Artigos

Complexity of educational projects in public administration

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Abstract

The purpose of this paper is to identify factors related to organizational evaluation and management in the complexity of projects with professionals working with projects in the area of education in the Brazilian public administration. The data were analyzed for a total of 536 respondents involved in this study. The constructs 'project variety', 'elements of context', 'interdependencies within the project' and 'project complexity' were analyzed by using Confirmatory Factor Analysis (CFA). This was in conjunction with an evaluation and estimation model with the application of the Structural Equation Modelling (SEM) with the use of the R software. The four identified measures played a significant role in the goodness of fit index of an underlying construct for the model. As a result, it was found that as the length of experience increases, the perception in understanding the complexity (trust and capacity) inherent to the projects, interferes in familiarity with the activity, but not in familiarity with the methodology. Finally, it is necessary that project managers who work in the public area are attentive to the socio-political aspect, since it presupposes the combination of the political and emotional aspects of those involved in the projects. This study contributes to a gap within the literature on the phenomenon 'complexity of projects' in the area of education in public administration, what is very important considering the Brazilian reality and its challenges for public managers, both from the point of view of strategic challenges and the complexity of the decisions required.

Keywords: Project management; Project complexity; Public Management; Project Management Education.

1 Introduction

An organizational project is a temporary and unique endeavor undertaken to deliver a result. This result is always a change in the organization, whether it is in its processes, performance, products or services (Vidal & Marle, 2008). Project management was created as formalized and structured activities and methodology.

The growing interest in the subject of project management is evident in recent research activities that define it in several perspectives, particularly complexity. Complexity can be understood through the study of Vidal and Marle (2008, p. 1099) like "different fields but has also different connotations within the same field".

The challenge is to understand what makes projects complex to manage and to provide a common understanding of the 'length of experience', 'familiarity of the activities' and 'familiarity with the methodologies' of managing or involvement in a project context (Williams, 2005; Cicmil et al., 2009).

The complexity of projects has several forms and can be seen from the social, technological, environmental and organizational points of view. In this regard, we used the work of Baccarini (1996), who developed the dichotomy which considers that the complexity of the project is composed of the complexity of the technology and the organization and, in view of that, an opinion that a detailed analysis of the complexities and organizational technology is imperative to understand the concept of project complexity.

Therefore, the objective of this article is to identify factors related to organizational evaluation and management in the complexity of projects with professionals working with projects in the area of education in public administration. Finally, this paper proposes checking present project complexity and its impacts on public project management and studying how it can be understood, this considering the reality in the management of educational projects in Brazil and its challenges for public managers, both from the point of view of strategic challenges and the complexity of the decisions required. This based on the fact that the evaluation of their impacts is the responsibility of society and not the sum of the interests of each individual (Moore, 1995).

The relevance of the research is considered from a scientific point and a social point of view. The research is aimed at contributing to the improvement of management practices in the public area with a better understanding of project complexity in different types of projects that are maintained, thereby improving project performance. Therefore, public management demands the development of numerous projects whose main purpose is to perform actions that are evaluated by society from the point of view of inherent social benefits, even as occurs with educational projects.

From the scientific point of view, this research aims to elucidate the understanding of the role of organizational complexity factors and their meanings (Bosch-Rekveldt et al., 2012). Qureshi and Kang's (2015) model was used as a basis, as it is intended to facilitate the understanding of the complexity of project management and its organizational factors contributing to employees. Also, it contributes to improving the understanding of the notion of complexity in projects.

2 Literature review

This section provides a brief explanation of the topics. Key terms and concepts are defined and explained before testing the proposed hypotheses. Based on the literature review, in this study, 'project variety' and 'elements of the context' are considered exogenous variables, while 'interdependence within the project' and 'project complexity' are endogenous variables. The exogenous variables are found to directly influence the complexity of the project. To meet the objectives of the research, three hypotheses were formulated from the replication of the study of Qureshi and Kang's (2015) model. To perform the measurement of these identified constructs, the observed variables are determined from the theoretical review for each construct.

2.1 The term 'complexity' and its characteristics in project management

The term 'complexity' can be perceived through various connotations not only in different fields but also

within the same field (Vidal et al., 2011; Whitty & Maylor, 2009; Abdou, Yong, & Othman, 2016).

Badii and Politi (1993) and Edmonds (1999, p. 72) propose an overview of the concept of complexity within different fields and tries to give a generic definition of what complexity is

> […] complexity is that property of a model which makes it difficult to formulate its overall behavior in a given language, even when given reasonably complete information about its atomic components and their inter-relations.

This definition emphasizes that complexity is relative to the project modeling system. While measuring project complexity, one should be able to define a general measure of this feature independent of the project model, the project complexity measure. Vidal and Marle (2008) noted that this definition, which is appropriate to encompass all the aspects of project complexity, emphasizes that complexity is related to the way the project system is modeled.

The three dimensions of complexity demonstrated to be of value in differentiating the description of complexity of projects. Representative concepts within each dimension are defined as follows (Maylor et al., 2013, p. 46-47):

(1) *Structural complexity:* The most easily recognized of the complexities by both practitioners and researchers and is described as complexity or level of interconnectedness, increases with the greater the number of: people involved, financial scale, interdependencies within and without, variety of work performed, pace, breadth of scope, involved specialist disciplines, locations and time-zones.

(2) *Sociopolitical complexity:* Associated with the relevance of the people, power, and politics, both within the project team and in the wider stakeholder communities. The dimension increases with the divergence of people involved, level of politics or power-play to which the project is subjected, lack of stakeholder/sponsor commitment, degree of resistance to work being undertaken, lack of shared understanding of the project goals, lack of fit with strategic goals, hidden agendas, and conflicting priorities of stakeholders.

(3) *Emergent complexity:* comprises uncertainty and change. Uncertainty is typically the result of novelty of technology or process (Wouters, Roorda, & Gal, 2011), lack of experience, lack of available information, or a combination of these. Increases with the novelty of the project, lack of technological and commercial maturity, lack of clarity of vision/goals, lack of clear success criteria/ benefits, lack of previous experience, failure to disclose information, increase expansion to include previously unidentified stakeholders, and any changes imposed on or by the project.

Construction projects involve a variety of interconnected factors which complexity with defined characteristics. Deciding when a project is complex or not has itself become complex. Thus, the complexity of projects means that different actions and states of the parameters of the world interact, so the effect of actions is difficult to be accessed (Kauffman, 1993).

The term 'project complexity' is also a key theme in an extensive number of project management studies as projects are becoming more complex and are the main factor in project failure (Bakhshi et al., 2016).

Vidal et al. (2011) define the complexity of projects as the property of a project that makes it difficult to understand and keep under control, their general behavior, even when given relatively complete information about the project system. This emphasizes the importance of accessing complexity and supporting decisions made while maintaining control of the behavior of the project.

In this sense, Rumeser and Emsley (2017) found that one project becomes more complex when it is ambiguous in a way that methods are unclear and there are significantly more 'wrong answers' than 'right answers' to its problems. Project complexity is also characterized by interrelatedness between its parts which makes it more difficult to manage.

Since complexity has several forms, namely social, technological, environmental and organizational, it is important to make clear the type of complexity that is

being analyzed (Baccarini, 1996). It is worth mentioning the work of Bosch- Rekveldt et al. (2011) that proposed the Technical, Organizational, and Environmental (TOE) structure, consisting of 15 factors in 3 the three forms. Bosch-Rekveldt et al. (2012) conducted an online survey using the TOE structure and came to an agreed position of the interviewees about the unpleasant nature of organizational complexity in engineering projects. They concluded that organizational complexity concerned project managers more than technological and environmental complexity.

The final outcome of this study of Qureshi and Kang's (2015) model was the creation of a relationship network that can be used to facilitate decision-making and enhance understanding of the subject by project managers and personnel aware of elements that demand sufficient attention. For this research we made only one adjustment including three covariances of factor analysis that will be analyzed later. The following is the proposed model (Figure 1) of this study with the explanation of each construct.
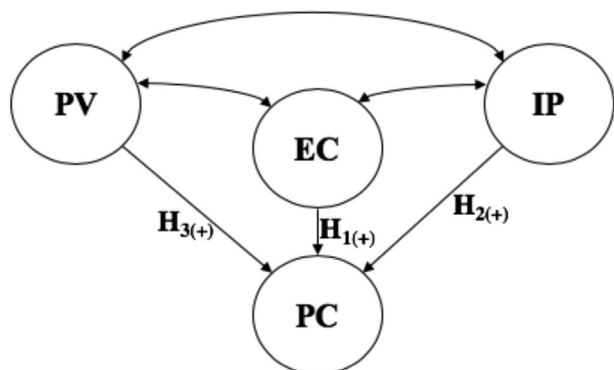

Figure 1: Proposed Model

2.2 Project complexity (PC)

Reducing or dealing with the complexity of the project has always been a difficult task and depends on the project manager's expertise and the entire team. The literature (Alderman & Ivory, 2007; Geraldi, 2008; Müller & Turner, 2007; Pundir et al., 2007; Vidal & Marle, 2008; Williams, 2005) suggests that nonlinearity, uncertainty, and uniqueness can prove to be good measures of project complexity.

Vidal and Marle (2008, p. 1101) propose a definition of project complexity

> […] project complexity is the property of a project which makes it difficult to understand, foresee and control its overall behavior, even when given reasonably complete information about the project system.

2.3 Elements of context (EC)

Elements of context are seen as one of the sources of Project complexity (Baccarini, 1996; Chu et al., 2003; Geraldi & Adlbrecht, 2007; Vidal & Marle, 2008). The competition, the complexity of the environment and the institutional configuration are seen as central elements of the context. In addition, the literature suggests that local laws and regulations and organizational degree of contextual elements of project innovation are also factors that affect the complexity of the project.

Elements of context are understood as directly related to the complexity of the project (Chu et al., 2003; Vidal et al., 2011). Thus, by evaluating the complexity of the project directly related to the organizational dimension, the elements of the context have their own significance.

Hypothesis 1: The elements of context positively affect the complexity of the project in the area of education in public administration.

2.4 Interdependencies within the project (IP)

In a project, several factors and activities are dependent on each other. Independently understanding activities is not as simple as is desired. A large part of project management literature talks about interdependence (Baccarini, 1996; Calinescu et al., 1998; Geraldi & Adlbrecht, 2007; Little, 2005; Millhiser & Solow, 2007; Tatikonda and Rosenthal, 2000; Thomas & Mengel, 2008; Vidal & Marle, 2008). Resource availability due to sharing, dependencies between schedules, environment dependencies, interconnectivity, and feedback cycles across task networks indicate if there is interdependence within a project.

A project is considered complex when the degree of interdependence and interconnectedness is greater. It is more difficult to deal with tasks that are influenced by their predecessors or successors, inducing complexity in projects (Baccarini, 1996; Calinescu et al., 1998; Cicmil & Marshall, 2005; Geraldi & Adlbrecht, 2007).

Hypothesis 2: interdependencies within the project positively affect the complexity of the project in the area of education in public administration.

2.5 Project variety (PV)

The project variety affects the complexity of the project (Baccarini, 1996; Geraldi & Adlbrecht, 2007; Jones & Anderson, 2005; Vidal & Marle, 2008; Williams, 1999). To measure this latent variable, several observed variables are determined from the theoretical review. The study shows that stakeholders' geographic location and the financial resource types contribute to the variety of projects. Other factors, such as a variety of information systems to be combined, a variety of organizational interdependencies and types of organizational skills required, are some of the sources of diversity or variety of projects.

Several factors influence the projects by their characteristics and diversities. Studies show that the variety of projects directly influences the complexity of the project (Baccarini, 1996; Jones & Anderson, 2005).

Hypothesis 3: The project variety positively affects the complexity of the project in the area of education in public administration.

3 Method

The present study employed a causal research design using a cross-sectional sample survey. For the treatment of demographic profile data: gender, age, educational level, and positions were descriptive and estimation analyses were performed using multivariate analysis of data from the Structural Equation Model (SEM).

3.1 Data collection

Data collection was performed by convenience sampling, a non-probabilistic technique, a fact that limits the generalization of research results (Malhotra, 2014). The questions in the questionnaire were developed based on a review of the related literature as well as expert opinions and were adapted to be applicable to the research site and target population. Data collection was performed within the Virtual Learning Environment of Moodle 3.4. Data collection occurred in November of 2018.

3.2 Data purification

To adapt the research instrument and the selected scales to the Brazilian context, the reverse translation process with academics was used, and before the application of the questionnaire, a pre-test was performed with n=52 to verify if there was an understanding of the research instrument. To prepare the data for subsequent analyses, the database was purified, eliminating questionnaires of respondents considered statistical outliers or who left a large number of questions blank or that used only one or two points of the interval scale. The purification process of the purification database removed a total of 48 questionnaires, leaving 536 questionnaires remaining.

3.3 Sample specification

The 536 are graduate students of the Public Education Management Course (PEM, a graduate study level, offered by the Federal University of São Paulo (UNIFESP). The course aims to train education professionals with adequate preparation to intervene in social, political and economic realities. The specific course was created by the National Training Program in Public Administration (Programa Nacional de Formação em Administração Pública - PNAP) and was released in 2009. This is a program offered by the Open University of Brazil (Universidade Aberta do Brasil - UAB) whose objective promotes initiatives that stimulate the partnership between the three levels of government (Federal, State and Municipal), with public universities and other

interested organizations, for the implementation of under-graduate and postgraduate courses in an intercropped manner, offered in the distance learning modality.

4 Data analysis and results

4.1 Respondent characteristics

For the descriptive analysis and test of medias, the data collected from the designed questionnaire were computed using several statistical techniques involving the Statistical Package for Social Sciences (SPSS). Data on the respondents' profiles were collected to characterize the sample that served as the basis for the evaluation of the complexity model of projects. Thus, information about gender, age, educational level and position (Table 1) has been detailed.

Table 1: Demographic profile

	n	%
Sex		
Male	149	27.80
Female	387	72.20
Age		
Up to 30 years	26	4.85
From 31 to 40 years	195	36.38
From 41 to 50 years	203	37.87
From 51 to 60 years	95	17.72
61 years or older	17	3.17
Higher education		
Doctorate	15	2.80
Masters	93	17.35
Specialization	302	56.34
Graduation	126	23.51
Position		
Manager/Director/President	83	15.49
Manager/Supervisor/Coordinator	85	15.86
Analyst/Advisor	14	2.61
Technical/auxiliary Support/Assistant	46	8.58
Professional Specialist/Graduated	8	1.49
Teacher	270	50.37
Other	30	5.59
Total	536	100

Source: Research data.

In addition to the demographic data presented in Table 1, some issues related to the involvement of respondents with project management were present in the survey, such as: 'length of experience, 'familiarity of the activities' and 'familiarity with the methodologies.' For the operationalization of the items, a seven-point scale was used, ranging from totally disagree (1) to totally agree (7).

The t-test for independent samples showed that on average (x=27.94), the group that has the longest period of project management experience (measured in months) has a greater familiarity of activities ($t_{(523)}$=6.676; p<.01) and familiarity with the methodologies ($t_{(523)}$=5.710; p<.01).

When analyzing the variable gender, both men and women presented equality of averages in the familiarity of activities ($t_{(534)}$=1.192; p=.234), as well as in familiarity with methodologies ($t_{(5\ 34)}$= 1.835; p = .067). Similarly, men and women also indicated equality in relation to the length of experience ($t_{(523)}$=1.148; p =.882).

When analyzing the age variable (x=43), both low and high age groups have equalities in the familiarity of activities ($t_{(534)}$=1.740; p=.820) and in familiarity with methodology ($t_{(534)}$=1.378; p =.182). This effect was also observed when analyzing the length of experience ($t_{(523)}$=1.853; p=.640).

4.2 The main educational projects developed in Brazil

The following are only the educational projects development in Brazil and that have involvement in direct participant this research, both as managers and as part of the development team, shown in Tables 2, 3 and 4 bring examples that were organized by spheres of coverage and progress status.

Through the national sphere, as can be visualized in Table 2, it is possible to observe countless challenges, such as understanding or controlling the specificities of each locality where the project will be implemented, depending on the size of the country and the plurality of citizens' profiles. Another important point to observe is the partisan issue inherent to projects originating from this sphere, since they may be difficult to be implemented in states and municipalities that count on different party managers. The same occurs with ideological issues that impair the progress

Table 2: Public education projects developed by respondents – Amplitude: National

Project name	Objective	Scope	Status
PNAIC-Pacto de Alfabetização na Idade Certa (Literacy Pact in the right age)	Ensure that all Brazilian children up to eight years are fully literate. For this, it contemplates the participation of the union, states, municipalities and institutions throughout the country.	It is a formal and supportive commitment assumed by the federal governments, the Federal District, the States and the municipalities	Start: 2012 *(in progress)*
Jovem Aprendiz (Young Apprentice)	Raise high-level schools of social vulnerability to invest in actions such as search for partnerships, training courses and so on, to monitor and improve school income indicators.	All Brazilian states are condemned by the project, except the Holy Spirit	Start: 2000 *(in progress)*
Respostas para o Amanhã (Answers for Tomorrow)	Challenge students to apply knowledge in STEM (Science, Technology, Engineering and Mathematics) in the elaboration of projects that present solutions for the improvement of the communities where they live.	Any public colleges of the municipal, state and federal networks.	Start: 2013 *(in progress)*
#Tamojunto	Discuss the practice of the social educator in the street with children and adolescents, between 12 and 18 years, based on the social pedagogy of Paulo Freire whose proposal is the construction of a problematizing and significant education, founded in dialogue as an existential necessity and recognizing the learner as the author of his own history. This practice seeks to stimulate the adolescent in the structuring of a life project, encouraging autonomy, the spatiality, valuing local potentials using the means as a tool of transformation and identity (educating city), with the purpose of awakening to the change of reality that signifies the street and/or neighborhood as a place of coexistence and leisure, making it a space in which the project happens, but not the only one.	It is the first Brazilian version of a methodology elaborated by European researchers, called 'Unplugged' and is present in the five Brazilian regions.	Start: 2014 *(in progress)*

Source: The authors.

and continuity of projects because they are supported by divergent theoretical currents between the current leaders and those who preceded it. In addition to the highlighted aspects, there is the challenging issue of management of these projects, since it can involve institutions, such as Non-Governmental Organization (NGO) and the management of financial resources can be compromised by the absence of clear policies of compliance.

These projects develop opportunities, such as the possibility of improving the quality of education, especially when the country faces the challenge of improving the indicators against other nations, such as the PISA (Programme for International Student Assessment), in which Brazil had a drop in position in the three evaluated areas (science, reading, and mathematics, respectively 63th, 59th, and 66th positions). In addition, the projects in this sphere bring as an opportunity the possibility of becoming a model for other countries that face similar challenges, not to mention the reverberation of these initiatives in other spheres of social problems, as is the case, for example, of the 'Young Apprentice' project in which the impact is not circumscribed to the academic or professional world, but it impacts the subject in an integral

way, including in its family nucleus and in the community where it is inserted.

As can be seen in Table 3, the city sphere is no different, and the projects bring challenges and opportunities for those involved, but in a smaller, but equally as important, dimension, In relation to the challenges, there is the question of the imminent possibility of discontinuity of projects when there is change of management, not that this does not occur in the national sphere, but in the sphere of the city this is seen more frequently, since the scope of the project is smaller and each manager desires to leave its mark in the city. In addition, budgetary issues also constitute an important challenge to managers, since more expensive projects are discontinued as federal funds or companies no longer wish to support the initiative.

With regard to opportunities, projects in this sphere allow, among others, to focus on finding alternatives to address the specific problems of the city, which in turn can contribute to improving national indicators, since each manager oversees the existing problems in a city in a different way and this can cause successful initiatives to arise and be shared among the other managers or even see a national project.

Table 3: Public education projects developed by respondents – Amplitude: City

Project name	Objective	Scope	Status
Música ao Ar Livre (Outdoor music)	Encourage the involvement of students in the teaching network with music and, at the same time, stimulate the learning process.	232 students from 5th to 9th grade in the city of Barueri.	Start: 2017 *(in progress)*
MMR (Método de Melhoria de Resultados) RIM (Results Improvement Method)	Improve the learning and flow of students in the State network through decentralized technical and financial support to the teaching boards and schools to qualify and implement the RIM improvement plans (results improvement method) according to their specific needs.	1,082 state schools, 13 teaching boards in the city of São Paulo.	Start: 2017 *(in progress)*
CEU Memórias & Ação (UEC Memories & Action)	To potentialize the spaces of the Unified Educational Centers (UECs) as integrators and integrated, from the construction, rescue and organization of the memories of the equipment UECs, its surroundings and its actors. This involving the community favoring these memories in a perspective of greater belonging, use and conservation of these spaces and potentially contributing to the sociocultural patrimony of the city.	46 UECs located in the city of São Paulo.	Start: 2018 *(in progress)*
Turma do Jiló (Jiló class)	To make the school context a reference space in inclusion and development for the lives of all involved. The main focus of the closure of the inclusive education program is to witness the spirit of inclusion and to celebrate, through music, learning and individual growth, the partnership of all those involved, school community, group of volunteers and partners, with the hope of continuing to sow the transformation of a new look, a new posture.	Directed to the public schools of São Paulo. The duration of the program is a school year. After this period, the Jiló class holds another school year of follow-up and surveys the results, improvements and update the program.	Start: 2015 *(in progress)*
Círculos de Leitura (Reading circles)	Support the youth in the development of their identity, citizenship and relationship with the community. Reading and group debate create a space for teenagers who want to share experiences and broaden the universe of knowledge through words and bonding with each other.	The activities are carried out in public schools of peripheral regions of the city of São Paulo.	Start: 2,000 *(in progress)*
Respeitar é Preciso! (Respect is accurate!)	Disseminating the culture of education in human rights in schools, through the "adoption of mutual respect and respect for diversity, thus repudiating any form of violence in the school life."	Colleges in areas of high social vulnerability of the municipal network of São Paulo, reaching approximately 1,500 educators and 15,000 children.	Start: 2014 *(in progress)*
Escolas do Amanhã (Schools of Tomorrow)	Improve the education of the municipal network through an intelligent and creative program of Integral education and a comfort and quality infrastructure for students and teachers.	It is a project of the city of Rio de Janeiro for the Municipal Education network.	Start: 2009 *(in progress)*
Escola da Família (Family School)	Create a culture of peace, awaken potential and broaden the cultural horizons of its participants. Bringing together education professionals, volunteers and university students, the program offers to the communities of São Paulo activities that can contribute to social inclusion, focusing on the respect for plurality and a prevention policy that competes for a better quality of life.	The program has a central coordination located in São Paulo (capital) and with the local administration of the 91 teaching directorates of the secretariat of Education of the State of São Paulo (SEESP).	Start: 2003 *(in progress)*
Fundação Tênis (Foundation Tênis)	Through sport, work with a pedagogical proposal based on the Olympic education through friendship, excellence and respect, remembering that the greatest promotion should happen with children and adolescents in a vulnerable situation.	Directed to children and adolescents in vulnerable situations of the cities Sapiranga, Porto Alegre and Igrejinha (RS), São Paulo and Santana de Parnaíba (SP).	Start: 2000 *(in progress)*
Projeto Jovens Desbravadores (Young Explorers Project)	Propose several playful spaces, so babies can explore and enjoy the elements, developing cognitive, emotional and motor stimulation.	Aimed at 5th year students of the Education network of the city of Santana do Parnaíba.	Start: 2016 *(in progress)*
Fazendinha Viveração (Farm LiveAction)	Focuses on patrimonial Education, presentation of cultural equipment and production of a completion activity, with the aim of students rescuing the historical context of the city and learning to preserve and propagate the importance of the Parnaibano cultural heritage.	Children from 5 to 11 years of elementary School – Cycle I – from the city of Itapecerica da Serra.	Start: 2007 *(in progress)*

Source: The authors.

Table 4: Public education projects developed by respondents – Amplitude: Neighborhood			
Project name	**Objective**	**Scope**	**Status**
VOCAÇÃO (Vocation)	To broaden the opportunities for integral development of children, adolescents and young people, valuing and enhancing socio-educational practices performed by the professionals of the coexistence and bond strengthening services, from the perspective of implementation of the rights assurance system.	Neighborhoods - Campo Limpo, M'boi Mirim and Cidade Ademar.	Start: 2015 *(in progress)*
Família Destaque (Featured Family)	Improve the rates of participation of families in school activities. This project is expected to improve the relationship of families with the school, constructing meaningful knowledge and interactions based on an educational proposal that teaches and learns to think about relationships in a cooperative way.	Implemented and developed by College of João de Barro that is part of the municipal network of Education of Santana de Parnaíba.	Start: 2017 *(in progress)*
Que som é esse? (What's that sound?)	Build meaningful learning spaces that allow children to express and build knowledge through music; familiarize children musical instruments. Families contribute to sending alternative materials (scraps, pans, lids, cutlery, keys etc. used) participants operate in workshops in the units for construction of sound toys for and in partnership with children.	Children's Educational Center Conde Luiz Zunta, Americanópolis.	February to december 2018 *(finalized)*
Mova - Movimento de Alfabetização de Adultos (Move-Adult Literacy movement)	Mobilize civil society, establishing partnerships, to overcome the illiteracy indexes of the municipality and the low schooling of the population as a whole.	It maintains partnership with organized civil society (churches, social entities, among others), resulting in more than 40 nuclei distributed in several neighborhoods.	Start: 1999 (finished in 2016)

Source: The authors.

The projects developed within the neighborhoods, presented in Table 4, whose relevance to the surrounding communities is immeasurable. In addition, in this type of project there is a strong involvement of the families and churches, which contributes to improve, for example, the participation of parents in their children's school and, also, in the school subjects.

Projects developed within the neighborhoods also bring challenges to those involved, since each is different, as is the case of support in terms of infrastructure, capital and people to drive these projects and ensure that they persevere over time, given that they often become dependent on crowdfunding due to the absence or insufficiency of public resources.

4.3 Structural model estimation

In the original model proposed by Qureshi and Kang (2015), 5 dimensions are analyzed. However, to achieve this article's objective, this research concentrated its focus on analyzing 4 dimensions because the project size construct was not sustained statistically when analyzing the convergence and discriminant indicators. This may be

explained by the nature of the items and that they were not understood by respondents as variables applicable to the organizational context of Brazilian public education.

The evidence of a good measurement model should have all the items loading greater than .50 (Hair et al., 2010). The reduction of variables of the original model, from 28 to 14, did not denote a loss of quality of the model. This is common in Structural Equation Modeling (SEM), mainly because the objective of the research is to detect the structure of the data or the causal modeling, increasing the partiality and, at the same time reducing the residual errors. However, the original model of Qureshi and Kang (2015) reached only 9 variables observed in the constructs that were selected for this study, which resulted in 14 observed variables that were sustained in the final model.

In addition, the items of scales or dimensions analyzed in this study indicated that they were more specific because they were concentrated in a sample containing individuals carrying out educational management activities. It is possible to bring as a contribution, a scale of resulting in items with specific characteristics to the public education area. Table 5 shows the details of the items used for each of the variables.

Table 5: Number of items on each variable

| Construct	Item numbers before remove (total items proposed by Qureshi and Kang, 2015)	Item numbers tested by Qureshi and Kang (2015)	Item numbers from this study
Project variety (PV)	7	4	4
Elements of context (EC)	5	-	3
Interdependencies within the project (IP)	10	3	5
Project complexity (PC)	6	2	2
Total	28	9	14

Source: The authors.

4.4 Model specification and refinements

The Structural Equation Model (SEM), as shown in Figure 2, is analyzed using the statistical computer program R (packages: Lavaan and semPlot) which allows for adjustment of the Structural Equation Models with observed and latent variables through the use of the maximum likelihood technique. We used the Likert scale with endpoints anchored at 1=strongly disagree and 5=totally agree, for the 28 statements that were part of the construction of the theoretical model.

After undergoing several interactions, the final model attains the recommended level of fitness and thus considered sufficient for the analysis. The SEMs have two components, a measurement model and a structural model. The measurement model is concerned with how well various exogenous variables measure latent variables, as previously described. A classical factor analysis is a measurement model that determines how well various variables describe a factor or factors, or latent variables. The measurement models within a SEM incorporate estimates of errors of measurement of exogenous variables and their intended latent variable. The second component of an SEM is the structural model. The structural model is concerned with modeling the relationships between latent variables (Molenaar, Washington, & Diekmann, 2000).

Table 6 represents four latent variables. In order to achieve a reliable final model and be compatible with the SEM framework, appropriate variables have to be selected from the list. Confirmatory Factor Analysis (CFA) and SEM were used to test the conceptual model that examined the antecedents of divers' underwater behavior. First, a CFA of the measurement model was tested, with all constructs (observed indicators and latent constructs) and was allowed to be freely inter-correlated. According to Anderson and Gerbing (1988), confirmatory measurement models should be evaluated and re-specified before proceeding to examining the structural equation model. The validity and reliability of the items and constructs were assessed by examining the loadings of items on their respective latent constructs. As shown in Table 6, all items loaded heavily and significantly (at $p<.05$) on their respective constructs (indicating individual item reliability). We assessed the reliability of scales through composite reliability (CR), which according to Hair et al. (2010) is preferable to Cronbach's alpha because it offers a better estimate of the variance shared by its indicators and because it uses the item loadings obtained within the nomological network. All CR scores exceeded the minimum threshold level of 0.70 indicating good reliability. Convergent validity of the constructs was also evaluated using the average variance expected (AVE) criterion, whose values exceeded the minimum limit of .50.

Figure 2: Adjusted Model
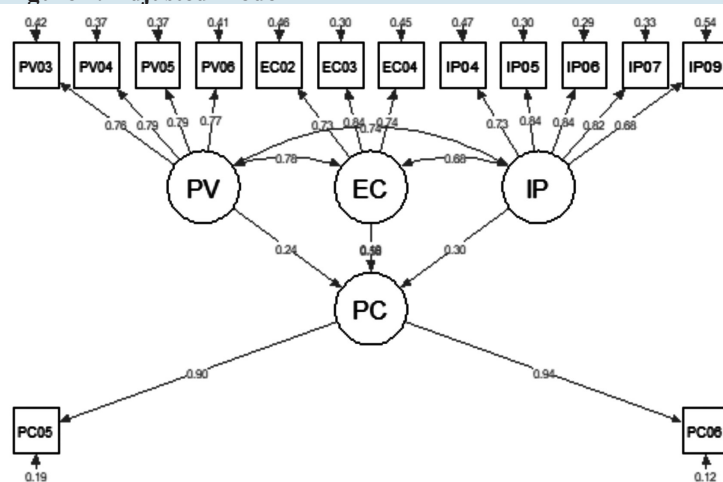
Source: The authors.

Table 6: Statistics of construct items

Construct	Items	Observed variables	Factor loadings	Cronbach's alpha (CA)	Composite reliability (CR)	Average variance extracted (AVE)
Project variety (PV)	PV03	Variety of information systems to be combined.	.762	.860	.860	.607
	PV04	Variety of organizational interdependencies.	.794			
	PV05	Types of required organizational skills.	.792			
	PV06	Variety of project management methods.	.770			
Elements of context (EC)	EC02	Environment complexity.	.732	.808	.813	.593
	EC03	Institutional configuration.	.836			
	EC04	Local and new laws and regulations.	.741			
Interdependencies within the project (IP)	IP04	Interconnectivity and feedback loops in the task and project networks.	.727	.881	.885	.607
	IP05	Interdependence between actors.	.837			
	IP06	Interdependence of information systems.	.840			
	IP07	Interdependence of objectives.	.816			
	IP09	Stakeholders interrelations.	.678			
Project complexity (PC)	PC05	Trust.	.901	.916	.916	.846
	PC06	Capability.	.938			

Source: The authors.

Pearson correlation analysis is used to validate the interrelationships among the constructs of project complexity in the final model achieved (Fornell & Larkcher, 1981). These correlations are presented in Table 7.

Table 7: Validity discriminant

Construct	PV	EC	IP	PC
PV	**.779**			
EC	.670	**.770**		
IP	.674	.676	**.779**	
PC	.608	.577	.605	**.919**

Notes: Diagonal elements (italics) are the square root of average variance extracted (AVE) between the constructs and their measures. Off-diagonal elements are correlations between constructs. For discriminant validity, diagonal elements should be greater than off-diagonal elements. All correlations are significant at p<.01.
Source: The authors.

Covariance Based Equation Modelling (CB-SEM) aims to estimate the theoretical structural model and examine the causal relationship between constructs and measure model practicality and authenticate according to the empirical data. This is featured in Table 8.

4.5 Results and discussion of SEM model

The results from Table 9 show the proposed model was accepted as the best model to be used in the testing of the proposed hypothetical model in this study (Qureshi & Kang, 2015).

After the results of the hypothesis test, it was observed that the H_2 obtained the most significant result (β=.301; p<.001) This indicates that the path IP->PC directly influences the reputation of the rulers in view of the ability to carry out projects. In addition, it can guarantee projects

Table 8: Model fit measures indices of the proposed model

Measures	Fit index	Description	Cut-off Values Based	Model index (value)	Conclusion
Absolute fit measures	X²/df	Check whether the covariance structure of the model is adequate and the same as the covariance matrix of the observed data.	≤ 5 Hayduck (1987)	4.88	Fit
	GFI	Goodness of fit index. Check overall fit of the model; percent of the covariance of the observed data can be explained by the covariance of the model.	0-1 ≥ .8 Scott (1991)	.911	Fit
	RMSEA	Root mean square error of approximation. Check the mean value of the covariance residual. One of the most widely used measures that attempts to correct for the tendency of the chi square.	.05 to .08 ≤ 0.08 Bagozzi and Yi (1988)	.08	Fit
	SRMR	Standard root means square residual.	.05 to .08 ≤ .08	.049	Fit
	AGFI	Absolute goodness of fit test or Adjusted for degrees of freedom is the development of a GFI to the degree of freedom ratio for a proposed model with a degree of freedom for the null model to as a null model.	0-1 ≥ .8 Scott (1991)	.868	Fit
Incremental fit measures	TLI	Tucker Lewis Index is a comparison of the normed chi-square values for the null and specified model.	0-1	.925	Fit
	CFI	Examine whether the model fits the observed data better than the independent model that has no relationships among variables.	0-1 ≥ 0.9 Bagozzi and Yi (1988)	.942	Fit
	NFI	Normed Fit Index is comparison between model proposed with null model. Explore the improvement of the overall fit of the model to independent model.	0-1 ≥ .9 Hair et al. (2010)	.925	Fit

Source: The authors.

Table 9: Hypothesis testing results

Hypothesis	Casual relationship	Standardised regression coefficient	Std. Err	p value	Conclusion
H$_1$	EC -> PC	.187	.103	.015	Supported
H$_2$	IP -> PC	.301	.089	***	Supported
H$_3$	PV -> PC	.239	.114	.005	Supported

Note: *** significant at .01 level.
Source: The authors.

understanding the main problems faced in the projects; (2) recommendations for future improvement; and (3) analysis for variations of the projects. Another important point is the interdependence of information systems that could contribute for both capacity and trust in the progress and proposition of new projects in the area of public education in the country, where it is possible to monitor in real-time the income of students from Brazilian public schools independently of the scope (neighborhood, city, states). In view of this, the information processing and the exploitation of communication channels constitute the main issues in the complexity of projects of information systems in the public education area (Müller & Turner, 2007).

with quality and value for its customers. The 'lessons learned' can contribute to the continuous improvement of a project by decreasing complexity and increasing trust. Unfortunately, 'lessons learned' are poorly used by organizations, as they require documentation for future learning. In many cases, the time factor is a determinant for this type of action. The learning generated could involve: (1)

H₃ also had a significant result (β=.239; p<.05) in which the relation PV->PC defends the influence capacity based on the use of methodologies. Therefore, the institutions should be able to adapt the changes and variabilities, using technologies and methodologies of project management that are adherent to the way the management processes are carried out. Thus, it is possible for the institution to opt for a traditional methodology (Project Management Body of Knowledge–PMBOK Guide) or Agile (Agile project management). This will depend on if the project manager's decision is aligned with the organizational structure. In relation to methodologies and project management tools, if the manager fails to conduct a team that establishes trust, it will be impossible to create harmony with the participants who are interested in the projects. Trust is obtained if the project team is informed of all phases of planning and with a good knowledge of their tasks. This can determine whether or not a project will meet the delivery timing and achieve the results (Alderman & Ivory, 2007). A project can be labeled complex only if the project organization faces difficulty in managing and executing it. This implies that improving the organizational capability in managing novelty can possibly mitigate the complexity (in terms of task uncertainty) induced by novelty (Pundir, Ganapathy, & Sambandam, 2007).

H₁ presented a significant causal relationship (β =.187; p<.05) of the EC->PC pathway, because the ability to perform these projects is recognized as a source of competitive advantage. Particularities of the configuration of public institutions make the environment more complex and affect their ability to enable projects due to the multiple relationships between the bodies involved. Regulatory changes can affect the reliability of project continuity as they can be changed at any time depending on the top-down decisions.

In addition, the confirmatory factor analysis (CFA) and the Structural Equation Modeling (SEM) provide for covariance of factor analysis, presented in Table 10, with the ability to compare revised or re-specified measure-

ment model through the statistical significance of the data with the theoretical model (Mustapha & Obid, 2015).

Table 10: Covariances testing results

Covariances	Standardised regression coefficient	Std. Err	p value
IP < > VP	.744	.026	***
EC < > VP	.777	.026	***
IP < > EC	.676	.031	***

Note: significant at .01 level.
Source: The authors.

When analyzing the moderator effect (Preacher et al., 2007) of the project complexity (PC) construct by software PROCESS v. 3.3, it is observed, represented in Figure 3, that as the length of experience increases, the perception of the project's complexity interferes with the familiarity with the activity (β=.437; p=.021). This is explained due to the maturity gained by those involved who begin to understand with greater depth the different nuances existing in the phases and areas involved in the projects. This will lead them, over time, to know how to cope with the possibility of resistance to the implementation of a project, to the fact that not all sectors/agents involved will embrace the proposal at the same time, that clear communication of benefits is a fundamental factor for the success of the initiative, among others.

Figure 4 indicates that as the length of experience increases, the perception of the complexity inherent to the projects does not interfere with the familiarity with the methodology. This is explained due to the fact that the experience gained by those involved is not significant (β=.248; p=.266), since the application of the chosen methodology makes the processes more practical, organized and efficient, because they constitute guides, manuals, structures ready for prior consultation or have the support of outsourced consultants to meet demands whenever necessary, in addition to standardized forms, reports and controls.

5   Conclusions

This paper gives a better vision of the concept of project complexity by identifying in the literature the
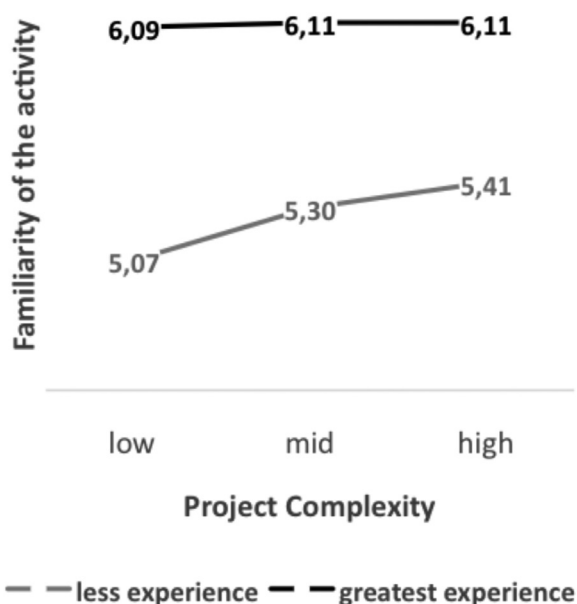
Figure 3: The impact of the length of experience on familiarity of the activity in projects regarding the complexity of projects
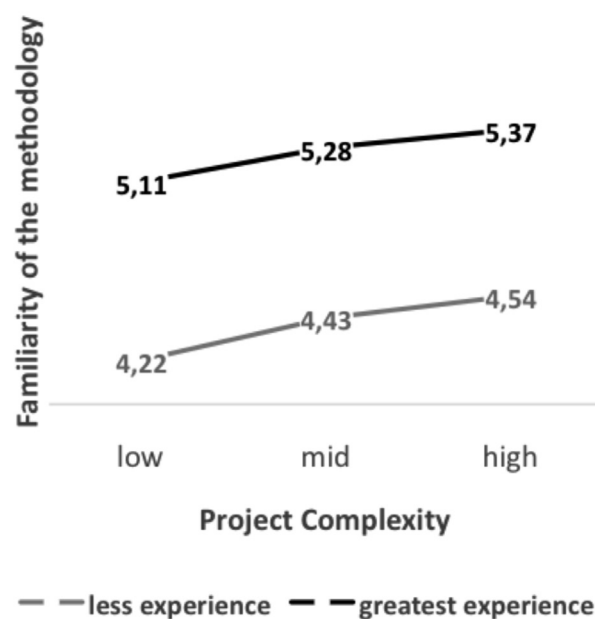Source: The authors.

Figure 4: The impact of length of experience on familiarity of the methodology in projects regarding the complexity of projects
Source: The authors.

main factors related to organizational assessment and management in the complexity of projects with professionals who work with projects in the area of education in public administration.

The constructs project variety, elements of context, interdependencies within the project and project complexity were analyzed by using Confirmatory Factor Analysis (CFA) for evaluation and estimation model. The four measures listed played a significant role in the goodness of fit index of an underlying construct for the model with the application of Structural Equation Modeling (SEM) using the R software.

Although authors consider the size of the project system as a project complexity factor (Corbett et al., 2002; Vidal & Marle, 2008) it is necessary to identify the parameters that characterize the size of the project system and consider the public initiatives of Brazilian public educational projects that were selected for this study. It became difficult to begin to scale this construct because, during execution, the project often goes through size adjustments and sometimes has no continuity. In this sense, the dimension of the project size was used in this

research, but it was not able to remain in the adjustment of the final theoretical model.

The literature review indicates that complexity can have a negative aspect (in terms of difficulty to be understood or controlled, and this is clearly perceived considering that the two observed project complexity factors, trust, and capability, that remained at the end of the model are related to this type of situation). It may also have a positive influence on the project system (due to the emergence of opportunities to leverage new management possibilities or even improve a product or service that is or may be developed).

The study may indicate that it is better to understand complexity in the project context during the project management, since complexity is related to the success of the project as well as the achievement of the goals, but complexity is also related to the scope and magnitude of the project. What can bring important challenges, in view of the high susceptibility to external factors that can compromise a project, as is the case, for example, of the exchange of government, of the partners in the projects, budgetary planning, and ideological issues. It can also emerge in these context inputs that contribute to the

development of these projects, such as the involvement of the community, the attendance to specific problems, the involvement of the family/religious.

Millhiser and Solow (2007) indicated that an optimum level of interaction can be achieved to reach the best compromise between the emergence of opportunities and risks induced by complexity. The concept of risks induced by complexity should be studied in future research, as concerns were observed in the Brazilian public educational management, among them: the possibility of discontinuity of projects; the idiosyncratic characteristics of each locality, especially when what is in question are nationwide projects; the type of human, technological and financial structures, among others.

Although complexity comes in different forms: structural, sociopolitical, and emergent (Maylor, Turner, & Murray-Webster, 2013), managers are frequently prepared to deal with only one type of complexity structure. However, it is necessary that project managers who work in the public area are attentive to the socio-political aspect, since it presupposes the combination of the political and emotional aspects of those involved in the projects.

In analyzing the methodological aspects, SEM is a statistical analysis tool that is currently underutilized in construction project management and management research. The intent of this paper was to introduce SEM framework and analysis techniques into a field of research that is still little explored – public educational projects within the Brazilian scenario. In addition, the quantification of these latent variables will enable researchers to better understand the complex nature of the project complexity in this area.

This study presented limitations regarding the scope of the sample, since the respondents were concentrated in the southeast region of the country: São Paulo, Rio de Janeiro, and Minas Gerais, and it would be interesting to extend to the other four regions to capture the different nuances existing in a country with continental dimensions. Also, in relation to the sample, another limiting factor is that, even though the respondents' profile is diverse, it is still concentrated in a group of professionals who have undergone a postgraduate training course in public education. Another limitation of the study to be considered is the type of scale used in the original model of the authors Qureshi and Kang (2015), because the measurement was

made by items (observed variables) selected in the literature and not by a psychometric response scale commonly used in questionnaires.

Despite the aforementioned limitations, the study contributed to professionals who work in public education in the country and stresses the importance to be more attentive to the question of familiarity with the activity, since it is impacted by the complexity of the project, and this is critical so that the project can succeed.

In view of this study, we to propose as an improvement for future research, applying this same instrument of data collection with other professionals who work with projects in the public area, in the different spheres of power in the country, working with a sample that contemplates the five regions. Moreover, even though this type of instrument has previously been used in reference research in the field of project management, it would be important for future studies to continue to improve the instrument for a psychometric scale.

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