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Towards a Framework for Cloud Computing use by Governments: Leaders, Followers and Laggers

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ABSTRACT

There are large varieties of governmental organizations using clouds in different ways. The purpose of this article is to explore and classify the types of public organizations using cloud computing. This will help to improve our understanding of cloud adoption and use by governments. For this, a systematic review of literature on cloud government (CloudGov) was performed by searching for articles in several databases. The review resulted into the main elements of the framework for classifying cloud use. In addition, using diffusion of innovation and institutional theory a categorization of public organizations was made. When applying the CloudGov framework empirically in government organizations, we identified three types of organizations: Leaders, Followers and Laggers. The types differ in various ways including their technology expertise, attitude towards innovation and level of political support. In further research, we recommend investigating which drivers influence the type of CloudGov users and generalize the framework to other contexts.

CCS CONCEPTS

• **Applied computing**; • **Networks** → Network services;

KEYWORDS

Cloud Computing, Use, Adoption, CloudGov, Government, Framework

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1 INTRODUCTION

The adoption of cloud computing in governments is focused on improving efficiency, services levels and on innovating and delivering higher quality public services to citizens [1]. Cloud computing has emerged as an answer to overcome infrastructure challenges as well as achieving cost reduction at the same time [2]. The use of cloud computing should result in a general, agile, efficient and low-cost infrastructure that can be used for supporting many types of applications [3]. Cloud Computing is the use of a virtual infrastructure for the storage, processing and management of applications in which the services are hosted and provided by service providers [4]. By using clouds by governments, they do not need to invest anymore in having their own data centre and the capabilities needed for operating a data centre.

The abbreviation *CloudGov* refers to to the use of cloud by governmental organizations. Cloud Computing has been an alternative for governments to modernize their infrastructures and applications, and provides an efficient environment with lower maintenance costs [5]. This enables government of focus on their public functions. Governments from all over the world have started using clouds, including Gloud.Gov in the United States of America (USA) [6], Project Yesser in Saudi Arabia [7] and Project Kasumigaseki Cloud in Japan [8]. These projects are often used for modernization of governments and innovating their public services. Publications in the field of CloudGov covered a wide range of topics including: Security [6], Connectivity [9], Maintenance Costs [10], Benefits and Adoption Viability [3], Software as a Service (SaaS) in Public Sector [1], and Challenges and Benefits [11]. None of the literature looks at how public organizations make use of the clouds.

This article aims to explore and classify the way public organizations use cloud computing. For this, a framework which characterizes public organizations in the way they use (or not) the cloud and how they operate the cloud is created. The framework was built by conducting a systematic literature review (SLR) resulting in the potential categorization of types and characteristics of CloudGov use. The Diffusion of Innovation (DoI) and Institutional Theory (IT) were used to arrive at three types of organisations using CloudGov, namely: cloud leaders, innovators and laggers.

This article contributes by constructing a framework to categorize of the CloudGov initiatives in governments, providing a classification of types of users and theirs characteristics. In addition, this research also contributes to the plea for research by Ali et al. [10] and Mohammed et al. [3] for obtaining explanations at

the organizational level of cloud use. As a practical contribution, the article presents a framework that can be applied in government organizations to categorize and identify theirs CloudGov characteristics, helping managers and engineers to manage and develop CloudGov initiatives.

This article is structured as follows. In next, our literature review on the topic CloudGov is presented which contains the elements of our framework. This is followed by third section deriving the theoretical foundations based on the DoI and IST for classifying user groups. Thereafter, section four describes the research method, followed by section five where findings are presented. The last section contains the conclusions, limitations and potential future research topics.

2 TOWARDS A CLOUD FRAMEWORK

CloudGov can be conceptualized as delivering services over the Internet, on demand, from a remote location [12] accessible on any device [5]. There are large varieties of government organizations using clouds in various way. CloudGov initiatives were described in some countries such as the USA [6], Saudi Arabia [7, 13, 14], Japan [8], The Netherlands [1], Brazil [5], Oman [15] and Yemen [3].

From a systematic literature review on the topic "Cloud and Government", we identified 84 articles in databases Web of Science (WoS), Scopus and Google Scholar about this theme. We scanned all articles found on the SLR aiming to find a set of characteristics that potentially would describe CloudGov using the methodology of the Webster and Watson [16] to map the Theme. The articles were classified in a spreadsheet and all bibliometric information (authors, methods, analysis, conclusions) was analysed in full. In addition, all the research objectives of the articles and the future gaps were mapped. Therefore, using this mapping of the literature we found 6 characteristics to classify CloudGov, including cloud types, cloud services, cloud providers, management models and level of utilization, and technical skills.

2.1 Types of Cloud

Literature about cloud computing [2, 4, 17] often classifies *Cloud Types* into public, private, hybrid and community. This classification is also used by the NIST - American Institute of Standards and Technology in implementation of the cloud computing [18]. The definition of *Public Cloud* is related to where information is stored and the infrastructure can be shared with other users, customers or governments [2, 18]. Sharing the infrastructure allows organizations to optimize resources usage, enabling competitiveness and reducing cost. However this type of cloud is constantly being criticized due security aspects [6].

In a *Private Cloud* the infrastructure is owned by the organization which internally manages the Cloud [4]. This type of cloud is frequently associated a to higher level of security [8], however, criticized for having high maintenance and management costs. *Hybrid Cloud* is a combination of all types of cloud mixing both private and public clouds solutions. This type of cloud is normally used when you have a high data risk management and it is possible to create different security levels according to the environment to be hosted and level of users [6].

Community Cloud type is focused on an environment that aims to act cooperatively on a theme or subject [2]. It is possible to cite initiatives of community cloud on the Nasa Nebule [19] and Healthcare [20] where multiple clouds are connected to achieve the goals of organizations involved.

2.2 Type of Cloud Services

The type of Cloud Services can be categorized as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) [4, 18]. *IaaS* is when the user uses the infrastructure such as hardware, networks, and configures it as needed. It is the use of a base to deploy operating systems according to the demand used. In IaaS, hiring is usually accomplished through the acquisition of preconfigured environments with processing and storage capabilities.

The *PaaS* acts as a second layer of service. It is an environment where you already have an operating system in place and usually the customer buys a platform solution, such as an management of e-mail, monitoring the cams platform or something [4]. The user has no control over the platform infrastructure, but can manage the entire environment already installed as well as the applications hosted in that environment [21]. It is a widely used service modality when a complete platform can be found that can address a particular area or theme of government.

Janssen and Joha [1] conceptualize *SaaS* as an environment where the software is already installed and the user pays only for the service used. It may be government Enterprise Resources Planning (ERP) software or simpler software, but the difference is that infrastructure, platform and environment do not need to be managed by the customer [18]. It is a type of service in high demand in companies, but in governments are more reluctant to the uncertainties surrounding the jurisdiction which is dependent on the location of the infrastructure that stores the information, because the infrastructure is usually not managed by the customer [5].

2.3 Cloud Providers

CloudGov Providers can be Public or Private. The big players of Public Providers technology are Microsoft, Amazon, Google, Oracle, IBM [22]. Large information technology players provide cloud environments because they have giant data center infrastructures and processing capabilities [4].

In the literature, it is possible to highlight questions about hiring large providers, as the government becomes hostage to certain suppliers [23, 24]. Some governments prefer to be cloud providers themselves to mitigate risks and possibilities of delivering citizen information to IT players [6, 25]. Private providers can be when the government itself offers cloud solution provider (formulate, create, operate and maintain) [26]. However, for this type of provider is need to overcome the problems of issues of technical and system interoperability [27].

2.4 Management Models

There are four types of management models in the literature, e.g.: Client, Broker, Provider and Orchestration [28]. In the *Client model* the consumer contracts the Cloud from a public or private provider

and only consumes the contracted amount. The Client is limited and hostage to vendor settings, and does not have as much autonomy to manage the contracted environment [29].

In the *Broker* model, the agent acts as an intermediary. Broker contract a vendor's public cloud, manages internally, and provides for its customers to use in departments below it. This model acts more in the negotiation and relationship between cloud suppliers and consumers [2]. In the *Provider* model government itself is the provider of a private cloud and does not use external hiring [30]. It provides a cloud for its customers in departments, but the management, delivery and maintenance of the cloud is entirely the responsibility of the provider. It might be a safer option, at the expensive of higher management and maintenance costs [31]. The last model is *Orchestration* where the government can contract to public and private clouds, mix with its own internal cloud and offer to its internal departments and even market to other governments. This model requires high-levels of knowledge by the government to ensure proper working of this model [28, 32].

2.5 Level of Utilization

Paquette et al. [6] used a four-stage classification to classify level of cloud computing utilization. These are: (1) Early use; (2) Strategic Direction; (3) Information Sharing and (4) Information Processing. Similar to this, Dermentzi et al. [33] proposed a model for CloudGov consisting of four stages: (1) ad-hoc eGov Cloud solutions, (2) cloud-based public services, (3) eGov cloud and (4) diffusion of cloud..

Some countries are still at *low level* of adoption of the CloudGov, with embryonic deployment initiatives looking at providers and possibilities for migrating their services to the cloud [5]. Typically these initial migrations occur through the hosting of portals (.gov) in cloud environments, in order to minimize infrastructure spending on hosting these portals [6, 33]. In this research, these initial initiatives were considered as Low Level of Utilization to CloudGov.

A *high level* of use of cloud computing in the government are those that use public cloud providers (Amazon, Microsoft) of the SaaS type [1] in governmental software. This leads to the processing of information involving citizen data in an environment that provides high scale, performance and low cost. Another high-level example of CloudGov utilization is hiring multiple public cloud providers (Multicloud) and also being a provider to other governments through an Orchestration model [28].

2.6 Technical Skills

Another relevant category to measure in this framework are the *Technical Skills* of the CloudGov team. In the literature it is possible to show that technologies have entered the organizations and at times the technical teams are not prepared for a sudden change [34, 35]. In this sense, it is necessary a formation of technical skills to manage the adoption and use. CloudGov shows that these skills can be a barrier to cloud adoption, delaying migration in government organizations [36, 37].

A *low level* of technical skills can be verified when teams are unaware of the previously presented technical concepts, such as cloud types, cloud services, and managing management models of CloudGov. [34, 35]. These skills can be gained through training and experience in CloudGov adoption and migration projects. In contrast, a *high level* of CloudGov technical skills can be identified when government teams are already teaching other governments, departments being used as benchmarking cases [21]. In practice, they are difficult to find as CloudGov worldwide is still in the migration or post-adoption phase.

Finally, the CloudGov usage framework according to Table 1 - was built from the literature review. The characteristics seek to classify the types of users and CloudGov characteristics.

3 CATEGORIZATION OF USERS: INTEGRATING DIFFUSION OF INNOVATION AND INSTITUTIONAL THEORY

After identifying the CloudGov characteristics, presented in the framework (see Table 1), we started to classify the type of governmental users. *Rogers' Diffusion Theory* (DoI) [38] identified 5 types of adopters, e.g.: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards. Roger [38] defined innovativeness as "the degree to which an individual is relatively earlier in adopting new ideas than other members of a system" (p. 22) . Chandler and Hwang [39] found that adoption of innovations is not a uniform process and is a type of learning process for organizations which can lead to variable results providing. The adoption of a certain technology is related to the benefits it provides, the process of how it will be adopted in the organization and its future legitimacy. Facing innovations, requires a cognitive process of imagination and adaptability, as a given technology can totally change the way a group of individuals or an entire organization works [40].

Institutional Theory (IT) is focused on explaining the changes and heterogeneity of public organizations [39, 41, 42]. Whereas DOI is focused on how users in a market adopt technology, IT can explain why government organisations use a technology. Hence DOI and IST are combined to explain how pubic organizations configure and shape the adoption of new technologies [38]. Whereas commercial companies react on market, public organizations respond to institutional pressures (internal and external) that organizations transmit about in the adoption processes. This requires an analysis at the most managerial level where you can see how the pressures occur and how they are responded to [38, 40]. Responses to institutional pressures can occur in several ways. One of them due to imitation in process mimetics [41], the other due to early innovation (early adopters) or they may not respond to pressures at all (non-adopters) [40].

By combining DoI and IS e three types of CloudGov organizations were identified based on their level of development and institutional pressures. The first types are the **Leaders**, as early adopters of technologies and other characteristics described in the section 2. The second are the **Followers**. Followers normally mimic processes seen by leaders after a while. The third are the **Laggers**. Laggers are a type of organization that avoid innovations or adopt lately the innovations on the field. The types of organizations are summarized in Table 1, and, better explained below in the sections 3.1, 3.2, and, 3.3.

Table 1: CloudGov Usage Framework

#	Cloud Characteristics	Item	Literature
1	Type of Cloud	Public, Private, Hybrid, Community	[2, 4, 18]
2	Type of Services	IaaS, PaaS, SaaS	[1, 4, 21]
3	Providers Cloud	Microsoft, Amazon, Google, Oracle, IBM, etc.	[4, 6, 25]
4	Management Models	Client, Broker, Provider, Orchestration	[28, 31, 32]
5	Level of Utilization	Low (1) and High (4)	[6, 28, 33]
6	Technical Skills	Low (1) and High (4)	[34, 35, 37]

3.1 Leaders

The first adopters of a technology are known in the literature as innovators [38]. Leading a novelty in the organization requires taking risks, ability to deal with uncertainties and being up to date with the frontier knowledge.

Leaders have no role models which can be readily adopted, as they create them. They have to build their own innovation models and they have leadership skills so that their teams can follow this transformation, even knowing the risks and uncertainties [40]. Being a Leader requires a high level of learning and be willing to reconfigure environments, sometimes from medium to high level, reconstructing all the routines of the organization. This vision of complete change, can be considered a distant reconfiguration strategy, as it makes Leader far removed from its competitors [39].

3.2 Followers

DiMaggio and Powell [41] found that public organizations face coercive, mimetic and normative isomorphic pressures. These pressures determines the adoption by public organizations. Coercive isomorphism is the pressure that less powerful, dependent organizations face from more organizations that are powerful. This might be the push by politicians to adopt clouds for a variety of purposes. Mimetic isomorphism is the tendency of an organization to mimic successes of other organizations and copy its innovations, whereas normative isomorphism concerns the pressures arising from the professionalism attached to formal education and professional networks and associations.

The mimetic process can be used to characterize followers. Redmond [40] cite in literature the after an innovation is accepted socially in an organization, followers usually imitate adoption to avoid being out-of-date. This imitation is needed for followers to remain up-to-date and to minimize the uncertainties or risks they would face when innovating without having to imitate.

The process of following an adoption can also be linked to the context of the adopter. An adopter may be that the place to have skilled labor, the necessary resources or might not have a favorable environment for leading. Social and environmental influences can be determine if an organization becomes an adopter, a follower or fail to adopt [42].

3.3 Laggers

Laggers are those who cannot keep up with the evolution of the adoption of new technologies. This can happen due to several factors, such as: context limitations, lack of resources, learning limitations or because they do not face r normative and coercive pressures to keep up-to-date [38, 41].

The context in which organizations are can have a high influence on becoming a late adopter. The geographic location of an organization might prevent access to cutting-edge technological resources or may require that an innovation takes time to reach a certain location [40]. In addition, individuals who are delimited to a region for socio-economic reasons may not have access to expertise about and not being able o follow developments in other places [39].

Laggers may become late adopters who, due to some influence, have not been able to keep up with developments, or they may become non-adopters for reasons specific to the context in which they operate [38]. Laggers are usually more traditional users and have cognitive processes focused on keeping operations running instead of changing. Change might remove some individuals from their comfort area, providing uncertainties and risks [40].

3.4 Adapting Diffusion of Innovation and Institutional Theory to CloudGov Framework

The cloud usage framework is linked to the types of CloudGov organizations as shown in Table 2. The six cloud characteristics of the Framework presented in Table 1 support empirically how the Cloud is implemented in an organization. When analyzing these characteristics in a qualitative and descriptive way, it is possible to identify how the organization is using cloud computing.

Based on the DoI organizations that adopt the cloud at a more advanced level are labbeled as Leaders or Innovators [38]. On the other hand, organizations that use the cloud in a reduced way or have not even migrated their systems to this infrastructure can be classified as Laggers behaving like Traditional Users and that do not follow innovations at a speed compatible with the market [40].

DiMaggio and Powell [36] found that public organizations face coercive, mimetic and normative isomorphic pressures. This pressure determines the type of adoption by organizations. Mimetic isomorphism is the tendency of an organization to mimic successes of other organizations and copy its innovations and result in the classification of organizations as follower.

Table 2: Adapting Theory to Framework

Base Theory	Type of Organisations	DoI Leaders	IST Followers	DoI Laggers
CloudGov Framework Characteristics	Type of Cloud	Hybrid or Private	Private or Hybrid	Private or Not Utilised
	Type of Services	IaaS or SaaS	IaaS	IaaS
	Providers Cloud	Public	Private or Public	Private
	Management Models	Orchestration or Broker	Provider or Client	Client
	Level of Utilization	High	Medium	Low
	Technical Skills	High	Medium	Low

Table 3: Characteristics, Items and Points

Cloud Char.	Item	Description	Points
Type of Cloud	Public	High Risks; Flexibility; Scalability; Low Costs	3
	Hybrid	Medium Risks; Require Tech Skills; Medium Costs	2
	Private	Low Risks; Not Flexibility; High Costs	1
	Not Utilized / Identified	Not migrated to the cloud or are reviewing proposals	0
Management Model	Orchestration	Best Governance Model – Tendency	4
	Broker	High Governance Model	3
	Provider	Medium Governance Model	2
	Client	Low Governance Model	1
	Not Utilized / Identified	Not migrated to the cloud or are reviewing proposals	0

4 RESEARCH METHOD

This research uses a qualitative methodology to rank and evaluate organizations [43]. Based on our framework a questionnaire was developed to collect data. This questionnaire obtained qualitative data from managers and engineers in charge of CloudGovs initiatives in Brazilian regional governments (Estados), aiming to identify the CloudGov characteristics (see Table 1) and categorize them in one of the three types of CloudGov Organizations (Leaders, Followers, and, Laggers). The questionnaire was refined and pre-validated with three experts (a researcher, government IT manager and technical support) and feedbacks was collected for improvement. No further changes were needed. Brazil has 26 regional governments (Estados). We received 17 responses resulting in a 65% response rate. The results from each were anonymized to avoid personal identification, and only thereafter analyzed.

The data collected from interviews were tabulated in a spreadsheet according to the characteristics investigated providing an overview about CloudGov. These tabulation was creating by ranking y CloudGov characteristics on each of the initiatives as shown in Table 3. As an example, types of cloud could be public, private or hybrid. This analysis resulted in a rank scored in accordance with points presented in Table 3 for each type of characteristic and level of use of each item on these characteristics.

To analyze the data, we gave points to determined type of characteristic that interviews provided to us (see Table 3, column points). In accordance with a certain number of points, we classified the initiatives in terms of CloudGov organization type (Leaders, Followers, and, Laggers). The total points that an organization could achieve was 17 points. The minimum was 2. To be considered a Leader, the initiative should score 10 or more points. To be considered a Follower, the range was between 6 and 9. To be considered a Lagger, the organization should score 5 or less points.

After that, we used the same interviews to identify types of institutional pressures of all type of organizations. This, let us to identify what are the most common (frequency) associated to each of the type of organization. As an example, we found that Leaders are highly associated with institutional pressure originating from the political agenda. Followers presented high association with acquirement of technical skills. Laggers had high association with problems of connectivity. Validation and reliability of this research is based on data triangulation through multiple respondents and validation with other sources [43] such as comparison of information with regional governments (Estados) by investigating websites. The research limitations are due to the fact that it uses data from regional projects in only one country. Not all data might be up-to-date and accurate.

5 FINDINGS

After collecting the data via questionnaire and interviews, a codification of characteristics was applied aiming to identify the characteristics of CloudGov (see Table 3), and later to classify the organizations in Leaders, Followers, and, Laggers (see Table 2).

5.1 Types of Cloud

The cloud types mentioned in the literature are Public, Private, Hybrid and Community [4]. An organization's security and risk positioning can change the type of cloud a user uses. It is noteworthy

that in this research were identified different types of cloud configurations with predominance of Private Cloud (59%), in sequence Hybrid Cloud (24%), and finish the Public Cloud (5,66%), Not used (5, 66%) and Not Identified (5.66%). The scoring method was used for Types of Cloud according to Table 3

The predominance of Private Cloud in this research may be explained by the occurrence of government transactions involving high risk, government and citizen information. It is possible to verify the managers' concern with the environment and the architecture that the data will transact (Private Cloud 59%). This concern led more than half to prefer the use of private environments.

In some cases, Hybrid Cloud is beginning to gain ground as bot sensitive data and low risk data need to be managed. If this is feasible depends a lot on the technical competences of the team. The Public Cloud is still in an early and embryonic stage, as a data security configuration is still required before sending all information to a public cloud.

5.2 Type of Services

The type of service used in the cloud may vary depending on client needs. In the literature the most used types are SaaS, IaaS, PaaS [1, 12]. In this research, most use IaaS (88%). This can be explained as it is more interesting for government entities to contract cloud infrastructure and to manage the environment, according to demand and need. Only one government organization uses SaaS (6%) and it is very difficult to locate commercially available software that meets government and security criteria. Other organizations that did not migrate to the Cloud were still rated Not used / in Contraction (6%) in this study.

5.3 Providers Cloud

Cloud providers may be technology companies or an internal department. In this research we found that most of the Governments (States) are the cloud providers (30%). This explain the large amount of Private Cloud found.

Public cloud providers for State organizations identified in this research are Amazon AWS (12%), Embratel (6%), Google Cloud (6%), Microsoft Azure (6%), Oracle (6%), Ustore (6%), VMware (6%). Some respondents reported Not Utilized/in Negotiation (11%) and Not identified (11%). Providing cloud to their departments, organizations and cities requires robust infrastructure and management models from CloudGov [31, 32]. There respondent mentioned MultiCloud being a trend for the area.

5.4 Management Model

The concept about Cloud Models is how cloud management with the user, vendor and intermediaries occurs. In the literature [28, 32] it is possible to highlight 04 models, such as: Client, Broker, Provider and Orchestration. These interviews found that 36% of the states investigated are in the Client model because are for the purpose of receiving and using the Cloud only.

In sequence, States have a Provider Own model (24%) as they are Provider States for their departments, business units and cities that depend on it. The Broker model (12%) appears in two cases as it acts more in the management of Receipt and Provider Cloud as an intermediary. With a Model of Cloud is a relevant topic to rate Governance on the Matrix CloudGov we used the Model Cloud scoring system as shown in Table 5. The States Not Identified (11%) and Not Utilized/in Negotiation (11%) were identified. Noteworthy is that a State using the Orchestration model (6%) is a trend in Cloud [28], because MultiClouds and integrate multiple Clients in multiple ways.

5.5 Level of Utilization

Cloud utilization levels were investigated using a Scale. The concept of utilization is a how much this technology is utilized in Organization in comparison to the total potential use. This measure quantitative gives respondent to say to level High or Low. Respondents reported the Point (4) for a High Cloud utilization rate in the Organization and One (1) for a Low utilization rate.

In this research it is possible to identify that the use of Cloud in government organizations is concentrated in Level 3, being Medium-High, making it a tendency to use Cloud in public services. This item demonstrates how much government used remote services or technologies, providing a future trend for a complete Government migration to CloudGov. In parallel, some respondents focused on Low utilization (1 - 23.53%) as they did not yet migrate to Cloud and were classified as Laggers users losing money by not following technological trends, resulting in low performance and high costs of maintenance.

5.6 Technical Skills

Cloud knowledge and technical skills are a relevant for cloud teams. Understanding and having skills in the technology you use can be a skill you have or should learn [34, 35]. In this sense, Cloud Technical Skills levels were investigated whit respondents using a Scale. Respondents reported Point (4) for a High Technical Skills index at the Organization and One (1) for a Low Technical Skills index, according to Table 5

In this study it was possible to show that CloudGov users' Technical Skills are low as shown in Table 5. Respondents concentrated on Level 2 (54.05%) being an average level below on a scale from 1 to 4. It is important to highlight there was no response to Level 4. This results give us an insight to research on the Governments as a high interest in migrating to the Cloud, but few have the technical skills and competencies to do so.

5.7 Framework CloudGov Analysis

In order to refine the descriptive analysis, we order to categorize and classify the characteristics, a CloudGov Matrix was constructed in Table 4 and 6. It was possible to insert in a panel all the information collected in the questionnaire in a summary form to build an overview about CloudGov. The sum of these characteristics developed a Types of Organizations of the Leaders, Followers and Laggers of CloudGov. Of the sample investigated, 30% are CloudGov Leaders users as they promote utilization with cutting-edge technologies, superior technical skills and a high level of cloud utilization. Followers (53%) are Leaders' apprentices and are focused on being Cloud Clients and not necessarily aiming to be providers or best players in this context.

They are focused on learning through mimicking others. Laggers (17%) did not migrate to CloudGov and were in the process of

Table 4: Data Analysis - CloudGov Framework

ID	Type Cloud	Type Service	Provider	Management Model	Type Cloud-Gov
R1	Hybrid	SaaS	Embratel	Orchestration	**Leaders**
R2	Private	IaaS	Own	Broker	
R3	Private	IaaS	Own	Provider	
R4	Private	IaaS	Own	Provider	
R5	Hybrid	IaaS	Amazon	Broker	**Followers**
R6	Hybrid	IaaS	Microsoft	Client	
R7	Private	IaaS	No identified	Not identified	
R8	Private	IaaS	Ustore	Client	
R9	Private	IaaS	Vmware	Client	
R10	Private	IaaS	Oracle	Client	
R11	Public	IaaS	Google	Client	
R12	Hybrid	IaaS	Amazon	Client	
R13	Private	IaaS	Own	Provider	
R14	Private	IaaS	Own	Provider	
R15	Not Use	IaaS	No use	No use	**Laggers**
R16	Private	IaaS	No identified	No identified	
R17	Not Use	No Use	No Use	No use	

Table 5: Matrix Analysis CloudGov Framework

ID	Type Cloud	Mgm. Model	Level Utiliz.	Tech. Skills	Sum.	Type Cloud-Gov
R1	2	4	3	3	12	**Leaders**
R2	1	3	4	3	11	
R3	1	2	4	3	10	
R4	1	2	4	3	10	
R5	2	3	3	2	10	**Followers**
R6	2	1	3	2	8	
R7	1	0	3	3	7	
R8	1	1	3	2	7	
R9	1	1	3	2	7	
R10	1	1	3	2	7	
R11	3	1	1	2	7	
R12	2	1	2	2	7	
R13	1	2	2	1	6	
R14	1	2	1	2	6	
R15	0	0	2	2	4	**Laggers**
R16	1	0	1	2	4	
R17	0	0	1	1	2	

negotiation behind other States. In some cases they are not migrated to the cloud at all and they had a conservative mindset, focused on physical machines, stable and functional services such as the data center itself. We performed a frequency analysis with the respondents' data for an empirical classification of user types in Table 5. After presenting the descriptive results of this research, we combined results from characteristics, giving us an overview of the types of CloudGov organizations and theirs scores. Figure 1 presents combination of the Level of Utilization and Technical Skills characteristics. This figure give us the opportunity to graphically see patterns among respondents.

Figure 1 shows Leaders are on the right and superior part of the graphic (green cloud), Laggers on the bottom left of the graphic (red cloud), and, Followers on the intermediary parts of the graphs (gray cloud).

5.8 Types of Pressures and Influence on each type of CloudGov Adoption Level

This section presents the results of analysis to identify institutional pressures and associate the frequency with each type of organization (Leader, Follower, Lagger). We found five different institutional pressures that influence the CloudGov. They were Connectivity, Political Agenda, Management Model, Technical Skills, and, Costs. Each of these institutional pressures are somehow associated with all types of CloudGov organizations in a positive or negative way. As an example, Leaders already have high skilled civil servants, while Followers are training their civil servants to achieve the same level of skills seen on Leaders. Below, we present the analysis for each of these five institutional pressures.

The **Political Agenda** and political support becomes relevant to the speed of government migration to CloudGov. In interviews in a Lagger Case (R16) it was possible to show that when there is no political support, be it internal or external, CloudGov projects do not advance, they are without resources and people and paralyzed for 10 years. On the other hand, in Case (R5) it was verified that the Governor is acting strongly in the innovation of the State, including bringing the implementation of Datacenters close to its database, aiming at the evolution and following government innovations.

Management Model used in CloudGov, can be considered as an internal Driver that will command the operation. When interviewing a Case (R3) classified as Leader, it is possible to verify the search for orchestration tools, and Cloud Management Platforms (CMP), which is a management model that connects with Multi-clouds. Such a model can be fully evidenced and, in contrast, in Laggers Cases (R16) in which the focus is only to be a Client Management model, only receiving the cloud and perhaps supplying only to its internal sub-clients. In this sense, we can consider the Management Model as a decisive factor for the operationalization of the CloudGov Strategy.

Technical Skills have emerged as a basic requirement for CloudGov. In Leaders' Cases (R3) they are always looking for new knowledge, training and qualification in the Cloud. This can happen through partnerships with public cloud providers, discussion rounds, among others. Having people interested in news and technology and qualified for this can become a differentiator in the Cloud. Regarding the Followers, we can evidence that they are trying to learn from Leaders, but there is a limitation regarding top trends, such as Container Management and Edge Computing. Laggers Cases, on the other hand, always arrive last in the training issue, but it is interesting in the interviews that it was possible to

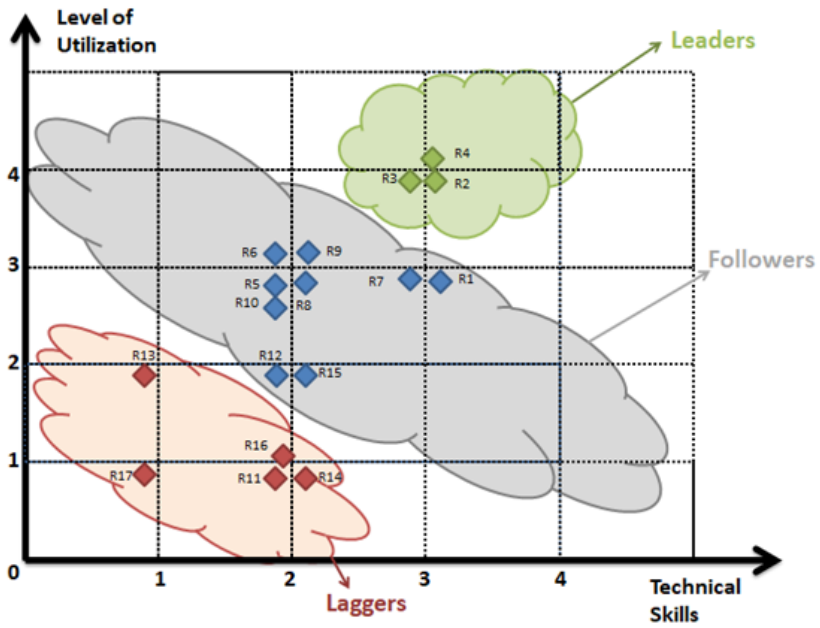

Figure 1: CloudGov Framework – Analysis

detect that they are trying to make up for lost time (R16), probably because the CloudGov Project was stopped because it had no political agenda.

The **Costs** of going to CloudGov are decisive factors given the expense savings discourse. There is an ambiguity still in research on Cloud Computing that migration to the Cloud results into cost savings for organizations. Henc, it is relevant to perform cost calculation in further research. Looking only with optics for infrastructure and machines, CloudGov is more financially viable, but in some cases it is neglected that people need high-level training, orchestration platforms (CMP) and increase investments and security. Cost is an important Driver for cloud adoption by Laggers and Followers.

6 DISCUSSION AND CONCLUSIONS

Cloud computing are used by public organizations all over the world, yet the level of use differs. The type of cloud, cloud services, cloud providers, management models and level of utilization and technical skills can be used to characterize cloud usage of organizations. Founded in Diffusion of Innovation and Institutional theory three types of organizations were identified, e.g. leaders, followers and laggers.

Leaders are innovative CloudGov users who have high levels of technical expertise and knowledge. They often use advanced management models, such as MultiCloud Orchestration with public and private cloud providers. Some cases have a fibre optic network resulting in reduced connectivity latency. They are supported by political agendas, and the CloudGov initiative should contribute to the political agenda.

Followers are influenced by mimetic pressures where they are sensitive to the news and what others do, but are also risk adverse. Most of them use Private Cloud environments to ensure high levels of control. Often the Cloud and political agenda are not aligned with each other. The Cloud political agenda in these cases had hardly any influence, but cloud use are internal initiatives by imitating others.

Laggers were identified in this research as users who have hardly or not adopted CloudGov at this time and, if adopted, they often use it only for their basic services. Some laggers wanted to adopt the cloud but were delayed due to lack of political agenda, excessive costs or lack of competent technical skills with the people who led projects in the governments. Some Laggers even have interesting cloud use proposals, but the uncertainty and fear by their management result in a lack of progress. They often lack the expertise and are not able to integrate the use of cloud in their overall policy.

We suggest future research to investigate the application of the CloudGov Framework presented in other countries, analyze adoption of Cloud in multilevel (local, regional and federal), and theoretical deepening of what are the pressures that government organizations suffer in the adoption of new technologies and how this process is configured.

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REFERENCES

[1] Janssen, M. and A. Joha. Challenges for adopting cloud-based software as a service (SaaS) in the public sector. in ECIS - European Conference on Information Systems. 2011.

[2] El-Gazzar, R.F., A Literature Review on Cloud Computing Adoption Issues in Enterprises, in IFIP Advances in Information and Communication Technology. 2014, Springer Berlin Heidelberg. p. 214-242.

[3] Mohammed, F., *et al.*, Cloud computing adoption model for e-government implementation. Information Development, 2017. 33(3): p. 303-323.

[4] Yang, H. and M. Tate, A Descriptive Literature Review and Classification of Cloud Computing Research. Communications of the Association for Information Systems, 2012. 31(2): p. 35-60.

[5] Pinheiro Junior, L.P. and M.A. Cunha. Cloud Computing in Government: Benefits and Risks in Cloud Contracting. in AMCIS - Americas Conference on Information Systems. 2017.

[6] Paquette, S., P.T. Jaeger, and S.C. Wilson, Identifying the security risks associated with governmental use of cloud computing. Government Information Quarterly, 2010. 27(3): p. 245-253.

[7] Alkhlewi, A., R. Walters, and G. Wills. Success Factors For the Implementation of a Private Government Cloud in Saudi Arabia. in International Conference on Future Internet of Things and Cloud. 2015.

[8] Abu-Shanab, E. and F. Estatiya. Utilizing Cloud Computing in Public Sector Cases from the World. in IEEE International Conference on Applied System Innovation. 2017. Sapporo, Japan.

[9] Ali, O., J. Soar, and J. Yong, An investigation of the main factors to be considered in cloud computing adoption in Australian regional local councils. Journal of Contemporary Issues in Business and Government, 2015. 21(1): p. 72-72.

[10] Ali, O., *et al.*, Assessing information security risks in the cloud: A case study of Australian local government authorities. Government Information Quarterly, 2020. 37(1): p. 101419.

[11] Sallehudin, H., R.C. Razak, and M. Ismail, Factors Influencing Cloud Computing Adoption in the Public Sector: An Empirical Analysis. Journal of Entrepreneurship and Business, 2015. 3(1): p. 30-45.

[12] Wyld, D., Moving to the cloud : An introduction to cloud computing in government. 2009: IBM Center of The Business of Government. 83-83.

[13] Mreea, M., K. Munasinghe, and D. Sharma. A Strategic Decision Value Model for Cloud Computing in Saudi Arabia's Public Sector. in IEEE International Conference on Computer and Information Science. 2016. Okayama, Japan.

[14] Alassafi, M.O., *et al.*, A validation of security determinants model for cloud adoption in Saudi organisations' context. International Journal of Information Technology, 2019.

[15] Alzadjali, K. and A. Elbanna, Smart Institutional Intervention in the Adoption of Digital Infrastructure: The Case of Government Cloud Computing in Oman. Information Systems Frontiers, 2019.

[16] Webster, J. and R.T. Watson, Analyzing the past to prepare for the future: Writing a literature review. MIS quarterly, 2002: p. xiii-xxiii.

[17] Sharma, R. and R.K. Trivedi, Literature review: Cloud Computing – Security Issues , Solution and Technologies. International Journal of Engineering Research, 2014. 3(4): p. 221-225.

[18] Mell, P. and T. Grance, The NIST definition of cloud computing. 2011, National Institute of Standards and Technology - US Department of Commerce. p. 1-7.

[19] Kundra, V., Federal Cloud Computing Strategy. 2011: Washington, DC. p. 1-43.

[20] Hu, Y. and G. Bai, A Systematic Literature Review of Cloud Computing in eHealth. HIIJ - Health Informatics-An International Journal, 2014. 3(4): p. 11-20.

[21] Wyld, D., The Cloudy Future Of Government IT: Cloud Computing and The Public Sector around the World. International Journal of Web & Semantic Technology (IJWesT), 2010. 1(1): p. 1-20.

[22] Bhisikar, A., G-Cloud : New Paradigm Shift for Online Public Services IaaS PaaS SaaS. International Journal of Computer Application, 2011. 22(8): p. 24-29.

[23] Ali, O., J. Soar, and J. Yong. Impact of Cloud Computing Technology on E-Government. in International Conference on Information and Software Technologies. 2014.

[24] Hasty, B.K., G.M. Schechtman, and M. Killaly, Cloud Computing: Differences in Public and Private Sector Concerns. International Journal of the Academic Business World, 2012. 6(1): p. 51-62.

[25] El-Gazzar, R. and F. Wahid. Strategies for Cloud Computing Adoption: Insights from the Norwegian Public Sector. in EMCIS - European, Mediterranean & Middle Eastern Conference on Information Systems. 2015. Athens, Greece.

[26] Danielsen, F., L.S. Flak, and A. Ronzhyn. Cloud Computing in eGovernment: Benefits and Challenges. in International Conference on Digital Society and eGovernments. 2019.

[27] Cellary, W. and S. Strykowski. E-Government Based on Cloud Computing and Service-Oriented Architecture. in ICEGOV - International Conference on Theory and Practice of Electronic Governance. 2009.

[28] Lnenicka, M. and J. Komarkova, Developing a government enterprise architecture framework to support the requirements of big and open linked data with the use of cloud computing. International Journal of Information Management, 2019. 46: p. 124-141.

[29] Liang, J. Government cloud: Enhancing efficiency of E-government and providing better public services. in International Joint Conference on Service Sciences. 2012.

[30] Ali, O. and S. Anup. Analysis of the Total Cost of Ownership for Cloud Computing Technology Adoption : A Case Study of Regional Municipal Government Sector. in Australasian Conference on Information Systems. 2017. Hobart, Australia.

[31] Ruiz, J.J. and O. Avila. Identifying criteria for evaluating Cloud Services in the Colombian public sector. in AMCIS - Americas Conference on Information Systems. 2017. Boston, USA.

[32] Janowski, T., Digital government evolution: From transformation to contextualization. Government Information Quarterly, 2015. 32(3): p. 221-236.

[33] Dermentzi, E., E. Tambouris, and K. Tarabanis, Cloud Computing in eGovernment: Proposing a Conceptual Stage Model. IJEGR - International Journal of Electronic Government Research, 2016. 12(1): p. 50-68.

[34] Shareef, S. The adoption of cloud computing for e-Government initiative in regional governments in developing countries. in ECEG - European Conference on eGovernment. 2013.

[35] Shafique, M.A., *et al.*, Determinants Impacting the Adoption of E-Government Information Systems and Suggesting Cloud Computing Migration Framework. International Journal of Advanced Computer Science and Applications, 2017. 8(9): p. 173-182.

[36] Wang, N., *et al.*, The dual roles of the government in cloud computing assimilation: an empirical study in China. Information Technology & People, 2019. 32(1): p. 147-170.

[37] Wahsh, M.A. and J.S. Dhillon, A Systematic Review of Factors Affecting the Adoption of Cloud Computing for e-Government Implementation. Journal of Engineering and Applied Sciences, 2015. 10(23): p. 17824-17832.

[38] Rogers, E.M., Diffusion of innovations. 2010: Simon and Schuster.

[39] Chandler, D. and H. Hwang, Learning from learning theory: A model of organizational adoption strategies at the microfoundations of institutional theory. Journal of Management, 2015. 41(5): p. 1446-1476.

[40] Redmond, W.H., Innovation, diffusion, and institutional change. Journal of Economic Issues, 2003. 37(3): p. 665-679.

[41] DiMaggio, P.J. and W.W. Powell, The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. American sociological review, 1983: p. 147-160.

[42] Scott, R., Institutions And Organization: Ideas and Interest. 2008, USA: Sage Publication.

[43] Yin, R.K., Case Study Research: Design and Methods. 5th ed. 2013, London: Sage Publications. 312-312.

[44] Bardin, L., Análise de conteúdo. rev. e atual, in Lisboa: Edições. 2009. p. 3.