generally the object of a decline or impulse. Finally, the bottom right quadrant represents the basic and transversal themes that are greatly influential and although bearing a great potential have not been correctly developed.

3. Results

3.1. Scientific performance analysis

Table 1 lists the ten countries producing the most publications on the subject of structural equation modelling in the framework of Social Sciences. The United States leads the list with 2,014 followed by China with 728 and United Kingdom with 360.

Table 1. Countries with the greatest number of publications.

Country	Publications	Total (%)
United States of America	2,014	36.50
China	728	13.19
United Kingdom	360	6.52
Australia	355	6.43
Spain	304	5.51
Taiwan	290	5.26
Canada	289	5.24
South Korea	284	5.15
Malaysia	262	4.75
Netherlands	206	3.73

3.2. Content analysis

Content analysis refers to a systematic analysis of texts with the aim to discover concepts and themes among the assemblage of data and highlight unknown qualities to arrive at valid and trustworthy inferences (Aliyev, Urkmez, and Wagner 2019; Krippendorff 2012). It yields detailed conceptual insights by focusing the analysis on the actual texts cited by authors (Biesenthal and Wilden 2014; Randhawa, Wilden, and Hohberger 2016). Strategic diagrams were designed for each of the different periods in order to visualise over time the most relevant themes in the publications applying the structural equation modelling. Each sphere in the diagram reflects a research theme and its size equates with the number of publications (López-Robles et al. 2019).

First period (1990–2003). This period yielded three themes: stress, middle-aged and older adults and behaviour (Figure 2). Stress is a motor theme represented by a central node to analyses on resources, events, disability, anxiety, quality of life, depression, health, support, psychological distress, social support and life events. Middle-aged and older adults is a highly developed and isolated theme represented with a central node denoting the areas of family and mental health. Behaviour, in turn, is a basic and transversal theme with a tendency to evolve into a motor or emerging or declining theme. This node stems from studies of the fields of experience, perceptions, gender, drug use, job and aggression. Table 2 lists the performance of these themes.

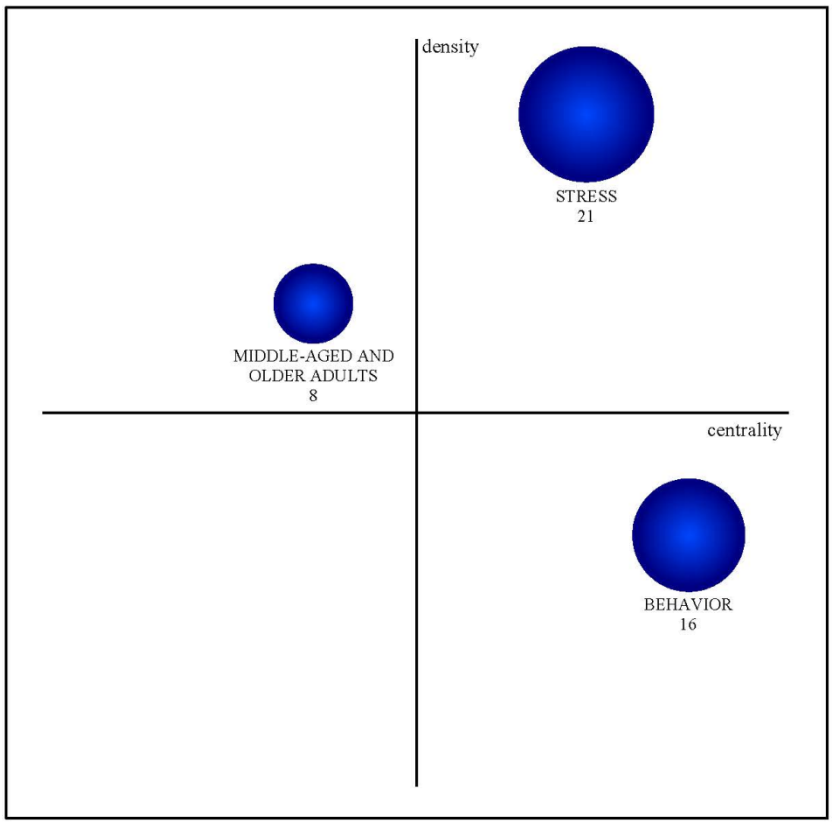

Figure 2. Strategic diagram for the 1990–2003 period.

Table 2. Performance of the themes during the 1990–2003 period.

Theme	Documents	h-index	Centrality	Density
Stress	26	21	5.19	16.98
Middle-aged and older adults	8	8	3.14	11.67
Behavior	16	16	7.37	5.92

Second period (2004–2009). The themes of stress and middle-aged and older adults disappear in this timeframe. Behaviour and eight other themes emerge: social support, loyalty, theory of planned behaviour, motivation, perceived risk, beliefs, performance and health (Figure 3). Social support and loyalty become motor themes in this timeframe. The first is closely linked with physical and mental health themes such as disability, antiretroviral therapy, health care, reported adherence, mental health, medication adherence and psychological distress. Loyalty, in turn, becomes a principal theme in the field such as perceived value, commitment, service quality, customer satisfaction, tourism, satisfaction, involvement, trust, expectancy theory, behavioural intention and specialisation. Hence loyalty lines up with aspects related to the customer.

Theory of planned behaviour, motivation and perceived risk in this timeframe are highly developed and isolated themes. Theory of planned behaviour becomes a central node for the fields of attitudes, intentions, intervention, experience, planning, reasoned action, self efficacy and decision making. Motivation, in turn, is studied from the perspective of sport, perceptions, goal orientation, competence, physical education, self-determination theory,

satisfaction, frustration, autonomy and activity intentions. The motivation theme is therefore linked to physical activity and feelings deriving from sport. Perceived risk is the final highly developed and isolated theme and is analysed from the perspective of risk, hazards, information and gene technology.

Beliefs, on the other hand, is the only emerging or declining theme analysed in fields linked to students, socialisation and physical activity. Finally, performance, behaviour and health become basic and transversal themes. Performance is approached from different aspects of investigation such as motivation, gender, organisational citizenship behaviour, job satisfaction, self esteem, feedback, leadership, quality, job and achievement. Behaviour in this timeframe is analysed from the perspective of customers, family, TAM-IDT, management, safety, young adults, communication, purchase and substance use. The third, health, is examined through the fields of determinants, adolescents, gender, HIV, risk, quality of life, depression, social cognition and stress. The detailed results for each theme are listed in Table 3.

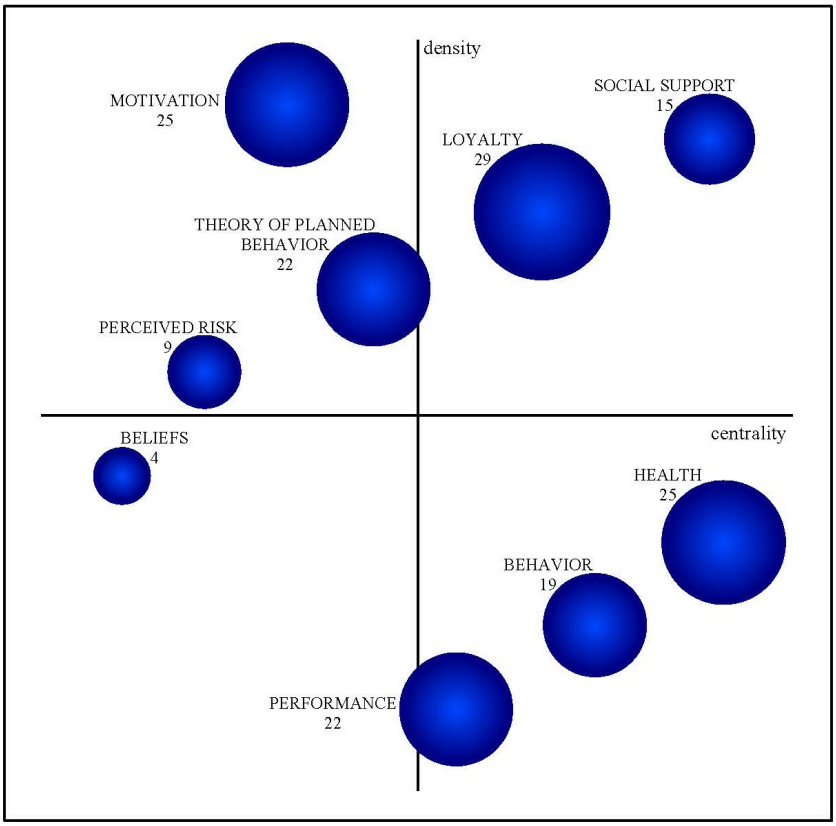

Figure 3. Strategic diagram for the 2004–2009 period.

Table 3. Performance of the themes during the 2004–2009 period.

Theme	Documents	h-index	Centrality	Density
Social support	19	15	36.75	26.72
Loyalty	40	29	27.44	21.19
Theory of planned behaviour	30	22	21.1	9.47
Motivation	30	25	17.31	31.58
Perceived risk	9	9	7.9	8.77
Beliefs	5	4	2.44	7.34

Theme	Documents	h-index	Centrality	Density
Performance	29	22	22.6	4.48
Behaviour	28	19	35.73	7.09
Health	42	25	38.46	7.18

Third period (2010–2014). Research in this timeframe can be broken down into eight themes (Figure 4) with satisfaction becoming the motor theme stemming from studies of perceived value, commitment, service quality, customer, experience, loyalty, quality, trust and behavioural intention. These themes are all linked to the customer as is the case of the first period where loyalty is a motor theme also linked to satisfaction.

The self-determination theory, together with TAM-IDT, performance and depression become highly developed and isolated themes in the third timeframe. The self-determination theory is studied in the fields of motivation, sport, well-being, style, satisfaction, physical education, basic psychological needs, frustration, autonomy and exercise. TAM-IDT is the main node in areas such as information and communication technologies (ICT), e-commerce, adoption and user acceptance, that is, aspects related to the adoption and acceptance of new technologies. It is noteworthy that performance turned out to be a basic and transversal theme in the previous period and is examined in this third period in fields such as organisational commitment, employees, organisations, corporate social responsibility, job satisfaction, leadership, management, job engagement and burnout. As in the previous timeframe, it is also related to areas linked to business. The theme of depression, the last of

the highly developed and isolated themes, now becomes a central aspect in the areas of mental health, stress and psychological distress.

The third timeframe also yielded three basic and transversal themes. Health, in this same quadrant in the previous period, becomes a field of analysis during these years through the fields of adolescents, children, gender, quality of life, personality, self efficacy, adults, satisfaction, life and social support. The second of these themes is attitudes, identified through the fields of behaviour, intentions, gender, beliefs, theory of planned behaviour, drivers, advertisement, tourists, destination image, internet and place attachment. The third, tourism, becomes the central node of areas such as image, destination, purchase and authenticity. Table 4 lists the results of all this period's themes.

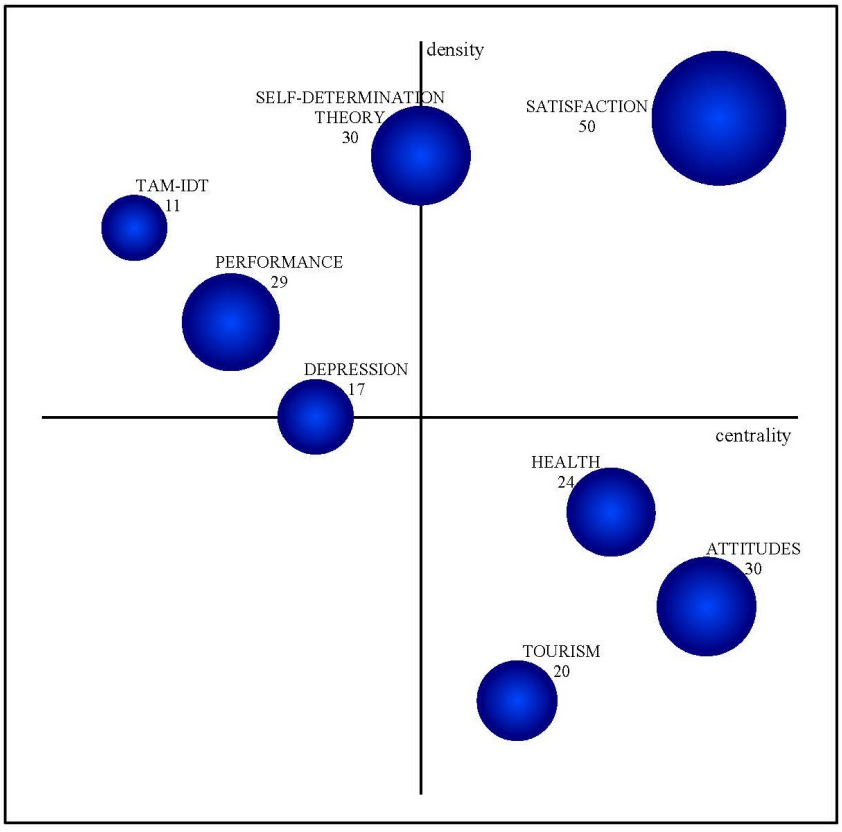

Figure 4. Strategic diagram for the 2010–2014 period.

Table 4. Performance of the themes during the 2010–2014 period.

Theme	Documents	h-index	Centrality	Density
Satisfaction	226	50	25.42	24.44
Self-determination theory	75	30	7.21	22.92
TAM-IDT	22	11	1.37	17.08
Performance	87	29	6.38	6.73
Depression	28	17	6.57	6.1
Health	93	24	13.55	5.5
Attitudes	88	30	16,5	3.22
Tourism	32	20	7.44	2.64

Fourth period (2015–2019). Thirteen themes are identified with this last timeframe (Figure 5). The main motor theme is behavioural intention which becomes the central node to fields such as perceived value, service quality, customer perceptions, image, satisfaction, destination image, corporate image, loyalty, quality and physical environment. There is a notable difference as to the first period since the earlier motor theme then became behaviour identified by research on health and in this last stage the motor theme becomes behavioural intention identified due to research on business and commerce. It should be noted that attitudes became a motor theme in this period due to studies in the fields of perceptions, intentions, theory of planned behaviour, world heritage site, tourism and purchase.

Furthermore, motivation becomes another motor theme due to research using structural equation modelling as it is a central theme in the fields of behaviour, experience, sport, revisit intention, satisfaction, self-determination theory, destination loyalty, autonomy, visitor and travel. Another motor theme is job satisfaction addressed through studies in the fields such as commitment, turnover intention, organisational commitment, organisational citizenship behaviour, frontline employees, leader member exchange, hospitality and tourism, job, transformational leadership and performance, that is, fields linked to organisation and the work environment. The last motor theme, HIV, becomes a central node stemming from studies in the fields of gender, antiretroviral therapy, depression, mental health, social support and adherence.

TAM-IDT and quality of life, in the second quadrant of the strategic diagram, become highly developed and isolated themes in this last period. The first item was also a highly developed and isolated theme in the previous period (2010–2014) and in the most recent period becomes a central node in areas such as perceived risk, determinants, mobile phones, systems, information and communication technologies (ICT), e-commerce, perceived ease of use, adoption, utilitarian and user acceptance. Quality of life stems from analyses in the areas of subjective well-being, resident attitudes, oncology, survivors, community, anxiety, middle-aged and older adults, care and support areas.

Four themes, in turn, now line up within the quadrant of emerging or declining themes. Business performance is from studies in the fields of innovation, perspective, resources, strategy, small and medium business, management, capacity, industry, market orientation and entrepreneurial orientation, that is, subjects related to business. Another emerging or declining theme is happiness

which was analysed in areas such as well-being, leisure, stress and life. The most outstanding declining theme is personality which is considered a central element in areas such as cross cultural research, gender and emotional intelligence. The last emerging or declining theme is adolescents which is present in fields linked to students, parents, gender, children, self esteem, health, young adults, body image, exposure and life satisfaction.

Finally, this period sees the surfacing of two basic and transversal themes. The first is leadership, the main theme in studies on employees, social exchange theory, job engagement, performance, ethical leadership and accommodation industry. The second, trust, becomes a basic and transversal theme stemming from research on service, customers, social media, risk, word of mouth, customer loyalty, social capital and online. Table 5 lists the results for each theme.

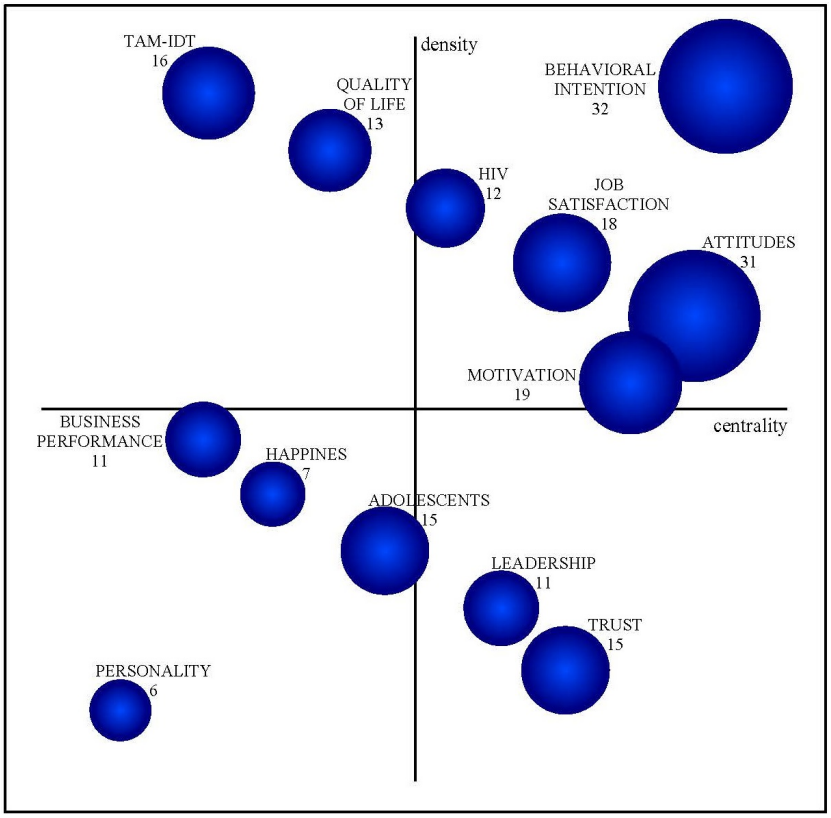

Figure 5. Strategic diagram for the 2015–2019 period.

Table 5. Performance of the themes of the 2015–2019 period.

Theme	Documents	h-index	Centrality	Density
Behavioural intention	523	32	54	27.39
Job satisfaction	225	18	21.63	10.1
Attitudes	382	31	38.41	8.33
Motivation	179	19	23.8	6.76
HIV	110	12	12.4	13.55
Quality of life	85	13	9.06	14.14
TAM-IDT	108	16	7.43	16.13
Business performance	124	11	6.7	5.77
Happiness	37	7	7.89	4.35
Adolescents	125	15	12.17	4.02
Personality	25	6	2.31	1.01
Leadership	65	11	12.86	2.87
Trust	105	15	14.65	2.03

3.3. Structural analysis of the evolution of research applying structural equation modelling

Bibliometric analyses also allow examining the evolution of the themes through the different periods in order to detect the main domains of the evolution of a

research field, as well as their origins and inter-relationships (Gutiérrez-Salcedo, Martínez, Moral-Muñoz, Herrera-Viedma, and Cobo 2018). Thus, the intent of the current analysis is to shed light on the conceptual evolution of the main themes of research applying structural equation modelling from 1990 to 2019. The findings indicate that the main thematic areas emerging in the first period (1990–2003) were stress, behaviour and middle-aged and older adults. New themes likewise surfaced for the second period (2004–2009) through the development of research in the fields of social support, motivation, health, loyalty, theory of planned behaviour, performance, perceived risk and beliefs. New themes applying structural equation modelling subsequently emerged in the following period (2010–2014). These include self-determination theory, satisfaction, attitudes, tourism, TAM-IDT and depression. The use of the method in the most recent period (2015–2019) coincides with the emergence of new areas such as behavioural intention, job satisfaction, HIV, adolescents, business performance, quality of life, TAM-IDT, trust, leadership, happiness and personality.

Figure 6 depicts the conceptual evolution of the various thematic areas in Social Sciences resorting to structural equation modelling. Each theme is represented in the chart by a sphere while the lines between the spheres represent the thematic networks (Aparicio, Iturralde, and Maseda 2019). The size of each node is proportional to the number of documents identified. The solid lines connecting the nodes denote links between the different thematic areas while the dashed lines indicate that related thematic areas share certain keywords (Moral-Muñoz, Cobo, Peis, Arroyo-Morales, and Herrera-Viedma 2014; Zhou, Luo, Fang, Gou, and Chen 2020). Moreover, the thickness of the lines is

proportional to both the strength of the relationships and inclusion index (Cobo et al. 2011). Following the indications of Murgado-Armenteros, Gutiérrez-Salcedo, Torres-Ruiz, and Cobo (2015), the different colour shadings serve to group the themes that form part of the same subject area.

Figure 6 therefore reflects a great cohesion among the research using applying structural equation modelling as most of the themes are present in the previous period and take shape in a common thematic area. The findings highlight six thematic areas consistent with the scientific research from 1990 to 2019 with behaviour and health repeating as classic themes from the outset. The figure also depicts a positive growth pattern of the thematic areas since different themes derive from each over time. Thus, the following notions can be garnered from the evolution and structural composition of each thematic area:

- *Health* was analysed from the outset from the angle of stress, that is, from the point of view of mental health. This theme endured throughout the second period through research related to mental health while it evolved simultaneously in studies of general health as it awakened an interest in themes of the more recent period such as HIV, adolescents and personality.
- *Behaviour* appears in the first period as one of the main themes. It subsequently evolves over the years subsequent to the highly developed and isolated theme of TAM-IDT, an area that remains as a field of interest in studies that make use of structural equation modelling.
- Loyalty, motivation, theory of planned behaviour and performance emerge as thematic areas of interest in the second period and most continue their evolution throughout the later stages.

- *Loyalty* suffers a division in its evolution as it is analysed on the one hand due to its link to satisfaction, the area with the greatest interest of this second period. It is further analysed, on the other hand, in the framework of the themes of tourism and behavioural intention, trust and attitudes. The last three currently evoke a great amount of interest.
- *Motivation* linked to behaviour, one of the main themes of the previous period, advances forward in the following period as a theme of great interest in the self-determination theory and endures until today.
- *Theory of planned behaviour* turns out to be another area of study linked to the theme of behaviour as a precedent in the earlier period. Its areas of study in later periods relate to attitude analyses.
- *Performance,* as in the case of the other thematic areas that emerged during the second period, has a precedent in behaviour, the motor theme in the initial period. This thematic area is maintained throughout the third period and it is from that moment on that it undergoes an evolution toward becoming a double theme such as job satisfaction and leadership, that is, it tends to evolve toward thematic areas linked to organisational and work environments.

It is noteworthy that happiness emerges in the most recent period as a new theme related to health and depression albeit not addressed with the same consistency. Happiness, in fact, becomes an emerging or declining theme in the most recent period that may evolve into a basic and transversal or motor theme in years to come.

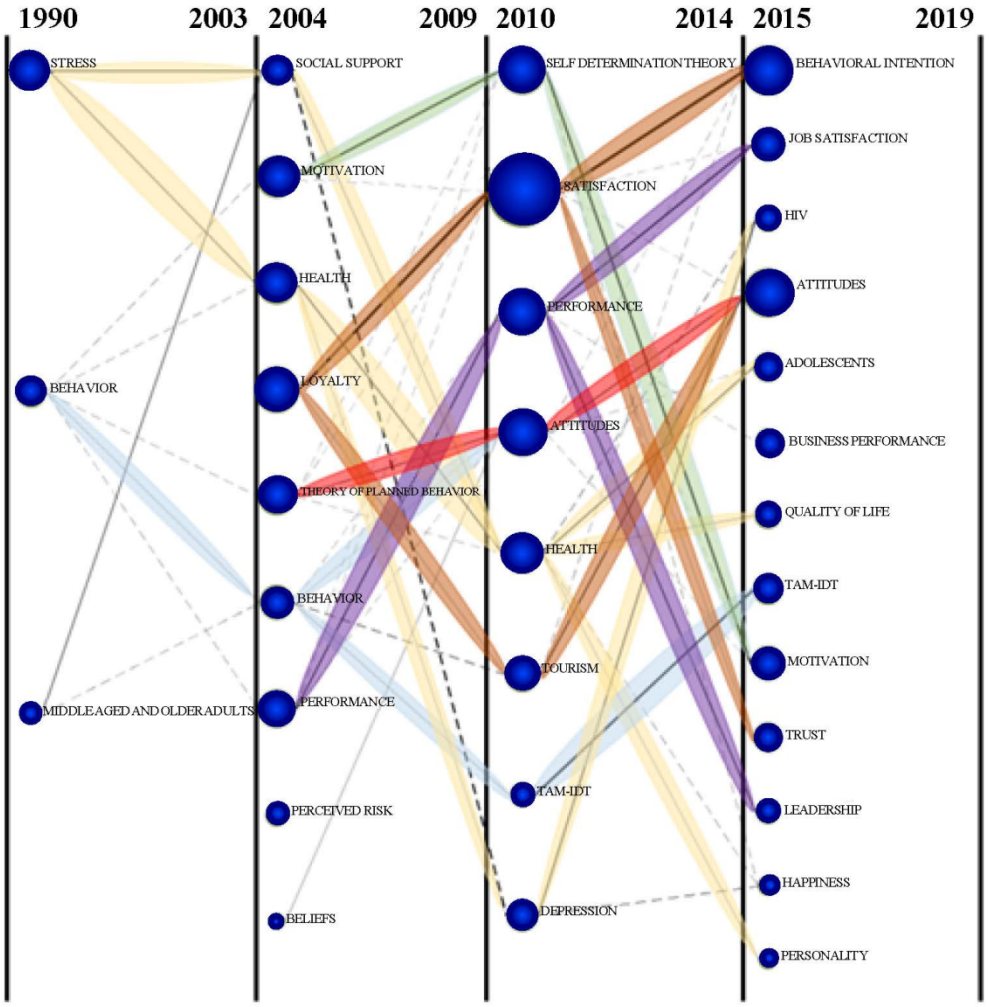

Figure 6. Evolution of the thematic areas throughout the four periods.

4. Conclusion

The current study is a quantitative bibliometric analysis that evaluates the application of the structural equation modelling method to different disciplines of Social Sciences over the last three decades and offers an overview of the trends spanning four time frames of the study period. The findings reveal the impact of the introduction and evolution of new information and communication technologies and highlight the gradual increase of publications and thematic areas throughout the different periods. Application of structural equation

modelling increased progressively and is reflected particularly by the surge of publications and thematic areas notably throughout 2010–2014 and 2015–2019, the study's last two periods.

The study identified six main thematic areas applying structural equation modelling. The period spanning 1990 to 2019 includes classic themes such as behaviour and health. Those of loyalty, performance, motivation and theory of planned behaviour, in turn, receive great interest in the more recent phase initiated in 2004.

The second period saw an evolution in behavioural research as to the acceptance and adoption of new technologies. This reflects the great impact that the new information and communication technologies fostered not only on the daily life but on different thematic areas of research (Kusumah 2015). It is noteworthy that behaviour was a basic and transversal theme during the first two periods and from the third period evolved into a motor theme, a role it plays today. It is in fact a classic theme resorting to the structural equation modelling method. Similarly, a change in its application to the field of health stands out as the structural equation modelling method in the first periods was applied to thematic areas associated with mental health whereas in more recent times the investigations using it are geared more to physical health.

It is also noteworthy that loyalty emerged as a motor theme during the second period and over time followed an evolutionary path toward satisfaction, another motor theme. It also turned out to be one of the themes with the largest number of publications in the third period and, finally, it has evolved toward two highly relevant themes today in marketing and market research: trust and behavioural

intention. Loyalty from the performance standpoint reveals a clear evolution from an emerging or declining theme to a basic and transversal one in the second period before developing into a highly developed and isolated theme in the third period. This has led it toward two highly significant problems in the field of business: job satisfaction and leadership. The current findings therefore suggest that performance has focused on the organisational and business area from the outset of the study timeframe. Motivation, in turn, emerges as a theme related to behaviour and became an element of great interest in the self-determination theory. Finally, theory of planned behaviour evolved into a theme that has been greatly exploited by different lines of research, transforming itself in the later periods into themes of great interest for example to the study of consumer attitudes.

5. Implications, limitations and future research

This article offers the first comprehensive examination of the evolution of the application of structural equation modelling in the framework of Social Sciences. It is of interest to researchers for several reasons. Firstly, it enables identification of the thematic areas applying the structural equation modelling method, which can serve as a starting point for them. Thus, it allows them to detect research related to their areas of interest and contrast their hypotheses, enabling the verification of similarities and differences of the results.

This study also contributes to academia by offering potential lines of research on how to examine through the structural equation modelling method new thematic areas that may be of interest today, notably quality of life in the area of health and job satisfaction in business. Likewise, the current analysis enables

identifying emerging themes such as trust and leadership that require further study by means of the method.

Furthermore, this study identifies the thematic areas yielded by structural equation modelling, rendering it possible to propose and compare the results of little-known complementary analytical techniques such as Frequentist Model Averaging (FMA) and the so-called Generalised Linear Latent and Mixed Models (GLLAMM) in the framework of Multilevel Structural Equation Modelling (MSEM). The FMA offers certain options such as the possibility of producing a robust mean-squared error, a superior coverage probability, and a better goodness-of-fit test (Jin and Ankargren 2019). The MSEM, in turn, combines the study of relationships between variables measured with an error central to structural equation modelling with an interest in macro-micro relationships central to multilevel models (Castanho Silva, Bosancianu, and Littvay 2019).

This study suffers nonetheless from limitations that require further research. The data were collected from a single database (WoS) and may differ from those gathered from other databases. Another limitation is that it took on a very broad framework (Social Sciences) which does not allow detecting thematic areas by discipline. In addition, although the bibliometric analysis allowed identifying the emerging thematic areas, it did not distinguish between approaches and methodological tools. It would therefore be of interest to carry out a bibliometric analysis applying the structural equation modelling within the framework of a specific discipline to further specify its relevant themes. Business, psychology and education would be such options. Yet another possibility is to turn to other databases such as Scopus or Google Scholar. To conclude, future studies should likewise attempt to identify emerging thematic

areas and further research trends relative to new procedures and tools serving, for example, when adopting a prediction perspective for an analysis (Shiau, Yuan, Pu, Ray, and Chen 2020; Shmueli, Ray, Velasquez Estrada, and Chatla 2016; Shmueli et al. 2019).

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