Artículo de reflexión

En Contexto

Validity of the general systems theory for applications in management

Vigencia de la teoría general de sistemas para aplicaciones en el área administrativa

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Abstract: This research validates the systems theory applied to management by mapping current knowledge and identifying gaps in the literature. The methodology is based on developing a systematic literature review with the main object in the search equation "General systems theory", contrasting it with the application in the administrative area. With this information, a bibliometric and content analysis is performed, in addition to statistically validating the theoretical relevance were conducted to answer the research question: Is the General systems theory in force and applicable to management?, which proves its validity and allows concluding that the general systems theory is valid and applicable in the scientific and management fields.

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Keywords: General systems theory, Management, Literature review.

Resumen: Esta investigación hace una validación de la vigencia de la teoría de sistemas en el área administrativa, trazando un mapa de los conocimientos actuales e identificando los vacíos en la literatura. La metodología se basa en desarrollar una revisión sistemática de literatura con objeto principal en la ecuación de búsqueda "*General systems theory*" haciendo un contraste con la aplicación que se da en el área administrativa. Con esta información se realiza un análisis bibliométrico y de contenido, además se valida estadísticamente la relevancia teórica que permite responder a la pregunta de investigación: ¿Está vigente la teoría general de sistemas para aplicaciones en temas relacionados con el área administrativa? la cual comprueba su validez y permite concluir que la teoría general de sistemas se encuentra vigente y es aplicable en el mundo científico y en el área administrativa.

Palabras clave: Teoría general de sistemas; administración; revisión de literatura.

JEL: M1, D21, L20

Validade da teoria geral dos sistemas para aplicações no domínio administrativo

Resumo: Esta pesquisa faz uma valoração da teoria dos sistemas na área administrativa, mapeando o conhecimento atual e identificando lacunas na literatura. A metodologia baseia-se no desenvolvimento de uma revisão sistemática da literatura tendo como objeto principal na equação de busca "*General systems theory*", contrastando-a com a aplicação na área administrativa. De posse dessas informações, realiza-se uma análise bibliométrica e de conteúdo, além de validar estatisticamente a relevância teórica que permite responder à pergunta de pesquisa "A teoria geral dos sistemas é válida para aplicações em assuntos relacionados à área administrativa?", o que comprova sua validade e permite concluir que a teoria geral dos sistemas é válida e aplicável no meio científico e na área administrativa.

Palavras-chave: Teoria geral de sistemas, administração, revisão de literatura.

Introduction

Some theories lose validity over time because of different reasons (Boag, 2015), evolutionary paradigms may be one of them (Lessa, 1996; Boag, 2015. highlight studies that demonstrate that characters undergo mutations (Jablonka & Lamm, 2015). They propose the law of use and disuse, which shows that changes in body structures are based on the use or disuse of their parts and concludes that what is used develops, if not, it reduces or becomes atrophied (Jay Gould & Scherezade, 2004). Therefore, it is necessary to make an analogy of the law with the current validity of the general systems theory, to verify whether the theories apply or not, for this reason this research aims to validate whether the general systems theory is in force based on this premise.

Among other reasons, theories may lose validity due to falsificationism (Popper, 1975) if they do not contain reason (Hacking, 2012), truth (Jacobs, 2020), experimentation factors (Sodian & Bullock, 2008), or sufficient scientific basis (Harman, 1991). However, until an invalidation is made (Letelier-Wartenberg, 2014), theories can be considered valid because it is not science but researchers, the common criterion, and the understanding of the world on epistemological criteria who gives them power, with hegemonized consciousness, and a position that allows restrictive thinking (Foucault, 1980). Hence, the normal sciences are established at a given time and society (Kuhn, 1962).

This article based on that background and aims to validate the applicability of the general systems theory in management. A descriptive-explanatory literature review is made (Grosof & Sardy, 1985; Merino-trujillo, 2013) to answer the question *Is the General systems theory in force and applicable to management?* A bibliographic search is carried out using the Citation Pearl Growing technique (Schlosser et al., 2006) and the search equation "General systems theory" and "Management" in the Scopus and Web of Science databases.

The documents were selected according to the way they link the general systems theory with management; subsequently, the quality evaluation was made including the seminal papers or the ones containing theoretical bases that give us the information necessary to answer the research question.

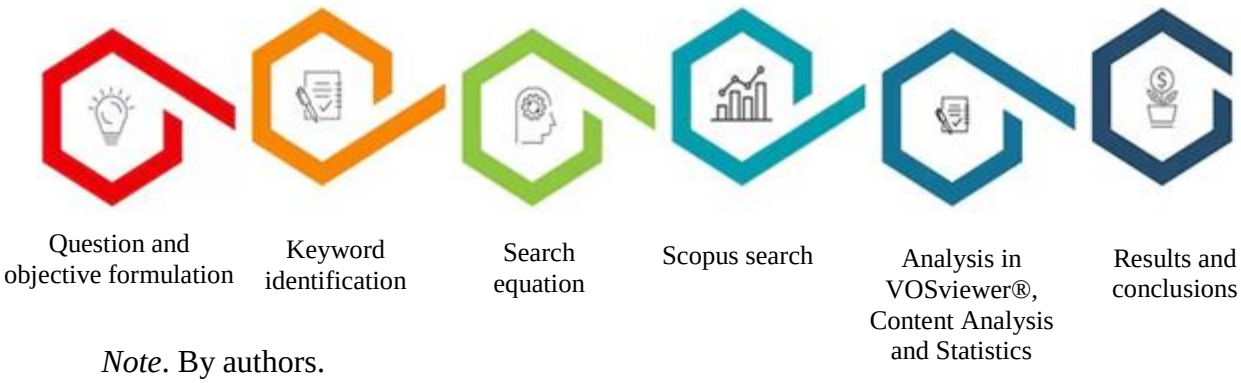
This article is presented as follows: first, the theoretical framework where the previous research is analyzed; then, the theoretical development that contains the findings; and finally, the conclusions reached after conducting the systematic literature review.

Materials and methods

The systematic literature review begins with a bibliometric analysis for the construction of the state of the art based on a search equation "General systems theory", which is entered into the SCOPUS indexer to proceed with a study of the cooccurrence of keywords with the VOSviewer® software as shown in Figure 1.

Figure 1

Systematic literature review methodology

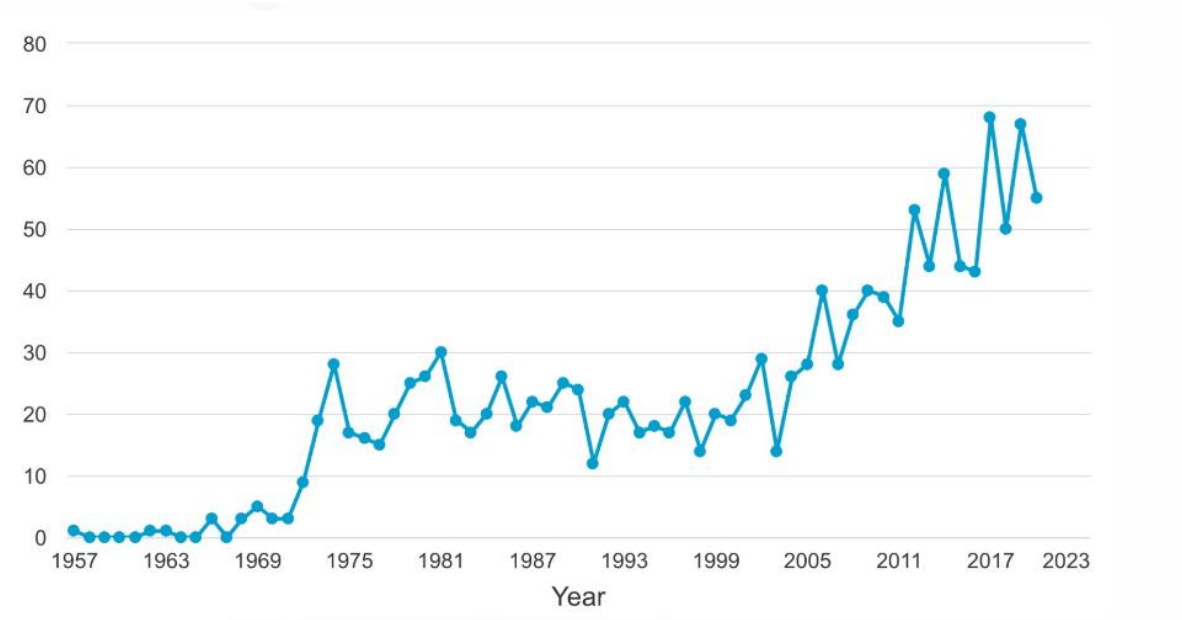


Note. By authors.

Once the search equation "General System Theory" was entered into the Scopus indexer with the TITLE-ABS-KEY filter, 1,235 articles published from 1954 to 2020 were found. The evolution of publications on this topic in the scientific literature is shown in Figure 2 below, showing that there is interest and relevance of research on this topic over time.

Figure 2

Evolution of publications in "General System Theory"



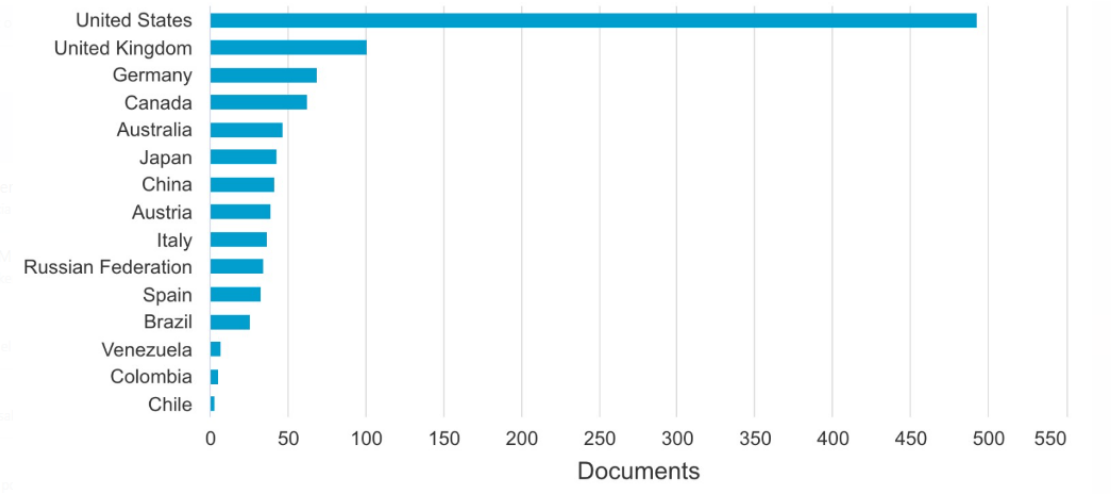
Note. By authors with Scopus samples.

This investigation also bases its methodology on the analysis of the publications made by sector, where it was found that the United States has been the country with the greatest interest in the subject of general systems theory, with 492 publications throughout history, followed by the United Kingdom with 100, Germany with 68, Canada with 62 and Australia with 46.

Figure 3 below shows the results of the search on which the content analysis is based, not only by topic and number of publications, but also by the countries showing interest in the theory, which is one of the criteria used to filter the documents analyzed.

Figure 3

Number of publications by country of "General System Theory"

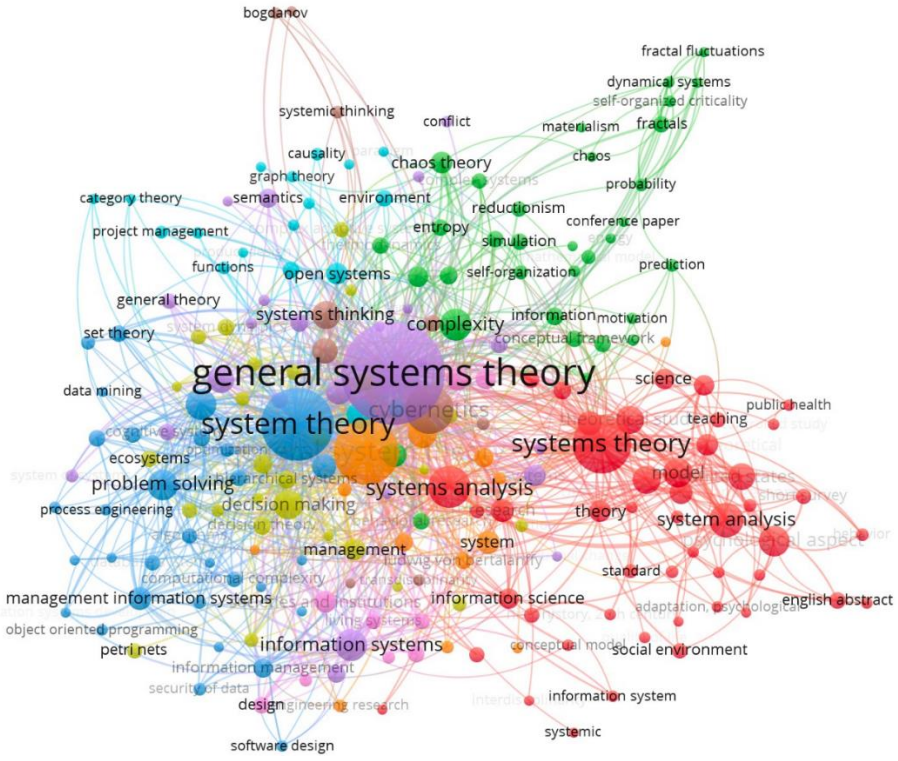


Note. By authors with Scopus samples.

Subsequently, the occurrence and co-occurrence analysis are performed and the data are processed using the VOSviewer® tool as shown in Figure 4.

Figure 4

Occurrence and co-occurrence analysis



Note. By authors in VOSviewer® with Scopus samples.

With this information, is proceeded to build the Conceptual framework to perform the content analysis of the articles found, considering the most frequent and co-occurring terms identified in the bibliometric analysis performed with the VOSviewer® software and finally to contrast the literature with the relevant discussions on the subject.

Conceptual framework

Review and description of the general systems theory

The general systems theory is successfully presented in the literature by Ludwig von Bertalanffy, the compendium of different approaches from various sciences and the studies he uses to support it. Hence, the applications used nowadays (Gute, 2020), which enable an approach to the relevant principle of the general systems theory. Boulding also developed the concept of systems and gender, although he did it from economics and social sciences, unlike Bertalanffy, who did it from biology (Bertalanffy, 1968).

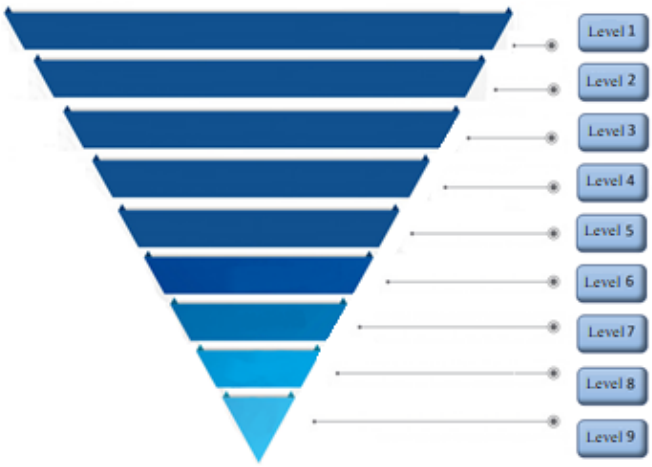
The author (Boulding, 1956) had already mentioned the need for a systems theory in his work General Systems Theory ─The Skeleton of Science. The challenge was to propose a way of having "generalized ears" by developing a general theory framework that allows specialists to understand relevant communications from areas different from theirs.

Certainly, this had happened before, new interdisciplinary studies such as cybernetics had appeared, which developed knowledge of engineering, neurophysiology, physics, and biology (Straussfogel & Schilling, 2009), thus growing the need to have expertise in each area but also enable generalization (Van Geert & Steenbeek, 2020). Another example was the theory of organization, where knowledge of economics (Hodgson, 1987; Javṇdi & Liu, 2019), sociology (Buckley, 1967), engineering (Carmichael, 2013), and physiology (Sherman, 2011) join, thus highlighting the need to seek the construction of general and relevant theoretical models.

Therefore, Boulding proposes the "system of systems" where he states that each system is composed of subsystems and considers that each one exists within an environment formed by others (Boulding, 1956). Figure 5 shows the classification of systems.

Figure 5

Classification of systems



Note. Where level 1 is framework, level 2 clockworks, level 3 thermostats, level 4 cells, level 5 plants, level 6 animals, level 7 human beings, level 8 social organization and level 9 transcendental systems. Source: (Javanmardi & Liu, 2020) and (Boulding, 1956) adapted by authors.

Boulding names his work "The Skeleton of Science" because it aims to show the theory of systems as a framework or structure that can be taken as a basis by other researchers to develop extensions of it.

Then, Bertalanffy's work appears and takes parts of Boulding's systems theory. He goes from specialized science theories to generalizing and basing the general systems theory on the structural similarities of different fields, the isomorphism of conceptual models, and the presence of general properties of the system in them.

Bertalanffy structures the system theory as a general science of "totality" (Caws, 2015), which would be a purely formal logical-mathematical discipline, but applicable to other sciences (Bertalanffy, 1986). This author defines it as "a set of elements in interaction" and considers closed and open systems (Amagoh, 2008).

The closed system definition states that the system does not exchange information with the external environment (Cummings, 2015). This is considered mechanical (Arnold &

Osorio, 1998) and its behavior is predictable because it contemplates perfectly known variables; hence, its operation is unchangeable and deterministic (Solís, 2012).

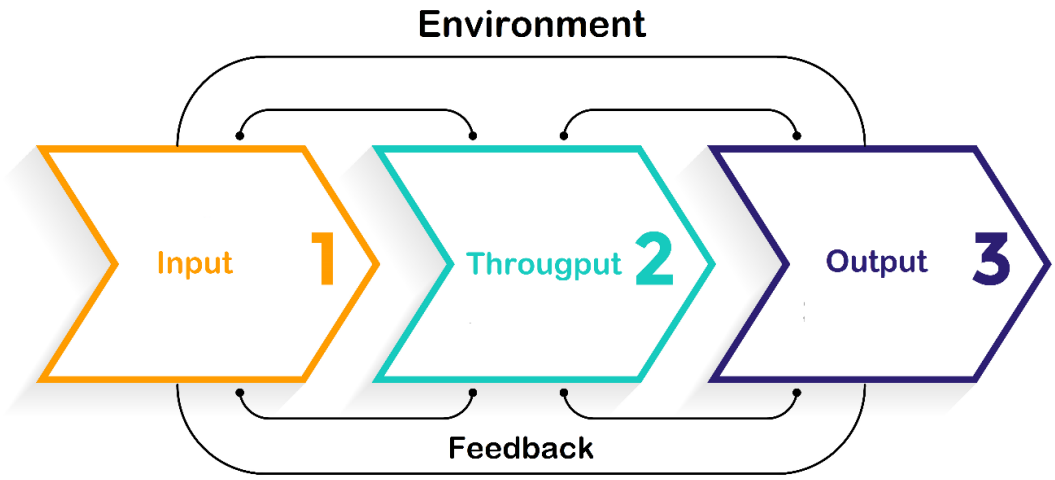
The closed system seeks certainty due to its nature; therefore, it excludes uncertainty and unpredictability (Arango-Otálvaro, 2020). It focuses on the internal parts of the system, and eliminates the effects of the environment because it rules out the cause-effect law (Bertalanffy, 1986); then, the solutions are framed in linear causal trains and make the system hermetic and monolithic.

The open system, on the other hand, is defined as one that exchanges matter with its environment (Velásquez, 2000); thus, there is import, export, construction, and breakdown of its material components (Aguilera Klink & Alcántara, 1994). In addition, it interacts with other systems within the environment, which can range from microsystems to supersystem ─ a more significant representation─ (Bertalanffy, 1986).

The open system receives inputs, processes them, and executes outputs (Velásquez, 2000); therefore, they are interrelated and the environment serves as a source of energy, materials, and information to the system.

Figure 6

Bertalanffy's System Regulatory Structure



Note. (Ramosaj & Berisha, 2014) adapted by the authors.

Open systems focused on organizations are exhaustively explained in the work of Katz & Kahn. They argue that organizations import energy from their environment,

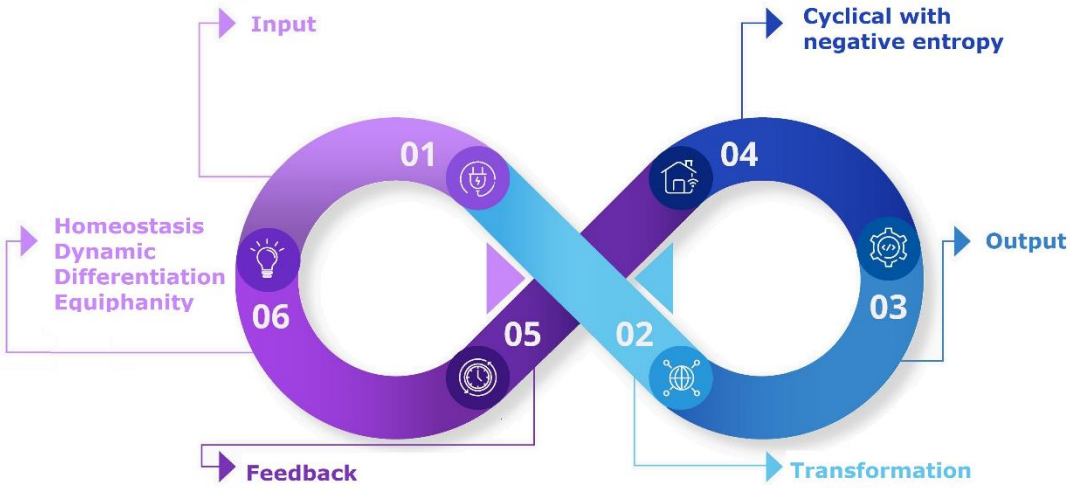
transform it, and then export the product back to the environment, this relationship reenergizes the system (Katz & Kahn, 1966).

From this perspective, it is important to consider that the system is subject to influences that cannot be controlled, therefore, uncertainty can be generated (Gallardo-Velázquez, 2002). These influences also evidence the interdependence between the system and the environment (Aguilera Klink & Alcántara, 1994).

The characteristics defined by Katz & Kahn are presented as an infinite cycle, since it is repeated iteratively and indefinitely until the survival of the system or environment is altered.

Figure 7

Characteristics of open systems



Note. (Rosenzweig et al., 1972) adapted by the authors.

After Katz & Kahn, Johansen (1982) delves into the concepts of subsystem, system, supersystem, and systemic characteristics, also into the importance of exchange or the relationship between systems. The author concludes that the relationship is not limited to just one group, but that there is ongoing contact with the outside world. Subsequently, he proposes a limit, understood as the line that separates the system from its supersystem and that defines what belongs to it and what is outside it (Bertoglio, 1993).

Perceiving the importance of the relationship between systems, the author noted the need to define the total system and the environment in which it is immersed, clearly specifying its objectives. He proposes a series of steps to understand the total system:

1. The objectives of the total system
2. The environment in which the system exists
3. The system resources
4. The system components
5. The system aims

These become relevant to establish the most important interactions with the system and to define how the exchange of time-sequence works (Bertoglio, 1993). It points out that each effect has a cause, thus defining the behavior modifications that may occur in the system as a result of the response of the environment.

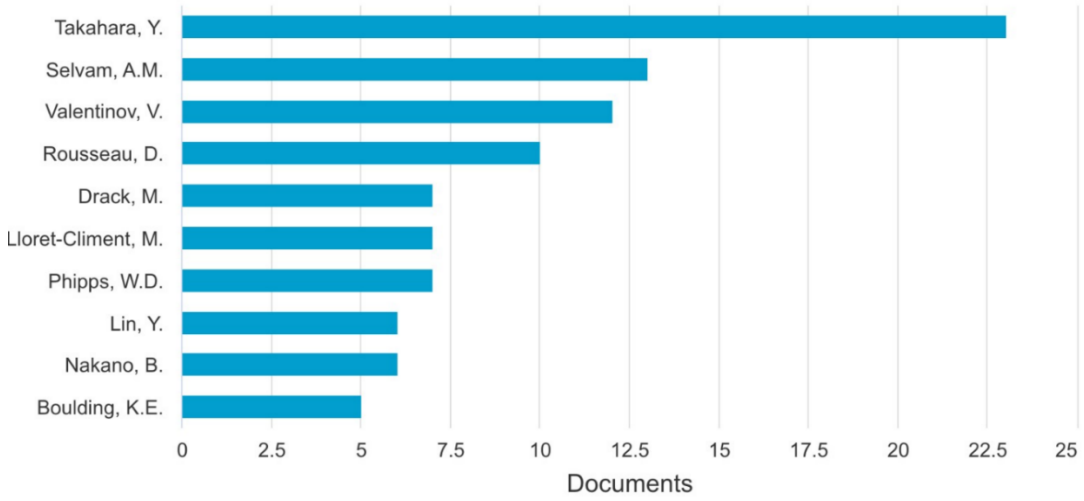
Once the concept of general systems theory and each of its elements ─the open system and the closed system─ is understood, it is possible to explain why management theories frame the concept of organization from both points of view, depending on the theory used to conduct the analysis.

Some management theories define organization as rational systems and start from the premise that they are closed and expect certainty and unpredictability, e.g., the management theory of Fayol (Parker & Ritson, 2005), the scientific management theory of Taylor (Taylor, 1919), or the bureaucratic theory of Weber (Lutzker, 1982).

On the other hand, contemporary theories support organizations as an open system that was established by man and maintains a dynamic interaction with its environment, influencing it and being influenced by it (Lorscheid et al., 2019), e.g., structuralism, behavioral theory, and systems theory. Figure 8 shows the authors who have published the most on this topic.

Figure 8

Authors with publications related to general systems theory



Note. By authors with Scopus samples.

Analysis scope

To analyze the validity of the theory, we determined the contrast of the information with different critical points on the subject, the usability of the theory at present, and the application in case studies found in databases.

Critical points or antithesis

Critics make observations of the elements developed in some theories, they evaluate and compare whether theories are well posed or are inconsistent with the information that is being developed. Below, some of the authors who have critiqued the general systems theory and their points of view are presented. Kast & Rosenzweig (1981) question the general systems theory arguing that it is not fully applied in organizations; they question how complete its development can be since knowledge about the subsystems relationship is limited. Therefore, they discuss the possibility of using general systems theory as a conceptual basis for the organization without first understanding the subsystems with contingency views to facilitate improved practice.

On the other hand, Coronado (2011) does a general critique of the hegemonic positions and reflects on the claims of the general systems theory to become a "science of the sciences". The author points out some restrictions of the theory and the reasons why it cannot

be acknowledged as a new science, scientific method, or epistemology; instead, it requires understanding to be able to selectively use its approaches. In this vein, Villamil (2004) also assesses the eagerness of the different branches of systemic thinking to explain a complex phenomenon that ultimately is based on Bertalanffy's purpose of finding a single measure for the sciences.

The general systems theory is also critiqued from the "generality", since the essential features of the system must be understood to acknowledge its transcendental value and coherent use thereof (De la Peña-Consuegra & Velázquez-Ávila, 2018). Therefore, when doing scientific research, it is important to understand system's objective reality in which all the essential features and characteristics of its elements, components, subsystems, relationships, and interactions with their nature and context are evidenced, as explained by these authors.

Theoretical development

The general systems theory has been used from the beginning, not only in management but in different sciences that allow its application (Peralta, 2016); publications that use this theory to carry out research are made to date (2020).

To determine the validity of the theory, we start from the moment it was implemented to the usability it has to date and the history around it. With the sources and documents obtained, a bibliometric analysis that allows obtaining sufficient statistical information in terms of the number of documents that use the general systems theory from its beginning to date is conducted.

As mentioned in the methodology, the review of scientific publications is performed using a bibliographic search with the technique *Citation Pearl Growing* (Schlosser et al., 2006) and the search equation "General systems theory" and "Management" and "Bertalanffy". Due to some limitations, it is reduced to "General systems theory".

To obtain the statistical information, we take the number of documents that appear in the ISI Web of Science, Science Direct, Emerald Journals, Jstore, Scopus, and Taylor and Francis Journal databases, using the general systems theory to conduct the research. For this, the different filters and search forms detailed in Table 1 are applied.

Table 1

Search for information

Database	No. of documents containing information of the theory	Search language	First year of publication	Last year of publication	Applied filter	Date of search
Web of Science	2.474	English	1991	2020	Title-Author-Key	23-nov-20
Science Direct	1.296	English	1973	2020	Title-Abs-Key	23-nov-20
Emerald Journals	537	English	1965	2020	Title-Abs-Key	24-nov-20
Taylor and Francis	1.088	English	1935	2020	Title-Author-Key	25-nov-20
Jstore	1.538	English	1928	2020	Title-Author-Key	26-nov-20
Scopus	1.235	English	1954	2020	Title-Abs-Key	24-nov-20

Note. Prepared by the authors.

With the information obtained above, a statistical analysis of the publications over time is made in order to verify the relevance and validity of the theory.

Statistical Analysis

A hypothesis test (Cobo et al., 2007) that will specify whether the approach on the validity of the system theory can be accepted or rejected is proposed (Badii et al., 2007). It was carried out using the data sample obtained from the bibliometric analysis.

Null hypothesis: The general systems theory has lost its validity in the management field.

Alternative hypothesis: The general systems theory is in force and applicable to management.

This hypothesis test will be evaluated with a significance level of 5% since a confidence level of 95% is established.

Equation 1. Alpha

Alpha $\alpha = 0{,}05 \quad \frac{\alpha}{2} = 0{,}025$

Sample: 8,168 documents

Equation source: Hernando & Botero, 2005.

Equation 2. Mean

Mean: 1,361

It is obtained from $\overline{X} = \frac{\sum N° \, of \, doc}{N° \, of \, databases}$

$\overline{X} = \frac{2474+1296+537+1088+1538+1235}{6}$

$\overline{X} = \frac{8,168}{6}$

$\overline{X} = 1,361$

Equation source: Rendón-Macías et al., 2016.

Equation 3. Deviation

Deviation: 584

It is obtained from $\sigma = \sqrt{\frac{\sum(X_i - X)^2}{n}}$

$$\sigma = \sqrt{\frac{(2474-1361)^2 + (1296-1361)^2 + (537-1361)^2 + (1088-1361)^2 + (1538-1361)^2 + (1235-1361)^2}{6}}$$

$\sigma = 584$

Equation source: Romero Villafranca & Zúnica Ramajo, 2013.

Equation 4. Z potential

$$Z = \frac{(0 - 1361)}{584}$$

Z: - 2.33255

Normal distribution standard: 0.00984

Equation source: Tejero-González et al., 2012.

Decision criteria:

2.33255 Z

0.990164142	Normal distribution standard
0.009835858	1 – CDF
0.019671715	P-value

Since p-value is less than α, there is no statistical significance, and the null hypothesis is rejected because statistical evidence allows to prove it false. Therefore, there is no statistically significant data to demonstrate that the general systems theory has lost validity. It is possible to conclude that it is in force and is used in management. However, rejecting the null hypothesis could be considered a type I error because it is true with a probability of 5%.

Discussion

The analysis shows that investigations have included the general systems theory for years, although it has been critiqued and has some limitations the scientific community keeps using it. This has also been demonstrated by the historical statistical significance that the documents have in the hypothesis testing.

The general systems theory can contain different statements, not only parallel, but from different points of view; there is a multiplicity of knowledge, information can even be distorted. However, if the pretension of truth survives and remains in different statements, it will continue in force because the foundation of the knowledge process in diverse ways will depend on the generation who uses it until the knowledge about the theory begins to be questioned. Foucault (1982) would think of it as the Mayan interpretation of the world: what exists is classified in a specific time, things can be read from different theoretical points of view, but those interpretations won't be endorsed by normal science just because they are socially accepted.

Truth is a pretension of the statements, not an attribute, because it is not progressive but verifiable. According to Foucault (1980), this theory could be postulated as the truth, potential truth, and permanent truth because empirical and theoretical knowledge are

simultaneously articulated with "disciplinary power", so as long as it is not proven wrong it remains a valid theory (N. & Popper, 1935).

Conclusions

The research begins with the systematic literature review which shows that general systems theory is a topic that has been studied worldwide and is relevant at a multidisciplinary level since it is studied in different areas of knowledge.

The systematic review of the literature carried out by means of a descriptive and explanatory analysis shows that the general theory of systems is widely used in scientific analysis even in recent years, since the statistical analysis of the publications showed that the general theory of systems is current and applicable to management. Despite the criticisms, some authors recognize that it contains useful and current concepts. Therefore, its contributions to different areas of knowledge are indisputable.

To support this information, we proceed to make a statistical analysis of the documents contrasting the hypothesis that the general theory of systems has lost its validity in the field of management, for this purpose we determined the mean, the standard deviation and the distribution criterion under the analysis of a normal distribution obtaining a P -_value that rejects the null hypothesis and leads to the conclusion that the general theory of systems is valid with applicability in the scientific world. The hegemonic thoughts have been tested so far and the world has accepted this theory based on its logical nature, development and scope, which will also depend on the epistemic matrix of the time in which it is applied.

Ethical considerations

The concept, design, analysis, and interpretation of data in this research, as well as the preparation, considers ethical aspects of correct use of sources and citation. Therefore, the authors Mariana Bravo Sepúlveda and César Ernesto Zapata Molina declare the conviction of doing a responsible work, product of good investigative practices, guaranteeing that the information contained in this document is the result of personal work in accordance with the intellectual property regulations. The article is unpublished and has not been sent simultaneously to other journals, the authors are responsible for the article presented.

Conflict of interest

The authors declare that they have no conflict of interest related to this publication.

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