Overview of Service and Deployment Models Offered by Cloud Computing, based on International Standard ISO/IEC 17788

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***Abstract*—Cloud Computing offers services over the Internet to support business processes, based on deployment models and service, meet business requirements in an efficient and cost-effective. A general context of the types of service models that it, as well as the models of deployment, are not known, so the following research questions are stated: Q1) How many studies refer to service models in Cloud Computing and Models of cloud computing deployment?, Q2) How the service models are classified in relation to the types of capabilities Application, Infrastructure y Platform in a Cloud?, and Q3) What types of cloud computing deployment models currently exist?. The objective of this paper is to investigate the service and deployment models that currently exist in cloud computing, for every which a process of systematic review of the literature has been used as a research methodology. The results show that 45 service models and 4 deployment models were found in Cloud Computing, this allows us to conclude that the offered models give a lot and diverse solutions for the business processes.**

Keywords—Cloud computing services models; IT demand management; deployment models; applications; platform; infraestructure

I. Introduction

The important development that we are going through in the 21st century, according to [1] the use of Information Technology (IT), Cloud computing and the Internet of Things (IoT) have become popular with the exponential usage of smart devices in recent years. It is considered one of the key elements to achieve the objectives of an organization through the best practices of IT Governance [2]. Today, cloud computing is an example in technology business processes as resources must be available within seconds, or in minutes, compared to the traditional physical server acquisition process that could take weeks and years.

Cloud Computing is a business model that is designed to deliver services and IT resources through virtualization and distributed computing technologies; these are consumed as a service on demand and paid for their use. This new paradigm has the potential to change the relationships between IT service providers and consumers that influence competitiveness in various sectors, as well as changing the role of top executives and IT professionals in organizations [3].

Cloud Computing technologically offers services in an organization through the design of its architecture, applications, deployment models, and service models generally organized into service categories such as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), and Business Process-as-a-Service (BPaaS). These models are fundamental to any service management process in Cloud Computing [4], [5].

Technological development has allowed creating opportunities in the business processes, being this a problem in its implementation when new needs arise in aspects that influence in Knowledge, Data management, Web learning, Information Security, Business Process, Application, Platform, and Infrastructure, due to which Cloud Computing has created new applications and services for the end user or organization to meet that demand.

According to [6] ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. The main task of the joint technical committee is to prepare International Standards.

The objective of this paper is to investigate the service and deployment models that currently exist in cloud computing, for which a systematic review process of the literature has been used as a research methodology.

The new models of cloud computing services that are appearing according to the needs of the 21st century are based on SaaS, PaaS, and IaaS [7]. Therefore, to implement a service model, it is necessary to decide the type of Cloud deployment model as Public, Private, Hybrid, and Community [8].

Computer services are currently available on demand, as well as any public service available in society, which for the different management of services need to be implemented through various models of deployment in the cloud.

It is considered that all business process management is based on the observation that each product that a company offers to the market is the result of a series of activities performed [9]. These activities can be performed by humans, systems or a combination of both. By identifying and structuring these activities in workflows, companies get information about their business processes. By monitoring and reviewing their processes, companies can identify the problems within these processes and can achieve improvements in using IT.

This article is structured as follows: the first section, makes a reference to the introduction of Cloud Computing, its service models and deployment, the second section refers to the historical background of Cloud Computing, in the third Section the methodology used for the writing of this paper is explained, the fourth section shows an analysis of the results found on this research and the conclusions are presented in the fifth section.

II. Background

The concept of Cloud Computing was introduced in the 1960s by John McCarthy, who suggested that advances in information and communications would lead to that “one day, computing would be organized as a public service” just like the water or electricity businesses [10].

In [11] the authors state that the evolution of Cloud Computing began in 1980 from the complex and widespread roots of IT, and in the 1990s companies began to offer virtual private networks.

Cloud Computing begins to be considered as a business model in services from the twentieth century, in a scenario of IT platforms supported by new technologies such as Web 2.0 and distributed computing. In 2002, Amazon launched the Amazon Web Service market and in 2006 introduced the term Elastic Compute Cloud (EC2) as a commercial service that allows small and medium-sized businesses to rent servers where they can run their own applications [10].

From then on, in the following years, big companies like Google or IBM began to investigate cloud computing and, as a result of these investigations, in 2009, OpenNebula and Eucalyptus were born, an open source platform that allowed the creation of systems in Cloud Compatible with Amazon EC2 web services, [12]. Google with its own google apps began to offer useful and reliable applications for computers, smartphones, and tablets that run in Cloud computing.

According to Aguilar [13], in 2011 Apple launched its iCloud service, a cloud storage system - for documents, music, videos, photographs, applications, and calendars - that promised to change the way we use the computer.

A definition is provided by Armbrust et al. From the University of Berkeley [14], where Cloud Computing refers to applications used as a service over the Internet, known for a long time as “Software as a Service.” National Institute of Standards and Technology (NIST) [15], [16] states that Cloud Computing is a technology model that allows ubiquitous, adaptive and on-demand network access to a shared set of configurable computing resources.

Therefore cloud computing is defined as a distributed consumer-oriented computing system, consisting of a collection of virtualized and interconnected computers [8]. Thus, the services that are in the network and offer their resources, highlight the services of hosting that allow us to save information outside our computers, that is to say, in servers that are in the cloud and to which we can accede through a communications network.

According to [17], the resources in a self-service demand allow access to the ubiquitous network to be scaled up and down quickly, [18] where resource use is measured, and service models are performed as a business through payment for consumer use. The diversity of business models through the use of IT, allows users to access a standardized service and respond to the needs of individuals and companies. In [9], [19], [20] the diverse applications are established, such as models of services that adapt to the necessities of computation in storage, speed, and availability, considering the most expensive part of the systems.

The IaaS provider in Cloud Computing allows the creation of a storage computing infrastructure and offering it for use in the business process, according to [21], [8], it requires an initial investment and established hardware maintenance in a service model. The utility of computing is based on service models and their implementation in Cloud, which are developed about the massive transformation of the entire computer industry of the twenty-first century.

At present, the emergence of Cloud Computing has drastically altered the perception of all infrastructure architectures, software design and development models within service management using IT.

ISO/IEC 17788 was prepared by Joint Technical Committee ISO/IEC JTC 1, Information technology, Subcommittee SC 38, Distributed application platforms and services (DAPS), in collaboration with ITU-T. The identical text is published as ITU-T Rec. Y.3500 (08/2014). ISO / IEC 17788: 2014 mentions service categories and emerging service categories as the service models and classifies them according to the types of capabilities in the cloud [6].

We consider this information as a source of research for its updating and expansion of the new models of cloud services found.

III. Research Methodology

The development of this work was done considering the guidelines used by [22], which have been adapted, focusing on main three processes: Research planning, development of information and results found..

A. *Planning of the Research*

According to the target of this investigation, the following research questions were elaborated: Q1: How many studies refer to service models in cloud computing and cloud computing deployment models?, Q2: How the service models are classified by the types of capabilities Application, Infrastructure, and Platform in a Cloud?, Q3: What types of cloud computing deployment models are currently available?.

In the construction of the search terms, the suggestions of [23] have been considered, such as the following:

- Keywords related to research questions.

- Identification of alternative terms and synonyms of keywords as search terms.

Searching for information by using the AND logical operator as a connector.

In this process, the inclusion and exclusion criteria are considered, elements which are very important in defining the results of the research.

The following are considered as necessary inclusion criteria: articles available in full text, the search range of the articles comprises from 2010 to 2018, articles related to research questions, limited search in the disciplines of Computer Science and engineering and sources of information from journals and congresses. The exclusion criteria considered are the following: articles that do not relate to service models in Cloud Computing, studies that are not related to research questions and articles that are not in the English language.

To obtain the results of the information needed for our research, we used the Internet and data sources in search of scientific knowledge that are accessible through a browser, a defined search string is applied taking into account the inclusion and Exclusion criteria, whose objective is to locate, select and obtain the documents that give answers to the questions asked.

In this paper, the following data sources were used: ACM Digital Library, IEEE Xplore Digital Library, Springer Link and Science Direct.

In the search chain, the protocols were defined, the sources of information were selected, and the search strategy was created. The following keywords were used for such purpose: Cloud Computing, Model Service, Model Types of services in Cloud Computing, Model service in Cloud Computing, Deployment Model in Cloud Computing, Implementation Model in Cloud Computing and the logical relationship was established using the operator AND, as detailed below: (Model Service AND Cloud Computing), (Model Types of services in Cloud Computing AND Model services in Cloud Computing), (Deployment Model AND Cloud Computing), (Implementation Model AND Cloud Computing)

The search was considered through specific fields (Title, Abstract, Key, Document title, Publication title) and delimited descriptors, dates, typology, etc.

B. Development of Information Search

In order to carry out the information search process shown in Figure 1, the criteria established in the previous section were considered. The information search process was performed by applying the search string to each of the data sources, and as a result, a total of 41857 articles were obtained, see Table 1.

A review and depuration of articles that did not meet the established criteria or were duplicated in different sources of information were made. Subsequently the abstract of the articles found was reviewed and a total of 40724 research work were eliminated, obtaining 1133 relevant studies from this process, from which the complete content of each of these articles was reviewed, obtaining 236 main studies and from the analysis of these articles, 45 service models offered by Cloud Computing and 4 deployment models were obtained.

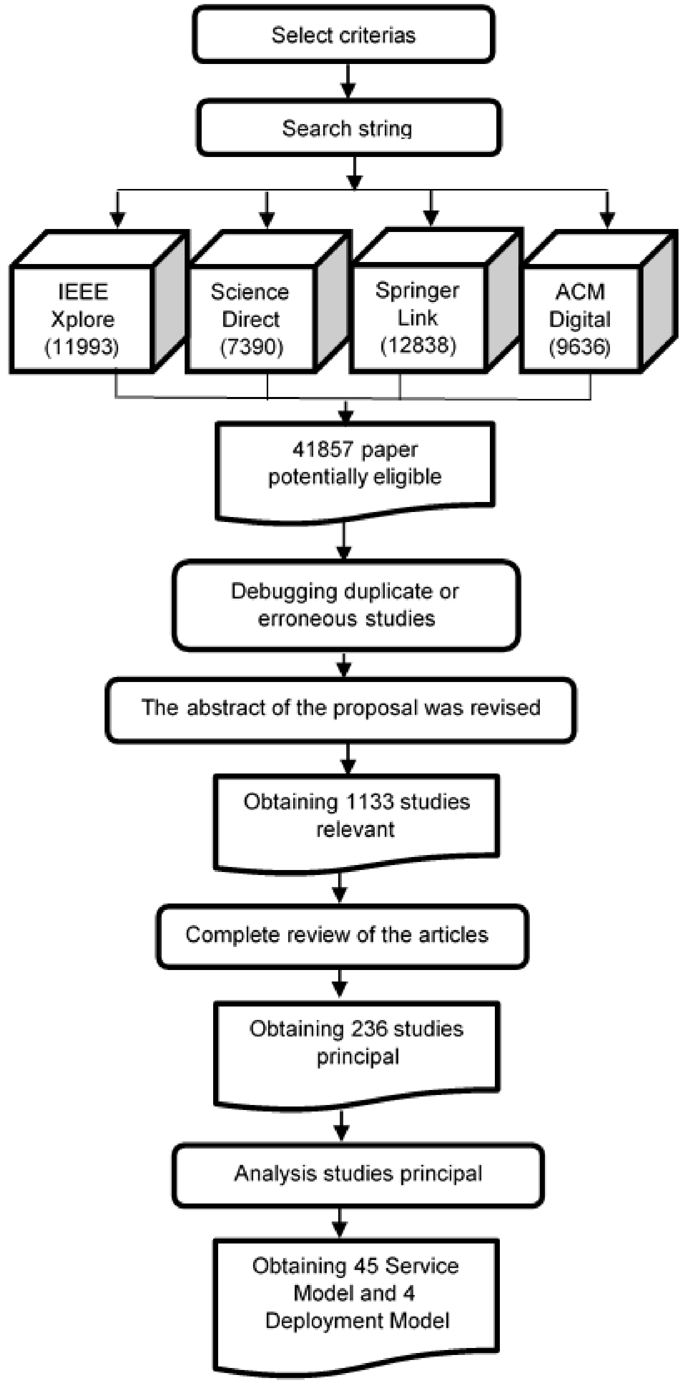

Fig. 1. Information Search Process Diagram.

TABLE I. NUMBER OF STUDIES OBTAINED THROUGH DATA SOURCES

Source	Potentially elegible studies	Studies Relevant	Studies principal	%
IEEE Xplore	11993	415	95	40,3%
Science Direct	7390	130	55	23,3%
Springer Link	12838	352	49	20,8%
ACM digital library	9636	236	37	15,7%
TOTAL	**41857**	**1133**	**236**	**100,0%**

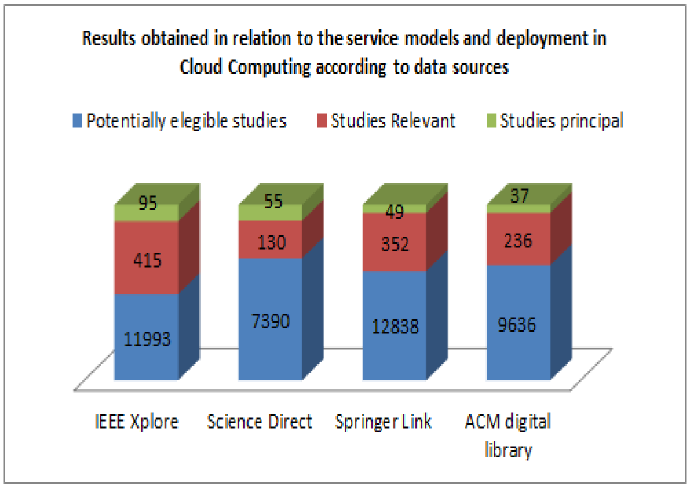

Fig. 2. Results Obtained In Relation to the Service Models and Deployment in Cloud Computing According to Data Sources

C. Results Found

In this section, the general results classified according to the data sources are shown, highlighting the potentially eligible studies, relevant studies and the primary studies with their respective percentage, as shown in Table 1.

Figure 2 shows the results obtained from the eligible potential studies in each of the data sources.

The following are the results found on the basis of the research questions:

a) Results that refer to the studies found in relation to the service and deployment models in Cloud Computing according to the data sources.

Results that refer to the studies found in relation to the 45 service models in Cloud Computing are diverse. Figure 3 shows the results of the number of studies found that refer to each of the cloud computing service models as detailed below:

The well-known models SaaS, PaaS, IaaS, BPaaS were the first service models that appeared for cloud computing. Later, from the combination of these 3 models new service models are looking, as well as the found in this research: Education Learning-as-a-Service (ELaaS), Hardware–as-a-Service (HaaS), Data-as-a-Service (DaaS), Application-as-a-Service (AaaS), Business Intelligence-as-a-Service (BIaaS), Testing-as- a-Service (TaaS), Communication–as-a-Service (CaaS), Knowledge-as-a–Service (KaaS), Actionable Knowledge–as-a-Service (AKaaS), Information Technology–as-a-Service (ITaaS), Broker–as-a-Service (BaaS), Modelling and Simulation-as-a-Service (MSaaS).

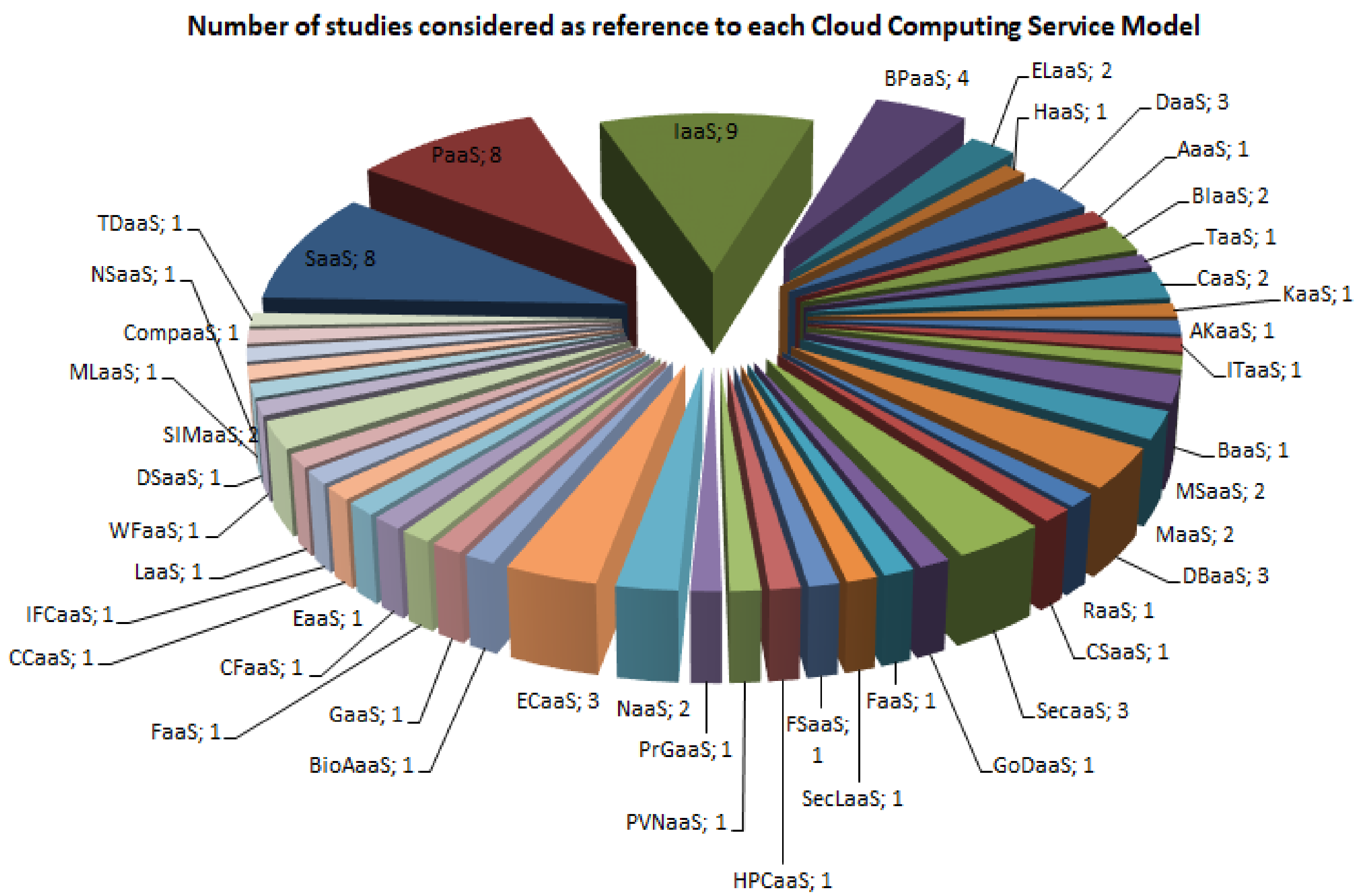

Fig. 3. Number of Studies Considered as Reference to Each Cloud Computing Service Model.

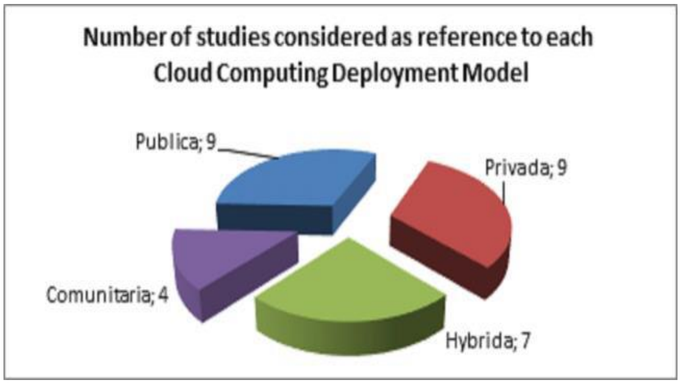

Fig. 4. Number of Studies Considered as a Reference to Each Cloud.

Modelling-as-a-Service (MaaS), Database-as-a-Service (DBaaS), Resource–as–a–Service (RaaS), Campus-System-as-a-Service (CSaaS), Security–as-a-Service, (SecaaS), (GoDaaS) Government Open Data-as-a-Service, Functions–as-a-Service (FaaS), Secure Logging–as-a-Service (SecLaaS), Failure Scenario-as-a-Service (FSaaS), High Performance Computing-as-a-Service (HPCaaS), Programmable virtual network-as-a-Service (PVNaaS), Prognostic-as-a-Service (PrGaaS), Network-as-a-Service (NaaS), E-Commerce-as-a-Service, (ECaaS), Biometric Authentication-as-a-Service (BioAaaS), Green-as-a-service (GaaS), Forensics-as-a-Service (FaaS), Cloud-Forensic-as-a-Service (CFaaS), Energy-as-a-Service (EaaS), Crowdsourced-Coverage-as-a-Service (CCaaS), Information-Flow-Control-as-a-Service (IFCaaS), Laboratory-as-a-Service (LaaS), Simulation-as-a-Service (SIMaaS), Workflow-as-a-Service (WFaaS), Data Security as a Service (DSaaS), Micro Learning as a Service (MLaaS), Network-Simulation-as-a-Service (NSaaS), Compute as a Service (CompaaS) and Traffic-Data-as-Service (TDaaS).

Figure 4 shows the results of the number of studies considered that refer to each of the cloud computing deployment models.

Computing Deployment Model

b) Results found from the cloud computing service models and relation with Cloud capabilities types.

In this section, we describe the service models found in Cloud Computing, and classification is made according to the type of capacity (Application, Infrastructure, and Platform), taking as reference the initial sorting in the International Standard ISO / IEC 17788: 2014 [6].

According to the studies conducted, the results found about the service models in the Cloud environment are 45, as shown in table 2.

To conclude the results section, Table 2 also shows the suppliers of the 45 service models found and the contribution of the service models in relation to technological, social and environmental aspects.

c) Results found from the cloud computing deployment models.

Depending on the relationship between the provider and the consumer, there are four different cloud computing deployment models within organizations as shown in table 3.

TABLE II. TYPES OF SERVICE MODELS FOUND IN CLOUD COMPUTING AND RELATION WITH CLOUD CAPABILITIES TYPES

N.	Services Models	Contribution			Cloud Capabilities Types			Providers	Author – reference	Total references
		Social	Environ-ment	Technology	Application	Infrastruc-ture	Platform			
1	SaaS	X			X			AppDirect, Concur, Ingram Micro, Net Suite, Parallels, Salesforce, GoogleApp, Office 365	[6], [52] , [53], [54], [55], [56], [57], [58]	8
2	PaaS			X			X	Amazon, Salesforce, long Jump, Windows Azure, IBM, OpenShift, CloudFoundry, GoogleApp, EngineYard	[6], [59], [60], [61], [62], [63], [64], [65].	8
3	IaaS			X		X		Ospero, Amazon, Microsoft Azure, , GoogleApp, Alibaba	[6], [66], [67], [68], [69], [70], [71], [72], [73].	9
4	BPaaS	X			X		X	BPM, Salesforce, BAM, ESB	[74], [75], [76], [77].	4
5	ELaaS	X			X		X	Avanzo, GoogleApp	[78], [79].	2
6	HaaS	X			X	X		Microsoft Azure, Amazon, Rackspace	[17].	1
7	DaaS	X			X	X	X	Oracle, Microsoft Azure, Forbes, Amazon	[6], [80], [81].	3
8	AaaS			X	X			GoogleApp, Microsoft	[82].	1
9	BIaaS	X			X		X	SAP, IBM, Oracle, Microsoft, Qlik, Tab leau, TeradataCorp.	[83], [84].	2
10	TaaS	X			X			Oracle,	[85].	1

11	CaaS	X			X		X	Oracle, IBM, Avoxi	[6], [86].	2
12	KaaS			X	X		X	GoogleApp	[87].	1
13	AKaaS	X		x	X		X	GoogleApp	[88].	1
14	ITaaS			X	X		X	IBM, Microsoft	[89].	1
15	BaaS	X			X		X	Amazon, Microsoft	[90].	1
16	MSaaS	X			X		X	IBM, CloudSME, Amazon	[91], [92].	2
17	MaaS			X	X		X	GoogleApp, Microsoft, Salesforce	[93], [94]	2
18	DBaaS	X		X	X	X	X	Azure SQL Database, DBaaS	[6], [95], [96].	3
19	RaaS	X			X	X	X	IBM, HP, Telcos	[97]	1
20	CSaaS	X		X	X		X	Windows	[98]	1
21	SecaaS	X		X	X	X	X	McAfee, Symantec, Trend Micro, VeriSign.	[6], [99], [100].	3
22	GoDaaS	X		X		X	X	Microsoft	[101].	1
23	FaaS			X	X			Microsoft Azure, Akamai	[102], [103]	2
24	SecLaaS	X		X	X	X	X	BackBlaze, Hightail, Akamai, SpiderOak	[104].	1
25	FSaaS			X	X			Windows, Amazon Web Services, Google App Engine	[105]	1
26	HPCaaS		X		X		X	IBM, Microsoft, AWS, ORACLE	[106]	1
27	PVNaaS	X			X	X	X	Microsoft, IBM, Office 365	[107]	1
28	PrGaaS	X			X			IBM, Amazon Web Services	[108]	1
29	NaaS	X		X	X	X	X	IBM, Akamai, Salesforce.com	[6], [109]	2
30	ECaaS	X			X		X	Inercia Digital, Microsoft, Amazon Web Services	[6], [110], [16]	3
31	BioAaaS			X	X	X	X	Symantec ES, Microsoft	[111]	1
32	GaaS		X		X		X	Amazon Web Services	[112]	1
33	FaaS	X			X			Amazon, Google App,	[113]	1
34	CFaaS	X		X	X		X	Google App	[114]	1
35	EaaS			X	X	X	X	IBM, Amazon Web Services aa	[115]	1
36	CCaaS			X	X		X	Microsoft, Salesforce.com	[116]	1
37	IFCaaS	X		X	X			Avoxi	[117]	1
38	LaaS	X			X	X	X	IBM	[118]	1
39	SIMaaS	X			X		X	Microsoft, Office 365	[119], [120]	2
40	WFaaS	X		X	X		X	Quantum, IBM, SddddAP	[119]	1
41	DSaaS			X	X	X	X	Akamai, Microsoft, Amazon	[121]	1
42	MLaaS			X	X	X	X	Microsoft, Windows, Google App, SAP	[122]	1
43	NSaaS		X		X	X	X	IBM, Salesforce	[123]	1
44	CompaaS			X		X	X	Windows, Oracle	[6]	1
45	TDaaS			X	X		X	Oracle, Microsoft Azure, IBM	[124]	1

TABLE III. CLOUD COMPUTING DEPLOYMENT MODEL

Deployment Models	**Description**	**Author – reference**	**Tot.Ref.**
Public cloud	Organization that sells services in the cloud.	[24], [25], [26], [27], [28], [29], [30], [31], [32].	9
Private cloud	Exclusive use for a single organization.	[33], [34], [35], [36], [37], [38], [39], [40], [41]	9
Community cloud	It's shared by various organizations-	[42], [43], [44], [45]	4
Hybrid cloud	Composition of two or more clouds (private, community or public)	[46], [47], [11], [48], [49], [50], [51]	7

IV. Analysis of Results

This section describes the report of the results obtained and gives an answer to each of the questions posed in section 3.1 and the analysis of the number of studies obtained through the data sources. IEEE Xplore found the largest number of main studies, 95 studies accounting for 40.3%, followed by Science Direct with 55 studies accounting for 23.3%, Springer Link with 49 studies accounting for 20.8% and ACM digital library with 37 studies representing 15.7%. of the 1133 relevant studies, 236 main studies were considered, of which reference is made to 45 service models and the 4 deployment models in Cloud Computing described in Table 1.

Table 2 shows the suppliers of the 45 service models found, and it is considered as a result of this analysis that IBM, Microsoft, Amazon suppliers are the most accepted in the business. The figure 5 shows the evolution of the cloud service models found from 2006 to 2018. These service models are suggested as proposed trends, from their first three initial models (IaaS, SaaS, PaaS).

A. Analysis of the Studies that Refer to the Models of Services and Deployment According to the Data Sources

This section analyses of the number of studies that refer to service and deployment models in Cloud computing.

Regarding the studies that refer to the Service models in Cloud Computing, we found 85 reviews, as can be seen in figure 3. SaaS and PaaS are two models of Cloud services referenced by authors in 8 articles; the IaaS model is referenced in 9 articles. IaaS, PaaS, and SaaS have more authors as a reference because they are the main service models in the cloud as a base structure for the construction of service models; BPaaS referenced by authors in 4 articles.

The DaaS, DBaaS, SecaaS, ECaaS, models are referenced each by three authors, the ELaaS, BIaaS, CaaS, MSaaS, MaaS, FaaS, NaaS and SIMaaS models are referenced each by two authors and Haas, AaaS, TaaS, Kaas, AKaaS, ITaaS, BaaS, RaaS, CSaaS, GoDaaS, SecLaaS, FSaaS, HPCaaS, PVNaaS, PrGaaS, BioAaaS, GaAs, FaaS, CFaaS, EaaS, CCaaS, IFCaaS, LaaS, WFaaS, DSaaS, MLaaS, NSaaS, CompaaS, TDaaS models are referenced by a single author, in which the services applied and used feasibly by different customers are described. of the 45 models found and displayed in Table 2, 17 models contribute to the social, 3 models contribute to the environment, 15 to technology, and 10 to the social and technological. It is considered that the contribution of these service models in the technical aspect refers to the storage of data in the cloud, the environmental aspect refers to the environment and social aspect is considered the human society.

In relation to the studies that refer to the models of Deployment in Cloud Computing, we found 29 studies, as can be seen in figure 4. Reference to Private Cloud and Public Cloud as deployment models is referenced by authors in 9 articles considering that they facilitate business operations in Cloud Computing, Hybrid Cloud is referenced by authors in 7 articles combines deployment models in Cloud and in a flexible, Agile and profitable manner and Community Cloud which is referenced in 4 articles.

Responding to Q1, the studies that refer to service models in Cloud Computing are 85 seen in Table 2. Also, the studies that touch the deployment models in Cloud Computing are 29 as can be seen in table 3.

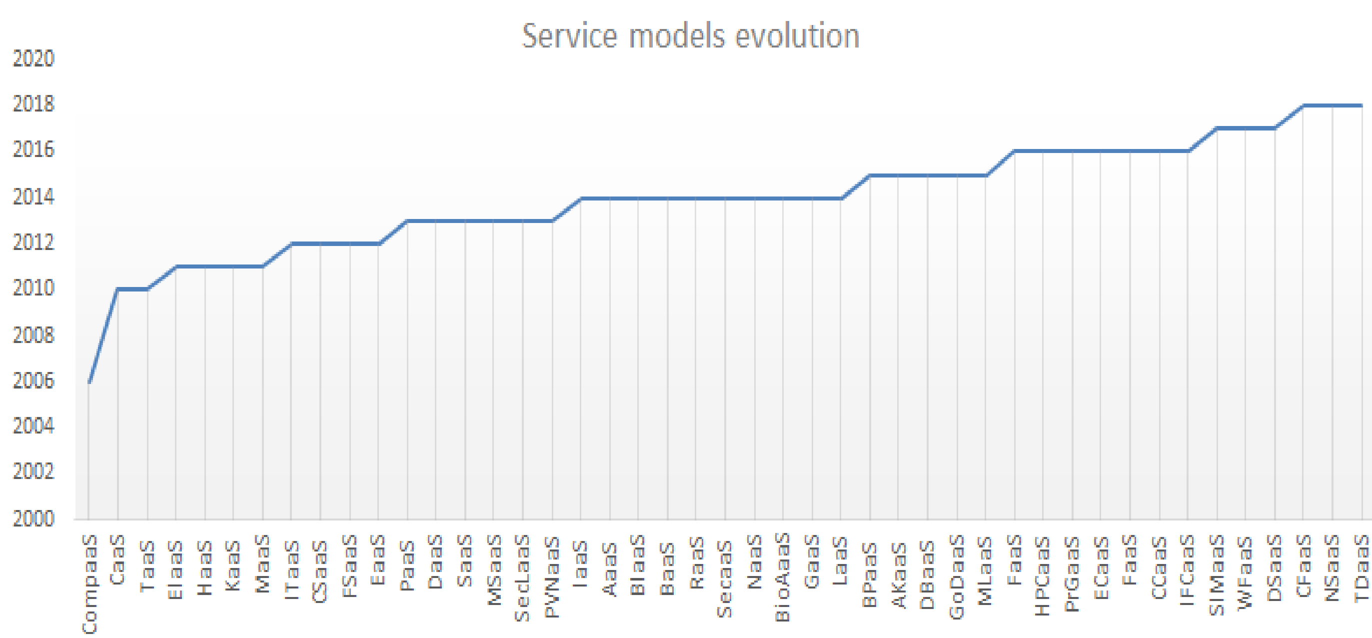

Fig. 5. Service Models Evolution.

B. Analysis of the Service Models of Cloud Computing Found and Relation with Types of Cloud Capability

As can be seen in the results found, there are 45 service models that appeared from the Infrastructure-as-a-Service, Platform-as-a-Service, Software-as-a-Service. Table 2 shows the service models found and classified according to their relationship with Cloud capability types (Application, Infrastructure, and Platform).

As it can be seen, the cloud computing services can have any of the combinations of the types of capacity in the cloud or just one class, which is indicated by an "X" and is detailed below: 8 have application type, 1 has a platform type, 1 has infrastructure type, 1 has application type and infrastructure, 19 have application type and platform, 2 have infrastructure type and platform, 13 have application type, infrastructure, and platform.

Responding to Q2, the service models found and classified in relation to the types of Application Capability, Infrastructure and Platform in a Cloud environment were 45 service models as indicated in table 2.

C. Analysis of the Cloud Deployment Models Found

As can be seen in the results found there are 4 models of deployment that have not changed since their appearance, as indicated in table 3.

Responding to Q3, the deployment models in Cloud Computing found were 4 models.

V. Conclusion

Considering the International Standard ISO / IEC 17788 as a basis, the classification of cloud service models was continued, and the search for information was done using search engines, obtaining a significant amount of information in IEEE Xplore that represents 42.2%.

The total result of the information search was 30173 articles, after performing a depuration of articles that did not meet the established criteria or were duplicated, obtaining 1050 relevant studies.

From the review of the relevant studies, we have found 211 main studies that reference the authors to 39 service models and 4 deployment models in Cloud Computing found and that help different users and organizations through the internet, which facilitate the development in businesses, storage, integration, scalability, and security, as well as the exchange of knowledge between developers of different applications.

The IaaS, SaaS and PaaS models are the basis for the creation of new service models that offer cloud computing and the types of models found in Cloud Computing generate solutions in strategic services to the business processes for companies, organizations, and users.

The types of capabilities in the cloud Applications, Infrastructure and Platform, allow the establishment of specific functions of the cloud service models considering aspects that influence the Virtualization, Knowledge, Data management, Web learning, Information Security and Business Process, which will continue to emerge as cloud computing continues to grow.

With the models of services found, suppliers, contribution and types of capabilities, it is suggested that ISO / IEC analyze and make modifications that cover these trends in their regularization.

It is concluded that each service model is aimed at different clients and their adoption is in relation to the time and present need, considering that the models of deployment in Cloud computing facilitate agile business processes.

As future work is being considered the analysis of the hypothesis related to the level of contribution and usability of cloud technologies in the Market. Where is considered the scalability of each service model found and its employability in business.

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