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VUCA environment on project success: The effect of project management methods

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ABSTRACT

Due to the ever-changing work environment in the age of digital transformation, project managers need to adapt to an environment which is volatile, uncertain, complex, and ambiguous (VUCA). Many organizations adopt management methods based on strict project management planning, assuming that they are the best way to succeed in any situation. However, projects may depend on flexibility to achieve success. This study aims to analyze the impact of adverse project environments on project success and the effect of the management method choice. A PLS-SEM model is tested on a survey of 332 project professionals. Findings showed that choosing a method that best fits the project's environment can help catch up on project success only when it undergoes frequent changes throughout its life cycle.

KEYWORDS

Adverse Project Environment, Project Success, Management Method

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1. INTRODUCTION

In the world scenario today, situations of risk may arise unexpectedly, and with the potential to influence organizations and business viability (Dhir, 2019). Several studies attest to the current moment in history as challenging, with increasingly frequent and inevitable changes (Mahapatra, 2018). This moment is often referred to as the VUCA era, which stands for volatility, uncertainty, complexity, and ambiguity (Szpitter & Sadkoswska, 2016).

VUCA describes the nature of some challenging conditions and situations in the environment in which organizations operate (Bennett & Lemoine, 2014). Volatility links to the unpredictability and instability of change, Uncertainty refers to the lack of knowledge of future events and their consequences, and Complexity refers to multiple connected parts forming an elaborate network of information and procedures. Finally, Ambiguity represents a lack of precedent for making predictions due to a lack of knowledge and understanding of the causes and effects of events and their relationships (Bennett & Lemoine, 2014; Mack et al., 2015).

Projects exist to promote organizational changes (Shenhar et al., 2001). Because they are into the organizational scenario, they influence and are influenced by the environment (Mack & Jungen, 2016). This scenario impacts the way products and services are developed, increasing risks and creating difficulty for management (Szpitter & Sadkoswska, 2016). This may explain the high rate of projects that fail to meet their goals. On average, 36% of projects executed worldwide do not meet the established goals and are considered unsuccessful (PMI, 2016). Project failures are estimated to cost hundreds of billions of dollars a year and are not limited to specific regions or industries (Joslin & Müller, 2016).

Projects come up to create something unique (PMI, 2017). Being unique, they need different methods for their management. In the absence of a method to choose the most appropriate method to apply in each case, organizations adopt classic project management methods (Shenhar et al., 2001). Classic project management methods mean a homogeneous collection of standardized tools, processes, procedures, and practices to improve project effectiveness and increase the chances of success (Vaskimo, 2011). Classic methods homogenize organizations' project areas and the way to manage projects. They assume that there are more similarities than differences in projects, thus enabling performance optimization through adopting practices based on process standardization (Shenhar et al., 2001).

On the other hand, the discussion of the nature of a project's success (De Wit, 1998) considers that projects are not isolated in time and space. They are implemented in an environment that influences and is influenced by the project. Assuming that methods apply to all projects, classical management methods can, in some situations, lower project success rates (Varajão, 2018).

Thus, project management literature diverges on what leads to project success: standardization of procedures, which implies slight environmental adjustment; the flexibility of procedures, which implies adjustments to the context; or hybrid models that propose combinations of both approaches (Špundak, 2014; Azenha et al., 2021; Gemino et al., 2021).

Classic project methodologies are regarded as the source of formality in project management, with rigid natures and the adoption of strict linear processes (Owen et al., 2006). Agile project management has a flexible and adaptable approach to delivering projects, products, and services (Macheridis, 2009). Agile project management involves the ability to act proactively in a dynamic, arbitrary, and constantly changing environment in a manner which is flexible, lightweight, and collaborative (Rico, 2008). A hybrid approach could combine two different methodologies, producing a new and more efficient model by mixing, for example, the agile mindset with plan-

driven structured frameworks. The outcome could improve corporate policies and procedures and promotes flexibility and productivity (Papadakis & Tsironis, 2020).

Shenhar and Dvir (1996) were the first proponents of customizing project management methods. This position was contrary to the literature's tendency that stated the "one size fits all" mantra (Wysocki, 2011). Fitzgerald et al. (2002) argue that the adoption of classic methods does not necessarily lead to a successful project. Milosevic and Patanakul (2005) argue that a balance should be sought by standardizing some parts of a project and making others flexible. Thus, scholars distinguish classic, flexible—commonly called agile—and hybrid management methods, which are three broad categories of choice (Charvat, 2003; Boehm & Turner, 2004; Wysocki, 2011; Highsmith, 2013; Papadakis & Tsironis, 2020; Azenha et al., 2021).

The present research premise is that project management needs adjustments throughout the project life cycle. This study assumes that the globalization of markets and rapid technological changes of the VUCA era cause changes in the environments in which the projects are inserted (Bennett & Lemoine, 2014). Projects are influenced by this business environment, leading to a mismatch between the management method and project results. This scenario emerges in this study to analyze the impact of project management's adverse environment on project success and the moderating role of the project management method choice. The environment is one factor that impacts the success of projects (Muller & Jugdev, 2012; Moura et al., 2018). Other factors also have influences, but this study is limited only to those related to the environment of projects characterized by VUCA.

Despite studies on hybrid methods that contemplate merging the characteristics of agile and classic methods, this study focuses only on traditional methods to explore their impact. As hybrid methods combine characteristics of both, their inclusion in the study would make it challenging to analyze the contributions of each method.

The remainder of this article is structured as follows: first, the section "Literature Review and Hypothesis Development" includes the theoretical foundation that supports the hypotheses of this study. Then the section "Research Methods" outlines our approach to exploring the project management success. Following this, the section "Results" shows the results and evaluates them. Then, the section "Discussions" discusses the obtained results. Finally, the section "Conclusions" summarizes our conclusions of this research.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. PROJECT SUCCESS

Several project success measurements include the variation in cost, time, and quality standards (Anantatmula, 2015). Pinto and Slevin (1987) proposed a project success measurement model of internal and external indicators. Internal being time, cost, and performance, with external ones being project use, customer satisfaction, and perceived impact on organizational effectiveness. Lim and Mohamed (1999) consider project success under two points of view: the stakeholders' macro point of view and the project team's micro point of view. Cooke-Davies (2002) distinguishes project success indicators and project management success indicators. The most subjectively charged aspects, such as organizational impacts and satisfaction by stakeholders, are project success indicators, while technical aspects related to goals are management success indicators.

This study analyzes the project's success from two perspectives: The first is from the project team's perspective. The second is from the stakeholders' point of view. Achieving project success represents how well the project met what it had initially accorded. It represents the level of

alignment between projects planned and executed and how people perceive project results, products created, or services delivered. A subjective dimension emerges from stakeholders' and the team's perceptions of project deliverables' benefits and satisfaction (Cooke-Davies, 2002).

2.2. ADVERSE PROJECT ENVIRONMENT AND PROJECT SUCCESS

The relationship between organizations and their environment is widely discussed in the organizational literature (Dvir et al., 1998). Contingency theory argues that organizational effectiveness results from the adequacy of the organization to the contingency situation. In essence, the theory defends the concept of adaptability and relates it directly to performance, which results in the ever-moving organization aligning to contingencies. Environmental stability, and the rate of technology change affect how organizations manage their resources and decision-making processes (Otley, 2016).

Bennett and Lemoine (2014) argue that the combination of four factors collectively known as VUCA – Volatility, Uncertainty, Complexity, and Ambiguity, characterizes the nature of some problematic environmental conditions for organizations. Awareness of these factors, and strategies to mitigate their effects are essential to process management. They propose a guiding matrix to identify, prepare, and respond to events generated by the four factors of VUCA. Figure 1 presents the matrix that relates volatility, uncertainty, complexity, and ambiguity to the manager's level of knowledge about the situation and the level of actions that results in predictability.

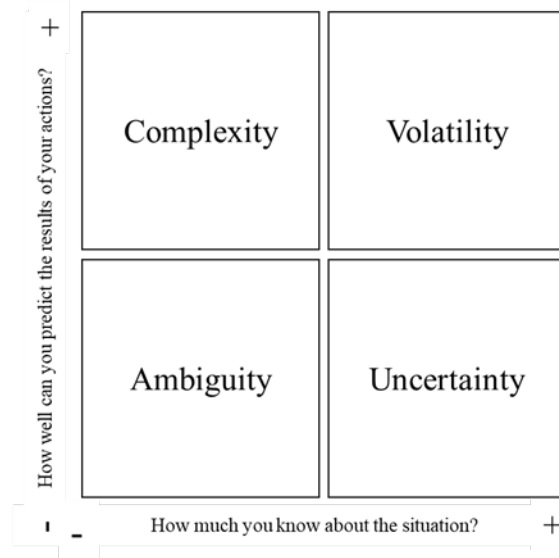


Figure 1. VUCA Matrix

Source: Bennett and Lemoine (2014)

Based on Bennett and Lemoine's (2014) work, this study analyzes the project environment on the four environmental characteristics of the VUCA matrix. In this study, complexity is treated as technological complexity. In project management studies, complexity is not a clear and unified concept (Daniel & Daniel, 2018), and its definition does not find consensus among scholars (Bakhshi et al., 2016). To bring this concept into alignment with VUCA, but in a project context, this study considers complexity as technological complexity, defined by Baccarini (1996) as many variables and interrelated parts operationalized in differentiation and interdependence.

Thus, volatility, uncertainty, technological complexity, and ambiguity characterize the nature of some adverse project conditions. The assumption is that the more these characteristics are present in a project, the stricter the conditions for managing it (Almeida & Souza, 2016).

Uncertainty is a limited state of knowledge about future outcomes (Kermanshachi et al., 2016). Project uncertainties lead to stakeholders' inability to determine their expectations of what the project will deliver accurately. It represents the degree of difficulty for those involved in the project in determining the expected results and specifying the steps or methods required to achieve them (Tatikonda & Rosenthal, 2000). Well-defined scope leads to better project performance (Muller & Jugdev, 2012). Poor understanding of the scope strongly correlates with project failure (Mirza et al., 2013). Thus, uncertainties may lead to a poor understanding of the scope and adversely affect project success. Thus, the first hypothesis is set out as follows:

- **H₁:** Uncertainty harms project success.

Ambiguity is manifested in a lack of clarity, making it difficult to understand a specific situation. In the context of ambiguity, information is available but not clearly (Bennett & Lemoine, 2014). The ambiguous situation may have little historical data to assist in predicting the results of specific actions. In this case, cause and effect relationships are not easily identifiable (Shaffer & Zalewski, 2011).

Ambiguity can lead to different scope understandings introducing interpretation conflicts (Gleich et al., 2010). An ambiguous situation does not allow the manager to clearly understand the project's expectations, leading to an inaccurate scope (Shaffer & Zalewski, 2011). It can make decision-making more difficult, causing forecast errors and project deliveries inconsistent with expectations (Mich & Garigliano, 2000). Then, the following hypothesis is proposed:

- **H₂:** Ambiguity harms project success.

Volatility means a high degree of change that affect the project (Schmidt et al., 2001). Changes can severely impact project planning, execution, and final deliverables (PMI, 2017). Volatility can cause additions or exclusions to project objectives, affecting costs, deadlines, and delivery quality. Volatility can change the initial understanding of what will be delivered by the project and how it should be implemented (Ibbs, 2012). Thus, it is hypothesized that:

- **H₃:** Volatility harms project success.

Technological complexity occurs when several interrelated technologies (Baccarini, 1996) and some novelty in the project (Tatikonda & Rosenthal, 2000). Technological complexity makes project management difficult, reducing the chances of success due to the variety of technological specialties or new knowledge needed to implement the project (Dao et al., 2016). Thus, it suggests the importance of investigating the hypothesis:

- **H₄:** Technological complexity harms project success.

2.3. PROJECT MANAGEMENT METHODS

The project management method is the mode or style of dealing with the project (Shenhar et al., 2001). The mode can be more rigid (prescriptive) or more flexible (adaptive). Classic or prescriptive methods depend on a defined life cycle and consider projects where the scope is previously specified and almost no change is expected (OGC, 2009). The environment is foreseeable, and planning techniques may optimize the project management (Vinekar et al., 2006). These processes are often resistant to change and cling to strict adherence to a plan to evaluate success (Wysocki, 2011; Sheffield & Lemétayer, 2013).

On the other hand, adaptative methods, based on agile principles, respond to the environment's dynamic aspects. They promise increased customer satisfaction, lower defect rates, and greater adaptability to changing requirements (Vinekar et al., 2006). They have acquired acceptance because organizations are looking for clear delivery cycles to deal with uncertainty and volatility. They are based on an iterative-aspect life cycle and see changes as good things (Wysocki, 2011). Planning is continuously adjusted by an iterative series of tasks performed when necessary, allowing changes to be fewer impacts.


2.4. MANAGEMENT METHODS, ADVERSE PROJECT ENVIRONMENT, AND PROJECT SUCCESS

The classic method allows us to predict problems during the project and plan a less turbulent path to success (Kerzner, 2017). Prescriptive methods work best when the scope is determined at the beginning of the project and remains reasonably stable. The adaptive method performs better in turbulent and dynamic environments (Boehm & Turner, 2004). Therefore, the project management method's choice must be based on the project's context. Considering that the management method is a way of dealing with environmental influence, the appropriate method choice can change the environment's negative effect and increase the project's success.

In situations where uncertainty is present, it is difficult to fully understand the scope, project objectives, and steps required to achieve these objectives (Shenhar et al., 2001). Thus, using a flexible method based on interactions and learning can bring better results to the project (Bergamn & Karwowski, 2018). However, in situations where the scope is fully understood and there is no doubt about what needs to be done to achieve success, the classical method tends to bring better results to the project (Wolf & Floyd, 2013). From these arguments, derives the following hypothesis:

- **H₅**: The project management method moderates the relationship between uncertainty and project success.

When ambiguity is present, an adequate understanding of the project's scope cannot be expected. Ambiguity causes conflicts of understanding, impacting planning and reducing the project's chances of success (Keil et al., 2002; Gleich et al., 2010). In this situation, one should consider using a method that leads to project planning through small incremental interactions that lead to a better understanding of the scope and steps necessary to achieve the objectives, reducing the ambiguity (Nerur & Balijepally, 2007). Thus, the following hypothesis is proposed:

- **H₆**: The project management method moderates the relationship between ambiguity and project success.
- 

In situations where the environment is less dynamic, adopting a prescriptive method tends to produce better results since the characteristics of formalization and standardization will be little affected (Borges Jr. & Luce, 2000). On the other hand, projects in dynamic environments can obtain better results with flexible methods (Nerur & Balijepally, 2007) because they tend to deal better with change (Ibbs et al., 2001). Based on these arguments, we derive the following hypothesis:

- **H₇:** The project management method moderates the relationship between volatility and project success.

Technological complexity tends to affect project implementation. It creates difficulty in integrating different technologies and specialists in these technologies (Baccarini, 1996). It can be expanded if innovative technologies and cutting-edge knowledge are involved in the project.

Technological complexity can mainly affect project execution and results. Thus, interactive methods can obtain better results in technological complexity scenarios by adopting shorter horizons of the planning execution cycle, enabling error correction more quickly and reducing the impacts on project objectives (Dao et al., 2016). On the other hand, projects involving low technological complexity can be conducted by prescriptive methods since the team master's knowledge. There is little need to integrate professionals from different technological specialties (Miller & Cardinal, 1994). Thus, the following hypothesis is proposed:

- **H₈:** The project management method moderates the relationship between technological complexity and project success.

These moderation analyses aim to analyze if the project management method's influence is stronger than the adverse project environment's direct influence on project success. If the project management method carries on an effect that leads to a change in the project's success, it can mitigate its effects. As all existing projects always act on a method's action, it is impossible to isolate this method's effects from the general effect of environmental variables. Thus, moderation is an instrument that can help explain its effects on the project's success.

The above hypotheses support the relationships in the structural model presented in Figure 2, in which the uncertainty, ambiguity, volatility, and technical complexity are related to the project success moderated by the project management method.

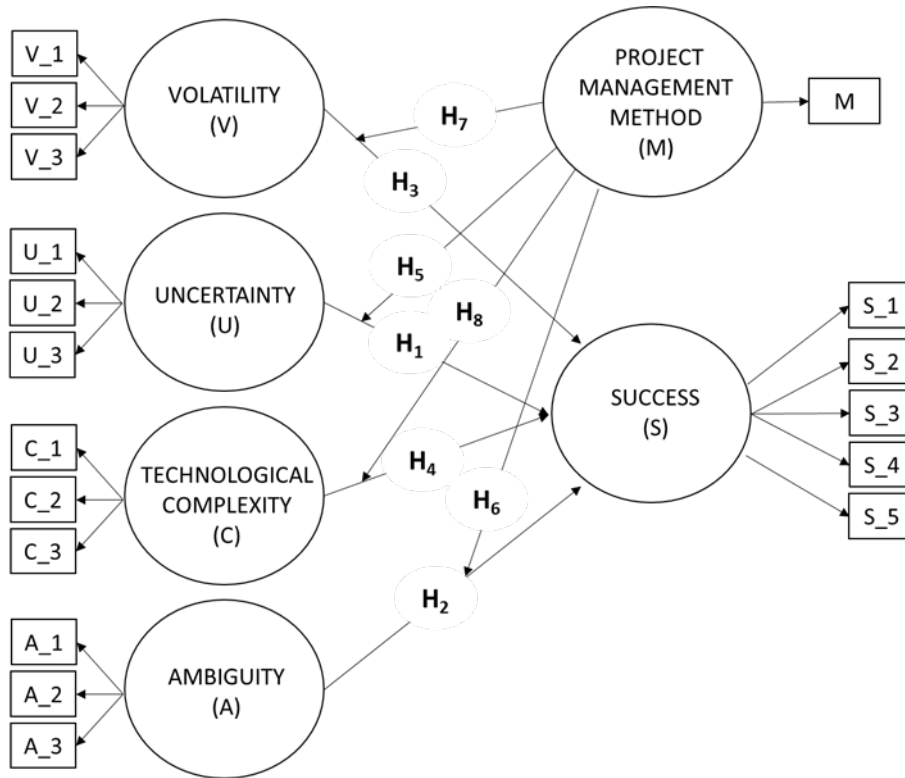


Figure 2. Theoretical structural model.
Source: authors, based on the literature review.

3. RESEARCH METHODS

It was decided to conduct a quantitative survey of a confirmatory nature to test the formulated hypotheses.

The hypotheses proposed in our conceptual model (Figure 2) were tested by utilizing the PLS-SEM (Partial Least Squares – Structural Equation Modeling) method, which is the most appropriate method of analysis when there are multiple simultaneous variables to be evaluated and when the study proposes to develop theory in research (Hair et al., 2017). The application of the PLS-SEM technique took place according to the script proposed by Hair et al. (2017), which involves the definition of the structural model, specification, and validation of the measurement models, collection and examination of data, estimation of the path model, verification of the results of the reflexive and formative models, and finally the analysis of the results of the structural model.

3.1. SAMPLING METHOD

The sampling was based on a systematic random draw for the participants’ choice. The professionals’ chosen group is called “Project Management Community,” with more than 400.000 members on LinkedIn, composed of project managers of various nationalities.

The selection was made by a draw in which all population members were equally drawn. It generated three random numbers between 0 and 25, equivalent to the alphabet letters. The resulting number determined three letters of the alphabet concatenated into a single text. The text was used as a search source in the LinkedIn search tool that returned several professionals who had the letters combination anywhere in their name. An additional random number was

generated and positioned within the number of people returned in the search. When choosing the person, an individual e-mail was sent with the electronic survey form's link. This process was repeated until the sample size was reached, assuming that not all selected would return the survey.

3.2. VARIABLES DEFINITION

The constructors formed the proposed structural model and were measured using the 7-point Likert scale. According to Dalmoro and Vieira (2013), the 7-point scale is more suitable when respondents master the subject. All constructions are reflective. In reflective constructs, the indicators are caused by the latent variable. Removing an indicator does not alter the construct's conceptual domain, and the indicators must share the same theme (Jarvis et al., 2003).

The constructs that make up the projects' environmental characteristics have not been fully explored empirically by studies related to projects. For this reason, the scale needed to be adapted through the composition of four studies. The scales used are Baccarini (1996), Wallace et al. (2004), Lee and Xia (2005), and Jun et al. (2011).

Project success is a reflexive construct that includes goals and satisfaction with the project's results, whose scales were based on several studies described in Appendix A.

All indicators shown in Figure 1 were operationalized using a 7-point Likert scale. The options presented to the respondents were: Strongly disagree (1), Disagree (2), Partially Disagree (3), Neither Agree nor Disagree (4), I partially agree (5), Agree (6), I totally agree (7).

The project management method construct was operationalized through a simple question asking the respondent which project management method was applied. High scores on the scale mean more flexible and adaptive methods, and low scores represent more formal and prescriptive methods. After the data collection, the variable was transformed into a dichotomic variable that divided (1) Agile methods and (0) Classical (predictive) methods. The transformation aims to enable multigroup analyses with two broad categories of project management methods: classical and agile.

4. RESULTS

The research sample consists of 332 valid answers. Most companies are medium and large, with more than 100 employees (73.34%). The business segments are varied, with the predominance of the service segment. The adoption of project management methods has a predominance of own methods (29.18%). Most projects have teams with fewer than 50 people (79.06%), and the IT infrastructure segment is the most present (17.33%). Table 1 presents the descriptive statistics of the sample.

Table 1
Descriptive statistics

Variable	Value	%
Gender	Male	73.25
	Female	26.75
Education	High school completed	1.82
	Higher education completed	98.18
	Engineers technicians or IT professionals	41.65
Professional role	Project Manager	25.23
	Senior Manager, Director, or CEO	18.54
	Other	14.58

Table 1
Cont.

Variable	Value	%
Region	South America	35.75
	Europe	14.85
	Central America	10.61
	North America	20.30
	Asia / Pacific e Africa	18.49
Company size	Less than 1000 employees	53.94
	More than de 1001 employees	46.06
Method	Agile Method	54.10
	Non-agile method	45.90
Team size	Less than 50 people	79.06
	More than 51 people	20.94
Project segment	IT Infrastructure	17.33
	Software Development	15.50
	Services	9.73
	Utilities	9.73
	Transports	9.12
	Construction	8.81
	Health	8.21
	Other (Aerospatiale, environmental, agriculture, military, manufacture e industrials)	21.59

Source: authors.

In order to ensure the homogeneity of the sample variances, an equivalence test was used (Mara & Cribbie, 2017). Thus, it was ensured that, although the survey participants were from different countries, the understanding of the measurement model was common to all.

4.1. STRUCTURAL MODEL ANALYSIS

The structural model analysis was performed in three stages. The first step evaluates the quality of the measurement and structural models. The second step validates the relationships between the project environment's adverse characteristics and success. The third step evaluates whether the project management method modifies the relationships between the project environment elements and its success. The last evaluation aims to verify whether the project management method has a moderating effect (Hair et al., 2017).

4.1.1. Evaluation of Measurement Model

Two criteria evaluated the reliability of the reflective constructs' internal consistency: Cronbach's Alpha greater than or equal to 0.70 and composite reliability between 0.70 and 0.90 (Hair et al., 2017). Table 2 presents the results of composite reliability. The first criterion to be evaluated is the reliability of the internal consistency of reflective constructs through Cronbach's Alpha. However, according to Hair et al. (2017), Cronbach's Alpha is sensitive to the numb'r of items in the scale and generally underestimates internal consistency reliability. Therefore, it is the most suitable composite reliability for this assessment.

The convergent validity of the model constructs was made by analyzing external loads. According to Hair et al. (2017), the values should be higher than 0.708. Loads between 0.40 and 0.70 can be removed if this removal increases composite reliability; otherwise, they must be maintained. The indicator V-2 showed 0.610 of external load, but removing this indicator did not increase the construct's composite reliability. Furthermore, the indicators' exclusion would affect the content's validity (Hair et al., 2017). Therefore, it was maintained. The indicator C1 presented -0.059 of external load, out of the valid range. This indicator was removed from the construct.

The convergent validity of each construct was also evaluated by the average variance extracted (AVE). Values above 0.50 indicate that, on average, more variance is explained by the construct than the remains in the items' error. Table 2 shows the average variance extracted from the constructs, all above 0.50, as Hair et al. (2017) recommended.

The value of cross loads verified discriminant validity. All the indicators presented external load criteria higher than their cross loads. The Fornell-Larcker process was also verified. The success construct formed by the first-order constructs project goals and satisfaction with the project results presented the AVE square root, less than the correlation between these constructs (Table 2). According to Hair et al. (2017), the evaluation of discriminant validity in second-order reflective-reflective constructs does not make sense, as conceptual and empirical redundancies are expected. In this way, all constructs were considered satisfactory.

Table 2
Validation and latent variables correlation.

	V	U	C	A	S	AVE	Composite Reliability	Cronbach's Alfa
Construct	V	0.769*				0.592	0.810	0.666
	U	0,247	0.789*			0.622	0.869	0.702
	C	0.239	0.012	0.831*		0.690	0.815	0.678
	A	0,154	-0.375	0.397	0.831*	0.691	0.869	0.781
	S	-0.392	-0.279	-0.458	-0.224	0.805*	0.647	0.902

Source: authors.

*Note1: The diagonal contains the AVE square root.

Note2: The model was estimated using SmartPLS 3.0 software (Ringle et al., 2015).

All constructs met the criterion Heterotrait-Monotrait Ratio - HTMT below 0.90, indicated by Henseler et al. (2015) to assess discriminant validity (Table 3). After evaluating the measurement models, no indicators were removed, and all constructs and indicators met the validation criteria.

Table 3
HTMT – Heterotrait-monotrait ratio analysis

	V	U	C	A	S
V					
U	0.382				
C	0.334	0.096			
A	0.178	0.522	0.562		
S	0.486	0.349	0.608	0.207	

Source: authors.

Finally, the structural model was evaluated with the verification of collinearity problems. VIF (Variance Inflation Factor) value of each predictor construct should be below 5.0; otherwise, it would be necessary to eliminate constructs or unite predictors in a single construct. All had a VIF value of less than 5.0 (Hair et al., 2017).

4.1.2. Evaluation of Structural Model

The structural model was evaluated without the moderate effect of the project management method. The objective was to validate the significance of the relationships between the project environment’s adverse characteristics and the project’s success. The bootstrapping technique evaluated the importance of relationships with 5,000 interactions. All path coefficients were significant, as shown in Figure 3.

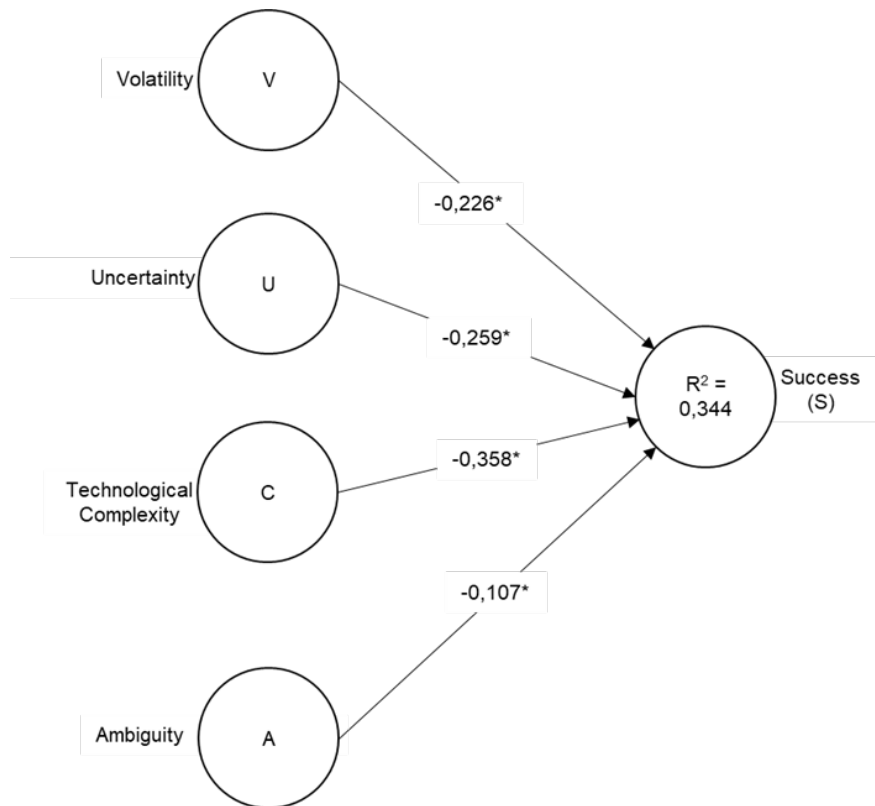


Figure 3. Structural model results without moderation.

Source: authors.

Note: * Significant for 95%.

The results of the model without moderation (Figure 3) allow us to verify that the adverse project environment characteristics explain 34,4% (R2=0.344) of the success variance (S) of the project. This value was expected once other factors explained the projects’ success beyond the environment (Moura et al., 2018).

Without the moderation of the project management method (M), the success of the project will be most negatively impacted by Technological Complexity (C) (beta=-0.358) and Volatility (V) (beta=-0.226) and less impacted by Uncertainty (U) (beta=-0.259) and Ambiguity (A) (beta= -0,107).

4.1.3. Evaluation of the Moderation Effect

The final stage evaluated the structural model with the moderation of the Project Management Method (M). Table 4 shows the bootstrapping results for the complete model. The moderator effect of the Project Management Method between Volatility and Success (M→V) (p-value = 0.009) was significant. The moderator effect of between the Project Management Method between Technological Complexity (M→ C) (p-value = 0.449), Ambiguity (M→ A) (p-value = 0.436), Uncertainty (M→ U) (p-value = 0.457) and Success (S) were not significant.

Table 4
Bootstrapping results

Hypothesis		Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
H ₃	V→S	-0.198	-0.200	0.053	3.752	0.000*
H ₁	U→S	-0.268	-0.275	0.051	5.259	0.000*
H ₄	C→S	-0.366	-0.365	0.053	6.950	0.000*
H ₂	A→S	-0.103	-0.112	0.051	2.035	0.042*
H ₇	M→V	-0.132	-0.131	0.051	2,608	0.009*
H ₅	M→U	0.040	0.041	0.054	0.744	0.457
H ₄	M→C	0.041	0.039	0.055	0.757	0.449
H ₆	M→A	0.043	0.043	0.056	0.778	0.436

Source: authors.
Note: *Significant for 95%.

The path coefficient between the Project Management Method and Success (M→S) (beta = 0.086) is positive. The path coefficients between Volatility (V) (beta = -0.198), Uncertainty (U) (beta = -0.268), Technological Complexity (C) (beta = -0.366), Ambiguity (A) (beta = -0.103), and Success (S), as shown in Figure 4, are negative. The R² value for Success (S) was 0.344 before moderation and 0.367 after moderation. Table 5 presents the results of the structural research model.

Table 5
Structural research model: significances and effects.

Hypotheses		Path coefficient	P-value	R ²	R ² adjusted
H ₃	V→S	-0.198	0.000*	36.7%	35.0%
H ₁	U→S	-0.268	0.000*		
H ₄	C→S	-0.366	0.000*		
H ₂	A→S	-0.103	0.050*		
H ₇	M→V	-0.132	0.009*		
H ₅	M→U	0.040	0.457		
H ₄	M→C	0.041	0.449		
H ₆	M→A	0.043	0.436		

Source: authors.
Note: *Significant for 95%.

Figure 4 and Table 6 present the results with the non-significant relationships highlighted in the model's blue dashed line.

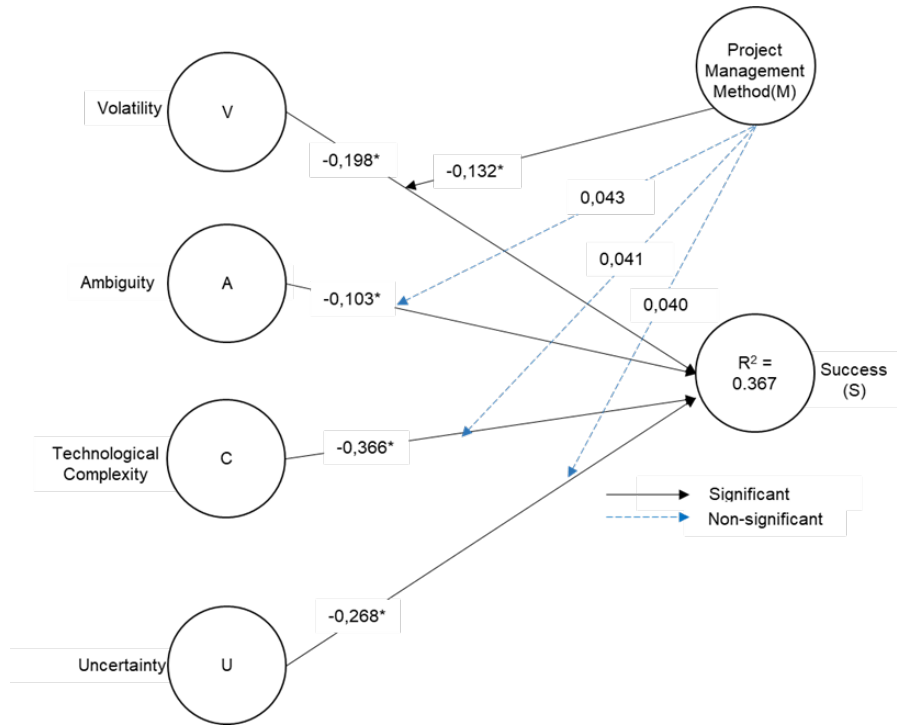


Figure 4. Structural model results
Source: authors.
 Note: * Significant for 95%.

The results show that the adverse project environment characteristics, when moderated by Project Management Method (M), explain 36.7% ($R^2=0.367$) of the variance of the Success (S). Project Management Method (M) affects de relationship only on one adverse environment characteristic: Volatility (V), reducing its adverse effects on project success. The Project Management Method (M) has no moderating influence on the relationship between Ambiguity, Uncertainty, Technological Complexity, and Success. Table 6 shows the final results of the hypothesis tests.

Table 6
 Hypothesis results

Path	Coeff.	t-value	Conclusions
H ₁	-0.268	0.000	* Confirmed
H ₂	-0.103	0.000	* Confirmed
H ₃	-0.198	0.000	* Confirmed
H ₄	-0,366	0.000	* Confirmed
H ₅		0.457	NS Not confirmed
H ₆		0.436	NS Not confirmed
H ₇		0.009	* Confirmed
H ₈		0.449	NS Not confirmed

Source: authors.
 Note: *Significant 0,005 level; NS=Not Significant

5. DISCUSSIONS

This paper's research objective was to analyze the impact of an adverse project management environment on project success, and the moderating effect of the management project method. Results reveal that uncertainty harms project success (H_1). Uncertainty, coupled with a lack of information, does not allow project managers to specify the scope and paths to achieve the project's expected results. Uncertainty makes it difficult to establish probabilities of future events that may affect project results. This finding can supplement Tatikonda and Rosenthal's (2000) findings, which indicated that projects with more significant task uncertainty have lower project success levels.

Our findings also show that ambiguity harms project success (H_2). Ambiguity generates a conflict of interpretation, makes it difficult to understand the scope correctly, and reduces the probability of achieving the project's objectives. This result is aligned with Keil et al. (2002), who argue that ambiguity in the project managers' perception is one of the most cited project failure factors.

Another finding of our research is that volatility harms project success (H_3). Volatility represents the changes that occur in the project environment during its implementation. Projects are fragile to change, as it almost invariably affects their core management resource: planning (PMI, 2017). The changes have at least two significant impacts on the project. The first is linked to re-planning, which can cause delays and cost effects. The second concerns the quality and consistency of what should be delivered (Ibbs et al., 2001). When change occurs throughout the project, the project's initial underpinnings may no longer be adequate. This result aligns with studies that advocate that changes impact project planning, producing adverse effects on project success (Ibbs, 2012; Dvir & Lechler, 2004).

Furthermore, according to the results, technological complexity harms project success (H_4). This result aligns with Baccharini (1996) and Dao et al. (2016). They argue that technological complexity is linked to the increase in the number of variables and interrelated parts of the project, increasing the difficulty of coordinating and integrating these parts, reducing planning accuracy, and making it challenging to implement a planned workflow with negative impacts on project performance.

Thus, our findings show that adverse environmental characteristics are detrimental to the project's success. Therefore, the actions required by managers can minimize or circumvent these effects. Adopting the most appropriate project management method may be the mechanism for mitigating the volatility effect.

Results show that the project management method choice does not affect the relationship between Uncertainty (H_5), Technological Complexity (H_8), Ambiguity (H_6), and project success. When choosing a project management method, the project manager uses procedures to minimize, nullify, or even reverse the negative effect of uncertainty, ambiguity, and technological complexity on project success. It means that both traditional project management and the agile method cannot act directly on the causes or effects of the uncertainty, ambiguity, and technological complexity present in the project. As it does not have a moderator effect, there is no evidence that the project management method's choice may increase project success when immersed in an environment with uncertainty, ambiguity, and technological complexity. Thus, both prescriptive and agile methods may deal with their effects in the same way. These results are in line with studies that argue that rigid or flexible methods help absorb and treat environmental effects in the project (Pick et al., 2002; Cohn, 2006; Nerur & Balijepally, 2007; De Wit & Meyer, 2010).

However, the project management method moderates the relationship between the project's volatility and success (H_7). Changes during the project execution have more significant adverse effects; the more advanced the execution phase is (Dvir & Lechler, 2004). The project management method may reduce the adverse effects of frequent changes after the execution plan is created.

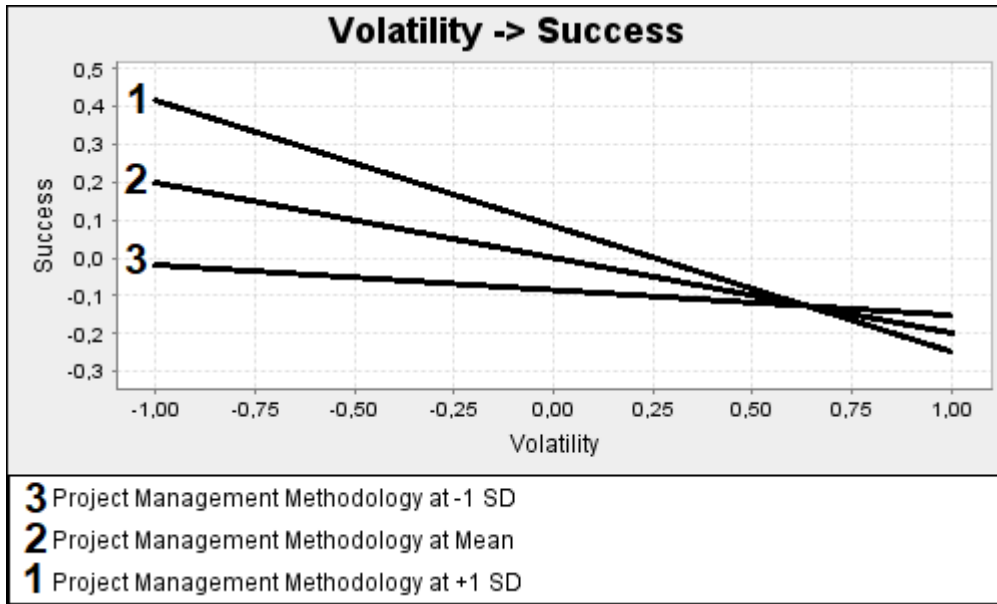


Figure 5. Relationship between Volatility and Success.

Source: authors, the graphic was generated using SmartPLS 3.0 software (Ringle et al., 2015).

The interaction term has a negative effect on project success (-0.132), whereas the simple effect of volatility on project success is -0.198. These results suggest that the relationship between volatility decreases when the project management method is agile-based (1). Line 1 (Figure 5) represents agile-based, and line 3 shows the classic project management methods. As line 1 is above the moderator's average level (when volatility has a negative effect), it indicates that agile-based methods bring higher success levels when the volatility is present in the project environment.

One possible explanation is that it is difficult to adapt to frequent changes when projects are not planned in small phases, as in classical methods. This result is aligned with flexibility advocates (Nerur & Balijepally, 2007; Serrador & Pinto, 2015). They argue that these methods help deal with adverse environmental situations and understand that the agile method can lead to better results by working with shorter horizons where possible errors can be corrected faster without profoundly impacting project objectives (Serrador & Turner, 2015; Dao et al., 2016).

Thus, empirical evidence shows that choosing a project management method that best suits the project's environmental conditions can be helpful, but only when changes occur.

6. CONCLUSIONS

The results showed that adverse environmental characteristics harm project success, and the agile project management method choice minimizes only volatility effects. Thus, choosing a management method that best fits the project's environmental conditions can be helpful only when occurring changes during the project. Other environmental variables (Ambiguity, Uncertainty, and Technical Complexity) that harm the project can not be addressed by choosing a specific method.

Based on the findings, it is also understood that one single method cannot meet all types of projects. Some studies point to agile methods when the environment is adverse (Bergamn & Karwowski, 2018), but this study showed that this could bring some gain only when volatility is present. Classical methods can also be applied in adverse environments when uncertainty, technological complexity, and ambiguity are present. Thus, by opting for a single project management method (e.g., agile) for all projects, organizations can create situations that hinder managing some projects with possible consequences on their results. These findings agree with other studies that advocate the use of agile methods only in specific contexts (e.g., Pells, 2019; Thesing et al., 2021).

Both methods (classical and agile) help achieve project success but must be carefully considered depending on the project environment. While these merits can be debated, none should be arbitrarily rejected. Perhaps the biggest challenge of project management is effectively dealing with both methods, as in hybrid approaches.

Additional future qualitative research can clarify; further, the project manager uses and leads to more targeted recommendations when ambiguity, uncertainty, and technical complexity are predominant.

This study aimed to seek evidence that the project management method choice influences the impact of environmental aspects (focused on VUCA) on the project's success. In this way, we understand that the evaluation of moderation in its carried out meets the work's objectives. Future works can further explore other aspects deeply.

6.1. THEORETICAL IMPLICATIONS

Our study has several implications for the literature on project management. First, the study provides empirical support for confirming an adverse environment's impacts on project success. Researchers in project management have made great efforts to discover ways to reduce these impacts and increase projects' success (e.g., Moura et al., 2018; Kineber et al., 2021; Imam & Zaheer, 2021; Wang et al., 2022). There is no consensus on different project management methods to reduce these negative effects of project success in these adverse scenarios (Gemino, 2021). According to our findings, choosing a management method more aligned with the adverse environmental characteristics has a limited ability to reduce the chances of project failure.

Secondly, our findings show that the ability to reduce the harmful effects of an adverse environment on project success is limited. It only helps reduce the adverse effects caused by volatility, factors that are more affected by the projects that have several changes during their life cycle.

Thirdly, the factors that affect the phases of implementing projects, such as ambiguity, uncertainty, and technological complexity, are not affected by project management method choice but can be enhanced when other factors are minimized.

6.2. MANAGERIAL IMPLICATIONS

The volatility during the project life cycle may reduce project success probability (Schimidt et al., 2001; Wang et al., 2012; PMI, 2017). The research results show that aligning the management method to the project's environmental characteristics, especially volatility, reduces these factors' impacts on the project's expected results.

Dealing with volatility requires controlling and managing change. Change control concentrates on changes that affect the project's objectives, such as schedule, budget, and scope (PMI, 2017). Change management focuses on the impact of the project results on the organization's environment.

Effective communication to manage expectations helps moderate the impact of the project results (Rajhans, 2018). Another way to trait volatility is to cultivate resilience, the capacity to adapt to change (Costantini et al., 2021). Plan the project knowing that volatility is actual. Changes should be expected; try to predict the changes faced, and be aware that things will change (Bennett & Lemoine, 2014).

Finally, our results showed that choosing the management method best suited to an adverse environment in which a project is inserted does not reduce technological complexity, uncertainty, or ambiguity impacts on the results and expectations around the project results. It remains a significant challenge to managers in the VUCA era.

Overall, our data and the findings provide valuable insights for current project managers, highlighting specific concerns and managerial strategies for managing projects in a VUCA environment.

6.3. LIMITATIONS AND FURTHER RESEARCH

This article has limitations. First, the VUCA era concepts are subjective, and there is little consensus on some definitions. We chose to focus on four indicators that define the VUCA environment. We chose to use a type of environment complexity, technological complexity, leaving the other aspects of complexity to be investigated in future research. These clippings certainly did not address all the factors involved in choosing a project management method.

Secondly, this study does not include hybrid methods focusing only on methods widely applied in project management.

Thirdly, the sample collected had a predominance of companies operating in South America in the segment of services and projects related to information technology. Software development and IT infrastructure projects account for 32.83% of total projects, presenting biased results.

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AUTHOR'S CONTRIBUTION

This paper's authors declare that they worked equally on the stages of conceptualization, investigation, methodology, project administration, supervision, validation, writing, and editing of this paper.

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CONFLICTS OF INTEREST

All the authors of this paper declare that they have no conflict of interest about the objects addressed.

APPENDIX A

Construct	Variable	Description	Authors
Ambiguity	A_1	<i>In my last completed project, there were incorrect requirements</i>	Wallace et al. (2004)
	A_2	<i>In my last completed project, there were conflicting requirements</i>	
	A_3	<i>In my last completed project, there were difficulties in defining the scope of the project.</i>	
Technical Complexity	C_1	<i>In my last completed project, there was the use of new technology</i>	Wallace et al. (2004)
	C_2	<i>In my last completed project, there was use of technology that had never been used before in previous projects.</i>	
	C_3	<i>In my last completed project, there was the involvement of different technical specialties.</i>	Baccarini (1996)
Uncertainty	U_1	<i>In my last completed project, the goals were ill-defined.</i>	Jun et al. (2011)
	U_2	<i>In my last completed project, there was a lack of project domain knowledge (knowledge about project theme)</i>	Wallace et al. (2004)
	U_3	<i>In my last completed project, the client did not know what he wanted.</i>	Jun et al. (2011)
Volatility	V_1	<i>In my last completed project, requirements changed</i>	Wallace et al. (2004)
	V_3	<i>In my last completed project, the technology involved changed</i>	
	V_3	<i>In my last completed project, the sponsor or members of the project changed</i>	Lee and Xia (2005)
Success	S_1	<i>My last completed project met intended requirements (scope).</i>	Wallace et al. (2004)
	S_2	<i>My last completed project was finished within the schedule.</i>	
	S_3	<i>My last completed project was finished within the budget.</i>	
	S_4	<i>In my last completed project, the overall quality of project deliveries (e.g. products or services) was high.</i>	
	S_5	<i>In my last completed project, deliveries met the client's expectations.</i>	
Project Management Method	M	<i>Which methodology was applied in your last completed project?</i>	Authors