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Diagnosis of Comparative and Future Studies on Social Machines

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ABSTRACT

The role of Social Machines has changed the understanding of the nature of computing in complex operations and services, increasing the interactivity and connectivity of applications, collaborative platforms, and social networks. The dissemination of the Web as a software development platform has led to a combination of computational and social elements to deal with the complexity of existing services and operations in the network through Social Machines. Social Machines establish relationships between people and machines through their restrictions. One of the main problems related to this theme of Social Machines is the lack of knowledge of the area and maturing of ideas. The objective of this research is to present perspectives of paths to be taken in mapping with criteria of the systematic review, comparative studies, and recommendations for subjects or themes that are relevant to the area of Social Machines. In this research, using a system of future studies are presented, whose possibilities are identified.

INTRODUCTION

The Internet has enabled the growth of systems that not only use computer concepts but are also guided by social processes leading to the argumentation of Social Machines (SMs) and social computing, a philosophical conception in which people and machines interact to solve problems. As a result, new applications are emerging rapidly, and new computational models and paradigms are needed to deal with them. This paradigm is called Social Machine.

We are in intensely experimental times with Web 3.0, that is, the Web as a programming platform in which the construction of Social Machines will be of revolutionary impact, which will reduce the level of complexity of networked systems, also known as sociotechnical systems, and which are already around us, creating their specific applications and providing innovations in the way they interact, communicate and articulate on the Web [19]. As a result, it is understood that it is feasible and necessary to describe a Social Machine using existing Software Engineering models and instruments because Social Machines are concepts of a model representing entities connected to the Web [19].

The Social Machine represents the insertion of the combination of computational and human elements in society. One of the first definitions, according to Hendler and Berners-Lee [11], is that the Social Machine is a computational entity that combines computational and social processes. However, some people think that the Social Machine is an artificial machine, which does not correspond to reality. In this sense, internet technology, in particular, involves interactions between humans and computers through complex information networks. Taking this thought to a logical conclusion, trust in such machines will be more significant when the user participates in the design and operation; that is, the more relationship exists, the better [5].

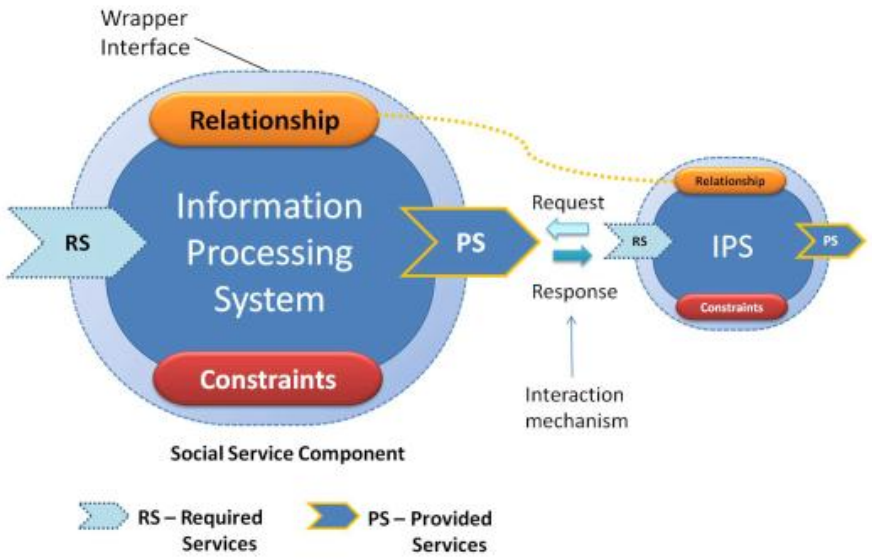
Currently, it is known that collaborative platforms such as Wikipedia, Salesforce, Social Networks in general (LinkedIn, Twitter, Facebook, Instagram, ...), applications (Uber, Waze, Spotify, ...) are characterized as Social Machines, since they constitute information systems relating human and computational elements, numerous factors must be taken into account when developing mechanisms of access to Social Machines, because there will be levels of complexity, limitations, and restrictions in the relationship.

One of the objectives of Social Machines, whether in the governmental sphere: health, education, and safety, is the heterogeneous combination of man and machine to solve problems for society. Thus, it was observed that there is a great need for further studies that deepen the theme of Social Machines. Therefore, it is intended to answer the following research question: what are the possibilities of research in the scope of Social Machines? Thus, the objective of this research is to present current perspectives of studies in the area of Social Machines.

The relevance of the contribution of this research because it is an emerging area of study is to present current perspectives of content in the area of Social Machines, mainly indicating real and contemporary possibilities of topics that can add value and evolution.

A definition presented by Meira et al. [19] says that a Social Machine is like a connectable entity that contains an internal processing unit and an interface that waits for requests and responds to other Social Machines (SMs). Social Machines represent a connection system to deal with the complexity that the Internet suggests since, for Meira et al. [19], the internet today is a programmable, open platform, where applications and services are increasingly used to transform industry and society.

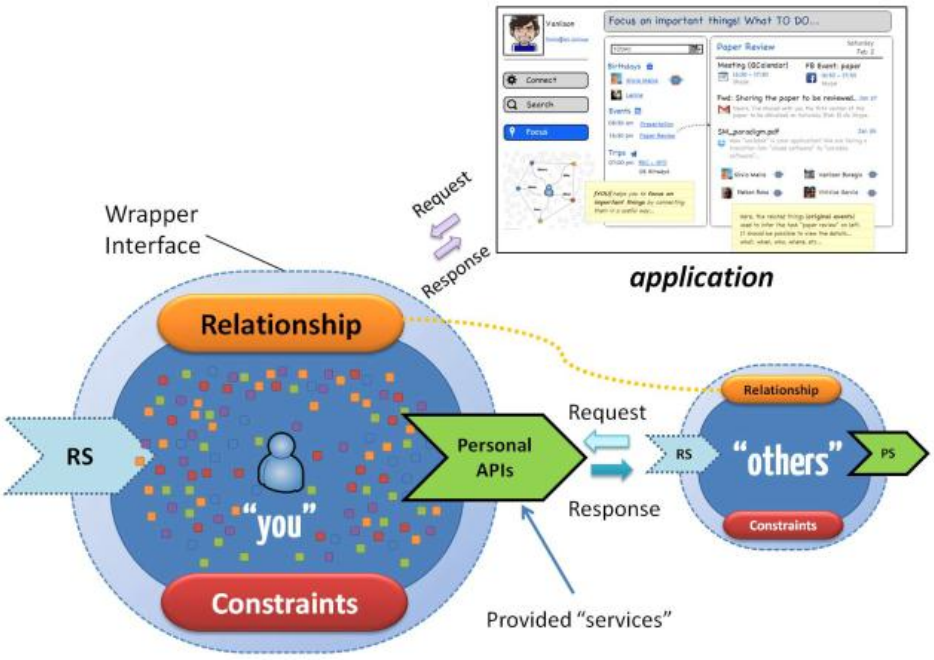
The Social Machine as a component of social service, presented in Figure 1, was defined as: "a connectable and programmable building block that involves communication interface (wrapper interface), an information processing system and defines a set of services required and provided, dynamically available under restrictions, which are determined, among other things, by their relationships with others" [6]. Emphasizing that a component of social service is built on three main concepts: computing, communication, and control. It is fundamental to understand the role that each one plays in understanding Social Machines.



Source: [6]

Figure No. 1: Social Machine as a social service component

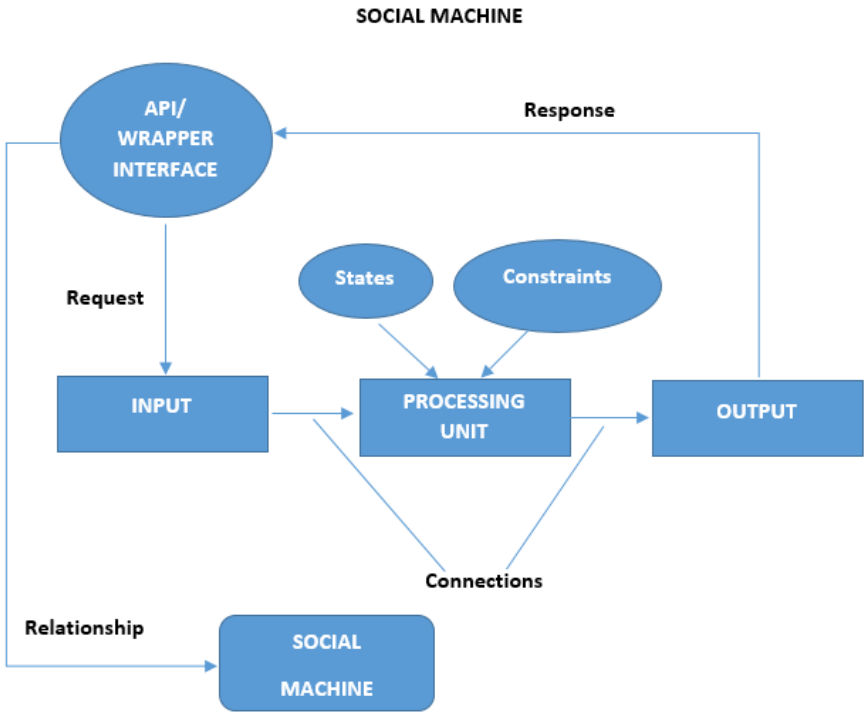
In practice, a relationship between two Social Machines can be obtained by establishing the persistent association between them in advance. For example, having specific types of app interactions, such as Twitter, Facebook, Dropbox, Instagram, a client app needs to be registered before calling its rendered services, and in most cases, different restrictions are associated with those relationships to determine the specific interaction view. Other types of relationships can also be considered. However, regardless of types, the main idea to highlight is the notion of the relationship as a key to determining the different sets of interaction views. The concept of relationships between Social Machines is similar to that of relationships between people; we can see them as relationships of trust between different Social Machines, satisfying the established restrictions, as shown in Figure 2 [7].



Source: [7]

Figure No. 2. People as "relationship" of Social Machines

The communication interface *(Wrapper Interface)* abstracts any communication layer through which a Social Machine externalizes its services to interact with other Social Machines. For example, considering Twitter as a Social Machine, the API provided can be regarded as a type of communication interface because, through the Twitter API, a client application can interact with its main services (for example, search, tweet, direct messages, retweet). This communication interface can also be responsible for composing the interaction views of the Social Machine according to the restrictions and relationships existing with other Social Machines [7]. Figure 3 represents the interaction between Social Machines through their communication interfaces through the existing relationship between them. One of the Social Machines is described in a detailed way internally, and the other is not, whose intention was to show the connection between the two. Thus, the Social Machine is an information system related to other systems, containing significant and restrictive elements in the relationship.



Source: [13]

Figure No. 3: Representation of relationship between Social Machines in the System approach

The Social Machine is considered as a sociotechnical system (STS) supported by software in which autonomous elements, humans and organizations, interact to exchange information and services [9]. These Social Machines relate to a variety of Internet of Things (IoT) resources that can automate certain interactions, involving humans, platforms and devices [17].

MATERIALS AND METHODS

Supported in Kitchenham [12], this research carried out a systematic mapping based on inclusion and exclusion criteria for a systematic review since it is a way of analyzing and explaining all available studies relevant to a defined question that, in this case, it is to address existing efforts and groups of people who work with the theme of Social Machines, without, however, being limited to the challenges they encounter. A survey of the work was carried out on the databases reported from January 2018 to April 2018 and revised from May 2020 to August 2020 using criteria for systematic review, but it is not a systematic review. The year of publication, where

the research was not taken into account, and there were already restrictions on a few papers. Figure 4 illustrates the classification of the phases for obtaining the search results based on [12].

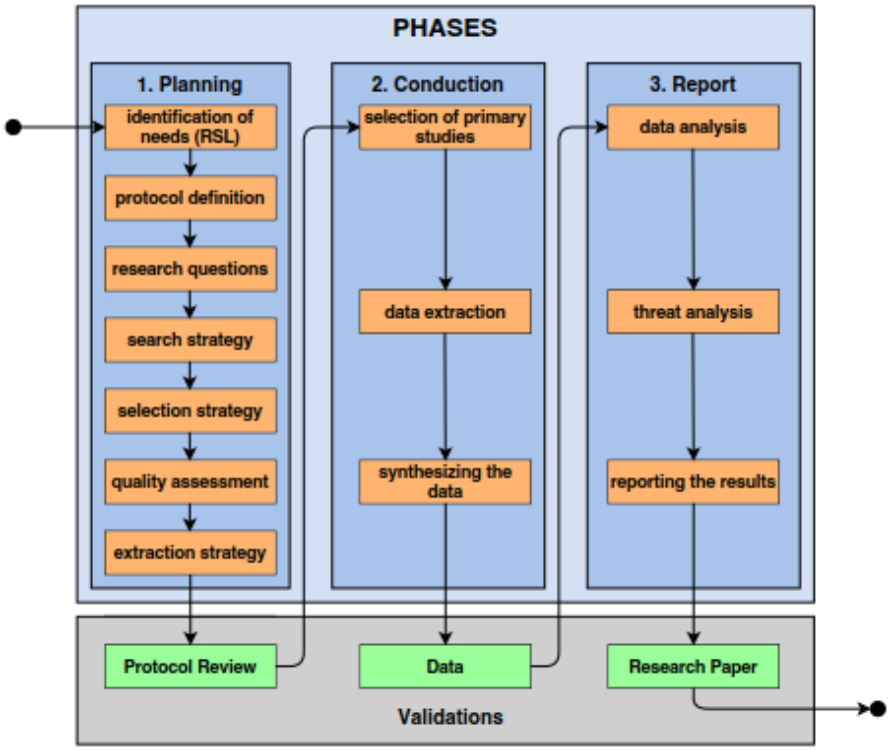


Figure No. 4: Phases of methodology

In phase 1, the conceptual bases were defined regarding the planning and definition of the study on Social Machines, and the need to make a systematic mapping was identified using procedures of a systematic review of the literature, creation of the definition of protocols as inclusion and exclusion criteria according to the research objective. For this, the following aspects were considered: intervention, context, and expected result. The following bases were defined: ***ACM Digital Library***, ***IEEE Xplore***, ***Scopus***, ***Science Direct, Web of Science and Google Scholar***, as well as the establishment of the string, which are search descriptors and which, in principle, was: **"*Social Machine*" *OR* "*Social Machines*"** through which studies were obtained, and the initial results were analyzed using the criteria. It is noteworthy that the inversion of the order of the terms in the descriptors did not present differences in the search results.

At first, the number of preliminary studies collected in the databases before and after the review process was following Table 1 and 2.

Table No. 1: Preliminary Results on Social Machines before the review process

IEEE XPLORER	SCIENCE DIRECT	ACM DIGITAL LIBRARY	SCOPUS	WEB OF SCIENCE	GOOGLE SCHOLAR
28	137	45	326	54	7.850

Table No. 2: Preliminary Results on Social Machines after the review process

IEEE XPLORER	SCIENCE DIRECT	ACM DIGITAL LIBRARY	SCOPUS	WEB OF SCIENCE	GOOGLE SCHOLAR
31	156	54	139	88	8.890

Note: It was not known why this decrease in the Scopus base, perhaps, some bug at the time.

The initial results were analyzed using the inclusion and exclusion criteria.

Inclusion Criteria: Related studies on Social Machines.

Exclusion Criteria:

C01- Study not written in English and Portuguese;

C02- Documents not accessible on the Web;

C03- Non-computing areas;

C04- Documents not available free of charge;

C05- Studies that do not present data in scientific format or lessons learned or report experiences;

C06- Incomplete documents, drafts, expanded abstracts, presentation of lectures, seminar report;

C07- Repeated studies will be considered only the first occurrence;

C08- Papers that do not present any findings or discussions about Social Machines or future work recommendations.

Next, the quality analysis of the selected studies whose syntactic (good text) and semantic (used for something) relevant aspects are objectives, research question, research method, results, and conclusion or analysis of validity (internal validity and construction). Soon after, a data extraction strategy was developed. Finally, a review of the entire protocol.

According to Dybå, e Dingsøyr [10] and Marshall et al. [18], the criteria for evaluating the quality of studies, considering scores assigned in each criterion, are: if there is a clear statement of the research if there is an adequate description of the context of the research project fits with the research objectives if the approach is transparent if the research strategy is sufficient to achieve research objectives if the analysis of the data is sufficiently rigorous.

In phase 2, regarding conduction, the primary studies were selected, and the data were extracted, and, finally, these data and validations were synthesized. In this phase, after the definition of search terms, search sources, and the application of inclusion and exclusion criteria, the selection of studies followed the evaluation steps by reading the title, keywords, abstract, introduction, and conclusion, or even the full text, resulting in a new set of selected studies.

In phase 3, referring to the report, the validated data were analyzed and extracted from the articles selected in the previous stage, and then examine possible threats of validity, such as internal validity (coherence) and construction validity (consistency). Finally, the research document was obtained. In this phase, a review of all studies selected in step 2 was performed according to the quality criteria established for this study.

RESULTS AND DISCUSSION

We started the discussion with the presentation of the most relevant aspects of the selected works for this research. These studies were chosen because they are a research group referring to Brazil, specifically Recife - Pernambuco, including some research outside that group with similar context and distinct elements, including sequential years.

In *"The Emerging Web of Social Machines"*, Meira, S. et al. (2011) describe web-based information systems that are beginning to work in a practical way how to deal with the complexity of this emerging network of Social Machines that are around us, defining the notion of Social Machine [19].

In *"SMADL: The Social Machines Architecture Description Language"*, Nascimento, L., Garcia, V., and Meira, S. (2012) define a notion of the machine and predict a language that can describe networks of such machines, that is, it presents an internal pre-version of the language of the description of the Social Machine architecture (SMADL). This aims to describe the relationships of Social Machines having a unique way to program the Web, regardless of technology (the use of the platform) [23].

In *"Implementing Web Applications as Social Machines Composition: A Case Study"*, Brito, K. et al. (2012) describe a case study that implements a web application, which is composed of several public services and acquaintances from different domains such as Wikipedia, Flickr, Twitter, Google Places, and Google Maps, following the Social Machines model. The results showed that it is possible to implement Web applications that interact with multiple web services from various domains and suggest improvements to the model [3].

In *"Social Machines: A Unified Paradigm to Describe Social Web-Oriented Systems"*, Burégio, V., Meira, S., and Rosa, N. (2013) decided to adopt the systematic mapping study to understand better the existence of research efforts that combine computational and social software elements. This provides a coherent conceptual basis for understanding, classification, and structuring Social Machines as a new paradigm for software development, focusing on different views [5].

In "*Moving Towards 'Relationship-Aware' applications and services: A social machine-oriented approach"*, Burégio, V. et al. (2013) broaden the notion of Social Machines to establish a unifying abstraction model that is used to specify relationship-compatible applications and services. In other words, it is taken to the idea of "Relationship-Aware" Software that addresses software with relationship knowledge utilizing the metaphor of human social relationships and, at the most superficial level, is the software whose behavior takes into account other software with which it interacts [6].

In *"On the Internet, Privacy and the Need for a New Architecture of Networked Information Services"*, Meira, S. et al. (2013) propose a new way to design and implement networked information systems around the notion of Social Machines. The purpose is to promote data ownership and privacy and detail the description language for Social Machine architecture (SMADL) [20].

In *"A New Architecture Description Language for Social Machines"*, Nascimento, L. et al. (2014) present a language that abstracts very complex details when developing and describing social machine networks, called SMADL - Social Machine Architecture Description Language [24].

In *"Personal APIs as an Enabler for Designing and Implementing People as Social Machines,"* Burégio V. et al. (2014) extend the initial classification scheme for Social Machines, including personal APIs as a new research theme. The authors show how this approach can enable the design and implementation of people like Individual Social Machines on the Web [7].

In *"Towards Government as a Social Machine"*, Burégio, V. et al. (2015) propose a machine-oriented social architecture as a way to expand the power of open data and create the basis for deriving government as a Social Machine (Gov-SM) [8]. They are based on some implementation experiences and understand that deriving government as a Social Machine can, in more than one sense, help converge to different visions of Social Machines presented in Burégio, V., Meira, S., and Rosa, N. (2013) [5]. The goal is to provide two-way channel communication between governments and their citizens (such as users), leading to different social interactions.

In "*From Social Machines to Social Protocols: Software Engineering Foundations for Sociotechnical Systems*", Chopra and Singh (2016) contemplate a Social Machine as a sociotechnical system (STS), which is a software-supported system in which autonomous elements, such as humans and organizations, interact to exchange information and services. They present Interaction Oriented Software Engineering (IOSE) as an expressly appropriate paradigm for capturing the social basis of STSs. This study's contribution is a new paradigm for STSs, evaluated by conceptual analysis [9].

In "*The Use of Trust in Social Machines*", Merchant, A., Jha, T., and Singh, N., (2016) present a detailed study of trust and help to gain intuitions about the operation of Social Machines, allowing designers to create better systems capable of involving more people and enabling efficient operations. They discuss the variety of ways in which trust can be observed in Social Machines, outlining a three-class taxonomy (personal, social, and functional). They are based on previous observations of the literature while seeking a broader definition. The idea is to promote

trust in social machines and present the various challenges and frontiers in response. The solution is, therefore, to make the different components work together [21].

In "*A Storm in an IoT Cup: The Emergence of Cyber-Physical Social Machines*", Madaan, A. et al. (2018) describe new sociotechnical systems called Cyber-Physical Social Machines (CPSMs), through different examples such as automation properties, scale, and performance, and considers the challenges associated with security and privacy. They present the first generation of CPSMs, using models to suggest how different types of CPSM can arise from a variety of IoT features, such as actuation, sensors, distributed networks, automation, and scalability. They consider that IoT contributes additional data points (related to the physical world, such as location) to social data and automates specific interactions involving humans, platforms, and devices [17].

In "*Where the smart things are: social machines and the Internet of Things*", Smart, P., Madaan, A., and Hall. W. (2018) seek to expand the scope of the social machinery research effort to cover the Internet of Things. They describe that one advantage of this expansion is that it helps to reveal some of the links between Social Machines and the sciences of the mind. A second advantage is that it favors the conceptual understanding of Social Machines and supports the search to derive a philosophically robust definition of the term "Social Machine". They suggest that Social Machines are better conceived as systems whose combination of social and technological elements plays a role in the mechanistic realization of phenomena at the system level. This analysis also highlights the relevance of cognitive science and the philosophy of mind to the general understanding of systems that transcend the cybernetic, physical, and social domains [31].

In *"A Mapping Study of Contributions and Challenges of Research in Social Machines", Silva,* R. and Burégio, V. (2018) investigate, in detail, the works published in the workshops of Social Machines and the central databases. A study map and a categorization scheme are created, producing an overview in the area of Social Machines through the main topics, types, trends, and challenges and defining the maturity of existing contributions and gaps [28].

In "*Evolution of the Web of Social Machines: A Systematic Review and Research Challenge*", Brito et al. (2020) bring concepts of Social Machines, in which he mentions that the theme was barely studied until 2013 when the series of workshops on Social Machines was created and

explains that the subject is not exact as to an explanation of its evolution. They conducted a systematic review analyzing the quality and quantity of publications representing current practices, research scenario, and point out some gaps [2].

In "*Social Micromachine: origin and characteristics*", Lemos de Souza, B.W and Meira, S. (2020) describe the appearance of the Social Micromachine as an equivalent system of the Social Machine, but its performance would be in specific services, that is, the level of granularity of services is low and more detailed. It also addresses the expansion of the different types of vision about the relationship, linking the term Relationship-aware to the Social Machine and the Social Micromachine as a subset of the Social Machine that relates to the types of architectural styles resulting from the type of service-oriented relationship, emphasizing microservices with their characteristics [13].

In "*Ontology of Social Machines*", Lemos de Souza, B. W (2020) addresses that the progress of research on Social Machines is not yet surfaced since it is needed to standardize the concepts, consequently, a higher level of understanding and maturity for the growth of future research related to the subject. There is a need to make a systematic mapping because different concepts about Social Machines are presented, and the elaboration of taxonomy would minimize the lack of standardization of ideas, followed by the construction of an ontology that would relate the types of Social Machines presented in the literature as a form of representation of knowledge that constitutes a set of related concepts within a domain. Therefore, constructing an ontology linked to a model through a taxonomy is the essential point of this work [15].

In "*Grounded Theory of the Evolutionary Behavior of Social Machines*", Lemos de Souza, B. W (2020) presents as a thesis proposal, map conceptual elements of Social Machines, elaborate taxonomy of Social Machines, describe the behavior and evolution of Social Machines, elaborate an ontology of Social Machines, obtain perspectives of Social Machines and elaborate a reasoned theory of the behavior and evolution of the Social Machine [14]. It yet surfaced since it is needed to standardize the concepts, consequently, a higher level of understanding and maturity for future research related to the subject. There is a need to make a systematic mapping because different concepts about Social Machines are presented, and the elaboration of taxonomy would minimize the lack of standardization of ideas, followed by the construction of an ontology that would relate

the types of Social Machines presented in the literature as a form of representation of knowledge that constitutes a set of related concepts within a domain. Therefore, constructing an ontology linked to a model through a taxonomy is the essential point of this work [15].

Next, Table 3 shows, utilizing some criteria, adopted a comparative study of the research work mentioned above. The standards adopted were: definition, language, implementation, Relationship-aware, API's, mapping, architecture, internet of things (IoT), taxonomy (Tx), ontology (Ont), and grounded theory (GT).

- The criterion of definition consists of a clear and concise explanation of something, be it its meaning, characteristics, concepts, own purpose, or other descriptions in what are related to Social Machines.

- The language criterion is based on the presentation of some written and formal programming language that specifies a set of instructions and rules for communication of social machines or something related to them.

- The implementation criterion is to create certain conditions so that somehow something related to Social Machines is achieved or put into practice.

- The standard of Relationship-aware is restricted to a type of relationship, which refers to relationship science.

- The API's criterion is expressed in applied interfaces used for communication between systems, human-machine, or machine-machine, enabling the connection of heterogeneous technologies, besides facilitating specific functionalities and tools of individual applications without this causing any difficulty.

- Regarding the mapping criterion, this is equivalent to studying how to structure, schematize, aggregate, work related to, or related to Social Machines.

- In the standard of architecture, we understand studies that contain or comment on something related to the construction or architectural structure of the Social Machine or any other.

- In the criterion of IoT, reviews of Social Machines are translated that rely on network communication devices.

- As for the taxonomy criterion (Tx), it is equivalent to a classification of social machines.

- The standard of Ontology (Ont) is a set of related concepts within a domain of Social Machines.

- The criterion of Grounded Theory (GT) is based on the creation of a theory of behavior and evolution of Social Machines.

Table No. 3: Comparative Study

Authors	Definition	Language	Implementation	Relationship-aware	API's	Mapping	Architecture	IoT	Tx	Ont	GT
Meira, S. et al., (2011)	X										
Nascimento, L., Garcia, V., e Meira, S. (2012)	X	X									
Brito, K. et al., (2012)			X								
Burégio, V., Meira, S., e Rosa, N. (2013)	X					X					
Burégio, V. et al., (2013)	X			X			X				
Meira, S. et al., (2013)	X	X	X								
Nascimento, L. et al., (2014)		X									
Burégio V. et al., (2014)	X		X		X						
Burégio, V. et al., (2015)	X		X				X				
Chopra, A. e Singh, M. (2016)	X					X	X				
Merchant, A., Jha, T. e Singh, N., (2016)	X					X					
Madaan, A. *et al*., (2018)	X							X			
Smart, P., Madaan, A., e Hall. W. (2018)	X							X			
Silva, R. e Burégio, V. (2018)						X					
Brito et al. (2020)						X					
Lemos de Souza, B. W e Meira, S. (2020)				X			X				
Lemos de Souza, B. W. (2020)						X			X	X	X

Extracting from Table 3, referring to comparative studies, we have the number of criteria represented in Figure 5.

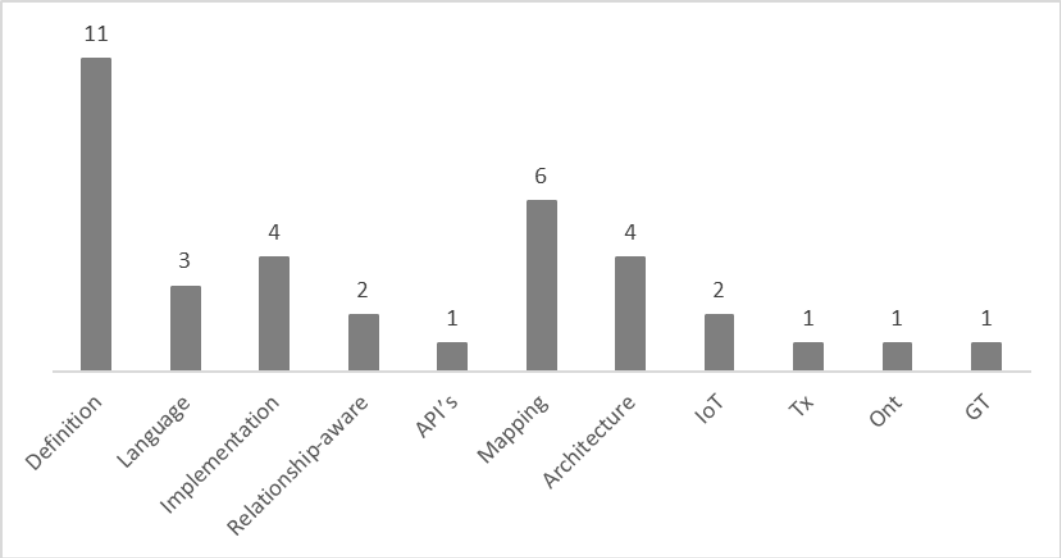


Figure No. 5: Quantitative of the criteria

It can be seen that because of the criteria established in comparative Table 3, there is already a diversification of research related to the theme. However, the three most searched criteria related to Social Machines so far were: definitions, concepts, characterizations that are equivalent to 64.70% of the researches presented. Then, studies on the mapping are equal to 35.29%. Regarding implementation and architecture, both are equivalent to 23.53%.

Subsequently, recommendations for future research papers published in journals and international conferences on Social Machines are presented. It is noteworthy that the researches mentioned here are those that, through its original text, declared future recommendations because studies that were not discussed here did not manifest future works.

At first, the recommendations of future studies of research published in journals will be described.

In "*The Emerging Web of Social Machines*", Meira et al. (2011) mention that, for future developments, social machines are a unifying architectural structure for information systems; a privacy policy framework for computing in Social Machines; an evolution of the Social Machines concept, considering people - people and their inherently human abilities - as a new

(old) Social Machine (computing) type that can be used (like any other) in the development, deployment, and evolution of applications on the emerging Web Of Social Machines. It is noteworthy that some proposals were not implemented despite the year of this work [19].

In "*Trajectories through Social Machines*", Page and De Roure (2013) believe that the identification of trajectories of Social Machines is fundamental for the construction of observations, prioritizing the properties that will provide more revelations, making a comparative analysis of a single (or small set of) elements through trajectories can help to explore these limits [25].

In "*Towards a classification framework for social machines*", Shadbolt et al. (2013) believe it is essential to perform an analysis of the behavior and phenomenology of Social Machines and their growth and evolution over time. They mention a future work that will seek additional opinions, classifications, and validation from a wider audience, to produce a comprehensive structure for the description, analysis, and comparison of Social Machines, as it is intended to add a series of constructions to emphasize the importance of the aspect of interaction in the theory, engineering, and operation of Social Machines [27].

In "*Social Palimpsests - clouding the lens of the personal panopticon*", Murray-Rust, Van Kleek, Shadbolt (2014) state that there is a continuous need to catalog Social Machines and understand their mode of operation; there is also a pressing need to understand its social impacts [22].

In "*A Taxonomic Framework for Social Machines*", Smart, Simperl, and Shadbolt (2014) report that more work needs to be done when referring to the Social Machine. There is a variety of competing, and available perspectives on the nature of Social Machines in terms of conceptual understanding, and these need to be analyzed more closely. Additional work is required to elucidate the exact nature of the relationships between the concepts involved. It is crucial to verify the degree of overlap in the extension projections of the ideas expressed by these terms, using various techniques to obtain knowledge. In addition to the repertory grid technique, several other methods for acquiring knowledge are available. These can be useful in exploring the conceptual panorama of the Social Machine. This includes ladder techniques (proper for hierarchically obtaining organized classes of Social Machines), concepts classification techniques (useful for identifying the resources of Social Machines), and concepts mapping

techniques (helpful in identifying relationships between Social Machines). As with other applications of knowledge-obtaining methods, the results of these studies could serve as a basis for ontology development efforts. Such ontologies could then be used to provide specific social machine-readable characterizations. They also comment that using a taxonomic structure is vital to identify and characterize additional instances of Social Machines. By locating these instances within the morphospatial of Social Machines, one can map unexplored areas or poorly explored regions of the design space, believing that the number of dimensions and potential Social Machines arises. This task is likely to be an uphill task of applying taxonomy and indicates an exciting possibility of designing a Social Machine to streamline the taxonomy application process. A specific idea would be to build a microtask environment [29].

In "*Social Machines*", Smart and Shadbolt (2015) state that as Social Machines become increasingly incorporated into our society, privacy, trust, and security issues become increasingly important. In addition to an ongoing effort to characterize, classify, and describe Social Machines and at the time already stated that there was a wide range of issues such as the focus of research efforts [30].

In "*A Universal Socio-technical Computing Machine*"**,** Luczak-Roesch et al. (2016) state that they require future work on defining this fundamental and generic instruction set to implement it in a way that can still intuitively be used by society to perform tasks rigorously and get answers. Extensive experimentation is needed to understand the properties and impact of various thresholds of activity and consensus and an entirely new set of analyses to be able to observe the system, this needs to be developed [16].

In "*Social Machines: a philosophical engineering*", Palermos (2016) indicates that computer scientists are particularly interested in establishing ontologies that could further guide their research so that it was expected that a definition of the term "Social Machine" would be welcome. It even mentions whether it should already invent a new name, "Social Machines 2.0" since the old term remains undefined for computer scientists to use as they please. This all means that, for the author, according to the epistemology and philosophy of particular cognitive science and, mainly his focus on the process of cognitive integration and the phenomenon of distributed cognition, there seems to be a clear distinction between mere social systems and systems that allow their members to act as if they were part of a unified distributed cognitive system. He

reiterates that it may end up being the case, but in this case, care must be taken that such a movement does not obstruct the potential transformation of Berners-Lee's initial idea [26].

In "*Understanding Human-Machine Networks: A Cross-Disciplinary Survey*", Tsvetkova, Yasseri, and Meyer (2017) declare that it is interesting how future work characterize Human-Machine networks (HMNs) to enable the prediction of emerging behavior [33].

In "*Where the smart things are: social machines and the Internet of Things*", Smart, Madaan, and Hall (2018) talk about the impact of different conceptual views (vision of cognitive systems, socio-computational vision, and mechanistic vision) of social machines and suppose abandoning the search for a standardized definition, accepting the term as applicable to various systems as an alternative perspective and conclude that the Social Machine concept is flawed in the face of some perspectives [31].

In "*A Mapping Study of Contributions and Challenges of Research in Social* Machines", Silva and Burégio (2018) present some trends and challenges of Social Machines research. They observed that there were attempts to set a standard accepted by the whole community, with doubts mainly about personal data security and privacy without a standardized architecture for researchers. Another bottleneck found in the definition and construction of algorithms, APIs, applications, or tools configured as a Social Machine, and the studies in this sense are still few, recent, and without much deepening. Social Machines have a high trend of research, especially in the field of applications. Another research idea is about the relationship-aware in which it is idealized that systems should be automatically aware of their relationships. They state that most of the studies are focused on the characterization of Social Machines to define a better understanding of the area and also establishing a standard and that few studies implement algorithms, APIs, applications, or tools using the architectures already described in Social Machines. Therefore, there is a relative lack of research that addresses the development of a tool based on an architecture, which can contribute to the construction of a Social Machine that is organized and standardized, according to the procedures of software engineering, including a systematic review focusing on the maturity of research in the area of Social Machines, or mainly a work that aims to structure and consolidate the theme, through the specification, design, and implementation of a Social Machine as a reference [28].

In "*Evolution of the Web of Social Machines: A Systematic Review and Research Challenges*", Brito et al. (2020) point out gaps and deficiencies regarding the definitions, classifications, and usability of Social Machines. They state that taxonomy needs to be more transparent, reducing misunderstanding about Social Machines. It also mentions that studies on the evolution of "things" combined with artificial intelligence possessing social behavior are promising, as are corporate systems, the internet of things (IoT), and urban mobility. They declare that Social Machines can be brought to a new architectural style of software with an integration of the network of people, artistic intelligence, and things and reaffirm that most fields involving Social Machines remain unexplored about defining and adopting new ideas, as well as requirements, constraints, and resources. Although there are some characterizations and classifications of Social Machines, they make it clear that there is still a lack of definitions, classification, especially their use. Thus, additional studies based on (and using) the current characterizations are needed and, mainly, identify their similarities and propose a typical structure to understand, define, and classify social machines. They also state that most studies are small scales and conducted in academic circles and that large-scale studies conducted in the industry are needed for better understanding. Also, they consider that empirical evidence, user concern engagement, reliability, scalability, and better human-machine collaboration are lacking. Finally, a research extension can be performed to expand the search strategy and number of sources, conducting a broader study [2].

Research published at international conferences will now be described.

In "*A Streaming Real-Time Web Observatory Architecture for Monitoring the Health of Social Machines*", Tinati et al. (2015) state that it is interesting to include a proposal to understand a broader analysis of current metrics and their combinations to measure the activity of Social Machines and how they contribute in different classes [32].

In "*DNA: From Search to Observation Revisited*", Brown, Harris, and Hall (2015) state that a model of sociotechnical systems known as Social Machines needs a broad model of interactions that includes both a technical vocabulary, processing, and a social. In this way, they seek a set of useful techniques and perspectives that approach a theoretical basis of operational factors for a wide range of evidence-based machines (grounded) [4].

In "*Exploring Cooperation with Social Machines*", Applin and Fischer (2016) understand that a future direction to explore is the experience of society created by Social Machines, such as those found in Waze, and can sustain and demonstrate a cooperative effect, after involvement with any particular Social Machine, because a sense of cooperation was created. So the most urgent is the role of Social Machines with the degree of behavior because people are not moving to network-based locations at the same time or with the same degree of enthusiasm. Machines can help make these changes more positive experiences for most and significantly impact the quality of life due to advances. In fact, given the pace of change, and consequences, Social Machines can improve substantially social cooperation during the transition from society to network locations [1].

In "*Ontology of Social Machines*" and "*Grounded Theory of the Evolutionary Behavior of Social Machines*", Lemos de Souza, B. W (2020) indicates that there is a need to make a systematic mapping because there are different concepts about Social Machines. It then mentions that the lack of standardization of concepts is due to a lack of taxonomy and construction of an ontology that represents a set of related ideas so that the behavior, evolution, and perspectives of Social Machines resulting in a grounded theory [14] [15].

Next, Table 4 shows a set of subjects related to research studies that recommend as future studies. A group of related areas or topics were: theory, concepts, taxonomy, standardization, and ontology were a set, followed by the location of privacy and security. Other subjects are behavior, evolution, perspectives, impacts, and architectures.

Table No. 4: Study of Future Work

Authors	Theory/Concept/ Taxonomy/Standard ization/Ontology	Behavior	Evolution	Perspectives	Impacts	Architecture	Privacy/ Security
Meira et al. (2011)	X		X			X	X
Page e De Roure (2013)		X					
Shadbolt et al. (2013)	X	X	X				
Murray-Rust, Van Kleek, Shadbolt (2014)	X				X		
Smart, Simperl e Shadbolt (2014)	X			X			
Smart e Shadbolt (2015)	X						X
Tinati et al. (2015)		X		X			
Brown, Harris e Hall (2015)	X			X			
Applin e Fischer (2016)		X	X		X		
Luczak-Roesch et al. (2016)	X				X		
Palermos (2016)	X						
Tsvetkova, Yasseri e Meyer (2017)	X	X					
Smart, Madaan e Hall (2018)	X				X		
Silva and Burégio (2018)	X					X	X
Brito et al. (2020)	X	X	X			X	X
Lemos de Souza, B. W. (2020)	X	X	X	X			

Extracting from Table 4, referring to future studies, we have the number of subjects represented in Figure 6.

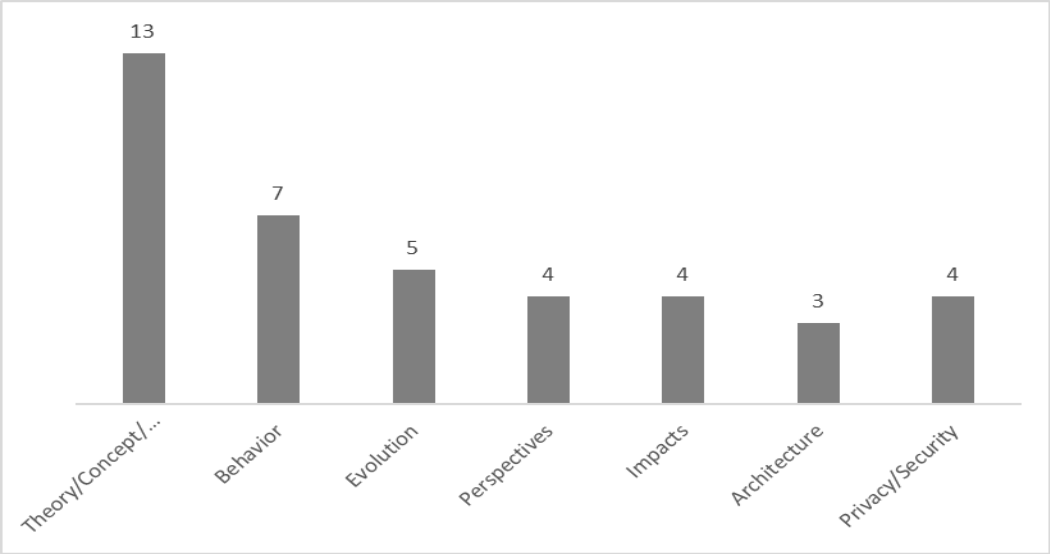


Figure No. 6: Quantitative of the criteria

It can be seen that because of the sets of subjects established in Table 4, there is already a diversification of issues related to the topic. However, the three subjects that have been most cited related to the theme of Social Machines so far were, of 81.25% the set of theory, concepts, taxonomy, standardization and ontology, 43.75% related to the behavior of Social Machines and 31.25% associated with the evolution of Social Machines.

CONCLUSION

Through the comparative study, we can notice that almost all selected studies comment on conceptual aspects. It is seen that there is a lack of conceptual pattern, lack of research related to behavior and evolution. This standardization will bring benefits mainly in the complete understanding, enabling further development of other existing and innovative works.

There is a survey of criteria established through recommendations of future studies in research already published in Social Machines about prospective studies reviews. It was observed that there is still a great need for research with theoretical approaches related to the standardization of concepts, classifications, relationships, etc. Even the criteria behavior, evolution, impacts, security, and privacy are also well demanded.

What draws a lot of attention is that a good part of the authors' future recommendations are related to conceptual issues, and what has been worked on so far have also been conceptual

aspects. This makes us think and understand that there is a lack of standardization, in fact, in the theoretical aspects to be further developed the practical ones.

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