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THE MODERATING EFFECT OF VIRTUALITY ON THE RELATIONSHIP BETWEEN COMMUNICATION AND SUCCESS IN PROJECTS

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Abstract

There is a growing demand for local teams to work with virtual teams due to the improvement of the computerized environment of companies and the search for greater efficiency in projects. Verbal communication is considered an essential skill for the success of project managers in organizational environments. Virtuality brings greater complexity to project team management and adds measurable factors to compare virtual teams and on-premises teams. The aim of this study was to evaluate the relationship between communication and success in projects, moderated by virtuality in local and virtual teams. The study uses a quantitative methodological approach of an applied nature. The data were collected through a survey of 347 project managers from various countries around the world. The data were initially explored by means of descriptive statistics and later the structural equation modeling analysis was performed. The results suggest that virtuality influences communications and project success in different ways, softening the strength of communication satisfaction for virtual teams but not for local teams, and softening the strength of communication effectiveness for local teams but not for virtual ones. This implies that virtuality requires distinct management strategies in distributed project management teams. It is possible to conclude that improving communication in teams, both local and virtual, through direct and indirect actions, can positively influence the success of projects and provide competitive advantages for organizations.

Keywords: Communication; Project Management; Virtual Teams.

Resumo

Há uma demanda crescente por equipes locais para trabalhar com equipes virtuais devido à melhoria do ambiente informatizado das empresas e à busca por maior eficiência nos projetos. A comunicação verbal é considerada uma competência essenciail para o sucesso dos gerentes de projetos nos ambientes organizacionais. A virtualidade traz maior complexidade ao gerenciamento de equipes de projeto e adiciona fatores mensuráveis para comparar equipes virtuais e equipes locais. O objetivo deste estudo foi avaliar a relação entre a comunicação e o sucesso em projetos, moderados pela virtualidade em equipes locais e virtuais. O estudoyem abordagem metodológica quantitativa de natureza aplicada. Os dados foram coletados por meio da realização de uma pesquisa survey com 347 gerentes de projetos de vários países do mundo. Os dados foram inicialmente explorados por meio de estatística descritiva e posteriormente realizada a análise de modelagem de equações estruturais. Os resultados sugerem que a virtualidade influencia as comunicações e a relação de sucesso do projeto de formas diferentes, suavizando a força da satisfação da comunicação para as equipes virtuais, mas não para as locais, e suavizando a força da eficácia da comunicação para as equipes locais, mas não para as virtuais. Isso implica que a virtualidade exige estratégias de gerenciamento distintas em equipes de gerenciamento de projetos distribuídas. É possível concluir que melhorar a comunicação nas equipes, tanto locais quanto virtuais, por meio de ações diretas e indiretas, pode influenciar positivamente o sucesso em projetos e proporcionar vantagens competitivas para as organizações.

Palavras-chave: Comunicação; Equipes Virtuais; Gerência de Projetos.

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INTRODUCTION

Within a project team, communication between people can occur with an emphasis on trust, team cooperation, team performance, cultural adaptation, and interpersonal relationships. On the other hand, communication is a physical means to transmit the message through the use of existing collaborative technologies, increasing the efficiency of virtual teams. In these aspects, some communication barriers can be found, such as cultural, idiomatic, physical, language difference between business and systems, difference in perception and lack of a project communication plan, among others.

In the literature, there are several terms to describe virtual teams, such as: multinational teams, geographically dispersed teams, distributed teams, remote teams, among others. Virtual teams consist of members located in different locations who communicate through technology to complete a project task. Although all these terms and their conceptions share common characteristics with those of traditional teams, the big difference is present in the virtuality inherent to the concept of virtual team. Therefore, team management and information technology and its collaborative tools become central themes when working with virtual teams.

Within organizations, communication gains a prominent role as a key element in project management. For this reason, communication becomes related to the outcome of projects, and can lead to success or failure. Such emphasis on communication ends up becoming part of effective practices related to project management, as can be seen in the guide to good project management practices (Project Management Body of Knowledge - PMBoK), which dedicates an area of knowledge to the management of communications and their respective project monitoring and control processes.

Therefore, due to the fact that communication in teams is associated with the success and performance of projects and, on the other hand, to the fact that organizations carry out their projects with local and virtual teams, a gap arose to carry out this research. The objective this paper is evaluating the relationship between communication and success in projects, moderated by virtuality in local and virtual teams. To achieve this objective, a quantitative and applied study was carried out. The data were collected through a survey of 347 project managers from various countries around the world. The data were initially explored by means of descriptive statistics and then the structural equation modeling analysis was performed.

This article is structured into six sections. Following this introduction, section 2 presents the theoretical framework on project success, communication, satisfaction and effectiveness of communication, virtuality, ending the section with the conceptual model of hypotheses. In section 3 the

research methodology is presented. Analysis and discussion of the results are demonstrated in section 4, followed by discussion in section 5. Finally, section 6 presents the conclusions.

THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

This section presents the assumptions about Success in Projects, Communication, and Virtuality that theoretically support the hypotheses model proposed in this research.

Success Project

The success of the projects can be influenced by several variables (LAI *et al*., 2018; SHAO, 2018; WEN, QIANG, 2019; FREIRE *et al*., 2023). Therefore, evaluating the performance and success of projects has become a concern to understand organizational performance (MESKENDAHL, 2010; ZAMAN *et al*., 2019). However, understanding and measuring the success of projects is still a challenge to be overcome by organizations (KHAN *et al*., 2020). Cooke-Davies (2002) still argues that no project metrics system is complete without the two measurement sets (performance and success) and without a means of linking them, so that one can evaluate the accuracy with which performance predicts success (KHOSRAVI *et al*., 2020).

For a more comprehensive assessment of project success, Shenhar and Dvir (2010) suggested five basic dimensions. These are Project Efficiency, Customer Impact, Team Impact, Direct Business and Organizational Success, and Preparation for the Future. Project Efficiency represents the short-term achievement of planned project goals (scope, cost, and timeframe) (PARNELL *et al*., 2020). Generally, maintaining these constraints indicates that the project was well managed, but does not guarantee that it will be successful in the long term.

The customer Impact represents the perception of one of the main stakeholders of the project (SHENHAR, DVIR, 2010). It indicates whether the project met expectations and improved the client's business. This dimension includes measures of product performance, functional requirements, and technical specifications. The Team Impact reflects how the project relates to the team. It assesses team satisfaction, morale, the team's overall loyalty to the organization, and team retention after project completion. In addition, it assesses team learning and growth, as well as the skills acquired by team members. Commercial and Organizational Success corresponds to the direct and immediate financial impact on the organization that controls the project. This dimension includes measures of profitability, positive return on investment, increased market share of the organization, the value of the organization's

shares, and direct performance of the organization. Finally, preparing for the Future addresses the long-term benefits of the project. It assesses how the project helps the organization prepare the infrastructure for the future and how it creates opportunities. Future infrastructure may be new organizational processes, and additional technological and organizational skills.

On the other hand, the complexity of the project is a challenge that project teams must achieve to ensure the success of the project (OFORI, 2013). The original dimensions of time, cost, and quality of the project's success were therefore expanded by scope and stakeholder satisfaction and quality (BERGMANN, KARWOWSKI, 2018). In addition, issues with leadership (BHATTI *et al*., 2021), resource restrictions (GEMINO *et al.*, 2021) and the competencies (SANDSTØ, REME-NESS, 2021) and personality of the project manager (CASTRO *et al.*, 2021). For this research, the scale proposed by Shenhar and Dvir (2010) was adopted. There may be other relevant dimensions for measuring project success, all dimensions contained in the Shenhar and Dvir (2010) study represent a broad spectrum of design situations and cover most cases and time horizons inside the organizations.

Communication

The communication between members of virtual teams from different cultures can be seen as a determining element for the success of the team (DUBÉ, PARÉ, 2001), and an essential theme in any virtual team (POWELL *et al.,* 2004). Communication between members of virtual teams from different cultures can be a source of many problems because when teams communicate, they bring with them different styles of communication (VERČIČ, 2021), as well as different ways of transmitting information (AMANT, 2001).

In this sense, managers must focus on cultural differences and similarities to create a unique work culture for each global project (IORIO, TAYLOR, 2015). As a reflection on operational performance, such factors can influence the transfer of project knowledge to other members of an organization (REN *et al*., 2019). The situation can cause team members to have difficulties with intercultural communication, as they do not consider cultural differences nor do they consider that this can affect team performance (POWELL *et al.,* 2004).

This intensifies the importance of understanding the forms of communication and behavior patterns of team members (WEBSTER, WONG, 2008). Therefore, for efficient communication to occur between team members from different cultures, the sender of the message must adapt the information so that the receiver can understand it (WARREN, 1998). Intercultural virtual teams are faced with more

significant challenges than localized teams (DUBÉ, PARÉ, 2001). Still, other problems stem directly from communication, such as misunderstandings and lack of trust (ANAWATI, CRAIG, 2006).

Concerning the involvement of virtual times and project performance, communication can play a role of temporary trust, motivated by the adoption of technological tools by the organization (JARVENPAA, LEIDNER, 1999; GROSSE, 2002), which can lead to possible negative impacts on the success of projects (DAIM *et al*., 2012). We quantify the effects of communication on project success and understand the moderating effect of virtuality on the relationship between communication and project success. To this end, two dimensions will be used to measure the communication construct (i) communication satisfaction and (ii) communication effectiveness. In the next section, these two dimensions will be explored, and their respective hypotheses will be presented.

Communication Satisfaction

According to Pincus (1986), research on the relationships between communication satisfaction, job satisfaction, and work performance primarily show a strong positive relationship in employees' perceptions of various aspects of communication and job satisfaction, particularly in terms of job satisfaction. refers to the relationship between subordinate and superior. In this sense, that employees' perceptions of top management and their communication practices may also be important influences on job satisfaction (GRAY, LAIDLAW, 2004).

Communication satisfaction can be defined as a socio-emotional result of communication interaction or as employee satisfaction with various aspects of communication within the organization (TKALAC *et al*., 2021). In the study by Guo *et al*. (2009), it is demonstrated, through a dialogue technique, that it was possible to help teams to develop their relationship and achieve the best results in team meetings. The results of this study support that teams obtained more cohesion from other teams, communication satisfaction, and decision-making satisfaction, and, consequently, an increase in the productivity of virtual teams.

Whereas communication satisfaction is an extension, where members feel part of the discussion and can actively engage in team interaction (HECHT, 1978), then if team members can communicate and understand each other better, this reflects in an increase in its productivity, and, consequently, in an increase in the success of the projects. Henderson *et al*. (2018) points out that communication satisfaction may be less effective in culturally diverse teams, both locally and virtually, and may cause misunderstandings among team members, which, in turn, positively impacts project outcomes. Given this context, it can be concluded that measuring the satisfaction of communication as an independent

variable of this research, it is possible to evaluate its effects on the dependent variable Success in Projects, allowing us to suggest the following hypotheses:

- H1: Communication satisfaction positively influences project success in the local context.
- H1a: Communication satisfaction positively influences success in projects in the virtual context.

Communication Effectiveness

The study by Sharma and Patterson (1999) concludes that the effectiveness of communication plays a critical role in the impact of perceptions of technical and functional quality, trust, and relationship commitment. This result is consistent with the theoretical precepts of Hatfeld (1993) and Bland and Kerry (1997), who emphasize that regular communication can help to develop a sense of closeness and ease in the relationship, in addition to being fundamental in building emotional bonds and social relationships, making the relationship more resistant to the occasional problems that inevitably develop from time to time. In the same vein, Barendsen *et al*. (2021) determine that at the practical level, the objective of communication effectiveness is to help organizations effectively manage the expectations and satisfaction of project teams, improving internal communication practices.

The study by Verburg *et al*. (2013) showed that one of the items for the successful execution of a project in a virtual environment includes clear communication rules. Kayworth and Leidner (2002) evaluated in their studies the effectiveness of communication in terms of quantity, quality, and clarity of communications. The results of this study indicate that team members' perceptions of communication effectiveness, communication satisfaction, and the leader's ability to establish role clarity among team members are associated with effective leadership. In this sense, we can say that communication plays a key role in traditional teams, however, it can assume additional importance in virtual teams (HILTZ *et al*., 1991).

Corroborating this idea, Paul *et al*. (2016) suggest that effective coordination in virtual teams can create a positive feedback loop with trust and cohesion, thus improving overall project performance and, consequently, project success (VARHELAHTI, TURNQUIST, 2021). Effective communication is an essential factor in the success of the project, keeping stakeholders in the project on track to achieve its objectives and enabling problems to be overcome and resolve conflicts during its implementation (MUSZYŃSKA, 2018). It can be suggested that proposing the effectiveness of communication, as an antecedent of Success in Projects, allows to bridge the gap between team performance and virtual/local team management. Therefore, this research suggests the following hypotheses:

- H2: Effective communication positively influences project success in the local context.
- H2a: The effectiveness of communication positively influences the success of projects in the virtual context.

Virtuality

According to Chudoba *et al*. (2005), characterizing virtuality is important to structure the concept of virtual teamwork, to cover previous definitions, which allows us to document and measure the conditions of virtual teamwork with more precision. The authors also point out that as a quantifiable index, it can be combined with outcome measures to assess the effects of individual virtuality resources on the performance of activities performed. A virtuality index can be useful for measuring fast-moving trends, understanding the different vectors of those trends, and responding strategically to vectors where the index indicates potential problems. All this contributes to group learning, interpersonal communication, and creativity, with a direct reflection on the performance of a ready (BEN MARDER *et al*. 2021; SANTOS *et al*., 2024).

About performance, virtual teams present satisfactory results in terms of time, budget, and value delivery of projects, mainly the determination and orientation of time results (OLIVEIRA *et al*., 2023). How virtual teams are for projects that require multifunctional contributions or cross borders and the key to their value creation is to have a defined strategy to overcome the problems associated with remote cooperation (LEE-KELLEY, SANKEY, 2007).

However, factors such as communication can affect the effectiveness of virtual team scans concerning project performance. In this relationship, Morgan *et al*. (2014) highlight that different methods of communication vary in their effectiveness in the context of virtual work, and that issues such as dispersion, competition, priorities, and objectives of the members of a virtual team can moderate the relationship of communication with the success of a project. Thus, it can be inferred that, when measuring the team's virtuality as a moderating variable in this research, it is possible to understand the moderating effects of the variable on topics related to communication and success in projects, allowing us to suggest the following hypotheses:

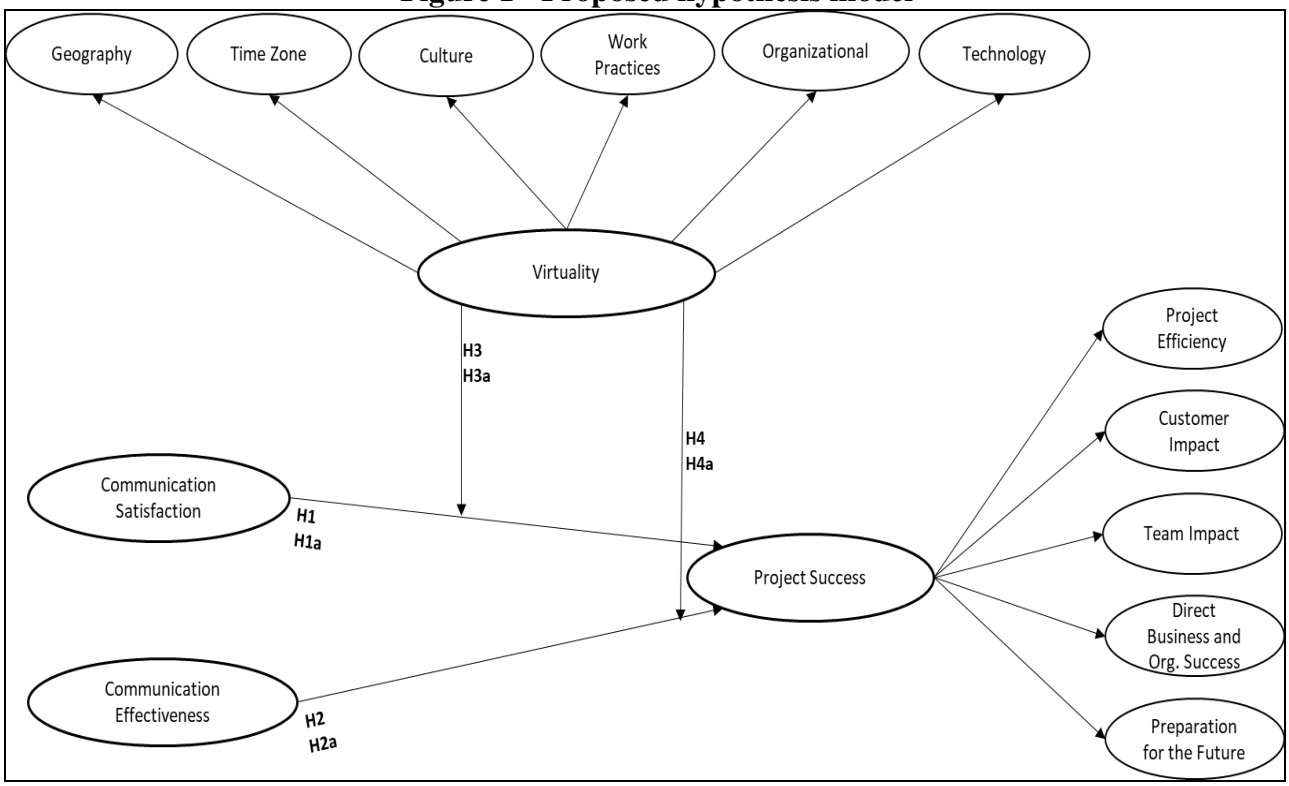
- H3: Virtuality negatively moderates the relationship between communication satisfaction and project success in the local context.
- H3a: Virtuality negatively moderates the relationship between communication satisfaction and project success in the virtual context.
- H4: Virtuality negatively moderates the relationship between communication effectiveness and project success in the local context.

- H4a: Virtuality negatively moderates the relationship between communication effectiveness and project success in the virtual context.

THEORETICAL MODEL

From the explanations about each variable used in our research, the theoretical model of the research is presented in Figure 1.

Figure 1 - Proposed hypothesis model



Source: Self elaboration.

The research looks for the effects of communication variables on a dependent variable Project Success. The research intends to understand the effects of the Virtuality construct, moderating on the themes of communication and success in projects. The research also plans the effects of communication on the success of projects in different team contexts: virtual and/or local. Finally, this research intends to determine at what level of virtuality moderates the relationship between communication and project success.

METHODOLOGY

This study is quantitative, hypothetical-deductive. Data collection was carried out through an online survey. Google Forms was used as a support tool for data collection. The tool was chosen because it allows the export of data in spreadsheet formats for later treatment by the SPSS software.

The link to the survey questionnaire via Google Forms was sent via email and social media, such as LinkedIn, Skype, WhatsApp, among others. There will be no distinction between respondents from the same company or industry, as respondents can choose different projects when responding to the survey. At the beginning of the survey, a contextualization of the survey in general and of the virtual and local contexts is presented, with the aim of leveling the respondent's understanding.

The initial questions of the questionnaire were used for the respondent's professional and personal knowledge and do not have a specific format. On the other hand, the format of the other questions related to the scales of the independent, dependent and moderating variables of the research will be a Likert-type interval scale. To standardize the forms, a seven-point numerical scale will be used, ranging from "strongly disagree" to "strongly agree" (1 to 7) based on the Likert scale. Likert scales are widely used when the researcher wants to measure opinions, beliefs, or constructs (DEVELLIS, 2016).

For this research, multivariate analysis techniques were used. The data collected from this research were analyzed through structural equation modeling (HAIR, *et al*., 2016) using *Smart PLS* software. To test the hypotheses, the SPSS v.21 software was used, using hierarchical linear regressions, procedures described by Hayes, Montoya and Rockwood (2017). Process Macro 4 was used for the moderation tests, additional statistics and regression tests. Regarding the validity of the research, a statistically significant test and a proven hypothesis of a p-value ≤ 5% will be considered (HAIR *et al.*, 2009).

The unit of analysis are project management professionals, such as consultants, analysts, coordinators, supervisors, project managers and the like, who participate or participated in project that have virtual and/or local teams. The population of this research includes professionals from the national and international market. The link was sent to professionals in the field of project management in several countries. Respondents were separated into the following contexts: National context, where professionals and teams reside in Brazil, and international context, where professionals reside outside Brazil.

The contexts were subdivided into Local teams, where the professional works with local and virtual teams, where the professional works with teams installed in other countries. The survey collected 362 responses, and after cleaning the database, 347 valid responses were obtained. Table 1 presents the sample details in all the contexts of the respondents.

As an important data, the three main functions are condensed in 92.5% of the interviewees in the sample. First, 64% of respondents are project leaders or managers. In second place, 22.2% are team members, controllers, or project analysts. In third place, there is 6.3% of the sample in the role of Project Owner or Scrum Master.

Table 1 - Sample detail

Survey Type	*Answers*		
	Complete	**Incomplete**	**Total**
International context - Local teams	54	1	53
International context - Virtual teams	74	3	71
National context - Local teams	104	1	103
National context - Virtual teams	130	10	120
Total	362	15	347

Source: Self elaboration.

Procedure

The data collection was carried out through an online survey. As a support tool for data collection, Google Forms was used. The tool was chosen because it allows the export of data in spreadsheet formats for further processing by the SPSS software. The link with the survey questionnaire via Google Forms was sent via email and social media, such as LinkedIn, Skype, WhatsApp, among others. There was no distinction between respondents from the same company or sector, as respondents can choose different projects when responding to the survey. To standardize the forms, a seven-point numerical scale was used, ranging from "totally disagree" to "totally agree" (1 to 7) based on the Likert-type scale (DEVELLIS, THORPE, 2021).

Variables and instruments

The research is quantitative in origin and aimed to determine to what extent virtuality moderates the relationship between communication and project success. Three constructs were used: Communication, Virtuality, and Success in Projects. To measure the Communication construct, the independent variables of Communication Satisfaction and Communication Effectiveness were used. The communication construct was measured from the variables of the effectiveness and satisfaction of communication. The items related to the topic of communication effectiveness were based on the scale developed by Sharma and Patterson (1999). For the communication satisfaction variable, the questions were based on the scale developed by Hecht (1978). The virtuality variable questions were based on the scale developed by Chudoba *et al*. (2005), and finally, the items related to the theme of Success in Projects were based on the scale developed by Shenhar and Dvir (2010).

Translation of scales

In relation to the scales, we opted for the integration between the reverse translation procedures, proposed by Douglas and Craig (2007), and the face validation procedure, to preserve the main

characteristics of the scales regarding the measurement of constructs involved. Face validation aims to ensure that a scale measures what is intended to be measured in a survey (HAIR *et al*., 2019), and must be obtained by observing the items of the survey variables and their ability to explain the construct, within the scope of the Brazilian version, after the reverse translation process (DEVELLIS, THORPE, 2021).

All scales were translated into Portuguese by a native speaker of English and fluent in Portuguese. Subsequently, the translations were analyzed by the author and confronted by two Ph.D. professors, with a line of research in project management. The reason for this procedure is justified by the fact that these scales have not been used in the Brazilian context, and because they involve project management concepts applied to the professional context. No changes were made to the initial translation after analysis by the Ph.D. professors. After this step, we proceed to face validation following as well DeVellis and Thorpe (2021) prescriptions.

Data analysis

The analysis process was based on the prescriptions of Hair *et al*. (2009) and DeVellis and Thorpe (2021) to ensure validity and reliability. The indicators used are compatible with the hypothesis tests proposed in this research. Therefore, tests were performed to verify normality, internal validity, communality, among others, which guarantee the quality required in this type of research.

Therefore, in the analysis of direct hypotheses, we choose to use structural equation modeling to test the direct hypotheses, with estimation by partial least squares, using SmartPLS 3.0 as software, based on a variance matrix, as it is more appropriate when the objective of the study is predictive (HAYES, 2017). For the test of indirect, mediation hypotheses, multiple regression was chosen (HAYES, 2017), using macro 1 of PROCESS®, based on Hayes and Preacher (2014). As for the validity of the research, it will be considered a statistically significant test and a proven hypothesis of p-value ≤ 5% (HAIR *et al*., 2009).

ANALYSIS AND DISCUSSION OF RESULTS

The results were evaluated through Structural Equation Modeling, using the Partial Least Squares method, using the SmartPLS 3.0 software. Such analysis is indicated for data not adherent to the normal distribution, reduced samples, and when the objective of the researcher is to increase the

predictive capacity of the model. The convergent and discriminant validity of the model was analyzed, (HAIR *et al*., 2014; RINGLE *et al*., 2015).

A confirmatory factor analysis was performed to debug the structural model proposed by the research. The minimum level of 0.5, according to Fornell and Larcker's criterion, of the average variance extracted, or AVE (Average Variance Extracted), must be observed until the model stabilizes. For this, items with a factor loading below 0.708 were eliminated from the model, so as not to harm the AVE of each construct, thus increasing the model's ability to explain. The procedure consists of performing the calculations using the Smart PLS 3.0 software algorithm.

At each run, it must be verified that the minimum threshold has been reached for all variables. Otherwise, it is necessary to eliminate the model variable with the smallest factor loading below the minimum threshold, and then run the algorithm again. Based on this criterion, the variables SC01 → 0.00; SC03 → 0.28; SC05 → 0.43; SC02 → 0.43; SC16 → 0.41; GE02 → 0.50; GE01 → 0.54; TECN4 → 0.6; SCD0D1 → 0.25 and PF1 → 0.70, were parsimoniously eliminated from the model. The validation statistics are presented in Table 2.

Table 2 - Convergent and discriminating validity

Construct	AVE	Composite reliability	R^2	Cronbach's Alpha	Communalities
Culture	0.852	0.920	0.531	0.826	0.852
Communication Effectiveness	0.721	0.912	0.161	0.871	0.721
Project Efficiency	0.628	0.871	0.540	0.803	0.628
Geographic	0.791	0.883	0.631	0.737	0.791
Impact on the Team	0.732	0.942	0.731	0.926	0.732
Impact on the Customer	0.705	0.923	0.724	0.895	0.705
Organizational	0.563	0.794	0.512	0.617	0.563
Preparing for the Future	0.614	0.888	0.453	0.843	0.614
Work Practices	0.679	0.864	0.583	0.764	0.679
Communication Satisfaction	0.632	0.895	0.000	0.854	0.632
Commercial and Direct Organizational Success	0.685	0.916	0.679	0.885	0.685
Technologic	0.823	0.933	0.410	0.892	0.823
Temporal	0.654	0.790	0.571	0.477	0.654

Source: Self elaboration.

It can be seen from Table 2 that all AVEs are above 0.50, indicating that all constructs were explained in more than 50% by the debugged items in the confirmatory factor analysis. It is still possible to observe Cronbach's Alpha (AC) and Composite Reliability (CC) values, as they are used to assess whether the sample is free of bias or whether the responses are reliable. AC values above 0.60 and 0.70 are considered adequate in exploratory research and, for CC, values of 0.70 and 0.90 are considered satisfactory (HAIR *et al*., 2014). As a point of attention, it is indicated that CC is more suitable for the PLS-PM, as it prioritizes the variables according to their reliability, while the AC is very sensitive to the number of variables in each construct.

It is also possible to observe through Table 2 that the items are reliable to measure the variables, as the AC and CC values are adequate to the indicated parameters. As an exception, the value of AC of 0.477 is found in the temporal dimension, since it was below the value defined as a minimum of 0.6. However, it is understood here that the CC value of this item (0.790) allows the continuity of this dimension in the calculations. It is also observed that the explained variance of each construct reached expressive values (R^2).

Also, as indicators of model fit, it is possible to observe the explanatory values and predictive capacity of the model (Q^2 and f^2). In this way, it is observed whether the model had constructs satisfactorily explained (endogenous or dependent variables within the model), as well as, among these constructs, what was the predictive capacity of each construct (exogenous or independent). This can be seen in Table 3.

Table 3 - Accuracy and effect of variables Q^2 e f^2

Construct	Variable / Dimension	Q^2	f^2
Virtuality	Culture	0.461	
Communication	Communication Effectiveness		0.522
Project Success	Project Efficiency	0.330	
Virtuality	Geographic	0.508	
Project Success	Impact on the Team	0.537	
Project Success	Impact on the Customer	0.513	
Virtuality	Organizational	0.277	
Project Success	Preparing for the future	0.278	
Virtuality	Work Practices	0.392	
Communication	Communication Satisfaction		0.450
Project Success	Commercial and Direct Organizational Success	0.463	
Virtuality	Technologic	0.366	
Virtuality	Temporal	0.377	
Project Success	Project Success	0.172	0.389

Source: Self elaboration.

As a criterion for evaluating Q^2 values greater than zero must be obtained (HAIR *et al.*, 2014). In a perfect model, one could have $Q^2=1$ (shows that the model reflects reality without errors). To obtain the f^2 values, it is necessary to include and exclude the constructs from the model one by one, and they evaluate how useful each construct is for the adjustment of the model. For the evaluation of f^2, 0.02, 0.15, and 0.35 are considered, small, medium, and large, respectively (HAIR *et al.*, 2014).

It can be seen from Table 3 that, in order of construct explained (Q^2) by the model, there are the variables Impact on the Team (0.537), Impact on the Customer (0.513), Geographic (0.508), Commercial and Organizational Success Direct (0.463), Cultural (0.461), Work Practices (0.392), Temporal (0.377), Technological (0.366), Project Efficiency (0.330), Preparation for the Future (0.278), Organizational (0.277) and Project Success (0.172). It is also possible to observe that the

Communication Effectiveness construct was more important in the predictive capacity of the model (f^2=0.522).

Finally, the calculation of the GoF (Goodness of Fit), which considers the AVEs and R2 of each construct. This index proposed by Tenenhaus *et al*. (2005), is basically the geometric mean (square root of the product of two indicators) between the average R^2 (adequacy of the structural model) and the weighted average of the AVE (adequacy of the model of measurement). For the evaluation of this indicator, Wetzels *et al*. (2009) suggest the value of 0.36 as adequate, and in our research, the calculated index was 0.595.

The relationship between the square root of each stroke of the construct versus the correlation of this construct with the others was also observed. It is expected that for the construct to be distinguished from the others, the square root of the AVE must be greater than the correlation of the construct with the others. It is possible to observe, on the diagonal of Table 4, the square root of the AVE of the corresponding construct in the column. In addition, it is possible to verify that these values are higher than the correlation of the construct with the other constructs (horizontally and vertically).

Table 4 – Discriminating validity

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Culture	**0.923**												
2. COMMUNICATION EFFECTIVENESS	0.005	**0.849**											
3. Project efficiency	0.139	0.273	**0.792**										
4. Geographic	0.505	0.047	0.115	**0.889**									
5. Impact on the team	0.147	0.394	0.616	0.120	**0.856**								
6. Impact on the customer	0.067	0.343	0.615	0.161	0.629	**0.840**							
7. Organizational	0.418	0.015	0.144	0.479	0.127	0.139	**0.751**						
8. Preparing for the future	0.240	0.321	0.316	0.239	0.446	0.438	0.203	**0.784**					
9. Work practices	0.467	0.046	0.205	0.513	0.155	0.151	0.531	0.231	**0.824**				
10. COMMUNICATION SATISFACTION	0.043	0.402	0.320	0.075	0.506	0.457	0.046	0.335	0.009	**0.795**			
11. Direct commercial and organizational success	0.265	0.370	0.464	0.216	0.564	0.644	0.199	0.575	0.246	0.363	**0.828**		
12. Technologic	0.247	0.036	0.151	0.456	0.137	0.229	0.306	0.254	0.331	0.126	0.185	**0.907**	
13. Temporal	0.633	0.064	0.149	0.557	0.184	0.194	0.450	0.306	0.431	0.066	0.347	0.376	**0.809**

Source: Self elaboration.

In regard of the cross-loadings, through which it is expected that these items may have a greater factor loading in the constructs they measure. For the present research, all variables presented higher factor loadings in their respective constructs. Regarding the VIF, all constructs and variables are within the established parameters, with tolerance values above 0.20 and a VIF value below 5, respectively, not indicating a potential multicollinearity problem (HAIR *et al*., 2014), thus, kept in the model.

Table 5 summarizes the hypothesis tests, showing the effects of Student's t and p-value dimensions of all dimensions, variables, and hypotheses. It can be observed that the hypotheses H1,

H1a, H2, H2a, H3a, and H4, proposed in the research, were confirmed, and the hypotheses H3 and H4a were not confirmed.

Table 5 - General summary of hypothesis tests

Hypotheses	Structural relationship	Γ	t	p	*Status*
H1	COMMUNICATION SATISFACTION→ PROJECT SUCCESS (LOCAL)	0.463	6.237	< 0.01	Supported
H1a	COMMUNICATION SATISFACTION → PROJECT SUCCESS (VIRTUAL)	0.288	4.464	< 0.01	Supported
H2	COMMUNICATION EFFECTIVENESS → PROJECT SUCCESS (LOCAL)	0.183	2.465	< 0.05	Supported
H2a	COMMUNICATION EFFECTIVENESS → PROJECT SUCCESS (VIRTUAL)	0.371	5.745	< 0.01	Supported
H3	VIRTUAL MODERATION → COMMUNICATION SATISFATION -> SUCESSO EM PROJETOS (LOCAL)	-0.015	-0.343	0.732	Not Supported
H3a	VIRTUAL MODERATION → COMMUNICATION SATISFATION → PROJECT SUCCESS (VIRTUAL)	-0.148	-2.805	< 0.01	Supported
H4	VIRTUAL MODERATION → COMMUNICATION EFFECTIVENESS -> PROJECT SUCCESS (LOCAL)	-0.104	-2.447	< 0.05	Supported
H4a	VIRTUAL MODERATION → COMMUNICATION EFFECTIVENESS -> PROJECT SUCCESS (VIRTUAL)	-0.047	-1.064	0.289	Not Supported
	COMMUNICATION SATISFATION → PROJECT SUCCESS (CONTEXTOS LOCAL E VIRTUAL)	0.379	7.587	< 0.01	
	COMMUNICATION EFFECTIVENESS → PROJECT SUCCESS (CONTEXTOS LOCAL E VIRTUAL)	0.286	5.618	< 0.01	
	PROJECT SUCCESS -> Project Efficiency	0.735	23.290	< 0.01	
	PROJECT SUCCESS -> Impact on the Team	0.855	44.441	< 0.01	
	PROJECT SUCCESS -> Impact on the Customer	0.851	49.118	< 0.01	
	PROJECT SUCCESS -> Preparing for the Future	0.673	17.622	< 0.01	
	PROJECT SUCCESS -> Commercial and Direct Organizational Success	0.824	36.975	< 0.01	
	VIRTUALITY -> Culture	0.729	23.495	< 0.01	
	VIRTUALITY -> Geographic	0.794	32.151	< 0.01	
	VIRTUALITY -> Organizational	0.716	20.652	< 0.01	
	VIRTUALITY -> Work Practices	0.764	27.161	< 0.01	
	VIRTUALITY -> PROJECT SUCCESS	0.284	6.658	< 0.01	
	VIRTUALITY -> Technologic	0.639	13.692	< 0.01	
	VIRTUALITY -> Temporal	0.756	28.634	< 0.01	

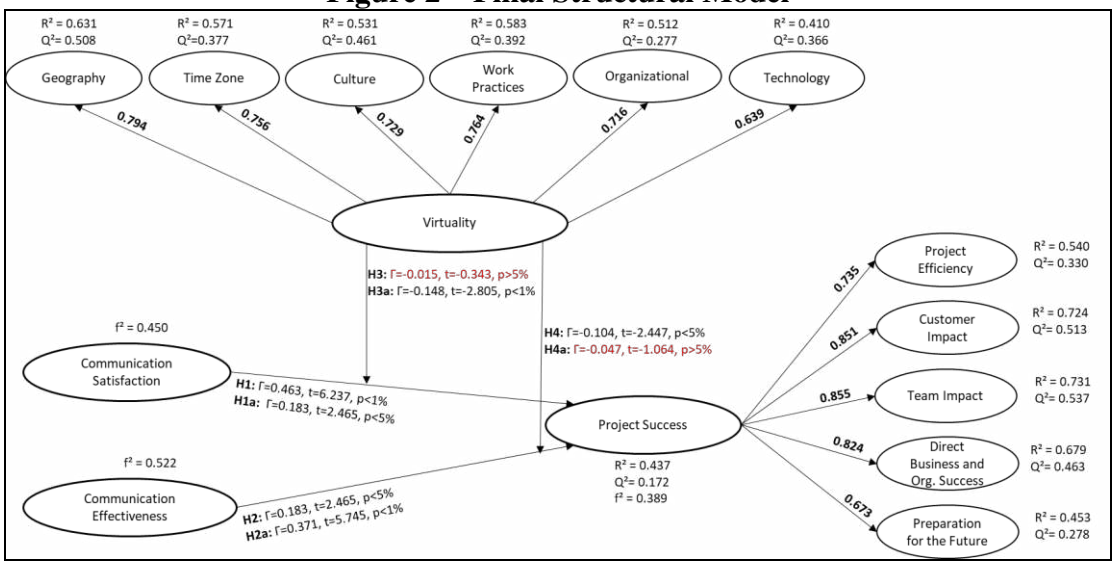
Source: Self elaboration.

The Figure 2 shows that several indicators of the structural model (Q^2, f^2, R^2 e beta), if the direct relationships of the model are observed, they indicate the confirmed hypotheses: H1 (Γ=0.463, t=6.237, p<1%), H1a (Γ=0.183, t=2.465, p<5%), H2 (Γ=0.183, t=2.465, p<5%), H2a (Γ=0.371, t=5.745, p<1%), H3a (Γ=-0.148, t=-2.805, p<1%) e H4 (Γ=-0.104, t=-2.447, p<5%).

At the end of the tests, it is possible to quantitatively determine the level at which virtuality moderates the relationship between communication and project success. Despite these tests, it was identified in the literature what has been studied about communications, the virtuality of teams, and about success in projects. Also, through a theoretical model between the constructs of communication, success in projects, and virtuality, a survey was carried out with professionals in project management, which ended with the quantification of the effects of communication on success in projects, in a way

that understand the moderating effect of virtuality on the relationship between communication and project success. The following are the analyzes and discussions of the research hypotheses.

Figure 2 – Final Structural Model



Source: Self elaboration.

RESULTS DISCUSSION

In this section are discussed the results of the relationships of the research constructs and the contributions to academia and practice.

The relationship between communication satisfaction and its effects on Project Success

The Hypotheses H1 and H1a were designed to understand how communication satisfaction influences project success in the context of local and virtual teams, respectively. To measure communication satisfaction, the survey was based on the Hecht scale (1978), which was conceptualized to understand how members feel part of the team discussion and can actively engage in team interaction.

Extant literature point to a high correlation between satisfaction in communication and overall job satisfaction and job performance (PINCUS, 1986; THIRY, 1977) and, as a result, the success of projects. Studies such as those by Guo *et al*. (2009) support that teams obtained more team cohesion, communication satisfaction, and decision-making satisfaction and, consequently, an increase in the productivity of virtual teams. Thus, corroborating the same results of the theoretical studies listed, the results of this research quantified and found that both hypotheses are confirmed: communication

satisfaction positively influences the project success in the local and virtual context, H1 (beta=0.463, t= 6,237, p<1%) and H1a (beta=0,288, t=4,464, p<1%), respectively.

Another important point found in this research, through the quantified effects H1 (beta=0.463) and H1a (beta=0.288), is the fact that it can be suggested that there is a decrease in the influence of communication satisfaction on the success of projects when deals with the virtual environment. It is noteworthy that the results of the H1 and H1a hypotheticals corroborate the research of Watson-Manheim *et al*. (2002), where the degree of virtuality can contribute to the reduction of the cohesion of communication, and consequently, in the results of teams.

These results corroborate the presupposition of Guo *et al*. (2009), where it is possible to contribute to virtual teams to increase their internal relationship and achieve the best results in meetings and in the execution of the activities of a project. Another important factor is the perceptions of virtual teams in relation to communication practices with senior management to contribute to maintain satisfaction in a team of projects derived from communication, thus corroborating the study of Pincus (PINCUS, 1986).

The relationship between effectiveness of communication and its effects on Project Success

The Hypotheses H2 and H2a were conceived to understand how the effectiveness of communication influences the success of projects in the context of local and virtual teams, respectively. To measure the effectiveness of communication, the research was based on the scale of Sharma and Patterson (1999), which conceptualizes the effectiveness of communication as the formal and informal sharing of meaningful and timely information between a client and a consultant, in an empathic way, being this value of fundamental importance for an ongoing relationship, or for any personal relationship for that matter.

In the literature studied, Kayworth and Leidner (2002) emphasize that the effectiveness of communication is one of the main attributes for effective leadership, both in a virtual or local environment. The study by Verburg *et al*. (2013) showed that one of the items for the successful execution of a project in a virtual environment includes communication rules and their clarity. To Anantatmula and Thomas (2010), leadership as one of the main success factors in projects, and Paul *et al*. (2016) suggest that effective coordination in virtual teams can create a positive feedback loop with trust and cohesion, thus improving overall project performance and, consequently, project success. Thus, corroborating the same results of the theoretical studies listed, the results of this research quantified and found that both hypotheses are confirmed: the effectiveness of communication positively

influences the success of projects in the local and virtual context, which is demonstrated in H2 (beta =0.183, t=2.465, p<5%) and H2a (beta=0.371, t=5.745, p<1%).

Another important point found in this research, through the quantified effects H2 (beta=0.183) and H2a (beta=0.371), is the fact that it can be suggested that there is a decrease in the influence of the effectiveness of communication on the success of projects when deals with the local environment, due to the lower effect observed on physical presence. This result contradicts what was proposed by Kayworth and Leidner (2002), where the authors' research on the effectiveness of communication is one of the main attributes for effective leadership, both in a virtual or localized environment.

The results confirm that the effectiveness of communication positively influences the success in projects, local teams, and virtual teams, obtaining as an impact the perceptions of increase in technical and functional quality, trust, and commitment of the relationship between both teams and senior management. This scenario validates the precepts proposed by Sharma and Patterson (1999).

The relationship between effectiveness of communication and its effects on Project Success in projects in the virtual and local context

The hypotheses H3 and H3a were conceived in this research to understand how virtuality moderates the relationship between communication satisfaction and project success in the local and virtual context. While hypotheses H4 and H4a were conceived to understand how virtuality moderates the relationship between and project success in the local and virtual context.

To measure virtuality, the research was based on the scale by Chudoba *et al*. (2005). The study shows that characterizing virtuality is important, as it structures the concept of virtual teamwork, and allows us to document and measure the conditions of virtual teamwork more accurately. The authors further point out that, as a quantifiable index, it can be combined with outcome measures to assess the effects of individual features of virtuality on performance. We point out that a virtuality index can be useful for measuring fast-moving trends, understanding the different vectors of these trends, and responding strategically to vectors where the index indicates potential problems.

The depending on the degree of virtuality exerted on the team, there is a greater or lesser impact on the performance of project teams (CHUDOBA *et al.,* 2005) and, consequently, on the success of projects (COOKE-DAVIES, 2002). Therefore, understanding the differences between virtual teams becomes an important step to understanding the problems associated with each factor and, thus, building necessary actions in collaboration technology platforms to improve performance (CHUDOBA *et al.,* 2005). Gibson and Cohen (2003) declared that virtuality imposes greater complexity on project

management and adds barriers when comparing virtual teams with local ones. Table 6 shows the main results of the research moderation hypotheses, H3, H3a, H4, and H4a.

Table 6 - Summaries of hypotheses H3, H3a, H4 e H4a

Hypotheses	Construct	Coefficient beta	se	t	p	Status
H3	Moderation (Local Context)	-0.015	0.044	-0.343	0.732	Not confirmed
H3a	Moderation (Virtual Context)	-0.148	0.053	-2.805	< 0.01	Confirmed
H4	Moderation (Local Context)	-0.104	0.043	-2.447	< 0.05	Confirmed
H4a	Moderation (Virtual Context)	-0.047	0.044	-1.064	0.289	Not confirmed

Source: Self elaboration.

The results of this research, summarized in Table 6, confirm the concept exposed in the studied literature, which states that, with the increase in management complexity and the addition of barriers that make it difficult for teams to communicate in virtual environments (GIBSON; COHEN, 2003), there is a negative influence on the communication relationships of the teams, and, as a result, on the success of the projects. In this research, through the hypotheses H3 (-0.015), H3a (-0.148), H4 (-0.104), and H4a (-0.047), even though hypotheses H3 and H4a have not been confirmed, convergence can be suggested, so that virtuality negatively influences, not only the relationship between communication satisfaction and project success in the context of a local and virtual team. But also, the relationship between communication effectiveness and project success in the context of local and virtual staff, thus contrasting the assumptions of Cooke-Davies (2002). The study shows evidence of the challenges faced by companies when managing virtual *versus* local teams in project management communication process and proposes that enhanced communication strategies can improve project success (SWART *et al*., 2022).

Within the scope of virtuality moderations on the relationship between communication satisfaction and the project success in the local and virtual contexts, H3 and H3a, respectively, the H3a hypothesis was confirmed (beta= -0.148, t=-2.805, p<1 %), which is related to virtual teams. Therefore, this research confirms that virtuality negatively moderates the relationship between communication satisfaction and project success in the virtual context. However, hypothesis H3 (beta=-0.015, t=-0.343, p=0.732), which is related to local teams, was not confirmed, that is, when the team is located, it is not influenced by virtuality.

To explain the non-confirmation of hypothesis H3, it is necessary to understand that the Communication Satisfaction variable, idealized by Hecht (1978), was conceptualized to understand how members feel part of the team discussion and can actively engage in team interaction. Given this concept, the importance of interactions between team members for this variable is perceived. It can be

suggested that, as the team is located, the local environment of the teams strengthens the discussions and interactions between the team members, with virtuality having low performance, and, thus, indicating the non-confirmation of hypothesis H3 (beta=- 0.015, t=-0.343, p=0.732). In the context of virtual teams, the concepts of interaction between team members and the team members' sense of belonging are weakened by the team's virtualization, thus confirmed by the research, the confirmation of hypothesis H3a, corroborating Hecht's (1978) assertions.

In the context of virtuality, moderations on the relationship between communication effectiveness and the project success in the local and virtual contexts, H4 and H4a, respectively, hypothesis H4 was confirmed (beta= -0.104, t=-2.447, p<5 %), which is related to local teams. Therefore, this research confirms that virtuality negatively moderates the relationship between communication effectiveness and project success in the local context. However, hypothesis H4a (beta= -0.047, t=-1.064, p=0.289), which is related to virtual teams, was not confirmed in this research, that is, when the team is virtual, and when communication is measured through the Communication Effectiveness variable, it is not influenced by virtuality. The results contradict the assumptions of Chudoba *et al*. (2005). The authors argue that evaluating the degree of virtuality in the work environment is important for organizations to understand the dynamics of the group, work processes and team performance, which could not indicate the results of H4.

To explain the non-confirmation of the H4a hypothesis, it is necessary to understand that the Communication Effectiveness variable, conceptualized by Sharma and Patterson (1999), is the formal and informal sharing of meaningful and timely information between a client and a consultant in an empathic way. Therefore, a communication between two people, the coordinator, and his subordinate. Given this concept, it can be suggested that coordinators and subordinates, accustomed to the virtual environment, have already created efficient means of communication to communicate virtually, thus not suffering the influence of imposed virtuality, and proving the result of the research, by not confirming hypothesis H4a. Likewise, it can be suggested that a coordinator and his subordinate, who work in the context of local teams, did not create efficient means of communication when they are communicating through a virtual environment, and may be influenced by virtualization, proving the research results by confirming hypothesis H4. Table 7 shows summarized data on the R^2 of hypotheses H3, H3a, H4, and H4a.

Another important point to note is the relationship between communication satisfaction and project success and between communication effectiveness and project success, when moderated by virtuality, in local and virtual contexts. Through the R^2 calculations reported in Table 7, it can be deduced that (a) the relationship between communication satisfaction and project success in the context

of local teams, when moderated by virtuality, is explained at 38% (H3 R^2 =0.380); (b) the relationship between communication satisfaction and project success in the context of virtual teams, when moderated by virtuality, is explained in 26.1% (H3a R^2=0.261); (c) the relationship between the effectiveness of communication and the project success in the context of local teams, when moderated by virtuality, is explained in 29.8% (H4 R^2=0.298); and (d) the relationship between communication effectiveness and project success in the context of virtual teams, when moderated by virtuality, is explained at 29.2% (H4a R^2=0.292).

Table 7 - R^2 of hypotheses H3, H3a, H4 e H4a

Hypotheses	R	R^2	Standard estimation error	Change statistics			
				F alteration	df1	df2	F alteration Sig.
H3	0.616	0.380	0.632	31.043	3	152	0.01
H3a	0.511	0.261	0.521	22.064	3	187	0.01
H4	0.546	0.298	0.715	21.544	3	152	0.01
H4a	0.541	0.292	0.499	25.744	3	187	0.01

Source: Self elaboration.

With the results, it can be inferred that there is a tendency for virtuality to negatively influence the relationship between communication satisfaction and success in projects in the context of the local team. This scenario is in line with that proposed by Hecht (1978), where members of a local team can feel part of the discussion and actively engage in team interaction, which may not occur in virtual teams. Similarly, the relationship of senior management with the local team has difficulty in creating transparent and objective means of communication in environments that are in which they are, corroborating the study by Gibson and Cohen (2003), which highlight that virtuality imposes greater complexity in communication on project teams, including local and virtual teams.

CONCLUSION

This study focused on the analysis of the relationship between communication and project success, using virtuality as a moderator in local and virtual project teams. The structuring of the research in two contexts allowed us to identify differences in the themes of communication and success of the project. The survey collected data from project managers in several countries, resulting in a study with global coverage.

The results point to differences between the variables used to measure the Communication construct and its impact on the success of the project. Communication satisfaction deals with the

interaction between team members, which can occur through various channels, while communication effectiveness involves the interaction between manager and subordinate, in a pre-established hierarchical relationship. These differences point to the need for more studies to better understand the relationships between communication and project success.

The negative effects of virtuality on the relationship between communication variables and project success were confirmed. However, the segmentation of contexts in the research provided a new perspective on communication in relation to the use of one or more channels. Thus, it is possible to conclude that project managers should consider local teams that use a single communication channel and virtual teams that use multiple channels to promote communication.

The research provides contributions to practice by indicating the importance of improving communication skills in project management. In this sense, this research suggests training in assertive communication, leadership and project management. In addition to training, it is possible to conclude that the use of collaborative communication tools and strategies to increase trust and interaction between team members can positively influence the success of projects.

Finally, the research highlights the relevance of adjusting communication strategies to the context of the project - local or virtual. This study contributes to the understanding of how to achieve effective communication, depending on the type of team, thus increasing the possibility of success of projects.

With the realization of this research, it was possible to conclude that improving communication in teams, both local and virtual, through direct and indirect actions, can positively influence the success of projects and provide competitive advantages for organizations. The fact that the research was divided into two contexts, local and virtual teams, made it possible to find important points for differentiating communication themes and success in projects, when the teams are working, mostly, locally, or virtually. Another important point to highlight was the fact that the survey sought respondents from various countries of the world, to deliver to the academy results that go beyond national borders.

It is also noteworthy the relevant difference between the variables chosen to measure the Communication construct and the influence on success in projects. While the satisfaction of communication deals with communication between team members, considered a phenomenon that may have a varied number of communication channels. The effectiveness of communication deals with communication between two or more people with a previously established subordination relationship, the manager, and his subordinate. This last relationship was not identified with the result of the literature review on the subject, opening a gap so that further research can establish possible relationships between communication and success in projects.

Similarly, we highlight the confirmation of the negative effects of virtuality on the relationship of communication variables (satisfaction and effectiveness of communication) and success in projects. However, with the distinction of contexts idealized by this research, it allowed us differentiated vision for communications between one and several communication channels. Through the results of moderations, it is suggested that managers are mainly concerned with their local teams that have a communication channel with no experience with the virtualization of the environment and with their virtual teams that have multiple communication channels.

In the practical field, it is widely understood among researchers that communication is a critical success factor in project management, and it is inevitable that, at some point in our professional lives, we will work virtually. In addition, direct and indirect actions to improve the internal and external communication of project teams, whether local or virtual, contribute to the success of projects and can add competitive advantages to the company to the market. The results of this research suggest actions to improve the communication of local or virtual teams in a project environment, such as: (i) assertive communication training for leaders and team members; (ii) leadership training for team leaders and project managers; (iii) training or workshops to improve trust among team members, including managers; (iv) support from senior management to improve the use of collaborative tools and more efficient means of communication; (v) training or workshops to motivate and increase interactions between team members, and (vi) standardization and institutionalization of virtual communication processes among team members.

As a limitation, the researchers used the Communication construct to understand its effects on success in projects, in addition to determining the moderation of virtuality over this construct. However, there are other important constructs of the project teams that also influence the success of the projects, and this factor is a limitation of this research. Trust, team cohesion, process perception, satisfaction of the decision-making process and decision satisfaction, among other variables of interaction and team integration, can be used to understand its effects on success in projects, in addition to determining the moderation of virtuality on these topics.

As a suggestion for future research, it is relevant to understand the moderating effect of virtuality on other integration or interaction variables with teams. Studies show that the confidence, the cohesion of the team and the perception of the process, among other variables, can influence the success of the projects. Through communication variables, there was a difference in the moderation of virtuality in a single or multiple communication channels. This gap found in the research can provide researchers with the study of other possible relationships between communication and project success.

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