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Veronezi Correia, Silvia Regina; Dai Pra Martens, Cristina
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Cloud computing projects: critical success factors

Silvia Regina Veronezi Correia
PPGP – Programa de Pós-Graduação em Gestão de Projetos, Universidade Nove de Julho – UNINOVE, São Paulo, Brazil, and

Cristina Dai Prá Martens
PPGP – Programa de Pós-Graduação em Gestão de Projetos e, PPGA – Programa de Pós-Graduação em Administração, Universidade Nove de Julho – UNINOVE, São Paulo, Brazil

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Abstract

Purpose – The purpose of this article is to identify the critical success factors (CSFs) of information technology (IT) projects using cloud computing. CSFs are variables that can influence the success of projects and therefore need to be identified and managed appropriately.

Design/methodology/approach – This is an exploratory qualitative study with 23 experts in cloud computing projects through semi-structured interviews. The data was analyzed using content analysis.

Findings – The results present a list of CSFs for projects in a cloud computing environment. The study demonstrated that the CSF with greater relevance to cloud projects is the team's technical capacity, followed by the support of senior management and the team's soft skills. In addition, results demonstrated that contract item management is a limiting factor for cloud projects.

Research limitations/implications – The sample comprised only Brazilian experts, so it may not represent the same scenario as in other locations. The CSF ratio for cloud computing projects may vary depending on the company's maturity in projects of this nature.

Practical implications – The CSF relationship can guide managers in properly conducting cloud computing projects, contributing to minimizing the risks and challenges that may interfere with the project.

Social implications – The relationship of the CSFs in cloud computing projects proposed fills a gap in studies specifically related to this context and tries to minimize project managers' stress.

Originality/value – Contract items for the cloud context are added to the CSF literature in IT projects, which have not been addressed so far.

Keywords Cloud computing, Critical success factors, Project management

Paper type Research paper

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1. Introduction

Global business models have undergone profound changes related to the use of technology. In this context, cloud computing emerges as an evolution of information technology (IT), changing the way IT products (infrastructure, development platforms and software) are delivered to customers (Wang, Wood, Abdul-Rahman, & Lee, 2016). In this IT model, customers pay only for services consumed, such as measured service, payment for use, service provisioning or subscription contract (Wang *et al.*, 2016).

Migrating to the cloud brings challenges to organizations such as provisioning services, migrations of virtual data machines, energy management, traffic management and analysis, maximization of machine use, software architecture and frameworks as well as data security and confidentiality (Zhang, Cheng, & Boutaba, 2010; Singh & Chatterjee, 2017). However, migrating to the cloud seems like a model that guarantees IT performance so that organizations can grow without restricting the necessary resources.

IT projects using the cloud are growing because IT has stood out as a tool capable of increasing organizational competitiveness (Priyadarshinee, Raut, Jha, & Gardas, 2017). Thus, discussing how IT projects are conducted in the cloud computing environment is inevitable because some new challenges arise (Wang *et al.*, 2016): team capacity, shared environments, specific technical knowledge, risks linked to changes and the customer and provider contract itself.

For successful planning and control of the project, it is necessary to properly manage the variables or conditions that may affect its success (Milosevic & Patanakul, 2005; Abylova & Salykova, 2019; Abdulla & Al-Hashimi, 2019). The critical success factors (CSFs) help minimize project risks and challenges. In addition, they can be linked to project environment, communication, team and resources beyond project boundaries, such as size and complexity (Milosevic & Patanakul, 2005; Besteiro, de Souza Pinto, & Novaski, 2015).

Thus, identifying CSFs becomes relevant. In light of this, the research question of this study emerges: What are the CSFs for projects using cloud technology? The objective is to identify the CSFs of projects using cloud computing technology. We conducted interviews with project management experts in cloud environments. Through content analysis (CA), according to Bardin (1977), the content of the interviews was interpreted, and the results were inferred. This step generated a list of CSFs demonstrating that the most relevant CSF for cloud projects is the team's technical capacity, followed by the support of senior management and the team's soft skills. This study also demonstrated that managing contract items between providers and customers is essential for cloud projects. This is a new factor in specific IT projects in the cloud context that has not been suggested in other studies on CSFs. Contract items need to be reviewed by the project manager (PM) during project planning as they limit projects that use the cloud as the IT architecture.

The list of CSFs in cloud computing project management proposed fills a gap in studies specifically related to this cloud context as the architecture in IT projects. Such a relationship of CSFs can direct managers in the proper conduct of cloud computing projects, contributing to minimizing the risks and challenges that may interfere with the project. In addition, it contributes to the theoretical framework on the subject. This study also contributes socially by minimizing PMs' stress regarding the need to avoid project failure.

2. Theoretical framework

2.1 Cloud computing

Cloud computing is defined by the National Institute of Standards and Technology (NIST) as a model for convenient and on-demand access permission of a shared set of configurable computing resources such as networks, servers, storage, applications and

services (Mell & Grance, 2009). The cloud revolutionizes the traditional adoption of IT (Hsu, Ray, & Li-Hsieh, 2014), as it allows contracting infrastructure, platforms and software as services, and it is not necessary to make them an organizational asset (Sultan, 2011). This model increases the flexibility and scalability of the business, as resources can be contracted and immediately released when no longer needed (Zissis & Lekkas, 2012), and changes the way IT services are designed, developed, implemented, sized, updated, maintained and paid for (Avram, 2014).

In the on-premise model (Wang *et al.*, 2016), applications, data, operating systems, servers, virtual machines, storage and network are maintained by the customers themselves, while in the cloud model, they are offered separately. As a result, incorporating IT through cloud services can shorten the schedule, optimize the scope, reduce the cost of IT projects (Wang *et al.*, 2016) as well as minimize service provisioning issues, simplify systems and application management or reduce deployment costs.

2.2 Challenges of projects using cloud computing

Some features of the cloud imply challenges for organizations and PMs. Cloud environments are shared service environments where several clients can host their data on the same physical server or datacenter, increasing the security and control required in this environment (Google, 2020). In the traditional IT approach, complete control of installed servers and systems is under the responsibility of the IT department, while in the cloud, the customer has restricted access, which makes it difficult to measure performance and control the reliability of some services (Hofmann & Woods, 2010; Wang *et al.*, 2016). Cloud services are acquired, managed and measured through contracts between customer and provider, making the proper management of contracts and changes fundamental factors for projects in this context (Wang *et al.*, 2016).

In the cloud context, challenges for project management can be technical knowledge; decentralized virtual teams of the customer and the provider; and different cultures arising from the location of the customer and the provider (Sultan, 2011; Wang *et al.*, 2016). Furthermore, considering that cloud services are contracted on demand (Armbrust *et al.*, 2010), the set of the services influences their availability during the project.

IT service provider support and maintenance are based on the service level agreement (Hofmann & Woods, 2010). In this regard, the installation of services, the problem solution or the communication between the customer and the provider are given by the means and deadlines agreed to (Hofmann & Woods, 2010). Therefore, such aspects should be carefully considered in the project planning as these deadlines may not meet specific project needs that are subject to various risks and therefore need a good risk management plan.

Customers can receive constant updates in the Software as a Service (SaaS) cloud model. In this respect, the management of stakeholder expectations and the cultural and social expectations related to change are aspects to be considered in project management (Wang *et al.*, 2016). Furthermore, about the transition to the cloud, Sheffield and Lemétayer (2013) highlight interpersonal skills because the PM will have to integrate activities between different teams of the customer and the provider, in addition to managing project stakeholders that have different organizational cultures.

2.3 Information technology projects and critical success factors

CSFs are defined as the areas that, with satisfactory results, can bring competitive performance to the organization (Rockart, 1979). CSFs in projects were explored by Fortune and White (2006), who listed 27 factors for various types of projects. They proposed the formal system model that grouped the CSFs into goals and objectives, performance

monitoring, decision-making, transformation, communication, environment, limits, resources and continuity.

Several authors have studied which variables are essential for the success of IT projects, pointing out CSFs in this context. Some studies that stand out are Chow and Cao (2008), Nasir and Sahibuddin (2011); Sudhakar (2012); Imtiaz, Al-Mudhary, Mirhashemi, and Ibrahim (2013); Ahimbisibwe, Cavana, and Daellenbach (2015); Martins Muller and Dal Forno (2017); Fayaz, Kamal, Amin, and Khan (2017); and, finally, Stevenson and Starkweather (2017). Chow and Cao (2008) is the most cited among all these studies. From the analysis of 109 projects, the authors evaluated the CSFs of software development projects using agile methods and tested 12 CSFs extracted from a complete ratio of 36 CSFs, grouping them into dimensions. The authors related the CSFs to the perspectives of success considering quality, time, scope and cost.

When studying CSFs of software projects, Nasir and Sahibuddin (2011) suggest the following factors: clear and frozen requirements, a realistic estimate of schedule and budget, along with a competent PM. The study found that non-technical factors (94%) dominated over technical factors (6%). Sudhakar (2012) demonstrated that the project management dimension concentrates most of the CSFs of software development projects and that the main CSF is the support of senior management, followed by communication.

Imtiaz *et al.* (2013) listed 15 CSFs in IT projects: top management support, leadership, work team, clear goals, team capacity, financial/budget support, effective communication, process quality, training, project progress monitoring, client/user involvement, risk management, effective monitoring and control, adequate requirements and correct team selection. Ahimbisibwe *et al.* (2015) study identified 37 CSFs for software development projects organized into four categories: organizational, team, clients and project. Finally, Martins Muller and Dal Forno (2017) studied the CSFs for software development projects considering the influence of the methodology used by the projects (agile, traditional or mixed), and pointed out that, for Brazilian organizations, there is a similarity in the contribution of the CSFs in software development projects that is independent of the methodology.

The study by Fayaz *et al.* (2017) suggests 15 CSFs: management support, budget support, effective communication, effective training, monitoring and control, leadership, clear goals, requirements specification, risk management, user engagement, project progress schedule, team capacity, right team, project duration and teamwork. Stevenson and Starkweather (2017) grouped the CSFs into five categories of analysis: communication, project, project management and team, organization and stakeholders. They point out that the main factor for the project to succeed is project management and team, especially the ability of the group to communicate at multiple levels. Table 1 shows the CSFs by the authors' approach.

It is possible to observe, in the cited works, that the CSFs have specific similarities and differences according to the focus of each study but are mainly based on variables found in the study of Fortune and White (2006) on CSFs in projects. However, observing more specific IT projects that deal with the implementation of enterprise resource planning (ERP) software, several authors such as Ehie and Madsen (2005), Finney and Corbett (2007), Françoise, Bourgault, and Pellerin (2009) and Beheshti, Blaylock, Henderson, and Lollar (2014) listed specific CSFs, which may mean that for specific types of projects, such as cloud projects, the CSFs may also be more specific.

Considering CSFs for project management in cloud computing, some studies address the theme in contexts of cloud model adoption in ERP projects (Gheller, Biancolino, Junior, & Giroletti, 2017), cloud in HR processes (Ziebell, Albors-Garrigos, Schultz, Schoeneberg, &

Authors	CSFs
Fortune and White (2006)	Realistic and clear objectives; commercial and sound basis for the project; effective monitoring and control; planning, review and acceptance of possible failure; senior management support; competent project manager; detailed/updated plan; realistic schedule; good leadership; good choice/correct experience of the methodology/project management tools qualified/adequately qualified/sufficient team/team good communication/feedback; political stability; environmental influences; past experiences (learning from); organizational adaptation/culture/structure; project size/level of complexity/number of people involved/duration; adequate budget; sufficient resources/well allocated; provision of training; proven/familiar technology; good performance by suppliers/contractors/consultants; risks addressed/assessed/managed; user/customer involvement; different points of view (appreciation); sponsor/senior project management; effective change management
Chow and Cao (2008)	Management commitment; organizational environment; team environment; team capacity; customer involvement; process management; process definition; agile software techniques; delivery strategy; nature of the project; project type; project schedule
Nasir and Sahibuddin (2011)	Clear requirements and specifications; clear objectives and goals; realistic timeline; effective project management skills/methodologies; top management support; user/customer engagement; effective communication and feedback; realistic budget; sufficient and qualified staff; frozen requirements; familiarity with technology/development methodology; proper planning; appropriate development processes/methodologies (process); updated progress reports; effective monitoring and control; adequate resources; good leadership; risk management; complexity, project size, duration, number of organizations involved; effective change and configuration management; support tools and good infrastructure; committed and motivated staff; good quality management; clear assignment of roles and responsibilities; good performance by suppliers/contractors/consultants; provision of end-user training
Sudhakar (2012)	Communication in the project; leadership; relationship between users and IT team; reduction of ambiguity; maximization of stability; technical tasks; problem-solving; technical uncertainties; technical implementation problems; system integration; top management support; realistic expectations; organizational policy; financial support; strength; user engagement; customer engagement; partnership with suppliers; events in the external environment; customer acceptance; output accuracy; output reliability; output opportunity; quality control; system documentation and procedures; team capacity/skills; teamwork; correct selection of the project team; team coordination; task orientation; project plan; control mechanisms; project schedule; management skills; clear goals for the project
Imtiaz *et al.* (2013)	Top management support; leadership; work team; clear goals; team capacity; financial support/budget; effective communication; process quality; training; monitoring project progress; customer/user involvement; risk management; effective monitoring and control; proper requirements; correct team selection
Ahimbisibwe *et al.* (2015)	Higher level management support; organizational culture; project planning level; leadership; vision and mission; monitoring and controlling; change management skills; team commitment; internal project communication; team training; team composition; the project team's experience with the tasks; general knowledge of the project team; lack of development team's skill; the project team's experience with software development methodologies; user participation; user support; training and customer education; customer experience; lack of end-user experience; technological uncertainty;

(*continued*)

Table 1.
Synthesis of CSFs by authors

Authors	CSFs
	development methodologies; project complexity; urgency; relative project size; changes in specifications; criticality of the project
Martins Muller and Dal Forno (2017)	Capacity and competence of the team; experience of the team; commitment and motivation of the team; experience and competence of the project manager; relationship team/user; specification of requirements; definition of objectives and goals; schedule planning; project planning; risk management (prior analysis and treatment); training and learning of users/clients; development methodology; team size; team composition; team experience with the methodology used; appropriate process and methodology; infrastructure and support tools; support from higher management; commitment of higher management; project leadership; adequate resources (human, financial and material); organizational culture (of the client); user/customer participation; user/customer commitment; variable factors; realistic expectations of the user/client; internal communication of the project; estimates of previous realized costs; realistic budget; project complexity; project size; monitoring and effective control of the project; quality control; process tests
Stevenson and Starkweather (2017)	Ability to communicate at multiple levels; define the project appropriately; customer acceptance; ability to coordinate; stakeholders have a common understanding of success criteria before the project starts; clearly articulation of what should be done; competence of the PM; communication and collaboration between PM and project owners; listening; commitment; meeting user requirements; top/senior management support; meeting stated objectives; ability to deal with ambiguity and changes; keeping the team moving toward a common goal

Table 1. **Source:** Prepared by the authors

Perello-Marin, 2019), cloud adoption in small and medium-sized companies (Hentschel, Leyh, & Baumhauer, 2019), cloud adoption in other industries such as construction (Oke, Kineber, Al-Bukhari, Famakin, & Kingsley, 2021) and cloud adoption in public sectors (Sallehudin *et al.*, 2019; Mohammed, Ibrahim, & Ithnin, 2016), but studies do not address CSFs in cloud project management with an approach that considers the cloud as an IT project architecture, which is the focus of the present work. In a literature review by Hentschel *et al.* (2019) that analyzed 28 articles that deal with CSFs in the cloud, 26 of them dealt with CSFs of cloud implementation projects, confirming different objectives than the present article, which deals with the management of projects carried out in a cloud environment. Cloud-based CSFs can present a different degree of importance and relevance from other projects carried out in on-premise architecture environments.

Therefore, this study presented and discussed a new CSF model that deals with the influence of the cloud contract on the project (analyzed with the interviewees), showing that the cloud contract items need to be known by the PM and may appear as limiting factors during the execution of the project.

3. Propositions

When analyzing the studies on CSFs in IT projects, it was not possible to observe, in the set of CSF established as vital, references to some specific characteristics of cloud projects, such as items related to contract management (Wang *et al.*, 2016), change management (Wang *et al.*, 2016), communication management (Wang *et al.*, 2016; Sheffield & Lemétayer, 2013) or

how the characteristics of the teams impact the success of the projects (Wang *et al.*, 2016). This suggests the need for a more cloud-driven CSF study.

We listed the propositions below from the theoretical framework analyzed to verify the CSFs for projects using cloud technology (Table 2). The Organizational, People, Processes, Technique and Project dimensions emerge from the study by Chow and Cao (2008), who listed the CSFs for agile projects. They were selected for their relevance and as the result of grouping several CSFs listed in other studies. The dimensions Contract management, Change and risk management and Communication management are proposed based on the literature on cloud projects.

4. Method

This research was based on the following phases: study for the theoretical framework; preparation of the interview protocol; face validation; interviews and objective questions with experts; transcription, codification and CA of the interviews; and presentation of results, analyses and conclusions.

A qualitative and exploratory approach was adopted, with data collection through semi-structured interviews (Bardin, 1977) with cloud experts. A script guided the interviews on the CSFs in IT projects to analyze their application to cloud projects. The script contained questions concerning the characterization of the respondent and CSFs, based on the propositions presented in Table 2. This instrument was tested with one respondent, and we certified that it was suitable for use in the other interviews. However, to minimize any bias of the researcher, a new instrument was created with multiple-choice questions addressing the CSFs based on the 20 propositions for the interviewees to evaluate the degree of influence each CSFs had on the success of cloud projects (five-point Likert scale, ranging from 1 – no influence to 5 – total influence). This new instrument was also validated with the same respondent.

For this research's unity of analysis, IT projects that used cloud computing technology as an IT architecture were considered, either as Infrastructure as a service, Platform as a service or SaaS. The projects' financial contribution was not relevant to the research, nor was the size of the organization to which the projects belonged. The region in which the company was located was not relevant, either. Respondents, or research subjects, were experts in cloud computing projects with experience in managing cloud projects, being leaders, PMs or directors directly involved in the project. There was no minimum amount of experience in managing projects of this type, but it was necessary that interviewees be involved with project management and not with the direct programming of IT resources in cloud environments.

We interviewed 23 specialists working in Brazil, totaling 23 h and 45 min of video recordings. The interviews were conducted through videoconferencing, using Skype and Google Meeting tools. In the sample of the interviewees, 2 were women and 21 were men. The participants ranged from 25 to 68 years (an average of 44). The professionals' experience in IT ranged between 7 and 40 years (an average of 20 years), while the time of experience in cloud projects was between 6 months and 12 years (an average of 4 years).

Of the interviewees, 5 worked for national companies and 18 for multinationals. Companies were divided into sectors: technology services (13), business process outsourcing (BPO) (4), transport (3), telecommunications (2) and insurance (1). Most of these companies had more than 2,000 employees. The experience of organizations whose interviewees provide services to (customer companies) is relatively new to cloud projects, ranging from two to five years (an average of four years). Throughout this document, interviewees (characterized in Table 3) are called I01 to I23 for confidentiality reasons.

Proposition dimension	Proposition	Theoretical basis	CSF analytics for cloud
a) Organizational	P1) The commitment of *senior management/sponsor* contributes to the project's success P2) The *company's organizational environment* contributes to the project's success P3) The *organizational environment of the project team* contributes to the project's success	Chow and Cao (2008)	
b) People	P4) The *capacity of the team (soft skills)* contributes to the project's success	Chow and Cao (2008)	
	P5) *Customer engagement* contributes to the project's success P6) The *team's technical* knowledge is a differential to the project's success P7) The *PM's knowledge of managing conflicts of interest* contributes to achieving the project's success	Wang *et al.* (2016); Sheffield and Lemétayer (2013); Sultan (2011).	Confirm the difference in relevance in the cloud
c) Proceedings	P8) *Process management* contributes to the project's success	Chow and Cao (2008)	
d) Technique	P9) The *delivery strategy* contributes to the project's success P10) *Agile techniques* contribute to the project's success	Chow and Cao (2008)	
e) Project	P11) The *nature of the project* contributes to the project's success P12) The *type of project* contributes to the project's success P13) The *project schedule* contributes to the project's success	Chow and Cao (2008)	
f) Contract management	P14) The *items negotiated in the contract* between customer and provider (agreed service level, access restriction, cost, type, quantities and prioritization of services) contribute to the project's success P15) The *knowledge of the PM in contract management* contributes to the project's success	Wang *et al.* (2016), Hofmann and Woods (2010); Armbrust *et al.* (2010), Avram (2014); Wang *et al.* (2016); Sheffield and Lemétayer (2013); Sultan (2011)	Suggested CSF for the cloud context Confirm the difference in relevance in the cloud
g) Change and risk management	P16) Proper *risk management* contributes to the project's success P17) Proper *change management* contributes to the project's success	Avram (2014), Wang *et al.* (2016); Google (2020), Wang *et al.* (2016)	Confirm the difference in relevance in the cloud
h) Communication management	P18) Effective *communication* contributes to the project's success	Wang *et al.* (2016); Sheffield and Lemétayer (2013)	Confirm the difference in relevance in the cloud

Source: Prepared by the authors

Table 2.
Propositions for CSFs in cloud computing projects

Interviewee	Age	Gender (male/female)	Years	Years	Sector	National/ Multinational	Years
I01	43	M	25	5	BPO	Multinational	3
I02	48	M	28	<1	Transports	Multinational	2
I03	36	M	12	<2	IT services	Multinational	5
I04	30	M	13	8	IT services	Multinational	2
I05	38	M	18	8	IT services	National	7
I06	50	F	25	2	Transports	Multinational	2
I07	25	F	7	4	Insurance	Multinational	5
I08	41	M	21	7	IT services	Multinational	6
I09	48	M	20	4	IT services	Multinational	2
I10	29	M	8	3	IT services	Multinational	4
I11	68	M	40	8	IT services	National	8
I12	54	M	30	12	IT services	National	12
I13	51	M	17	1	IT services	National	2
I14	40	M	22	10	IT services	Multinational	10
I15	38	M	16	4	BPO	Multinational	3
I16	41	M	20	<1	Transports	Multinational	2
I17	53	M	31	11	IT services	National	11
I18	54	M	20	3	Telecommunications	Multinational	3
I19	42	M	17	4	BPO	Multinational	3
I20	38	M	15	2	BPO	Multinational	3
I21	53	M	13	2	Telecommunications	Multinational	2
I22	41	M	15	3	IT services	Multinational	3
I23	52	M	30	8	IT services	Multinational	9

Notes: IT time: professional IT experience time; Cloud time: professional cloud project experience time; Enterprise cloud time: enterprise cloud project experience time
Source: Compiled by the authors

Table 3. Overview of interviewees' characteristics

The interviews were transcribed for later analysis, which was carried out through CA (Bardin, 1977; Silva & Russo, 2019) by one of the researchers. The phases of CA are divided into pre-analysis, exploration of the material and analysis and treatment of the results. In the pre-analysis phase, the corpus of the research is constituted. In this work, it consisted of the transcription of 23 interviews with 24 questions per interviewee, totaling 552 answers. In the exploration phase, the recording and context units are constituted. In the case of this article, 18 CSFs and their strengths (positive view from the interviewee) and weaknesses (negative/doubtful view from the interviewee) were explored. In the last phase of CA, data were categorized and analyzed with inferences and interpretation.

In this study, the categories were separated by CSF. After that, strengths/weaknesses in the interviewees' statements that characterized the relevance of the HR were evaluated. Thus, each HR was interpreted individually.

No specific software was used to support analysis; instead, a Word document was produced observing each CSF for each of the interviewees and determining the importance and prominence of the CSF in their responses.

5. Results

5.1 Analysis of critical success factors in cloud projects

According to the interviewees, several CSFs mentioned have some or total influence on the success of cloud projects, whereas others do not. The CSFs of this study are addressed

according to their dimensions, namely, Organizational, People, Processes, Technique, Project, Contract management, Change and risk management and Communication management, as available in a complementary file (Supplementary materials).

5.2 Summary of critical success factor analysis in cloud projects

In addition to the CA of the questions addressed in the interviews, the objective questions sought to consider the degree of influence that each CSF considered in this study has on the success of the cloud project (on a scale of 1–5, ranging from *no influence* to *total influence*, respectively). These questions allowed an overview of this matter, in addition to minimizing any bias in the inference of the qualitative analyzes summarized in Table 4. Although the number of responses is too small to make statistical inferences or reflect the reality of this article's analysis effectively, it corroborates the interviews' CA. It is worth noting that the objective of these closed questions is to compare the CSFs based on the interviewees' responses and corroborate with the analyses and inferences previously made. Table 4 shows the results obtained from the objective questions.

It is noteworthy that several CSFs had a median of 5.0, which means that among the interviewees, more than half of them attributed these CSFs as having total influence on the success of cloud projects.

It is also noteworthy that the contract items factor, suggested in this work for the context of cloud IT projects, seems to have become more relevant over the years as the company becomes more experienced in using cloud technology [1]. From this, there is space for future research to address the influence of cloud maturity on the CSFs of projects conducted in such an environment.

5.3 General analysis of propositions and discussions

Based on the analysis of the collected data, it is possible to present the confirmation of the propositions (Table 5). In addition, the most relevant points analyzed in the CSF proposition stand out. In the table, "yes" means that the proposition was confirmed because responses that attest to the relevance of the CSF (positive mentions, agreement) were found in most of the interviews. In addition, when observing the closed answers that deal with the CSFs, the average of the interviewees corroborates this inference. On the other hand, "Not necessarily" represents that, despite being mentioned by the interviewees, no great relevance was found on the proposition (doubt, partial agreement), in addition to not being confirmed by the interviewees in the closed questions whose average was equal to or below 4.0.

Propositions P1 and P2 were not confirmed as CSFs for agile projects, according to Chow and Cao (2008); however, they are essential for projects conducted in the cloud, according to the interviewees of this study. Propositions P3, P4, P5, P6 and P8 were confirmed by Chow and Cao (2008) and by our interviews. On the other hand, Propositions P9 and P10 were confirmed only by Chow and Cao (2008), while Propositions P11, P12 and P13 were neither confirmed in this study nor by Chow and Cao (2008). Propositions P7, P14, P16, P17 and P18 that emerge from the theoretical framework for the cloud were confirmed, but Proposition P15 was not confirmed.

We noticed that, in the cloud environment, a new CSF dealing with contract items has now arisen after not being previously evidenced. It is suggested that this factor arises as a result of the management of the cloud environment through contracts (Wang *et al.*, 2016). On the other hand, the CSFs *change management* (P17), *risk management* (P16), *conflict of interest management* (P7) and *communication* (P18) are not evidenced in the work of Chow and Cao (2008) but are present in the CSF literature in Fortune and White (2006), Martins Muller and Dal Forno (2017) and Stevenson and Starkweather (2017). It is also noteworthy

Critical factor for success	Description	Size	Average	Standard deviation	Median
Technical knowledge of the team	Documentation, coding, deliveries, quality, testing, simple design, previous experience	People	4.9	0.3	5.0
Commitment of senior management/ sponsor	Commitment and leadership aligned with the project's decisions and delivery	Organizational	4.7	0.5	5.0
Team capacity (soft skills)	Adaptation, communication, cooperation, motivation, creativity, delegation of tasks, conflict management, among others	People	4.7	0.6	5.0
Change management	Adequate control of changes in systems, with correct people involved, with processes and communication channels defined and properly explored	Change and risk management	4.5	0.6	5.0
PM's ability to manage conflicts of interest	Conflicts of interest between customer and provider or with stakeholders, the sponsor or the team	People	4.5	0.6	5.0
Process management	Processes clearly defined, mapped and managed appropriately	Processes	4.5	0.7	5.0
Organizational environment of the company	Culture of cooperation, communication, adequate working environment, appreciation of people and work, etc.	Organizational	4.4	0.7	5.0
Internal organizational environment of the project	Environment in which the team operates properly – culture of cooperation, communication, adequate work environment, appreciation of people and work, openness to change	Organizational	4.4	0.7	5.0
Communication	Adequate communication with suppliers, teams or stakeholders, service providers and stakeholders in the project	Communication management	4.4	0.9	5.0
Customer engagement	Strong commitment, decision authority and readiness with the project	People	4.4	1.2	5.0
Contract items	Agreed service level, access restriction, cost, quantities, type and prioritization of services	Contract management	4.2	1.1	4.0
Risk management	Event management (threats or opportunities)	Change and risk management	4.1	1.1	4.0
Delivery strategy	Regular deliveries, value deliveries, key features first	Tech degree	4.0	1.0	4.0
Schedule	Activities defined and controlled by dates, effort and resources	Project	3.8	1.3	4.0
Project management techniques	Agile (scrum, etc.), traditional (cascade) or mixed	Tech degree	3.7	1.5	4.0
PM's knowledge in contract management	Know and manage the items negotiated in the contract	Contract management	3.6	1.3	4.0
The nature of the project	Closed scope or variable scope	Project	3.4	1.1	4.0
Project type	Strategic, tactical and operational improvement	Project	3.2	1.0	3.0

Source: Prepared by the authors

Table 4. CSFs and their degree of influence on the success of cloud computing projects

Proposition	Confirmation of the proposition	Highlights
P1) The commitment of senior management/sponsor contributes to the project's success	Yes	Collaborates with the resolution of problems, definitions and themes related to the project's costs in a consumption model
P2) The organizational environment contributes to the project's success	Yes	Highlights for freedom to err, collaboration and positive environment
P3) The team's organizational environment contributes to the project's success	Yes	Willingness to learn, freedom of expression, collaboration and multidisciplinary
P4) The team's capacity contributes to the project's success	Yes	Cloud has non-traditional solutions; adaptation and flexibility help the cloud model adhere
P5) Customer engagement contributes to the project's success	Yes	Minimizes project risks; needs to participate in decisions and prioritizations; customer satisfaction is achieved faster, which can improve this relationship with the customer
P6) The team's technical knowledge is a differential to the project's success	Yes	It is critical in cloud; knowledge needs to be acquired; difficult to have cloud teams formed; technical knowledge helps to make good decisions
P7) The PM's knowledge in managing conflicts of interest contributes to the project's success	Yes	It mediates the issue of costs and deadlines and communicates between areas involved in the project
P8) Process management contributes to the project's success	Yes	Absence of processes for the cloud model; different processes for cloud and on-premise that have diverse ways of deploying solutions
P9) The delivery strategy contributes to the project's success	Not necessarily	Making partial deliveries is possible because today there are more modern software engineering tools that manage partial deploys that can be automated by DEVOPS
P10) Agile software techniques contribute to the project's success	Not necessarily	PM's techniques can collaborate with the success of cloud projects, especially agile techniques
P11) The nature of the project contributes to the project's success	Not necessarily	Nature depends on organizational strategy and contract
P12) The type of project contributes to the project's success	Not necessarily	The type of project is linked to the drive (prioritization, time, visibility) that the project will have within the company
P13) The project schedule contributes to the project's success	Not necessarily	Controls and directs the project, manages expectations, but needs constant review and may not adapt to the reality of the project
P14) The items negotiated in the contract between customer and provider (agreed service level, access restriction, cost, prioritization of services) contribute to the project's success	Yes.	Govern how cloud services will be made available and consumed; need to be reviewed so as not to interfere with the project's progress
P15) The knowledge of the PM in contract management contributes to the project's success	Not necessarily	It helps to understand the deadlines and constraints that can influence the project's progress; several organizations have a specific area that assists the PM with contractual ones

Table 5.
Analysis of the research propositions

(*continued*)

Proposition	Confirmation of the proposition	Highlights
P16) Proper risk management contributes to the project's success	Yes	Minimizes project risks, whether because of ignorance of the cloud or anticipation of problems that differ from the on-premise model
P17) Proper change management contributes to the project's success	Yes	Teams have the autonomy to manage change; rigid change processes hinder the agility of deliveries made possible by the cloud
P18) Effective communication contributes to the project's success	Yes	Communication is used to talk about both deliveries and difficulties; it is important to talk about costs because this variable changes in the cloud model

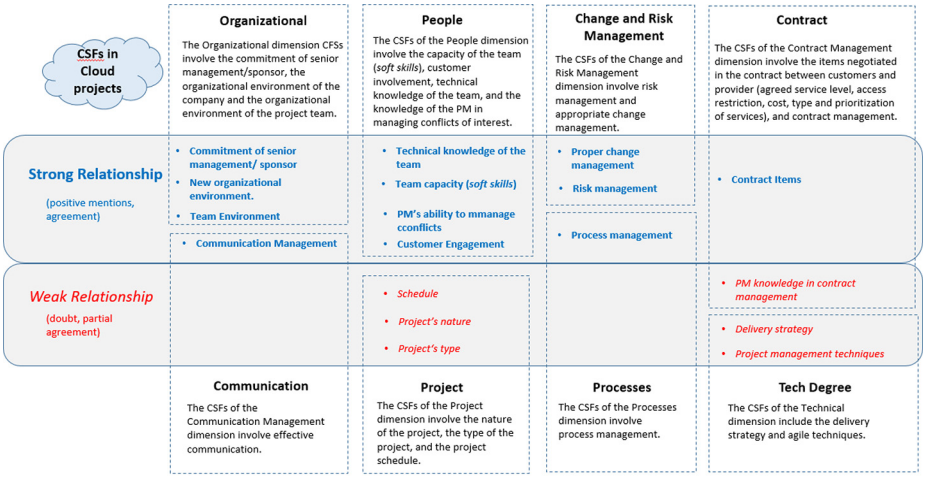
Source: Compiled by the authors

Table 5.

that the dimension that encompasses CSFs related to projects loses importance for cloud projects [which differs from what was found by Chow and Cao (2008)], whereas the dimensions *team management*, *organizational* and *people* stand out. The dimensions *contract*, *changes*, *risks* and *communication* are not addressed by Chow and Cao (2008) but are evidenced as significant for cloud projects.

Based on the general analysis of the research, we developed a framework with the results and relationships between the CSFs in cloud computing projects, as shown in Figure 1.

Thus, it is possible to note the relevance of the People and Organizational dimensions, which have a more significant set of CSFs with a strong relationship, and the low relevance of the technical and project dimensions that have a more significant



Source: Compiled by the authors

Figure 1.
Relationship between CSFs in cloud projects and their dimensions

set of CSFs with a weak relationship in the success of cloud computing project management.

6. Final considerations

The list of CSFs in cloud projects proposed in this study fills a gap in related studies because this work deals with CSFs in the context of cloud as an architecture of IT projects. In addition, the contract items for the cloud context, which have not been addressed until now, are added to the CSF literature in IT projects, suggesting the relevance/originality of the theme. Contract items need to be part of the PM's planning review in the early phases of the project as they can be limiting. Another relevant factor is that cloud projects need technical teams with experience, something not so relevant in the CSF analysis of other IT projects. Thus, this study's theoretical contribution stands out for presenting significant variables for the success of projects in cloud architecture environments and expanding the theoretical framework on the subject. As a social implication, it is possible to minimize the PMs' personal stress regarding the risk of failure of the projects they manage.

In terms of contributions to the practice of IT cloud project management, the set of CSFs proposed in this study can be helpful in guiding PMs and IT on aspects that need to be appropriately managed, so that cloud projects have a greater chance of success. Furthermore, attention to the proposed CSFs can contribute to the realization of diagnosis and improvement plans in the context of cloud projects.

This study has some limitations. First, the sample included only Brazilian experts, so the findings may differ from other populations. Second, the CSF ratio for cloud computing projects may vary depending on the company's maturity in projects of this nature. Finally, the selected interviewees were directly managing the cloud projects, so experts from the project teams were not heard, which may represent a variation in the CSFs. These limitations may also suggest that future studies investigate each of these aspects.

Future studies can be conducted to evaluate CSFs quantitatively in a sample of professionals and companies working with cloud projects. Quantitatively evaluating the propositions of this work can confirm the CSFs found for the cloud and confirm the cloud CSF's influence when compared to on-premise projects. A quantitative study may also cover a more extensive sample regarding location and diversity. In addition, there is room for elaborating a specific CSF scale for cloud computing projects.

Note

1. The complete instrument used for the calculations is available upon request.

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Supplementary material

The supplementary material for this article can be found online.

Author contributions are as follows: Silvia Regina Veronezi Correia https://orcid.org/0000-0002-0427-9294 – Corresponding Author, Conceptualization (Lead), Data curation (Equal), Formal analysis (Equal), Funding acquisition (Supporting), Investigation (Equal), Methodology (Equal), Project administration (Supporting), Supervision (Supporting), Validation (Equal), Writing – original draft (Lead), Writing – review & editing (Equal), Cristina Martens https://orcid.org/0000-0003-0955-9786, Conceptualization (Supporting), Data curation (Equal), Formal analysis (Equal), Funding acquisition (Lead), Investigation (Equal), Methodology (Equal), Project administration (Lead), Supervision (Lead), Validation (Equal), Writing – original draft (Supporting), Writing – review & editing (Equal).

Corresponding author

Silvia Regina Veronezi Correia can be contacted at: silviaveronezi@gmail.com

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