

# On the Adoption of ICT Best Practices in Brazilian Federal Higher Education Institutions

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**Abstract**—ICT governance aims at guiding a better investment of technological resources so that the organization improves its performance and productivity. To this end, organizations often employ well-tested, and documented processes also called ICT best practices. Due to its own nature and way of management, public institutions are examples of organizations that need specific studies to implement ICT best practices. The focus of this work is to investigate how ICT best practices are employed by the Brazilian Federal Higher Education Institutions (IFES). We use two regulations to perform such analysis: the IFES IT Director Plans (PDTI) documents and the IN04/2014 normative instruction of the Brazilian federal government that provide guidelines about how institutions should hire their ICT solutions. With information gathered from such documents, and also some related literature materials, was possible to determine an initial set of ICT best practices that could suit the needs of the IFES. This initial set was used to build a survey that was sent to all of the IFES. The results show heterogeneity in the use of best practices by the Brazilian universities that may be related to particular characteristics of each institution such as the size of the ICT department and the academic degree of its employees.

**Index Terms**—IT governance, best practices, public sector, Brazilian federal education institutions, survey.

## I. INTRODUCTION

Currently, companies from various sectors rely on technology, as it provides a more flexible communication between the stakeholders. The technology also provides several other benefits such as greater agility in performing tasks, which results in better functioning of the organization and consequently a higher revenue. Another studies that exhibit strong indications that ICTs positively affect the performance of organizations are [1], [2], [3] and [4].

However, organizations should not just use technology without proper counseling. They should use technology according to their needs and business segment. It is well known that technology must be applied consistently to better profitability. [5], for example, shows the importance of employing ICT governance, with a return of up to 40% ICT investment in such companies, contributing to a better alignment between information and business systems. On the contrary, [6] explains that on average 70% of the projects involving ICT do not come to an end which causes a deficit of 30 billion dollars to the United States annually.

Lunardi [7] points out that although some organizations view ICT as one of its primary assets, decisions on adoption, implementation, and management remain quite difficult, which has wasted a lot of money in poorly performed technological acquisitions. The *frameworks* ITIL [8] and COBIT [9] are examples of tools that can be used to assist the information and communication technology governance (ICT Governance). One of the primary objectives of COBIT is to meet the needs of ICT management through the promotion of an updated and automated set of processes/best practices applicable to ICT. Its adoption ensures that ICT objectives are aligned with the company's goals, allowing an indication of the resources to be used, as well as risk management.

Brazilian normative documents assisting in the implementation of ICT Governance bring their benefits since, along with what must be followed, manuals and models are made easier to implement, which is a positive point because they have the necessary practices that help ICT in the institution, such as the PDTI for example. These documents may be a limitation if the instruction is not reviewed in periodicity to follow the new technologies and processes that appear in the market.

To guide and improve the management of its information systems and technology the Brazilian federal government has created the System of Administration of the Resources of Information Technology (SISP) [10] under the decree no. 1,048 of 21 January 1994 and subsequently updated by Decree No. 7579 of October 11, 2011.

In addition to SISP, the Brazilian federal government instituted IN04/2014, that deals with the process of contracting IT solutions by the SISP members. Together with IN04/2014, several manuals were released to assist in the implementation of the IT Management Committee (CGTI). In other words, SISP, IN04/2014, and CGTI are attempts by the Brazilian federal government to encourage the implementation of a more efficient ICT Governance within its units. The IT Director Plan (PDTI) is seen as a significant document in institutions, since it has the primary function of meeting the information and communication technology needs of the organization in a certain period, taking into account the area of action, expectations, and goals. Such a document may have a different validity. The SISP also shows that the ideal period of validity for a PDTI is around two years, but presenting annual updates

containing guidelines, plans, and budgets.

Despite the incentives of the federal government, the adoption of ICT Governance in public organizations could be problematic. Ferreira Batista [11] states that there are several restrictive factors to strategic planning in public organizations. Some of them include the views of leaders and the manipulations by the interest groups that are sometimes more important than the issues and the definition of good performance in public organizations that is arguable and in some cases difficult to understand and measure.

By looking to the Brazilian federal higher education institutions (IFES), in addition to the previously mentioned factors, other factors may hinder the adoption of ICT Governance mechanisms such as the decentralization of decision making, different conceptions of the university coexistence and reduced coordination tasks [12]. Such complexity requires managers creativity in the development of innovative management models and approaches to make decisions within the scope of academic freedom [13].

Despite the complexity of the academic environment, recent work [11], [13] show that some IFES are trying to adopt practices of ICT Governance to better use of resources especially making use of an IT Director Plan.

Given the raised discussions, this study has the following objectives: 1) identify a set of relevant ICT best practices for IFES, based on documents such as institutional PDTI and the IN 04/2014 and 2) provide an initial overview of the situation of Brazilian federal universities facing the adoption of ICT best practices.

This paper is structured as follows. Section 2 describes related work. Section 3 presents the methodology used to identify a particular set of ICT best practices for Brazilian federal higher education institutions. Section 4 discusses the results obtained with the methodology employed in the research. Section 5 presents some implications of the study. Finally, Section 6 concludes the paper.

## II. RELATED WORK

Several papers point out to the issue of ICT governance in Brazilian companies. [7] presents an evaluation of the most commonly used ICT frameworks is presented in national companies. These tools include ITIL, COBiT, SOX, Own Model, SLA/SLM, and others. In this evaluation, the authors conclude that the most widely used mechanisms are ITIL followed by COBiT applied in industry and service sector. In another investigation conducted by Lunardi et al. [14], the authors studied the perceived impact of the adoption of several ICT Governance mechanisms on the ICT management performance. The study was conducted with 83 ICT managers and allowed the identification of the most used ICT Governance mechanisms adopted by their organizations. Some of the mechanisms include the adoption of a Strategic Planning of Information Technology (PETI), the feasibility analysis of ICT projects and the use of committees for specific ICT projects.

The application of ICT governance in private companies and public institutions in Brazil is difficult to measure accurately.

Silva and Rosa [15] evaluated the alignment between business and ICT by using popular frameworks of ICT management as a reference. They sent electronic questionnaires to 230 Brazilian companies, but only 32 provided answers. Among the answers, 27 of them stated that they use some tool for ICT governance, such as COBiT, ITIL, and CMMI.

Sohal and Fitzpatrick [16], through an electronic questionnaire, showed the similarities and differences between high, medium and low-level ICT companies and then established a set of recommendations to be provided to companies of such sizes. Some of these recommendations are the alignment between Chief Information Officer (CIO) and Chief Executive Officer (CEO), for better contact between them, better financial management for checking the benefits of ICT for the organization and increase management commitment to ICT, which increases the need to improve their visibility in organizations.

Another research that studies private companies is proposed in [17]. Huygh [17] discussed the transparency of ICT governance in Belgium and South African companies with centralized and decentralized ICT governance. The authors show the importance of information transparency since in the companies studied, those in South Africa follow an IT framework that relies on information dissemination, leaving them better prepared than the firms in Belgium.

Among the works that deal specifically with public companies, we can mention the research proposed by [18]. Using a survey, the authors evaluated the situation of ICT Governance in a public research institution, the Oswaldo Cruz Foundation - FIOCRUZ, in which, they compare the difference of the ICT Governance in the different sectors of the institution. The results show that the ICT Governance, when done in a decentralized way, may present differences between the vision/functioning of the manager from one sector to another.

Another work to be mentioned when talking about IT governance in public universities is [19], where the author presents the state of the application of PDTI in UFSM in its first version and brief information on the second version. The author presents the level of governance in the institution since its first PDTI was implemented in 2012 with a two-year term, where it had 25 goals, of which 14 were met. At the end of the first year of PDTI an evaluation was made based on COBIT 4.1, which showed that with the progress of governance in the institution and inclusion and fulfillment of goals, 17 ICT practices were continuous, 13 at the initial level and 4 at no applied.

It is well known that public institutions have aids to implement the IT governance of the federal government (like PDTI adoption manuals and IT committee for example), there is a need to identify the most relevant practices for such institutions, since there are standards for such a group some of the practices may be more important than others. The present study intends to extend the results presented in Borges et al. [20] where have been investigated only some of the Brazilian federal higher education institutions. In the present paper, we were able to add new institutions and also to expand the analysis.

### III. METHODOLOGY

The methodology used in this research was partially based on the work proposed by Borges et al. [20]. The figure 1 illustrates the main steps of the methodology. First, we identified the need for research on ICT Governance, to understand what the practices commonly used by ICT managers, and which would be related to the objectives of an IFES.

In order to comply with the first step, the following works were chosen: [18], [21] and [22] since they had a methodology that could help in parts as well as several best practices. With such a bibliography was possible to determine an initial set of best practices.

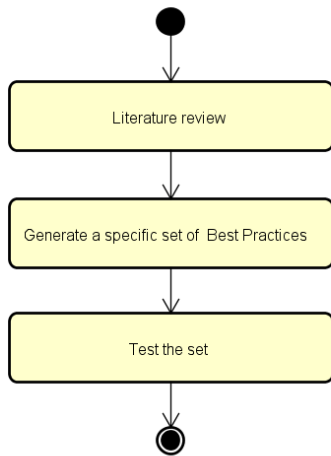


Fig. 1. Simplified process for testing set of [20]

The second step is to compare these practices with the content of two documents designed to help standardize the ICT processes of IFES, such as the PDTI of one IFES (used as a reference) and the other normative instruction (IN04/2014). The objective is to verify which of the practices present in the initial set are related to the contents of the PDTI and normative instruction. At the end of this step, it was possible to create a new set of good practices, closer to the needs of the federal institutions of higher education.

The set of best practices specific to IFES can be seen in the table I. It reflects characteristics of federal educational institutions, respecting current norms described by SISP, SLTI, and IN04/2014. Whereas, according to the SISP, the PDTI is a mandatory document for IFES linked to the SISP, such as the IFES. The IN 04/2014 reflects the norms of the Brazilian federal government that the IFES should follow when it comes to contracting third-party ICT services.

The set presents twenty-five practices which are divided into the four macro processes proposed in [21]. The macro processes are Business Processes and ICT Strategy, ICT Management, ICT Operation and ICT Security. The macro processes are defined as follows:

- **Business Processes and ICT Strategy:** Macro process responsible for identifying the business situation and the

IT environment, thus seeking to achieve the company's strategic objectives.

- **ICT Management:** Responsible for managing and allocating use of ICT resources, aiming at the best return on investment in ICT.
- **ICT Operation:** Macro process responsible for ensuring continued support of the ICT environment, thus ensuring business continuity.
- **ICT Security:** Macro process responsible for managing information in the corporate environment.

The next step in the methodology is to evaluate the adoption of the best practices of our group on IFES. Thus, the third step is related to the creation and analysis of an electronic questionnaire answered by IFES ICT managers.

Before the release of the questionnaire to the respondents, it was necessary to validate it with a profile similar to the public respondents. This phase took a week, and we had the collaboration of researchers from the Information Technology Center (CTI) of the Federal University of Uberlândia, as well as researchers from the research group in Software Engineering GAIA, linked to the State University of Londrina. Throughout the validation process, was possible to improve understanding of some of the proposed issues and to refine how exposed best practices would be to respondents.

With the questionnaire validated, the following attempts were made to contact the managers of the IFES:

- 1) Sending the questionnaire electronically to all ICT managers of IFES using a particular email list used for communication among managers;
- 2) Submission of the questionnaire by electronic means to a list drawn up on the pages of IFES along with an email list raised by contact in the social networks of the universities - In this attempt was made contact with all the forty-four universities that owned a page in the network to collect personal e-mail from the IFES's ICT manager and thus forwarded the questionnaire to the same.
- 3) Contact via phone - In this attempt, the number of the manager of ICT or ICT center was collected on the page of the IFES and tried to contact with him.
- 4) Sending the questionnaire by electronic means to the list of the Brazilian Society of Computing (SBC). This attempt was similar to the first one, but this time everyone present on the SBC list was contacted.
- 5) Direct contact with teachers and students that shared some association with the ICT staff of the institutions to collect answers.

The preliminary results of this electronic questionnaire can be seen in [20]. The objective of the current work is to expand the number of participating IFES and propose new analyzes to improve understanding about the adoption of ICT Governance in IFES. Therefore, the questionnaire saw in Figure 2 was used again, but this time it was sent to all of the 40 remaining IFES, thus totaling a total of 103 IFES.

Such questionnaire was sent electronically to the ICT Man-

**Caracterização do respondente**

Esta seção visa caracterizar o respondente (Gestor de TIC). (5 questões)

**Qual a instituição em que você trabalha? \***

Sua resposta

**Qual o seu nível de escolaridade? \***

Ensino Médio

Técnico

Graduação

Mestrado

Doutorado

**Qual sua área de formação? \***

Matemática, Administração, Computação, etc.

Sua resposta

**Onde concluiu sua graduação?**

Sua resposta

**Onde obteve sua/suas Pós-Graduações?**

Caso possua mais de uma Pós-Graduação colocar os nomes em ordem de conclusão separados por ; (Ex para doutorado: UFPA, UFPA)

Sua resposta

**Mapeamento de boas práticas de TIC implementadas em Universidades Federais**

Esta seção visa conhecer as boas práticas de TIC consideradas mais importantes ou aplicadas para os Gestores de TIC das universidades federais. (25 boas práticas)

**Assimile a boa prática de TIC de acordo com os indicadores. \***

	Não Aplica	Aplica Parcialmente	Aplica Integralmente	Planeja Aplicar
Definir um Plano Estratégico de TIC	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Definir Processos, Gerenciamento da Capacidade	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciamento do Catálogo de Serviços	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Planejamento de Contratação	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assegurar a Conformidade com Requisitos Externos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Adquirir e Manter Infraestrutura de Tecnologia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciamento de Segurança da Informação	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assegurar Continuidade de Serviços	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assegurar a Segurança dos Serviços	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciar Projetos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Adquirir e Manter Software Aplicativo	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciar Softwares de Terceiros	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciar Capacidade e Desempenho	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educar e Treinar Usuários	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciar a Central de Serviços e os Incidentes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciamento Financeiro	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciamento da Demanda	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciamento da Capacidade	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciamento do Catálogo de Serviços	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Planejamento de Contratação	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assegurar a Conformidade com Requisitos Externos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Adquirir e Manter Infraestrutura de Tecnologia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gerenciamento de Segurança da Informação	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assegurar Continuidade de Serviços	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assegurar a Segurança dos Serviços	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Fig. 2. Mirror of the proposed questionnaire

agers, ICT Officers or even to the Rectors of the covered institutions. In addition to these emails, people related to the authors were contacted, such people being ICT-related and Directors or senior staff in the IFES to respond to the questionnaire.

As presented by Kotulic and Clark [23] there is a difficulty in collecting information via questionnaire. Since in his work one thousand and five hundred questionnaires were sent by different means of contact, but received only sixty-seven.

The following section shows the results obtained with the application of the questionnaire and outlines a profile on the use of ICT best practices in IFES.

TABLE I  
SET OF ICT BEST PRACTICES FOR IFES OF BORGES [20]

Macro processes	#	ICT Best Practice	Origin
Business and ICT Strategy	1	Define an ICT Strategic Plan	ITMP
	2	Define ICT Processes, Organization and Relationships	ITMP
	3	Identify Solutions	ITMP
	4	Provide ICT Governance	ITMP
	5	Strategy Generation	ITMP
	6	Management Model	IN04
	7	Information Technology Director Plan (PDTI)	IN04
	8	Information Technology Committee	IN04
ICT Management	9	Managing ICT Human Resources	ITMP
	10	Manage Projects	ITMP
	11	Acquire and Maintain Application Software	ITMP
	12	Manage Third-Party Software	ITMP
	13	Manage Capacity and Performance	ITMP
	14	Educate and Train Users	ITMP
	15	Manage Service Desk and Incidents	ITMP
	16	Financial Management	ITMP
	17	Demand Management	ITMP
	18	Capacity Management	ITMP
	19	Service Catalog Management	ITMP
	20	Hiring Planning	IN04
ICT Operation	21	Ensure Compliance with External Requirements	ITMP
	22	Acquire and Maintain Technology Infrastructure	ITMP
ICT security	23	Information Security Management	ITMP
	24	Ensuring Continuity of Services	ITMP
	25	Ensuring Service Security	ITMP

## IV. RESULTS

The results of our survey might uncover some details regarding the ICT characteristics of the IFES, for instance: which best practices are being adopted by them? Since all IFES should report to the Brazilian government laws, is there a pattern of practices adopted by them? Which ICT areas could be seen as problematic due to a low adoption rate of a particular best practice?

It is possible to point out similarities between the set used for IFES and sets used in other segments. In the literature it was possible to mention three works with collections that had practices contained in the set used in this paper: Albuquerque [18], Junior [24], and Barreto [21] shown in Figure 3 as *reference #1*, *reference #2* and *reference #3* respectively along with the similar practices below.

It is also possible to note that some of the best practices of all educational institutions are dependent on one another, and can be seen as an example of the PDTI and the ICT Strategic Plan (PETI), which is a document that takes the strategic ICT plan into account develop the IT director plan. Also, the best practices of the ICT security macro-process reflect a current concern of managers of public institutions [25], [26]. These same practices are recommended in other works such as [18] and [21], which can be seen in Figure 3. It seems that the macro-process related to ICT Management is very relevant for the Brazilian federal higher education institutions, given the relative number of best practices related to this item.

As seen in the set proposed by Barreto and Hino [21], it was divided into four macro processes, being:

- **Business Processes and ICT Strategy**
- **ICT Management**
- **ICT Operation**
- **ICT Security**

The ICT management macro-process has significant number of best practice in both cases Hino and Barreto [21] and Borges

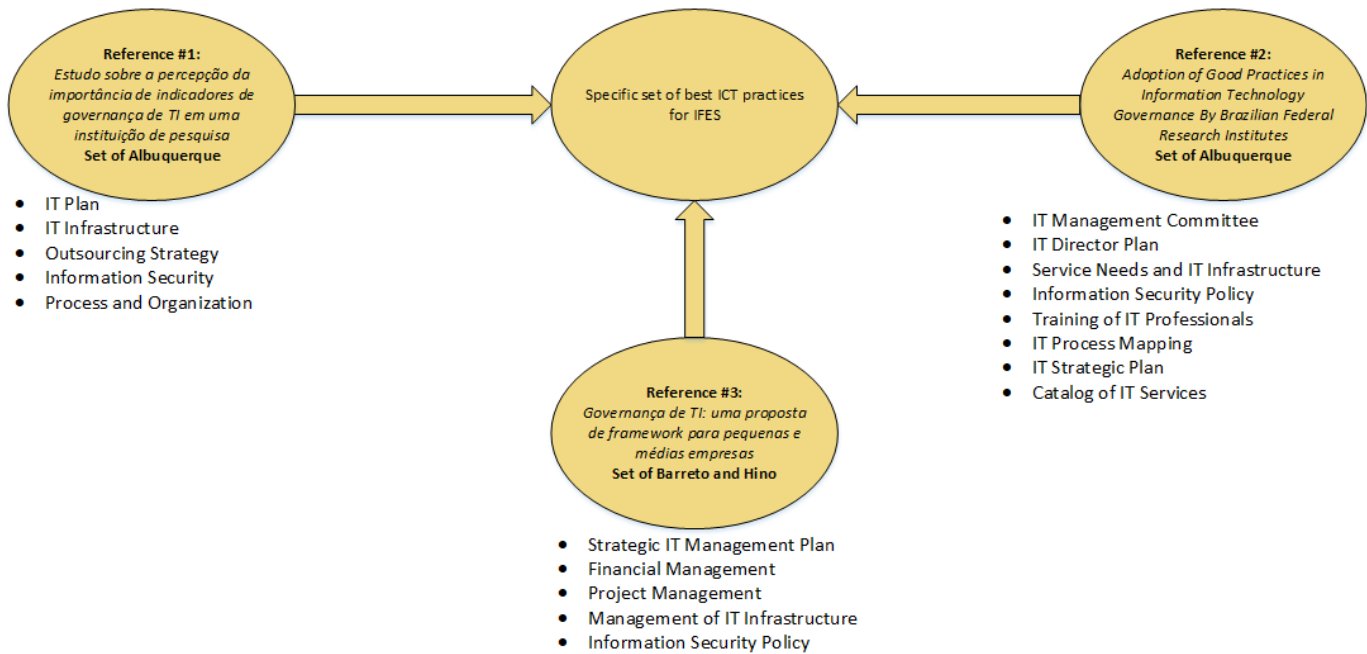


Fig. 3. Similarity between the sets found in literature and the proposed set

[20]. This process is responsible for managing all resources of the institutions aiming at a better return on resources, which leads us to consider this macro-process as one of the most relevant for the implementation of ICT governance, corroborating the vision previously identified in [14], and [3]. Unique macro-processes to particular types of organizations such as ICT Operation and ICT Security present different best practices comparing with the set of Barreto and Hino [21], which highlights the particularity of public companies, particularly Brazilian federal universities, concerning other types of companies.

#### A. Questionnaire

The primary objective of the questionnaire is to begin a discussion about the adoption of ICT best practices in IFES. Based on such goal, we developed a questionnaire divided into five sections, as seen in Figure 2:

- Presentation (Apresentação) - It has no questions, only information about the author and the goals of the survey;
- Context (Contextualização) - It has five questions covering ICT Governance and ICT management;
- Characterization of the institution (Caracterização da instituição) - It has five questions to gather information about the IT area of the institution;
- Characterization of the respondent (Caracterização do respondente) - It has five questions to collect information about the respondents;
- Mapping of ICT best practices implemented in Brazilian federal universities (Mapeamento de boas práticas de TIC implementadas em Universidades federais) - It consists of a table with a Likert scale for each of the twenty-five

ICT best practices. For every best practice the respondent should answer: "Does not adopt", "Partially adopt", "Fully adopt" and "Intend to adopt".

The target audience of the questionnaire are directors, managers and ICT analysts of the Brazilian IFES, that is, employees capable of identifying ICT best practices and respond questions related to their adoption within the work environment.

The entire process of attempting to contact the IFES and waiting for replies took one hundred and eighty three days. In the end, our response rate was 18.5% - 19 out of 103 IFES as shown in Table II.

TABLE II  
 NUMBER OF INSTITUTIONS AND RESPONDENTS BY KIND

	Universities	Federal Institutes	CEFET's
Total	63	38	2
Respondents	10	8	1

Next, we present a brief analysis of the characterization of our respondents. First, all IT managers who answered the questionnaire have knowledge about ICT governance and ICT management, with good or total clarity about the difference between them. Only 10% of managers say that they do not apply such approaches in their work environment, while 37% apply ICT Governance or ICT management (of which 30%, 20% apply ICT Governance, and 10% apply ICT management) and 53% use both as seen in Figure 4. In the field of knowledge of ICT best practices, some managers do not know best practices (40%) of ICT and from which they can be withdrawn. Our results also show that most of the ICT employees have a bachelor degree 89% while only 11% of them hold a master

degree. As for the exclusive ICT staff employed by the IFES, 37% of them have fifty to one hundred employees, 31.5% from ten to fifty and 31.5% less than ten. Finally, the ICT employees are working with the IFES for five years and eight months, on average.

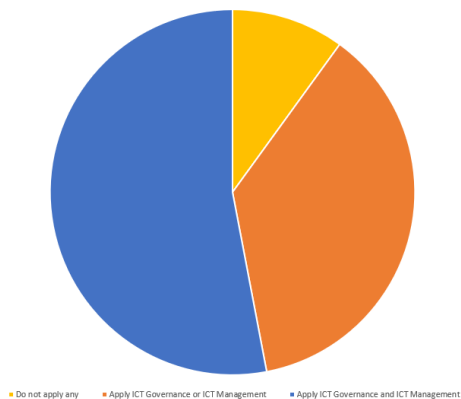


Fig. 4. Application of ICT Governance or ICT management

The most important part of the survey is the list of ICT practices. The presentation of such list allows identifying which of the practices the ICT managers apply in the institutions. They should be considered at four levels, *fully implemented, partially implemented, not implemented and planning to implement*. Figure 5 shows that only one practice is partially or integrally applied as it is *acquiring and maintaining technology infrastructure*. It is worth highlighting the two practices that have the best rates of fully adoption *Information Technology Director Plan* and *Information Technology Committee*. Another relevant discovery is that 58% of the respondents do not partially or fully apply the best practice related to financial management. Regarding the PDTI and the information technology committee, it is possible to notice that in 79% of the cases it is implemented in whole or in part and in another 5% they are in the planning phase, which indicates a compliance to the IN04/2014 regulation. The practice *ensuring compliance with external requirements* was the only one that does not have an integral application, only partial.

To have a big picture of the practices adopted by the IFES, we established a numeric score for each practice: two points for the full application, one for partial use, one for planning to apply and none for not applying. With this, it was possible to rank the institutions between the one that uses the practices the most and the one that least applies.

Since there are twenty-five practices, it would be possible to achieve up to fifty points if it had full application in all practices. Using this logic, we might recognize the UFSC (Federal University of Santa Catarina) with forty-five points as Table III (organized according to respondents returned contact) as better prepared in terms of the set used in this study and the IFSULMG (Federal Instituto Sul de Minas Gerais) as the least prepared one.

## B. Evaluation of factors influencing the adoption of best practices

Four hypotheses were proposed to improve the understanding of the factors that influence the adoption of best practices in IFES. All the hypotheses were formulated to understand the relationship between the different characteristics of an ICT department and the adoption of best practices.

- *Hypothesis # 1 Maintaining an ICT department with a qualified manager (the ICT manager holds a masters or doctoral degree, for example) influences the amount of best practice applied within the institution.* We compared two sets: the average number of best practices adopted by organizations in which the respondent has only undergraduate ( $H1_{M1}$ ) and the average number of best practices adopted by institutions in which the respondent has a postgraduate degree ( $H1_{M2}$ ).
- *Hypothesis #2 Institutions with more outsourcers in the ICT area tend to be more concerned with user education and training.* Was compared two sets: the average value of adoption of the "User Education and Training" (2 = applies fully, 1 = partially applies, 0.5 = plans to apply and 0 = does not apply) to institutions without outsourced employees within the ICT area ( $H2_{M1}$ ) and the average value of best practice adoption "Education and User Training" for institutions with at least one outsourced employee within the ICT area ( $H2_{M2}$ ).
- *Hypothesis #3 Institutions with a larger number of ICT staff tend to adopt a higher number of best practices.* We compared two sets: the average number of best practices adopted by institutions where the number of ICT staff is between 0 and 50 ( $H3_{M1}$ ) and the average number of best practices adopted by schools in which the number of ICT staff is between 50 and 100 ( $H3_{M2}$ ).
- *Hypothesis #4 Institutions with more experienced ICT staff tend to adopt a higher number of best practices.* We compared two sets: the average number of best practices adopted by institutions where the number of ICT staff has up to 5 years of experience ( $H4_{M1}$ ) and the average number of best practices adopted by schools in which the number of ICT staff has more than 5 years of experience ( $H4_{M2}$ ).

We employed T-test, which is a statistical test commonly applied for comparing two independent samples, to verify the significance of our hypotheses. The results of the T-tests for each of the hypotheses can be seen in Table IV. We use a confidence level of 95%, that is, values  $p < 0.05$  are considered significant.

With the aid of the test, we verified the validity of the hypotheses #1, #2 and #3. This shows that, according to the samples investigated, the qualification of the ICT department of a Brazilian federal higher education institutions influences the number of best practices applied (hypothesis #1). This is consistent with the argument that the qualification of the leaders might contribute in a positive way to the formation of a team, leading towards better results [27]. Another factor

TABLE III  
APPLICATION OF BEST IT PRACTICES BY BRAZILIAN FEDERAL HIGHER EDUCATION INSTITUTIONS

	UFU	UFERSA	UFPA	UFMG	UTFPR	UFPR	UFMG	UFLA	UFBA	UFSC	IFC	IFPB	IFS	IFCE	IFGOIANO	IFSULMG	IFTM	IFAC	CEFET-MG
1	2	2	2	1	2	0,5	1	2	1	2	1	1	2	2	0,5	0	1	0	0
2	1	1	1	1	1	1	0	1	1	2	1	0	1	1	1	0	0	1	0
3	2	1	2	0	2	2	1	1	1	2	1	1	2	2	1	0	2	1	1
4	2	2	2	0	2	2	1	2	1	2	0	0	1	1	1	0	1	1	1
5	0	1	2	0	1	1	0	1	1	1	0	0	1	1	0,5	0	0	0	1
6	0	0,5	1	0	1	0,5	0	1	0,5	2	0	1	2	1	0,5	0	1	1	0
7	2	2	2	1	2	2	1	2	0,5	2	1	0	2	2	2	0	2	0,5	2
8	2	2	2	1	2	2	1	2	0,5	2	1	1	2	2	2	0	2	2	1
9	1	1	1	0	1	0,5	1	1	0,5	2	0	0	1	1	0,5	0	0	1	0
10	1	1	1	1	1	0,5	1	1	2	1	0	1	2	0,5	0,5	0	1	1	0
11	1	2	1	1	2	1	0	2	1	2	1	1	1	0,5	0	1	1	2	1
12	1	2	1	0	0	1	0	2	1	2	0	0	2	0,5	0	0	2	1	1
13	0	1	1	2	1	1	0	1	1	2	0	1	1	0,5	0,5	0	2	0	0
14	1	1	1	1	1	2	1	1	1	2	0	1	2	1	0	1	1	1	1
15	0	2	1	1	2	2	1	0,5	1	2	0	2	1	1	1	0	1	0	2
16	0	0	2	0	2	0,5	0	0	1	1	0	1	1	0	0	0	2	0	0
17	0	0,5	1	1	2	0,5	1	1	1	2	0	1	2	0,5	2	0	2	0	1
18	0	0,5	1	1	1	0,5	0	1	1	2	0	1	1	0,5	0,5	0	2	1	1
19	0	2	1	1	1	2	0	0,5	1	2	0	1	2	1	0,5	0	2	1	0
20	2	0,5	1	1	2	2	1	1	1	2	0	1	2	1	2	0	1	2	0
21	1	0,5	1	1	1	0,5	1	1	1	1	0	0	1	0,5	0,5	0	1	1	0
22	1	2	1	1	1	2	1	1	1	2	1	1	2	1	1	1	2	1	2
23	0	2	1	1	2	0,5	1	1	2	1	0	1	2	1	1	1	2	1	2
24	0	0,5	1	1	1	0,5	1	1	1	2	0	0	1	0,5	0,5	1	2	1	2
25	0	0,5	1	1	1	0,5	1	1	1	2	0	0	1	1	0,5	1	2	0	2
SUM	20	30,5	32	20	35	28,5	16	29	25	45	7	17	38	26	19,5	6	35	20,5	21

that influenced the implementation of best practices was the number of employees dedicated to ICT (hypothesis #3). Since there are more employees dedicated to the institution, it is also expected that there will be an increase in the activities developed, thus influencing the implementation of ICT best practices. The results also showed that the experience of ICT staff is not a significant factor for the implementation of best practices within a federal educational institution (hypothesis #4). [28] presents the *turnover* effect as a significant problem in the frequent exchange of employees in the company, which could lead to difficulties in inexperienced teams. However, in our case, this frequent exchange of employees is not typical at IFES, since most of the IFES employees (including ICT managers and analysts) holds a stable position guaranteed by the Brazilian law.

Finally, the number of outsourcers allocated within the ICT area proved to be a relevant factor in the adoption of the best

practice "Education and Training of users" (hypothesis #2), this assumption is necessary because as presented by [27] It is recommended that employees at all hierarchical levels of the company be trained as this will result in a higher return on investment, providing knowledge and skills to the employee, thus generating a competitive advantage.

Using the answers obtained with the questionnaire, it is also possible to establish relationships between the levels of adoption of different best practices (*fully implemented, partially implemented, not implemented and planning to implement*) found in the institutions. Our goal here is to verify if best practice A is somehow related to a best practice B. In particular, we are interested in understanding the relationship between the establishment of the *Information Technology Committee* with the following practices: *Acquiring and Maintaining Technology Infrastructure* and *Managing ICT Human Resources*. That is, we would like to evaluate the impact that the creation of

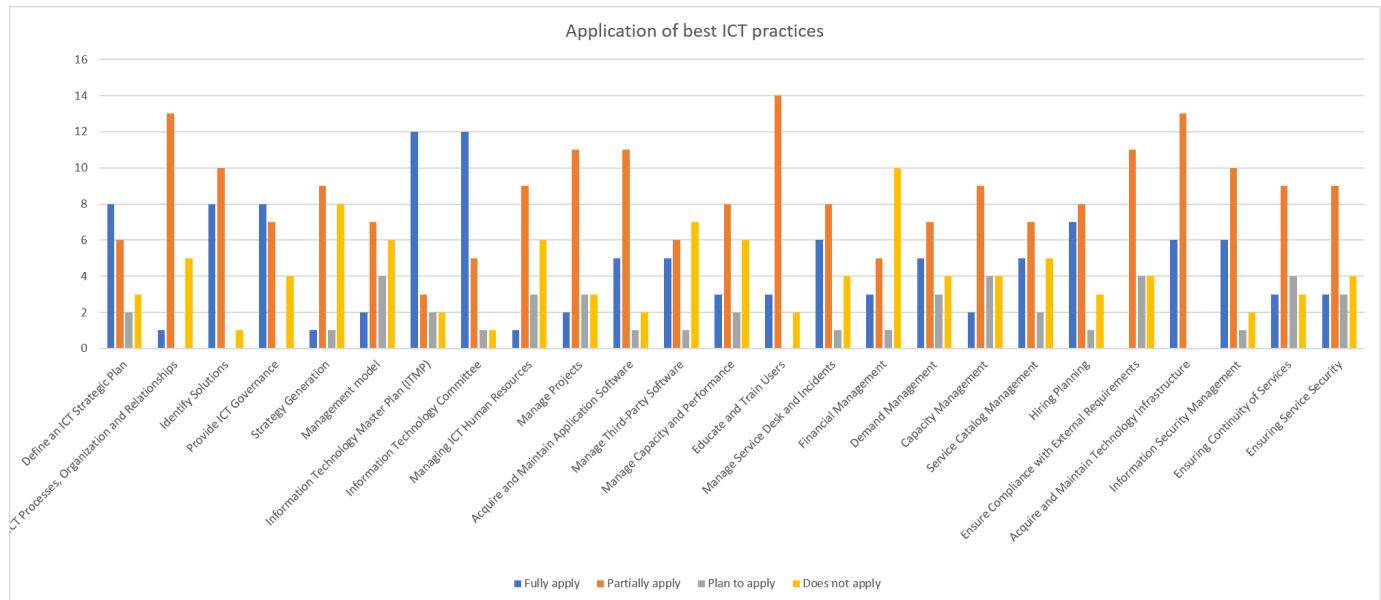


Fig. 5. Application of best ICT practices by IFES

TABLE IV  
T TEST RESULTS

Hypotheses	$H1_{M1}$	$H1_{M2}$	$H2_{M1}$	$H2_{M2}$	$H3_{M1}$	$H3_{M2}$	$H4_{M1}$	$H4_{M2}$	t value	p value
#1	21,2	16,14							1,7783	0,046622
#2			1,43	0,82					-2,75875	0,00699
#3					15,5	20,86			-2,13352	0,023875
#4							16,38	19,83	-1,22636	0,118389

an Information Technology Committee has on best practices related to the infrastructure of technology and human resources management.

These practices were chosen due to the following reasons: the *Information Technology Committee* was the practice with the highest *fully implemented* rate. *Acquire, Maintaining Technology Infrastructure* was one of the practices with the highest *fully* and *partially* implementation rate and *Human Resources Management* was fully implemented by only one IFES.

Spearman's non-parametric correlation coefficient was used to ascertain the relationships between *best practices*. We applied the following interpretation of the correlation coefficient: [29]

- Less than 0.2 without correlation;
- Between 0.2 and 0.4 low correlation;
- Between 0.4 and 0.7 moderate correlation;
- Between 0.7 and 0.9 high correlation;
- Above 0.9 a very high correlation.

The correlation coefficient between committee and information technology and Acquiring and Maintaining Technology Infrastructure was 0.302, that is, there is a low relationship between the two practices. The correlation between the committee and information technology and the Management of Human Resources of ICT was 0.644, which represents a moderate correlation. Our results indicate that the Information Technology Committee could be an important factor to boost the adoption of other practices since the committee is responsible for managing all the technology of the institution and its resources.

## V. IMPLICATIONS

From the academic point of view, this study sheds new light on the ICT Governance for the public sector theme, especially in Brazil, since the subject is not widely approached as it is in the United States [5], South Africa [17], Belgium [17], Australia [16] and others. It would be important to conduct similar tests with other universities to understand the impact of culture on ICT Governance for the public sector. Our research is particularly useful when it comes to specific frameworks for public companies. In Brazil, there is no ICT Governance framework designed for public companies, such as the IFES. This work could be seen as an initial study for proposing a framework to support the implementation of ICT Governance in Brazilian Federal Higher Education institutions.

From the decision-making point of view, our results indicate that the need for a program to establish and regulate the adoption of ICT Governance for IFES. With a program that is more focused on educational institutions, IT managers can make use

of greater agility and reliability in their activities. It is also important that this potential program would be straightforward to all of the stakeholders [17]. In other words, government and educational institutions should be work together to achieve excellence in such important area.

## VI. CONCLUSIONS

The Brazilian federal government's effort to encourage the implementation of ICT governance can be measured by the publication of recent laws and strategic programs such as IN04/2014 and its application guides for ICT Governance, PDTI, and others. Even with the effort of the Brazilian federal government, our research indicates that the federal educational institutions do not yet have an ICT Governance standard.

The considerable number of such institutions in Brazil and the autonomy that each of them has concerning ICT management requires that specific studies related to the ICT Governance of these institutions be carried out. Our work aims to assist in the process of identification of best ICT practices geared to them.

The survey results can be used to initiate discussions about how IFES (and other educational institutions) deal with ICT Governance in both legal and practical terms. It was also possible to note a great difference in the adoption of best ICT practices from one institution to another. While some best practices are being pursued in most of the universities studied, *IT director plan*, for example, another such as *financial management* seems to be problematic.

Future work includes finding ways to increase the scope of the study by expanding the questionnaire for state and private universities and relate the results obtained with external factors such as the institution's budget, security incidents, and demographic issues.

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