- ORIGINAL ARTICLE -

Governance of Technologies and Information Systems for the Higher Education: Systematic Mapping of Study

Gobierno de Tecnologías y Sistemas de Información para la Educación Superior: Mapeo Sistemático de Estudios

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Abstract

The pandemic has led to more attention to how technologies and information systems (T&IS) are governed in higher education institutions (HEI). However, many of the aspects used to study them do not gather the expectations of those who benefit from these studies and the institutions are shocked as a result that major aspects of governance are not considered. This paper seeks to summarize the current knowledge that is available regarding the strategies adopted to know the state of governance of T&IS for the higher education between 2015 and 2022 years. To fulfill the objective, a systematic mapping of studies was carried out in order of identifying the state of the art and discovering the aspects that have been used by the researchers in the different studies. The results show that 30% of the works reviewed are broad and cover variables of operation, management, and government; they provide a renewed set of judgments, dimensions, and indicators to measure the level of institutional achievement, in addition, COBIT v5 is the most widely used reference framework to measure capacities in the governance of technology and information system for processes.

Keywords: governance of IT, higher education, state of governance of IT, systematic mapping of study, technologies and information systems.

Resumen

La pandemia ha llevado a que se preste más atención a cómo se rigen las tecnologías y los sistemas de información en las instituciones de educación superior IES. Sin embargo, muchos de los aspectos que se utilizan para estudiarlos no reúnen las expectativas de quienes se benefician de estos estudios y las instituciones se sorprenden porque no se consideran los principales aspectos de la gobernanza. Este artículo busca resumir el conocimiento actual que se tiene sobre las estrategias adoptadas para conocer el estado de la gobernanza de las TI para la educación superior entre los años 2015 y 2022. Para cumplir con el objetivo, se realizó un mapeo sistemático de estudios con el fin de identificar el estado del arte y descubrir los aspectos que han sido utilizados por los investigadores en los diferentes estudios. Los resultados muestran que el 30% de los trabajos revisados son amplios y abarcan variables de operación, gestión y gobierno; brindan un renovado conjunto de juicios, dimensiones e indicadores para medir el nivel de logro institucional, además COBIT v5 es el marco de referencia más utilizado para medir capacidades en gobernanza de tecnología y sistemas de información para procesos.

Palabras claves: educación superior, estado del gobierno de TI, gobernanza de TI, mapeo sistemático de estudios, tecnologías y sistemas de información.

1. Introduction

The governance of technologies and information systems (T&IS) in an organization approaches the structures, processes, and related mechanisms [1] that enable both business and technologies and information systems T&IS stakeholders to take responsibility in support of effective and efficient business / T&IS alignment, and the creation and sustainability of generated value. Therefore, the governance of T&IS is an important enabler in this alignment [2].

The challenge of governing T&IS in higher education institutions has led to paying more attention to T&IS with initiatives that approach current and future problems strongly related to governance within HEI [3]–[5]. Although there is literature on the state of T&IS in HEI [6]–[8], has not been possible to find

literature with aspects that approach the governance expectations of higher technical and technological institutions in a particular way. Much experience is scattered in different studies, perhaps because each HEI has its peculiarities from the normative point of view that affects any study. Particularities that drove by the expectations of researchers in some cases, and in others, by the needs of the higher education systems of each country. Therefore, there is a need for more systematic identification of the studies number and aspects that have been applied in the study of HEI.

A systematic mapping research proposal provides an effective procedure focused on determining the nature and scope of the research that is available to answer a generic question [9], related to a research trend. Furthermore, this type of study also helps to identify gaps in current research to suggest areas for further observation [10], [11], keeping the secondary research in question up-to-date.

This paper presents an updated systematic mapping to determine the studies that have been carried out and have made it possible to know the current state of T&IS in HEI within the framework of governance of T&IS; starting from the following research question: What are the T&IS studies, in the context of governance of T&IS, that researchers have carried out to assess the state of T&IS in HEI?

The paper is structured in the following sections. In section 2, the background and key concepts are presented. In section 3, the systematic mapping process is described. In section 4, the results are analyzed. In section 5, the results are discussed. In section 6, the conclusions and future suggested topic work are presented.

2. Theoretical – Conceptual Background

2.1. Governance of T&IS

Both the OECD [12] as well as the Cadbury [13] reports and the South African King IV [14] governance standard were defined to address bad corporate governance practices, including agency issues and fraud against stakeholders. These de facto standards together with the Australian standard AS8015 were the origins that gave birth to the discipline of Governance of T&IS. Thus, the main government activities are to direct and control the use that companies and organizations make of IT, ultimately, produce business value with technology [15], [16].

Unfortunately, IT has not yet been able to produce the expected value, although it is present in almost all processes, procedures, activities, and actions of people in companies. Another pitfall not entirely saved is that the terminology used in IT tends to be too technical and this isolates the asset from other more traditional organizations [17]. Perhaps for this reason, executive boards and committees have not included IT as part of corporate governance for many years. However, this would not prevent companies from having to ensure that their businesses and activities are not harmed using IT. Since IT is such an important asset for business development, executive boards and committees can no longer afford a negative reputational, financial, or regulatory impact. Additionally, the boards and executive committees hope to align the strategy with IT to increase their profitability as well as generate added value to the company’s products and services. Not all organizations have achieved these expectations and hence the raison d'être of good IT corporate governance [18], [19].

The relationship mechanism between T&IS and the business has evolved in each of the organizations, consequently, the awareness and understanding of the Governance of T&IS has been strengthened. Being the Governance of T&IS a term that has experienced many definitions from the study perspective. In this sense, from the point of view of behavior, a representative definition [20] is the one proposed by the ISO/IEC 38500 standard [21], which mentions: "The system by which the current and future use of T&IS". Another definition [16], supposes the management, evaluation and follow-up of the plans for the use of the T&IS that provide support to the organization through performance indicators. On the other hand, a vision based on processes is mentioned in the COBIT 2019 proposal [22], which says: "interest is the delivery of value derived from digital transformation and the mitigation of business risk resulting from said digital transformation". In this case, the management processes are assumed in the management of T&IS resources and risks, through the management of investment projects and their prioritization. These definitions have had a direct impact on the role of T&IS Governance because each proposal makes it possible to focus on various aspects of the actions of those responsible for T&IS; for example, leadership effectiveness based on an activity or a process.

However, defining the Governance of T&IS in a precise way is complicated because there is no consensus on the terms to be used or their interpretation because it is a subject treated from different disciplines: audit, strategic planning, systems management, security, risks, etc. A shortlist of definitions is presented in [23].

Governance of T&IS is a clear responsibility of a top-level CEO known as the Chief Information Officer (CIO) [24], helping to define the highest degree of leadership [25]. This means the visible head of a structure with responsibility functions; processes

that refer to T&IS monitoring and strategic decision-making, and relational mechanisms that include alliances and participation of the T&IS organization [1], with leadership [26].

In the same way, there are more definitions that involve the good governance of T&IS [27], responsibilities through decision-making on a wide range of T&IS resources [28], the focus on processes, structures and mechanisms of relationship with responsibilities defined for the alignment between the business / T&IS [29], managerial capacity for the strategies of T&IS [30], definition of organizational control structures adding value and balanced risk [31], effectiveness and efficiency in the use of T&IS [32], competencies of the organization that facilitate the exercise of the highest authority [33], structures for decision-making and defined administrative processes [34], among others aspects. Based on the definitions in the [23] above, the Governance of T&IS includes different topics by different experts, for example, locus of authority, business / T&IS alignment, T&IS support business strategy, T&IS peak performance and creator of business value, decision rights, risk control, prioritization and justification of T&IS investments, accounting, performance evaluation, etc. However, most Governance of T&IS literature references deal more with processes, structure and strategy than with good corporate governance from a behavioral standpoint. Another recurring theme in the literature is the three usual governance mechanisms: structures, alignment processes, and communication [1], [19]. Ultimately, organizations have clear motivations to fight for good Governance of T&IS [15], as this allows new structures, processes, and protection of the company's T&IS value [35] to emerge in which others can manage your activities effectively. Defining and disseminating the necessary working mechanisms to ensure that the business / T&IS alignment objectives are accomplished.

2.2. Systematic Mapping Necessity

We are aware of three related publications: the first is a previous literature systematic mapping of study around HEI Governance of T&IS in Malaysia [36], the second is a scientific literature systematic analysis work and unconventional [3] in general and the third publication is a systematic review of the literature on Governance of T&IS in HEI globally [37].

The first case aimed to review the existing Governance of T&IS research in Malaysian HEI. Seven research articles were reviewed, which showed that T&IS resource management has the highest amount of research carried out about other domains and that the research is led by the public sector. The evaluative research and the solution proposal are those that dominate the type of research carried out.

The second case is based on the Systematic Literature Review (SLR) method whose objective was to demonstrate the existence of research in the field of Governance of T&IS in universities in general. 386 publications were reviewed, which evidenced various challenges in T&IS Government research in general, and the progressive interest in specific jobs in universities.

The third case is presented as an SLR on the governance of T&IS in HEI through a collection of scientific and unconventional data (grey literature) from the T&IS Government in other countries that allow defining an adequate framework for the higher education system in Tunisia. The results show reality from two perspectives; on the one hand, they show the support of senior management to introduce the Governance of T&IS in HEI through the adoption of regulatory frameworks and common laws; and on the other, the solid culture of Governance of T&IS in other countries. Ultimately, the results demonstrate that there is no single way to implement a Governance of the T&IS framework designed for HEI. However, two mandatory aspects are required to implement the Governance of T&IS: the T&IS Assets and Communication Committee (IT, Business, and Stakeholders).

These works demonstrate that there is a need for a more systematic identification of which studies of the state of T&IS in HEI have been successfully applied in the Governance of T&IS. This work aims to improve and expand the information through the systematic mapping study, defining a search chain that allows retrieving more articles, and applying new data extraction criteria to present useful information both to professionals and researchers.

Systematic mapping is one of the most widely used techniques in Evidence-Based Software Engineering (EBSE), providing a systematic and objective method to determine and classify all relevant research published so far around a generic research question and series of consistent steps [10], [11], [38]. However, it must be considered that the quality of the studies identified is their “Achilles heel”.

3. Methods

The detailed systematic mapping process of studies considers the guidelines provided in the works of Petersen et al. [38] and Kitchenham et al. [11]; works synthesized by Genero Bocco et al. [9]. In this sense, the process was carried out in three phases: planning, preparation, and presentation of the final report.

3.1. Planning Stage

In this stage, the following activities were carried out

to establish the review protocol: 1) Definition of the research question, 2) Definition of the search strategy, 3) Selection of primary studies, 4) Evaluation of the quality of the studies, 5) Definition of the data extraction strategy; and 6) Selection the synthesis method.

3.1.1. Investigation Questions Definition

The goal of this study is to determine the works that have made it possible to know the state of T&IS in HEI within the framework of Governance of T&IS, starting from the following research question: What are T&IS studies, in the context of Governance of T&IS, that researchers have carried out to assess the state of T&IS in HEI? This will allow us to classify and synthesize the current knowledge of the variables, criteria, dimensions, and indicators to suggest and structure a research proposal to be applied. Since the research question is too broad, it has been broken down into more specific sub-questions to be able to address the research topic (See Table 1).

3.1.2. Search Strategy Definition

a) Sources selection

Among the main existing information sources, the Scopus, Web of Science (WoS), DOAJ, OpenAlex, and Scholar Google databases were selected. This is because they are databases that rigorously index a wide range of scientific literature and a reliable and friendly search engine with results export facilities.

In addition, manual searches were carried out through reference research carried out in the higher education system of Spain, Mexico, and Ecuador; in which studies of this type would have been published in previous years.

b) Search chain

To carry out the automatic search in the selected sources, a search chain composed of three parts was defined to cover the concepts that represent the domain of the state of Governance of T&IS in the HEI. The first is related to the studies that have been developed in the field of HEI; the second is related to the studies that are related to the topic of Governance of T&IS, and the third is related to the studies that show the state of art. Table 2 shows the search string with the following definitions:

1) Concepts definition and, alternative & synonymous words.
2) Use of the Boolean symbol OR, to join alternative & synonymous words.
3) Use of the Boolean AND symbol, to unite the three main concepts.

Table 1. Research sub-questions.

Research sub-questions	***Motivation***
MQ1. ¿What is the underlying definition of Governance of T&IS used in the study?	To discover the homogeneity in the definitions of the concept of Governance of T&IS on which the studies are based.
MQ2. ¿What research methods most study?	To discover whether the proposals in this field of research are more practical or more basic research.
MQ3. ¿Which Governance of T&IS variables most applies?	To discover the parts in which the study has been divided most frequently to know the state of T&IS in HEI.
MQ4. ¿Criteria underlying each Governance of T&IS variable used in the study?	To discover the frequent essential components that collect the characteristics that guarantee the results of the T&IS studies carried out in the HEI.
MQ5. ¿Dimensions or indicators underlying each Governance of T&IS criteria used in the T&IS study?	To discover the aspects and quantitative manifestations used that allows measuring the achievement of each one of the evaluated criteria.
MQ6. ¿Lines of action provided in each T&IS study?	To discover whether the studies address actions to the HEI to overcome Governance of T&IS problems or whether they are only limited to listing the findings or recommendations.

Table 2. Search chain applied.

Concepts	*Alternative words & synonyms*
Higher education institution	(“Educación Superior” OR “Higher Education” OR “Instituto” OR “Institute” OR “Institutos” OR “Institutes” OR “Universidad” OR “University” OR “Universidades” OR “Universities”) AND
IT Government	(“Gobierno de las TI” OR “IT Government” OR “Gobernanza de las TI” OR “Governance of IT” OR “Gobierno de las Tecnologías de la Información” OR “Information Technology Government” OR “Gobernanza de Tecnologías de la Información” OR “Information Technology Governance”) AND
Assessment - Evaluation	(“Estado Actual” OR “Actual State” OR “Estado” OR “State” OR “Evaluation”)

Table 3. Search chain definition.

Database	*Search chain*
SCOPUS	(TITLE-ABS-KEY ("Educación Superior" OR "Higher Education" OR instituto OR institute OR institutos OR institutes OR universidad OR university OR universidades OR universities) AND TITLE-ABS-KEY ("Gobierno de las TI" OR "IT Government" OR "IT Governance" OR "Gobernanza de las TI" OR "Governance of IT" OR "Gobierno de las Tecnologías de la Información" OR "Information Technology Government" OR "Gobernanza de Tecnologías de la Información" OR "Information Technology Governance") AND TITLE-ABS-KEY ("Estado Actual" OR "Actual State" OR estado OR state OR evaluation)) AND PUBYEAR > 2014 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA , "ENGI") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "BUSI")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (EXACTKEYWORD , "IT Governance") OR LIMIT-TO (EXACTKEYWORD , "Information Technology") OR LIMIT-TO (EXACTKEYWORD , "Information Technology Governance") OR LIMIT-TO (EXACTKEYWORD , "COBIT") OR LIMIT-TO (EXACTKEYWORD , "Information Systems") OR LIMIT-TO (EXACTKEYWORD , "Corporate Governance Of It") OR LIMIT-TO (EXACTKEYWORD , "ISO/IEC 38500") OR LIMIT-TO (EXACTKEYWORD , "IT Governance Mechanisms") OR LIMIT-TO (EXACTKEYWORD , "Information Systems And Technologies")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish"))
WOS	(AB=(("Educación Superior" OR "Higher Education" OR "Instituto" OR "Institute" OR "Institutos" OR "Institutes" OR "Universidad" OR "University" OR "Universidades" OR "Universities") AND ("Gobierno de las TI" OR "IT Government" OR “IT Governance” OR "Gobernanza de las TI" OR "Governance of IT" OR "Gobierno de las Tecnologías de la Información" OR "Information Technology Government" OR "Gobernanza de Tecnologías de la Información" OR "Information Technology Governance") AND ("Estado Actual" OR "Actual State" OR "Estado" OR "State" OR "Evaluation"))) AND IDIOMA: (English OR Spanish) Índices=SCI-EXPANDED, SSCI, A&HCI, ESCI Período de las TIempo=2015-2022
DOAJ	"Educación Superior" OR "Higher Education" OR instituto OR institute OR institutos OR institutes OR universidad OR university OR universidades OR universities AND "Gobierno de las TI" OR "IT Government" OR "IT Governance" OR "Gobernanza de las TI" OR "Governance of IT" OR "Gobierno de las Tecnologías de la Información" OR "Information Technology Government" OR "Gobernanza de Tecnologías de la Información" OR "Information Technology Governance" AND "Estado Actual" OR "Actual State" OR estado OR state OR evaluation AND PUBYEAR > 2014 AND PUBYEAR < 2023
SCHOLAR GOOGLE	("Educación Superior" OR "Higher Education" OR instituto OR institute OR institutos OR institutes OR universidad OR university OR universidades OR universities) AND ("Gobierno de las TI" OR "IT Government" OR "IT Governance" OR "Gobernanza de las TI" OR "Governance of IT" OR "Gobierno de las Tecnologías de la Información" OR "Information Technology Government" OR "Gobernanza de Tecnologías de la Información" OR "Information Technology Governance") AND ("Estado Actual" OR "Actual State" OR estado OR state OR evaluation) AND PUBYEAR > 2014 AND PUBYEAR < 2023 AND IDIOMA: (English OR Spanish)
OpenAlex	https://api.openalex.org/works?page=1&filter=default.search:%22Educaci%C3%B3n+Superior%22+OR+%22Higher+Education%22+OR+instituto+OR+institute+OR+institutos+OR+institutes+OR+universidad+OR+university+OR+universidades+OR+universities+AND+%22Gobierno+de+las+TI%22+OR+%22IT+Government%22+OR+%22IT+Governance%22+OR+%22Gobernanza+de+las+TI%22+OR+%22Governance+of+IT%22+OR+%22Gobierno+de+las+Tecnolog%C3%ADas+de+la+Informaci%C3%B3n%22+OR+%22Information+Technology+Government%22+OR+%22Gobernanza+de+Tecnolog%C3%ADas+de+la+Informaci%C3%B3n%22+OR+%22Information+Technology+Governance%22+AND+%22Estado+Actual%22+OR+%22Actual+State%22+OR+estado+OR+state+OR+evaluation,type:article|book-chapter,language:en|es,publication_year:2015-2022,concepts.id:C41008148|C121017731|C29848774|C2776664667|C67363961|C201359696|C189922023&sort=relevance_score:desc&per_page=10

Considering the alternative & synonyms words in Table 2, they were combined with the logical operators “OR” and “AND”. The resulting search strings are defined in Table 3.

The period reviewed includes final papers published in English or Spanish, in Computer Science between the years 2015 and 2022; since at the beginning of this period, the current version of the Governance of T&IS standard was released [21].

3.1.3. Primary Studies Selection

a) Inclusion Criteria

Inclusion criteria were defined to analyze only those studies that are considered useful for mapping. Thus, the coded inclusion criteria were:

1) I1: Studies that present the definition of Governance of T&IS applied to the domain of HEI.
2) I2: Studies that report the current state of technologies in the domain of HEI using current T&IS management and governance practices.
3) I3: Studies published in several databases, only one was considered.
4) I4: Works published in the period 2015 - 2022.

b) Exclusion Criteria

Form exclusion standards were defined to analyze only those studies that are considered useful for systematic mapping. Thus, the coded exclusion criteria were:

1) E1: Studies that are not focused on the domain of HEI.
2) E2: Studies that only present recommendations, guidelines, or principles for the design of Governance of T&IS for universities.
3) E3: Publications that only present implementations of an Governance of T&IS framework in an HEI.
4) E4: Publications that only list dimensions, descriptors, or evaluation indicators.
5) E5: Publications that only list variables or evaluation criteria of HEI.
6) E6: Duplicate reports about the same study in different databases.
7) E7: Introductory publications for special editions, books, or workshops.
8) E8: Publications not written in English or Spanish.

3.1.4. Evaluation of the Studies Quality

A team of experts worked on evaluating the quality of the studies to be selected. Their criteria were based on three closed questions:

1) The work presents a detailed description of the evaluation applied in HEI.
2) The work presents orientations or understandable guidelines on how the evaluation process can be applied.
3) The work presents the support of research centres, universities or governing bodies of education.

The criteria used were not to exclude studies or research papers but to have representative information for discussing each research sub-question. In this sense, the answers to the closed questions were: "I agree", "Partially agree", and "I do not agree".

3.1.5. Data Extraction Strategy Definition

The data extraction strategy that was applied was based on the criterion of relating a set of possible answers created by the research team with each research sub-question. The set of possible answers is described below.

a) Regarding sub-question MQ1: ¿What is the underlying definition of Governance of T&IS used at the study?:

1) Standard: the definition is based on a standard or standard type ISO / IEC 38500
2) Temporary: the definition is based on a definition of other authors
3) Framework: the definition is based on a reference framework such as COBIT, dFogIT, Canvas, and Calder Moir, among others
4) Hybrid: the definition is based on a combined definition between a standard and that of other authors

b) Regarding the sub-question MQ2: ¿What researcher methods most study?:

1) Empirical: the method is based on an experiment, a case study, or a survey
2) Non-empirical: the method is based on speculation, an example, or a literature review
3) Hybrid: the method is based on the empirical and non-empirical process

c) Regarding sub-question MQ3. ¿Which Governance of T&IS variables most applies?:

1) Operation: the variable is based on the hardware and software infrastructure
2) Management: the variable is based on the planning, execution, and control of activities
3) Government: the variable is based on the related organizational structures, processes, and mechanisms
4) Hybrid: the variable is based on the best of T&IS operation, T&IS management and Governance of T&IS
5) No definition: there is no definition in this regard.

d) Regarding sub-question MQ4: ¿Criteria underlying each Governance of T&IS variable used at the study?:

1) Yes: the study provides evaluation criteria to HEI on which it is possible to understand and correct the Governance of T&IS problems that have been identified. What are these criteria?
2) No: the study does not provide evaluation criteria to HEI on which the Governance of T&IS problems that have been identified can be understood and corrected

e) Regarding sub-question MQ5: ¿Dimensions or indicators underlying each Governance of T&IS criterion used at the T&IS study?:

1) Yes: the study provides dimensions or indicators associated with criteria that measure the achievement achieved by each criterion. How many dimensions and/or indicators?
2) No: the study does not provide dimensions or indicators associated with criteria that measure the achievement achieved by each criterion

f) Regarding sub-question MQ6. ¿Lines of action provided in each T&IS study?:

1. Yes: the study provides lines of action for HEI on how to solve their identified problems
2. No. The study provides no lines of action and is only responsible for listing the findings

3.1.6. Synthesis Method Selection

Both quantitative and qualitative synthesis method was applied. The quantitative synthesis was based on the following:

1) Counting of primary studies and classification according to each research sub-question.
2) Presentation of results in tables to report the frequencies of the results of different research sub-questions.
3) Count of works found by year of publication.
4) The qualitative synthesis is based on the following standards:
5) Include representative studies considering the research references and the results of the quality assessment.
6) Describe the benefits and limitations of the methods used in the studies classified in each research sub-question.

3.2. Implementation Stage

The implementation stage considered data retrieval, study selection, data extraction and data synthesis. This section explains the execution of these activities, performed according to the protocol defined above, the preliminary results of which are shown in Table 4.

Table 4. Search results.

Source	*Potential studies*	*Selected studies*
WoS	8	2
Scopus	26	6
DOAJ	5	1
Scholar Google	24	0
OpenAlex	153	0
Others	3	3
TOTAL	219	12

We found 219 works. After the application of the inclusion and exclusion criteria, a total of 12 works remained, which apply to the research topic. However, some problems were found at this stage:

- Some studies have been published in more than one journal and/or conference. In this case, the most complete version was selected.
- Some studies appeared in more than one source. In this case, it was considered only once according to the search order applied: WoS, Scopus, DOAJ, OpenAlex, Scholar Google and others.

4. Results

The results stage represents the final step of the study. This section presents the results of the systematic mapping of the study based on 12 papers that were finally selected. The content structure of the results is based on the research questions that were formulated in paragraph 1) of the planning stage. The data extracted from each of the papers were analyzed both quantitatively and qualitatively to accurately answer the research questions.

4.1. Empirical Studies Counting

It is important to explain some details about how the empirical studies were accounted for. The collected works were classified according to the answers to the research questions.

4.2. Research Questions Answers

First, we found four of the 12 works that are related to T&IS management and governance in HEI, and the remaining eight are related to the Governance of T&IS in certain HEI. Answers to the research sub-questions are provided below.

4.2.1. MQ1: ¿What is the underlying definition of Governance of T&IS used at the study?

The results of question MQ1 (See Table 5) show that 45% of the Authors are based on the definition of the ISO/IEC 38500 standard, being the most widespread in the selected studies. 18% make temporary use of the proposals of other authors. Another 27% use frames of reference, and the remaining 10% make use of a mixed proposal.

Bianchi and Sousa [39] guide their study by the definitions of authors Bajgoric [40], De Haes and Van Grembergen [41] and Hicks et al. [42] to demonstrate how to control and direct T&IS resources in any type of organization, including universities.

De Jesús Muriel et al. [43], on the other hand, are guided by the definition of the authors Weill and Ross [16] in a framework of archetypes of governance and dominance, operating model, committee model and portfolio of T&IS projects in a Higher Education organization.

Seyal et al. [44] propose the use of the definitions of Control Objectives for Information and Related Technologies (COBIT) because it is appropriate for the educational context [45], [46], also because it measures decisions about T&IS resources and because it aligns with institutional planning.

El-Morshedy et al. [47] propose the use of the definition of COBIT v5 based on [48] because it is considered the most appropriate in the higher education environment. The basic reasoning is that higher education is important to the success of any nation currently. Today, it is impossible to imagine a university without a strong T&IS capacity to manage information for decision-making.

Pillo-Guanoluisa et al. [49], representing the remaining 10% of the studies, guide their work on the definitions cited by Céspedes Lorente in [50] and the COBIT framework version 5 [51]. The basic reason is the strategic alignment of T&IS with the business to achieve the maximum benefit expressed in value. In addition, COBIT v5 has been the frame of reference that has expanded the most so far [52].

Menekşe & Camgöz Akdağ [60] propose the use of the COBIT 5 definition [51] by expert consensus and the guidelines by Khouja et al. [37].

Scalabrin Bianchi et al. [61] guide their study by the definition of De Haes and Van Grembergen [41].

As mentioned above, the most widespread definition in the studies of Governance of T&IS in the context of Higher Education is that proposed by the ISO/IEC 38500 standard, which we consider consistent with the documentary hierarchical order that regulates the Governance of T&IS.

Table 5. Underlying definition.

Concept	*Studies*	*Percentage*	*Authors*
Standard	5	42%	[6], [7], [37], [53], [54]
Temporary	3	25%	[39], [43], [61]
Framework	3	25%	[44], [47], [60]
Hybrid	1	8%	[49]

4.2.2. MQ2: ¿What researcher methods most study?

The MQ2 question results (See Table 6) show that 83% of the research articles have used the empirical research method, being the most widespread method in the selected studies, and the remaining 17% make use of the non-empirical method. Understanding the empirical as the use of surveys, questionnaires, interviews, or case studies. For example, representative cases of this method were found in Gómez [6], Ponce [7], Cadena Vela et al. [54], Scalabrin Bianchi et al. [61], and Menekşe & Camgöz Akdağ [60].

Gómez [6] proposes the use of a survey assisted by a web computer application named kubernao of Information Technologies (kIT) for the collection of data through a structured form in which 74 universities participated, between public and private, with a response rate of 66.22% (49 universities), a sampling error of ±8.2% and a confidence level of

95%.

Ponce [7] presents a descriptive study, through an online survey allowed to obtain information on the problem and the study subjects of 195 HEI, with a response rate of 70.26% (137 HEI), with a base sample of 129 HEI, a confidence level of 95% and a margin of error of 5%. The results are in general use and significant for the population.

Cadena Vela et al. [54] present a descriptive study, which through the application of an online survey aimed at the 25 participating universities allowed to obtain and analyze data effectively. The number of participating universities allowed results with a confidence level of 90% and a sampling error of 13%. The authors consider the results to have integrity.

Scalabrin Bianchi et al. [61] present the case study method applied semi-structured interviews were conducted in ten universities across five different countries: Brazil, Portugal, the Netherlands, Spain, and Israel. The result proposed the most suitable and essential practices for universities that may be useful for all types of university, regardless of size and others contingency factors.

Pillo-Guanoluisa et al. [49] present a case study where the COBIT v5 reference framework is used through which the capacity of each process of governance and management of the T&IS of the university of study is evaluated. The results are overwhelming in the absence of implementation of a Governance of the T&IS model.

Rijati et al. [55] present a case study by designing a university computer governance model as a basic quality assurance system to implement the tridharma component in an Indonesian university. The results are considered by the authors as not applicable in other countries.

De Jesús Muriel Perea et al. [43] propose 3 case studies through consultations with experts from the HEI study that identify the governance profile of IT, the design of a performance matrix and the location of HEI. The results demonstrate the lack of capitalization of good Governance of T&IS practices which impacts academic and administrative performance.

Seyal et al. [44] present research in 4 HEI of Bruneia Darussalam with a qualitative approach to the Tipo case study based on what Benbasat et al. [56] stated [56] and following the design of multiple (comparative) cases of Yin [57]. Basic reasoning points out that case studies address the question "how", in the exploratory stage of knowledge construction. The results considered by the authors show that not all five COBIT v5 domains are fully applicable in these institutions.

El-Morshedy et al. [47] present a case study [57] evaluating the Governance of T&IS in an Egyptian HEI. Interviews were applied to the administration and appropriate members of the HEI. The results were evaluated using the COBIT framework, which demonstrates the very low capacity of T&IS processes on average.

Menekşe & Camgöz Akdağ [60] present the spherical fuzzy AHP ELECTRE method to evaluate the T&IS governance levels of academic units based on COBIT 5. For this, five dimensions of the COBIT 5 framework are evaluated by three decision makers with AHP methodology and four academic units are classified with ELECTRE methodology. The applicability of the model is illustrated through a numerical example in a higher education institution.

The resulting 17% of the works [37], [39] considered as non-empirical present the state of the art of the HEI through Systematic Literature Review (SLR) and Literature Review based on the proposals of [58] and [59], respectively. On the one hand, HEI is analyzed comprehensively at a global level, and on the other, the Governance of T&IS mechanisms (structures, processes, and related mechanisms) that institutions have implemented. The results conclude similarly on two points: 1) governance committees need to be established for T&IS assets, and 2) effective communication between T&IS, the business, and stakeholders.

In short, 58% of the selected studies present case studies as a research method, 25% as a survey (descriptive research) and 17% as a literary review.

Table 6. Research method.

Method	*Studies*	*Percentage*	*Authors*
Empiric	10	83%	[6], [7], [43], [44], [47], [49], [53], [54], [60], [61]
Not empiric	2	17%	[37], [39]
Hybrid	0	0%	

4.2.3. MQ3: ¿Which Governance of T&IS variables most applies?

The results of the MQ3 question show that 58% of the articles reviewed present the mixed variable as a combination of Governance of T&IS variables, being the most widespread in the selected studies, 34% make use of the governance variable and the remaining 8% do not define a variable (See Table 7). For example, we can mention representative studies that have divided the HEI to proceed with the evaluation, these are Gómez [6], Ponce [7], Cadena Vela et al. [54], Scalabrin Bianchi et al. [61], Bianchi and Sousa [39] and Menekşe & Camgöz Akdağ [60].

Gómez [6] presents a broad catalogue of indicators grouped into two layers: the T&IS description layer and the T&IS management layer. The first consists of a set of 5 criteria and the second

is composed of a set of good practices from 6 points of view. The criteria together cover the variables of T&IS operation, T&IS management, and Governance of T&IS.

Ponce [7] presents an extensive study of HEI in Mexico named "Current State of Information and Communication Technologies: Study 2019" focused on the main indicators of Information and Communication Technologies grouped into two large groups: T&IS management and Governance of T&IS, which cover the variables of Governance of T&IS.

Cadena Vela et al. [54] propose a study of HEI in Ecuador on the state of T&IS in Ecuadorian universities based on a set of indicators that are structured in seven sections, which cover the variables of operation, management, and Governance of T&IS.

Scalabrin Bianchi et al. [61], and Bianchi and Sousa [39] propose a literature review of mechanisms of the Governance of T&IS variable implemented in HEI based on the understanding of practices for related structures, processes, and mechanisms.

Menekşe & Camgöz Akdağ [60] propose the spherical fuzzy AHP ELECTRE model applied to the T&IS governance evaluation problem for a higher education institution. The T&IS governance maturity levels of four academic units are evaluated by three experts against five criteria and all-inclusive COBIT 5 framework.

If significant studies are observed, it will be observed that the most relevant variables are it operation, management and governance. These variables present slight modifications of application between studies to highlight the fact that they are specific to a country. For example, good practices and maturity of Governance of T&IS occupy an important place, non-existent in other significant studies, but an essential topic in the HEI. The studies evaluate the variables from the perspective of how they are managed to obtain the desired effects. T&IS management is a common activity in significant studies and the results depend on it. Finally, the content of the variables, on the contrary, is very differentiated because it depends on the complexity of the local HEI, which makes the studies very particular.

Table 7. Governance of T&IS variables.

Variable	*Studies*	*Percentage*	*Authors*
Operation	0	0%	
Management	0	0%	
Goverment	4	34%	[39], [43], [53], [61]
Hybrid	7	58%	[6], [7], [44], [47], [49], [54], [60]
No definition	1	8%	[37]

4.2.4. MQ4: ¿Criteria underlying each Governance of T&IS variable used at the study?

The results of the MQ4 question show that 92% of the papers reviewed present Governance of T&IS criteria, and 8% do not define criteria that are grouped around the defined variables (See Table 8). For example, we can mention representative studies that define essential components of the evaluation, these are Gómez [6], Ponce [7], Cadena Vela et al. [54], Scalabrin Bianchi et al. [61], Bianchi and Sousa [39] and Menekşe & Camgöz Akdağ [60].

Gómez [6] presents a set of indicators grouped into 11 criteria: 5 in the T&IS description layer and 6 in the T&IS management layer. As criteria for describing IT, they defined teaching-learning, research, management processes, information management and T&IS training and culture; and, as T&IS management criteria, T&IS resources, T&IS projects, T&IS services, T&IS direction, quality, T&IS regulations and standards, and collaboration were defined.

Ponce [7] presents a set of indicators grouped into criteria. In the case of T&IS management, there are criteria such as administrative information systems, services to academia and research, T&IS infrastructure, T&IS organization, project portfolio, T&IS services, information security, T&IS quality, electronic administration, new technologies and free software. And, in the case of Governance of T&IS, there are criteria related to the maturity of good practices for Governance of T&IS and maturity in the use of IT.

Cadena Vela et al. [54] present a set of indicators that are structured and grouped into seven criteria: general data, T&IS organization, general T&IS services, T&IS services for teaching and research, information systems, T&IS infrastructure, and T&IS security. Each criterion has several indicators that try to describe its most significant aspects.

Scalabrin Bianchi et al. [61], and Bianchi and Sousa [39] present a set of criteria related to the maturity of good practices for the Governance of T&IS. These criteria are related to structures, processes, and mechanisms.

Pillo-Guanoluisa et al. [49], Rijati et al. [55] and El-Morshedy et al. [47] present a set of criteria related to the maturity of 37 T&IS management and governance processes.

De Jesús Muriel Perea et al. [43] propose 4 criteria related to the Governance of T&IS [19]: governance domains and archetypes, operational model, engagement model and T&IS portfolio.

Seyal et al. [44] present a set of five domains

including T&IS strategic alignment, service delivery, risk management, resource management, and performance management. All domains related to the existence and maturity of Governance of T&IS processes.

Khouja et al. [37] do not define Governance of T&IS criteria in HEI because the work focuses on the state of the art based on the guidelines of an SLR. The research questions are generic and do not focus on knowing the evaluation of the Governance of T&IS in HEI.

Menekşe & Camgöz Akdağ [60] define five criteria of the COBIT 5 framework: C1: assess, direct and monitor; C2: align, plan, and organize; C3: build, acquire and implement; C4: provide service and support, and C5: monitor, evaluate and value.

Table 8. Governance of T&IS indicators.

Decision	*Studies*	*Percentage*	*Authors*
Yes	11	92%	[6], [7], [39], [43], [44], [47], [49], [53], [54], [60], [61]
No	1	8%	[37]

The results of this sub-question show that descriptive studies (30%) and process maturity studies (30%) were the types of work that covered the criteria with the greatest extent of use for evaluation purposes. However, it would seem necessary to conduct more Governance of T&IS assessment studies in HEI per country.

4.2.5. MQ5: ¿Dimensions or indicators underlying each Governance of T&IS criterion used at the T&IS study?

The MQ5 question results show that 83% of the articles reviewed have dimensions and/or indicators that group the Governance of T&IS criteria, and 17% do not present (See Table 9). Each study sets a set of dimensions that can be expanded, reduced, or modified according to the characteristics of the study and those who lead them. The most representative studies were found in Gómez [6], Ponce [7] and Cadena Vela et al. [54]; and the least representative were found in Scalabrin Bianchi et al. [61], De Jesús Muriel Perea et al. [43], Pillo-Guanoluisa et al. [49], Rijati et al. [55], El-Morshedy et al. [47], Seyal et al. [44] and Menekşe & Camgöz Akdağ [60].

Gómez [6] presents 214 indicators grouped into fourteen strategic objectives for each defined criterion that serve to demonstrate the extent to which these objectives are achieved and to be able to act accordingly in the future.

Ponce [7] presents 134 indicators, 105 good practices and the level of compliance with six principles defined by the ISO/IEC 38500 standard.

Cadena Vela et al. [54] present 104 direct and 14 indirect indicators. The latter represent indicators provided by a third party to HEI in Ecuador and serve to monitor resources and services delivered.

Scalabrin Bianchi et al. [61] present a set of 28 practice dimensions related to structures, processes, and mechanisms.

De Jesús Muriel Perea et al. [43] propose 39 indicators that are grouped into the four defined criteria.

Rijati et al. [55], El-Morshedy et al. [47] and Pillo-Guanoluisa et al. [49] present a set of 6 maturity levels that allow evaluating the capacity of 37 T&IS management and governance processes of HEI grouped into five domains. In the case of Seyal et al. [44] only 15 T&IS management and governance processes were evaluated due to the circumstances that the HEI were going through.

Menekşe & Camgöz Akdağ [60] does not define a set of dimensions and/or indicators, however, the authors assume that the model could evaluate T&IS management and governance processes because it has the application of COBIT 5.

The results of this research sub-question indicate that the most representative studies have been designed to support strategic objectives and be able to act accordingly in the future. In this sense, the need to maintain a renewed inventory of dimensions or indicators is evident according to the total practice in the HEI and when they are considered saturated. All studies, when formulating indicators, must consider current aspects and implicitly maintain those of a general order because they represent the level of assurance of the Governance of the T&IS system.

Table 9. Underlying dimensions or indicators.

Decision	*Studies*	*Percentage*	*Authors*
Yes	10	83%	[6], [7], [43], [44], [47], [49], [53], [54], [60], [61]
No	2	17%	[37], [39]

4.2.6. MQ6: ¿Action lines provided in each T&IS study?

The MQ6 question results show that 33% of the articles reviewed present lines of action and 67% do not consider presenting this section (See Table 10). This means that each study sets out a set of lines of action as strategic reflections, key issues and T&IS expectations aimed at improving the Governance of the T&IS landscape of HEI. Representative studies were found in Gómez [6], Ponce [7], Cadena Vela et al. [54] and Pillo-Guanoluisa et al. [49].

Gómez [6] presents a chapter called "Beyond data" where he exposes important and urgent issues such as T&IS strategy of present and future, innovation, and audit of T&IS in the framework of Governance of T&IS, standardization and information security in the context of digital transformation in HEI in Spain. Ponce [7] presents chapters that expose an important value to higher education in Mexico such as Lines of action of ICT Managers for digital transformation in HEI; Lines of action in cybersecurity in HEI and implementations for digital transformation in education through emerging technologies in HEI. Cadena Vela et al. [54] presents a set of key aspects derived from each of the seven sections of the final report. Pillo-Guanoluisa et al. [49] propose an action plan to reduce the existing Governance of the T&IS gap in the HEI studied. The Plan considers 7 strategies, 24 actions and 19 deliverables.

Table 10. Action lines.

Decision	*Studies*	*Percentage*	*Authors*
Yes	4	33%	[6], [7], [49], [54]
No	8	67%	[37], [39], [43], [44], [47], [53], [60], [61]

The results of this research sub-question indicate that the most representative studies have been designed to find a comprehensive list of Governance of T&IS problems and lines of action. Something that most of the selected studies do not consider. HEI need to discover their problems and find ways to solve them. In other words, they need more support to explore new alternatives to improve their Governance of T&IS systems. To achieve this goal, T&IS studies need to be further integrated into continuous improvement processes to understand the Governance of T&IS issues detected and their root causes of them.

4.2.7. Research Topic Interest

The T&IS state in the framework of Governance of T&IS in HEI has been a topic little studied at the country level for the last 8 years. The studies, considered representative, are broad and coincide with the importance of knowing the state of T&IS in the variables of operation, management, and governance.

Fig. 1 shows the number of selected publications on the state of T&IS in HEI per year of publication. The number of studies shows little interest in the subject and the largest number of articles are presented in 2017 and 2019.

It cannot be concluded as to which are the best bibliographic sources because all the selected publications come from diverse sources such as international journal of human capital and information technology professionals, procedia computer science, Informatics Journal, Revista Iberica de Sistemas e Tecnologias de Informacao, proceedings - 2017 International Seminar on Application for Technology of Information, Communications in Computer and Information Science, Advances in Intelligent Systems and Computing, ICET 2014 - 2nd International Conference on Engineering and Technology, Crue Universidades Españolas, Corporación Ecuatoriana para el Desarrollo de la Investigación y la Academia. (CEDIA), Lecture Notes in Networks and Systems, Asociación Nacional de Universidades e Instituciones de Educación Superior ANUIES.

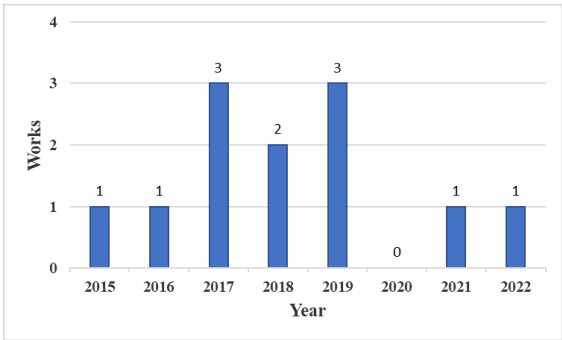

Fig. 1 Publications per year.

5. Discussion

This section summarizes the main findings of the systematic mapping study. It also highlights the limitations found that represent effects on its validity and discusses the implications for researchers.

5.1. Important Findings

The objective of this paper is to summarize the current knowledge on the strategies adopted to understand the state of T&IS governance in HEI. In this sense, the main findings of this study are the following:

In countries such as Spain, Mexico and Ecuador, regular T&IS studies sponsored by the same HEI have been carried out for some years now. These studies evaluate different aspects of the Governance of T&IS depending on underlying objectives, goals, and approaches that are presented as necessary in each locality. Although they manage a criterion of

collaboration and contribution between the consortia of universities in different countries, this collaboration is regularly adapted to the needs and circumstances of the HEI in each country. Our findings suggest that a document structural adoption could improve outcomes in form and substance.

Most studies present the maturity assessment of the Governance of the T&IS system in HEI. This generates a disadvantage in the integrality of the study, mainly because they focus on the processes and their level of maturity. These works should go beyond presenting capacity results and help with strategic action plans that provide solutions to the problems and future expectations of IT.

The study that presents the state of T&IS in HEI is an important topic that has matured year after year; providing feedback and information from case studies that help institutions improve their governance indicators and practices.

5.2. Limitations of the Systematic Mapping Studies

Typically, these types of papers are affected by publication bias, interpretation of data and information extraction, and inappropriate classification; this research is no exception. But to alleviate this threat we have decided to analyze works that are recorded in high-impact databases. However, we do not rule out the fact of affecting the validity for not having considered other databases, grey literature, and unpublished works.

Selection bias refers to distortion in information analysis due to the criteria used to select papers. We try to solve this threat by defining our inclusion/exclusion criteria that bring together as many jobs as possible that fit into the Governance of the T&IS study object in HEI.

Interpretation in data and information extraction and inappropriate classification refers to the likelihood that information from a study will be extracted differently by reviewers. To solve this threat, the researchers carried out the extraction and classification of the works based on the matrices of information provided by the sponsoring companies of the research databases.

Finally, researchers have tried to be consistent with the objective of systematic mapping studies by categorizing selected articles and making know representative articles rather than adding empirical results which demands specific research questions typical of a systematic literature review.

5.3. Implications

The researchers in this work believe that there are implications for both researchers and professionals who are working in consulting and management companies. They would be interested in integrating criteria and dimensions into their processes effectively and prospectively. In the case of the researchers, we believe that the Governance of T&IS has been transformed in recent years and that therefore greater consistency is needed in ISO/IEC 38500 because it would observe a value-based integrity problem that fails to cover the standard effectively even though the selected significant studies are effective. Therefore, it is considered that new T&IS studies should consider the new definitions of Governance of T&IS in a structural way to provide more comprehensive and contemporary results.

An additional observation was that most of the papers reviewed only described the state of T&IS in HEI through dimensions and/or indicators, and nothing more. There is little guidance to help HEI with the problem of how to correct the problem and/or take advantage of Governance of T&IS opportunities. We believe that all work of this type should include lines of action on how to face the new opportunities and problems identified. We also found some lessons that can be useful for professionals, they are related to the scope and types of research that can be applied in the different moments of T&IS states in HEI and how they can be combined.

6. Conclusions and future work

More than 15 years have passed since the concept of Corporate Governance of Information and Communication Technology was introduced with the Australian standard AS 8015 in 2005, then it would be useful to gather empirical evidence of the use of this standard in the governance of companies, specifically in the direction and control of T&IS that are considered the weak functions in the management of T&IS resources; and even more so now that the pandemic effect has been presented, which has led to a lot of attention being paid to the way T&IS is governed in HEI. Considering this need to collect such information, this research paper presents a systematic mapping study on empirical studies carried out on Governance of T&IS in HEI. In this sense, it covers works published in journals, conferences and workshops that are indexed in Scopus and WoS databases. In addition, about the higher education system of Spain, Mexico, and Ecuador in the period between 2015 and 2022.

The systematic process that was carried out makes this study rigorous and in-depth. Thus, we highlight two important aspects that were addressed during the process: 1) each study was evaluated from a complete review of the text, and 2) the database engines provided the option to define a complex search string, therefore, it can be searched directly. In addition, the

well-defined protocol will allow the study to be efficiently updated and extended for subsequent years.

During the systematic mapping of studies, an attempt was made to answer the main research question: What are the studies of IT, in the context of Governance of T&IS, that researchers have carried out to assess the state of T&IS in HEI? In this sense, we found 219 studies, but only 12 met the requirements for inclusion and exclusion. Three were considered by the researchers to be the most significant during the whole process [6], [7], [54]. These three studies plus the remaining eight [37], [39], [43], [44], [47], [49], [55], [60], and [61] show that T&IS management and control is more effective and efficient when a basic Governance of T&IS system is in place.

The results obtained show the need to study T&IS in HEI with a focus on Governance of T&IS, which allows knowing its status and thereby designing T&IS strategies oriented to specific areas in the generation of value. Finally, the main findings according to the sub-questions used to classify the 12 selected works are:

- Research method: most use the survey, and its results are expressed descriptively.
- Context: Most surveys are conducted in HEI.
- Subjects: most of the surveys are carried out by researchers and answered by managers and teachers.
- Dependency: The state of T&IS that is reflected in operation, management, and governance.
- Concept: ISO/IEC 38500
- Criteria: Most use Governance of T&IS mechanism criteria.

In short, the researchers believe that studies should be maintained regularly, improving in breadth, and considering current issues such as the identification of external ecosystems, data intelligence, digital transformation, T&IS leadership, and digital awareness of users. With this, we are confident that the present study will serve as a basis for future research to support other researchers and practitioners by providing a library of relevant articles with empirical evidence on the state of T&IS in HEI in the context of Governance of T&IS.

Competing interests

The authors have declared that no competing interests exist.

Authors' Contribution

The authors confirm contribution to the paper as follows: VM: Conceptualization, Methodology, Formal Analysis, Data Curation, Supervision, and Writing – Original Draft preparation. CJ: Conceptualization, Data Curation, Writing – Review and Editing. All authors reviewed the results and approved the final version of the manuscript.

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