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Article

Assessing the Quality of Virtual Student Internships in Brazilian Organizations: Potential and Use of Fuzzy TOPSIS Class

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Abstract

This research delves into the assessment of students' perspectives regarding virtual internships within Brazilian organizations, a phenomenon accelerated by the global pandemic. Evaluating 78 students' virtual internships via a survey, the study employs the Fuzzy TOPSIS Class method for analysis. Additionally, a sensitivity analysis was conducted to assess the robustness of the results. Key insights for enhancing virtual internships encompass: emphasizing application and deeper understanding of topics learned during the undergraduate course, enhancing understanding about how organizations work, and fostering comprehension of market dynamics. Among the points best rated by students are the opportunity to explore new subjects, development of soft skills, and supervisors' competence in managing teams in virtual environments. This paper contributes methodologically by proposing a multicriteria decision-making approach to assess virtual internships. The findings serve as a valuable resource for internship supervisors in companies and higher education institutions, aiding them in guiding students through this pivotal developmental phase that shapes their future careers.

Keywords: fuzzy set; fuzzy TOPSIS; multicriteria decision-making; virtual internship; remote internship; online internship; higher education institutions

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1. Introduction

In recent years, a significant number of companies have undergone substantial changes in their work structures [1]. Especially after the COVID-19 pandemic, many companies have adopted hybrid or virtual work arrangements, presenting both advantages and disadvantages for employees. These aspects need to be thoroughly studied in a multidisciplinary manner by academia [2].

A particularly sensitive point in the emerging new forms of work within companies is related to internships. Typically, it is through these positions that young individuals about to graduate enter the job market and gain valuable experience for their future careers. This phase serves as a learning opportunity, where the exchange of knowledge with more experienced professionals becomes extremely important. Wolinsky-Nahmias and Auerbach [3] support this argument, emphasizing the significance of the professional environment for interns.

The characteristics of internships represent a crucial phase that bridges the gap between theory and practice. During internships, students, having undergone years of classroom learning, gain exposure to real work environments, where they can apply the theoretical knowledge previously encountered only in examples [4,5]. This experience also exposes them to interpersonal relations and offers the opportunity to develop valuable networking skills while engaging in various tasks, fostering their personal growth. The practical experience gained through internships helps students make informed career decisions even before formally starting their careers, effectively serving as trial periods to explore areas where their motivation and productivity thrive [3,5,6].

Amidst the pandemic, many companies opted to transition their interns to virtual work, and even post-pandemic, several organizations have continued to embrace this mode of engagement [4]. This situation has sparked a debate about the merits and demerits of virtual internships [7] and whether they deliver the expected learning outcomes for students [8]. In addition to the complex situation brought about by the pandemic, it is important to consider pre-existing concerns, such as the quality of virtual interaction and the need for specific competencies for virtual learning activities [9].

Against this backdrop, this research aims to assess students' perceptions regarding the quality of virtual internships within Brazilian organizations. Beyond this introductory section, the article is organized into four distinct sections. Section 2 provides the theoretical foundation of the study, expanding on the debates surrounding virtual internships. Section 3 outlines the methodological procedures adopted to achieve the research objectives, while Section 4 delves into the presentation and analysis of the results. Finally, Section 5 presents the conclusions drawn from the study, as well as limitations and suggestions for future research.

2. Theoretical Background

Despite the increasing attention virtual internships have received during the COVID-19 pandemic [10], the literature underscores that they have been subject to research and experimentation for many years [7]. While conventional, in-person internships offer temporary and non-permanent job opportunities bridging the gap between college graduation and entry into the job market, virtual internships cater to the same period but involve complete computer-mediated communication and other tools [11].

Jeske and Actell [12] emphasize that certain educators and employers still harbor biases against virtual internships, perceiving them as less advantageous compared to traditional in-person internships. Engaging in further research on this internship approach and developing theories and insights into its effective implementation can significantly mitigate the biases [7].

Jeske [7] underscores that internship quality, whether conducted in a virtual or conventional in-person setting, transcends modality, pivoting instead on diverse factors such as robust supervision and mentoring, networking avenues, and the provision of a prospective employability panorama for interns, alongside other considerations. A profound eagerness on the part of interns for learning, coupled with a resolute dedication from supervisors to nurture this learning, emerges as imperative even within the virtual realm [13]. Supervisor engagement in internships, entailing the provision of constructive feedback to interns, assumes indispensability irrespective of the modality; simultaneously, it is anticipated that interns capitalize on such feedback to rectify potential challenges and amplify their career trajectories [14,15].

AlGhamdi [4] illustrates the effective feasibility of seamlessly integrating, instructing, and cultivating interns through virtual modalities. Jeske [7] adds that corporations need to channel resources into infrastructure to facilitate optimal work performance across all personnel. In general, it is incumbent upon stakeholders to ascertain whether virtual internships duly fulfill their mandate of affording students the opportunity to translate theoretical knowledge into practice, thereby fostering heightened affinity with their impending professions. Moreover, internships frequently serve as the crucible wherein students commence honing expertise in a specific subdomain of their chosen vocation, thereby accruing specialized and advanced proficiencies [8,10].

It is important to highlight that internships offer a valuable avenue for students to cultivate an array of soft skills—including teamwork, proactivity, communication, analysis, and decision-making—that prove pivotal for their transition into the professional realm [16]. Moreover, internships often provide students with a comprehensive understanding of internal organizational structures, as well as market dynamics and other parameters that significantly influence company performance [3].

Numerous studies delve into students' perspectives on virtual internships, a matter of particular significance considering that many of these investigations consider the unique backdrop of the COVID-19 pandemic. For example, Jenkins et al. [17] conducted their study within this context and discerned that distractions and internet connectivity emerged as the predominant challenges encountered by students engaged in virtual internships. Challenges such as subpar communication quality, time zone disparities, and the intricacies of virtual work were also highlighted. Additionally, literature underscores underlying issues that are not novel but warrant attention in the current landscape, notably, equitable internet access [18].

In the context of the pandemic, Jenkins et al. [17] state that there was a rise in the proportion of students indicating minimal issues with virtual experience. This suggests that with the passage of time and adequate preparation, virtual internship programs have grown increasingly effective and tailored to meet students' needs. Thus, it is important for companies, higher education institutions, and researchers to join forces to comprehend how to continually enhance this internship modality, which constitutes a significant period of student learning so that the internet can increasingly become an ally for their personal and professional development.

3. Materials and Methods

3.1. Survey

The research methodology employed in this study involved the implementation of a survey, aligning with the guidance provided by Forza [19]. According to this author, the successful execution of survey research hinges upon the precise definition of research objectives and the careful delineation of the profiles of potential respondents. In the context of the current study, the primary aim was to conduct an exploratory investigation into the realm of virtual internships within Brazilian corporate entities. This encompassed students who were actively engaged in or had prior experience with such initiatives during the research period, with the overarching goal of collecting data to inform future discourse [20].

Forza [19] underscores the value of formulating clear, succinct survey questions that are devoid of ambiguity and recommends steering away from excessive openness that could lead to responses misaligned with research goals. Furthermore, the logical sequencing of questionnaire items is deemed essential, ensuring a seamless respondent experience and facilitating subsequent data analysis [21]. Forza [19] also recommends maintaining the confidentiality of collected data, pre-testing the survey before distribution, and meticulously selecting a data collection method that resonates with research requisites and relevant considerations. In this study, the chosen approach involved distributing a questionnaire via email.

The design of the questionnaire was informed by the insights gleaned from studies by AlGhamdi [4], Bayerlein [22], and Bayerlein and Jeske [8]. Students participating in the study indicated their perceptions regarding virtual internships considering the propositions in Table 1.

Table 1. Propositions used in the survey for students to evaluate the quality of virtual internships.

Code	Proposition
IT1	Virtual internship provided me the opportunity to apply, gain a better understanding, and delve deeper into specific topics learned in my undergraduate course
IT2	Virtual internship allowed me to explore new subjects and themes that I was not familiar with
IT3	Virtual internship facilitated the development of soft skills (proactivity, communication, analytical capabilities, etc.)
IT4	Virtual internship offered me a better understanding about how an organization works
IT5	Virtual internship improved my understanding of market dynamics (competition among companies, the influence of economic parameters in the sector the company operates in, etc.)
IT6	My supervisor regularly conducted meetings with me to provide feedback on my performance and deemed the frequency of these meetings relevant
IT7	The feedback I received from my supervisor was consistently valuable and contributed to my professional growth
IT8	My immediate supervisor possessed strong skills in managing teams in virtual or virtual environments

Source: Elaborated by the authors based on AlGhamdi [4], Bayerlein [22], and Bayerlein and Jeske [8].

3.2. Preliminaries

In this section, we present the basic mathematical concepts related to the fuzzy set theory used in this research. The method employed, Fuzzy TOPSIS Class [23], relies on fuzzy numbers and their associated operations [24].

Definition 1. *Fuzzy set: A fuzzy set* $\widetilde{A}$ *in a universe of discourse* X *is characterized by a membership function* $\mu : X \to [0,1]$*, which assigns to each element* $x \in X$ *a membership degree* $\mu(x)$*.*

Definition 2. *Triangular Fuzzy Number (TFN): A triangular fuzzy number* $\widetilde{A}$ *is denoted by a triplet* $(l,\ m,\ n)$*, where* $l \le m \le u$*, and has the membership function represented by Equation (1).*

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x < l \\ \frac{x-l}{m-l}, & l \le x \le m \\ \frac{u-x}{u-m}, & m \le x \le u \\ 0, & x > u \end{cases} \quad (1)$$

Here, l and u represent the lower and upper bounds, respectively, and m is the most probable value.

Algebraic operations: Let $\widetilde{A} = (l_1, m_1, u_1)$ and $\widetilde{B} = (l_2, m_2, u_2)$ be two TFNs. The basic operations are defined as follows:

Addition: $\widetilde{A} + \widetilde{B} = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$

Subtraction: $\widetilde{A} - \widetilde{B} = (l_1 - u_2, m_1 - m_2, u_1 - l_2)$

Multiplication: $\widetilde{A} \cdot \widetilde{B} = (l_1.l_2, m_1.m_2, u_1.u_2)$

Division: $\frac{\widetilde{A}}{\widetilde{B}} = \left(\frac{l_1}{u_2}, \frac{m_1}{m_2}, \frac{u_1}{l_2}\right)$, where $l_2, m_2, u_2 > 0$

These operations are used in the Fuzzy TOPSIS Class computations for normalizing, weighting, and comparing fuzzy values in the decision-making process.

3.3. Fuzzy TOPSIS Class

The participants employed the rating scale provided in Table 2 to convey their viewpoints, which also shows the fuzzification process of the response alternatives.

Table 2. Scale used in the survey for students to indicate their perceptions and fuzzified representation.

Scale	Fuzzy Numbers		
	l	***m***	***u***
The proposition is not related to the virtual internship I undertook	0	0	2.5
The proposition is weakly related to the virtual internship I undertook	0	2.5	5
The proposition is moderately related to the virtual internship I undertook	2.5	5	7.5
The proposition is strongly related to the virtual internship I undertook	5	7.5	10
The proposition is very strongly related to the virtual internship I undertook	7.5	10	10

Source: Authors.

A total of 78 students participated in this research. The sample consisted of students from Brazilian higher education institutions who had specifically participated in virtual internships. These students were invited to participate in the study both online (via institutional email) and in person during academic meetings or classroom visits. Participation was voluntary and based on self-selection. Only those who completed the full questionnaire and confirmed their consent were included in the final sample, ensuring that responses came from individuals with direct experience in virtual internships.

The companies where students completed their virtual internships varied in size and sector. They included medium and large organizations operating in both industrial and service domains. Examples include manufacturing firms, financial institutions, logistics companies, educational organizations, and retail chains. These companies had sufficient digital infrastructure to support remote workflows and assigned tasks related to business operations, analysis, planning, and support. The diversity in company profiles reinforces the applicability of virtual internship models across multiple segments of the Brazilian economy.

The students were allocated into three different groups based on the duration of the internship they had completed at the time of the study: 29.5% were placed in the category "up to 6 months", 41% in the category "between 6 and 12 months", and 29.5% in the category "more than 12 months". This served as a basis to define their ability to answer the questions.

The collected data were analyzed using a multicriteria decision-making method, Fuzzy TOPSIS Class. This method was proposed by Ferreira et al. [23] and aims to classify alternatives (propositions) into categories (or classes). In comparison to traditional Fuzzy TOPSIS, the "class" approach involves identifying the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS) for each of the classes [23].

Several MCDM methods have been employed to support decision-making processes under multiple and often conflicting criteria. Analytic Hierarchy Process (AHP) [25,26] relies on pairwise comparisons and structured hierarchies but requires consistent judgments and becomes cumbersome with large numbers of alternatives. Traditional TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) [27] ranks alternatives based on their distance from ideal and anti-ideal solutions but typically assumes crisp input values, which limits its suitability for problems involving uncertainty or subjective assessments.

VIKOR [28], another prominent method, focuses on ranking and selecting from a set of alternatives with conflicting criteria, emphasizing the decision-maker's strategy of compromise solutions. However, like standard TOPSIS, it often lacks mechanisms to incorporate linguistic assessments or fuzziness in data. Similarly, the RADAR (Ranking based on Distance And Range) method [29], including its variant RADAR II, is designed to identify stable solutions across criteria and is particularly well-suited for reliability-related problems. While RADAR offers a more flexible approach, RADAR II is considered more rigorous, with both methods effectively highlighting the quality of alternatives across critical attributes.

Compared to these methods, the Fuzzy TOPSIS Class approach offers several advantages. First, it directly accommodates uncertainty and subjectivity by employing triangular fuzzy numbers in both alternatives and weights [23]. Second, it allows classification rather than strict ranking, making it particularly suitable for problems involving perceptual assessments or grouped evaluation (as in survey analysis) [30]. Third, the method reduces cognitive load by not requiring pairwise comparisons across all alternatives, as in AHP, and supports scalable evaluation even with numerous propositions and respondents [31].

In this paper, the following notation is used for the application of Fuzzy TOPSIS Class:

- $\tilde{A} = (l_1, m_1, u_1)$: a triangular fuzzy number representing the student's response to a given proposition.
- $\tilde{w}_i = (l_i^w, m_i^w, u_i^w)$: a triangular fuzzy number denoting the student's ability to infer about virtual internship quality.
- D_i^+: the distance between the alternative and the Positive Ideal Solution (PIS).
- D_i^-: the distance between the alternative and the Negative Ideal Solution (NIS).
- CC_i^p: the closeness coefficient, calculated to determine the classification of each alternative.

Based on that, the steps for conducting Fuzzy TOPSIS Class are outlined in Table 3.

Table 3. Steps for the application of the Fuzzy TOPSIS Class method.

Step	Procedures
1	Define linguistic variables to assess the weight of the criteria and evaluate the alternatives for the given criteria. Based on this, construct the decision matrix $\tilde{D}$ and the weight vector $\tilde{W}$.
2	Normalize the decision matrix $\tilde{D}$ using Equation (2). The matrix $\tilde{R} = \left[\tilde{r}_{ij}\right]_{m\times n}$ will be obtained. $$r_{ij} = \begin{cases} \left(\frac{l_{ij}}{u_j^+}, \frac{m_{ij}}{u_j^+}, \frac{u_{ij}}{u_j^+}\right), \ u_j^+ = \max_i u_{ij} \ for\ benefit\ criteria \\ \left(\frac{l_j^-}{u_{ij}}, \frac{l_j^-}{m_{ij}}, \frac{l_j^-}{l_{ij}}\right), \ l_j^- = \min_i l_{ij},\ for\ cost\ criteria \end{cases} \quad (2)$$
3	Calculate the matrix $\tilde{V} = \left[\tilde{v}_{ij}\right]_{m\times n}$ by weighting the matrix $\tilde{R} = \left[\tilde{r}_{ij}\right]_{m\times n}$ with the weight vector $\tilde{W} = \left[\tilde{w}_j\right]$.
4	For each class, define PIS (A_p^+) and NIS (A_p^-) using Equation (3) and (4). $$A_p^+ = \left\{\tilde{v}_{p1}^+, \tilde{v}_{pj}^+, \ldots, \tilde{v}_{pm}^+\right\}, \tilde{v}_j^+ = \tilde{q}_{pj} \quad (3)$$ $$A_p^- = \left\{\tilde{v}_{p1}^-, \tilde{v}_{pj}^-, \ldots, \tilde{v}_{pm}^-\right\}, \tilde{v}_j^- = \tilde{q}'_{pj} \quad (4)$$ $\tilde{q}_{pj}$ = nearest profile of the class, weighted and normalized. $\tilde{q}'_{pj}$ = farthest profile of the class, weighted and normalized.

Table 3. *Cont.*

Step	Procedures
5	Calculate the distance of each alternative i relative to PIS (D_i^+) and NIS (D_i^-) using Equation (5) and (6). $$d_v\left(\widetilde{v}_{ij},\widetilde{v}^+_{pj}\right)=\sqrt{\frac{1}{3}\left[\left(l_{ij}-l_{v^+_{pj}}\right)^2+\left(m_{ij}-m_{v^+_{pj}}\right)^2+\left(u_{ij}-u_{v^+_{pj}}\right)^2\right]} \quad (5)$$ $$d_v\left(\widetilde{v}_{ij},\widetilde{v}^-_{pj}\right)=\sqrt{\frac{1}{3}\left[\left(l_{ij}-l_{v^-_{pj}}\right)^2+\left(m_{ij}-m_{v^-_{pj}}\right)^2+\left(u_{ij}-u_{v^-_{pj}}\right)^2\right]} \quad (6)$$ $$D_i^+=\sum_{j=1}^{n} d_v(\widetilde{v}_{ij},\widetilde{v}^+_{pj}) \quad (7)$$ $$D_i^-=\sum_{j=1}^{n} d_v(\widetilde{v}_{ij},\widetilde{v}^-_{pj}) \quad (8)$$
6	Calculate the coefficient of each alternative i $\left(CC_i^p\right)$ using Equation (9). $$CC_i^p=\frac{D_i^-}{(D_i^+ + D_i^-)} \quad (9)$$
7	For each alternative i, determine its class. The class will be the one that presents the highest value of CC_i^p for alternative i among all classes.

Source: Elaborated by the authors based on Ferreira et al. [23].

It is worth noting that in this research, each participating student assumed the role of a criterion, with their response weighted by their ability to infer on the topic. This ability was defined based on the duration of the student's internship (up to 6 months, between 6 and 12 months, and more than 12 months), implying that the longer the internship duration, the higher the ability to infer on the topic. It is important to highlight that a similar methodological approach using Fuzzy TOPSIS was undertaken in Bobel et al. [32] and Pompilio et al. [33]. Table 4 presents the fuzzification of values representing such ability using triangular numbers.

Table 4. Fuzzy weights for the ability to infer about the quality of virtual internships.

Ability to Infer About the Survey Item (Questions)	Fuzzy Numbers		
	l	*m*	*u*
Small ability to infer about the item	0.2	0.2	0.4
Low ability to infer about the item	0.2	0.4	0.6
Intermediate ability to infer about the item	0.4	0.6	0.8
High ability to infer about the item	0.6	0.8	1
Very high ability to infer about the item	0.8	1	1

Source: Authors.

In the baseline scenario, it was considered that students in the group "up to 6 months of internship" have low ability to infer about the propositions (0.2; 0.4; 0.6), as they are generally still in an adaptation phase. Students in the group "between 6 and 12 months of internship" were regarded as having moderate ability to infer about the propositions (0.4; 0.6; 0.8). Students in the group "more than 12 months of internship" were considered to have high ability to infer about the propositions (0.6; 0.8; 1).

Upon completion of all stages of Fuzzy TOPSIS Class, it is important to highlight that a sensitivity analysis was conducted. This is crucial to verify the robustness of the achieved results. Once the results were obtained, they were discussed, and conclusions were established.

4. Results and Discussion

4.1. Assessing the Quality of Virtual Internships in Brazilian Organizations

Given that the research involved 78 participants, and a triangular fuzzy number (l, m, n) was assigned to each of them, the matrices generated for the calculations of Fuzzy TOPSIS Class in MS Excel were of significant dimensions. Thus, simplified versions of these matrices are used to present the results.

Table 5 highlights the collected data, characterizing the decision matrix $\widetilde{D}$ with each respondent (R) assuming the role of a criterion. Table 6 displays the weight vector $\widetilde{W} = \left[\widetilde{w}_j\right]$, which was constructed based on the respondents' ability to infer about the quality of virtual internships.

Table 5. Decision matrix $\widetilde{D}$ with respondents assuming the role of a criterion.

Item	R1			R2			R3			R4			…	R78		
	l	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	…	*l*	*m*	*n*
IT1	5	7.5	10	2.5	5	7.5	5	7.5	10	7.5	10	10		5	7.5	10
IT2	7.5	10	10	2.5	5	7.5	7.5	10	10	5	7.5	10		7.5	10	10
IT3	0	2.5	5	5	7.5	10	7.5	10	10	5	7.5	10		5	7.5	10
IT4	0	2.5	5	2.5	5	7.5	7.5	10	10	7.5	10	10	…	2.5	5	7.5
IT5	0	0	2.5	0	2.5	5	7.5	10	10	2.5	5	7.5		2.5	5	7.5
IT6	0	2.5	5	0	2.5	5	7.5	10	10	0	2.5	5		5	7.5	10
IT7	2.5	5	7.5	0	2.5	5	7.5	10	10	0	0	2.5		5	7.5	10
IT8	0	2.5	5	2.5	5	7.5	7.5	10	10	7.5	10	10		5	7.5	10

Table 6. Weight vector $\widetilde{W} = \left[\widetilde{w}_j\right]$ based on the respondents' ability to infer about the quality of virtual internships.

Respondent	R1			R2			R3			R4			…	R78		
Fuzzy	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	…	*l*	*m*	*n*
Weights	0.2	0.4	0.6	0.6	0.8	1	0.6	0.8	1	0.4	0.6	0.8	…	0.4	0.6	0.8

The data from Table 5 were normalized considering the benefit criteria [23] and weighted by the weight vector presented in Table 6, obtaining the matrix $\widetilde{\mathrm{V}} = \left[\widetilde{\mathrm{v}}_{\mathrm{ij}}\right]_{\mathrm{m}\times\mathrm{n}}$ shown in Table 7.

Table 7. Normalized and weighted judgment matrix $\left[\widetilde{v}_{ij}\right]_{m\times n}$.

Item	R1			R2			R3			R4			…	R78		
	l	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	…	*l*	*m*	*n*
IT1	0.1	0.3	0.6	0.15	0.4	0.75	0.30	0.6	1	0.3	0.6	0.8		0.2	0.45	0.8
IT2	0.15	0.4	0.6	0.15	0.4	0.75	0.45	0.8	1	0.2	0.45	0.8		0.3	0.6	0.8
IT3	0	0.1	0.3	0.3	0.6	1	0.45	0.8	1	0.2	0.45	0.8		0.2	0.45	0.8
IT4	0	0.1	0.3	0.15	0.4	0.75	0.45	0.8	1	0.3	0.6	0.8		0.1	0.3	0.6
IT5	0	0	0.15	0	0.2	0.5	0.45	0.8	1	0.1	0.3	0.6	…	0.1	0.3	0.6
IT6	0	0.1	0.3	0	0.2	0.5	0.45	0.8	1	0	0.15	0.4		0.2	0.45	0.8
IT7	0.05	0.2	0.45	0	0.2	0.5	0.45	0.8	1	0	0	0.2		0.2	0.45	0.8
IT8	0	0.1	0.3	0.15	0.4	0.75	0.45	0.8	1	0.3	0.6	0.8		0.2	0.45	0.8

The highest level of the scale (i.e., "the proposition is very strongly related to the virtual internship I undertook") was considered as class "excellent", the intermediate level of the scale (i.e., "the proposition is moderately related to the virtual internship I undertook") was classified as class "regular", and the lowest level of the scale (i.e., "the proposition is not related to the virtual internship I undertook") was categorized as class "unacceptable". In this manner, the PIS for the class "excellent" became the highest level of the scale, and the NIS for the same class became the lowest level of the scale. The PIS for the class "regular" became the intermediate level of the scale, and the NIS for the same class became the lowest level of the scale. Finally, the PIS for the class "unacceptable" became the lowest level of the scale, and the NIS became the highest level of the scale. The values of the solutions for each class, already normalized and weighted, are presented in Tables 8–10.

Table 8. PIS and NIS for the class "excellent" with weighted and normalized values.

Respondent		**R1**			**R2**			**R3**			**R4**		...		**R78**	
Fuzzy	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	...	*l*	*m*	*n*
A_p^+	0.15	0.4	0.6	0.45	0.8	1	0.45	0.8	1	0.3	0.6	0.8	...	0.3	0.6	0.8
A_p^-	0	0	0.15	0	0	0.25	0	0	0.25	0	0	0.2		0	0	0.2

Table 9. PIS and NIS for the class "regular" with weighted and normalized values.

Respondent		**R1**			**R2**			**R3**			**R4**		...		**R78**	
Fuzzy	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	...	*l*	*m*	*n*
A_p^+	0.05	0.2	0.45	0.15	0.4	0.75	0.15	0.4	0.75	0.1	0.3	0.6	...	0.1	0.3	0.6
A_p^-	0	0	0.15	0	0	0.25	0	0	0.25	0	0	0.2		0	0	0.2

Table 10. PIS and NIS for the class "unacceptable" with weighted and normalized values.

Respondent		**R1**			**R2**			**R3**			**R4**		...		**R78**	
Fuzzy	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	*l*	*m*	*n*	...	*l*	*m*	*n*
A_p^+	0	0	0.15	0	0	0.25	0	0	0.25	0	0	0.2	...	0	0	0.2
A_p^-	0.15	0.4	0.6	0.45	0.8	1	0.45	0.8	1	0.3	0.6	0.8		0.3	0.6	0.8

With all distances obtained, it became possible to calculate D_i^+ e D_i^- for each class, as presented in Tables 11–16.

Table 11. Distance D_i^+ for each alternative for the class "excellent".

Item	**R1**	**R2**	**R3**	**R4**	**R5**	...	**R78**	D_i^+
IT1	0.065	0.323	0.144	0	0.144		0.104	14.259
IT2	0	0.323	0	0.104	0		0	5.495
IT3	0.260	0.144	0	0.104	0.323		0.104	6.999
IT4	0.260	0.323	0	0	0.144	...	0.238	13.029
IT5	0.358	0.520	0	0.238	0.144		0.238	11.902
IT6	0.260	0.520	0	0.388	0		0.104	11.016
IT7	0.155	0.520	0	0.520	0		0.104	7.638
IT8	0.260	0.323	0	0	0		0.104	6.819

Table 12. Distance D_i^- for each alternative for the class "excellent".

Item	R1	R2	R3	R4	R5	…	R78	D_i^-
IT1	0.318	0.380	0.581	0.520	0.581		0.448	27.772
IT2	0.358	0.380	0.684	0.448	0.684		0.520	35.950
IT3	0.104	0.581	0.684	0.448	0.380		0.448	34.671
IT4	0.104	0.380	0.684	0.520	0.581	…	0.294	28.797
IT5	0	0.185	0.684	0.294	0.581		0.294	30.076
IT6	0.104	0.185	0.684	0.144	0.684		0.448	30.757
IT7	0.210	0.185	0.684	0	0.684		0.448	34.213
IT8	0.104	0.380	0.684	0.520	0.684		0.448	34.896

Table 13. Distance D_i^+ for each alternative for the class "regular".

Item	R1	R2	R3	R4	R5	…	R78	D_i^+
IT1	0.108	0	0.204	0.238	0.204		0.155	8.260
IT2	0.155	0	0.323	0.155	0.323		0.238	14.991
IT3	0.108	0.204	0.323	0.155	0		0.155	14.198
IT4	0.108	0	0.323	0.238	0.204	…	0	10.906
IT5	0.210	0.204	0.323	0	0.204		0	11.703
IT6	0.108	0.204	0.323	0.155	0.323		0.155	12.926
IT7	0	0.204	0.323	0.294	0.323		0.155	14.115
IT8	0.108	0	0.323	0.238	0.323		0.155	14.702

Table 14. Distance D_i^- for each alternative for the class "regular".

Item	R1	R2	R3	R4	R5	…	R78	D_i^-
IT1	0.318	0.380	0.581	0.520	0.581		0.448	27.772
IT2	0.358	0.380	0.684	0.448	0.684		0.520	35.950
IT3	0.104	0.581	0.684	0.448	0.380		0.448	34.671
IT4	0.104	0.380	0.684	0.520	0.581	…	0.294	28.797
IT5	0	0.185	0.684	0.294	0.581		0.294	30.076
IT6	0.104	0.185	0.684	0.144	0.684		0.448	30.757
IT7	0.210	0.185	0.684	0	0.684		0.448	34.213
IT8	0.104	0.380	0.684	0.520	0.684		0.448	34.896

Table 15. Distance D_i^+ for each alternative for the class "unacceptable".

Item	R1	R2	R3	R4	R5	…	R78	D_i^+
IT1	0.318	0.380	0.581	0.520	0.581		0.448	27.772
IT2	0.358	0.380	0.684	0.448	0.684		0.520	35.950
IT3	0.104	0.581	0.684	0.448	0.380		0.448	34.671
IT4	0.104	0.380	0.684	0.520	0.581	…	0.294	28.797
IT5	0	0.185	0.684	0.294	0.581		0.294	30.076
IT6	0.104	0.185	0.684	0.144	0.684		0.448	30.757
IT7	0.210	0.185	0.684	0	0.684		0.448	34.213
IT8	0.104	0.380	0.684	0.520	0.684		0.448	34.896

Table 16. Distance D_i^- for each alternative for the class "unacceptable".

Item	R1	R2	R3	R4	R5	...	R78	D_i^-
IT1	0.065	0.323	0.144	0	0.144		0.104	14.259
IT2	0	0.323	0	0.104	0		0	5.495
IT3	0.260	0.144	0	0.104	0.323		0.104	6.999
IT4	0.260	0.323	0	0	0.144		0.238	13.029
IT5	0.358	0.520	0	0.238	0.144	...	0.238	11.902
IT6	0.260	0.520	0	0.388	0		0.104	11.016
IT7	0.155	0.520	0	0.520	0		0.104	7.638
IT8	0.260	0.323	0	0	0		0.104	6.819

After obtaining D_i^+ and D_i^- for each class, it was possible to calculate the CC_i^p indicator and, by selecting the highest value, ascertain the corresponding class for each alternative (Table 17).

Table 17. Values of CC_i^p calculated for each class and identification of the class to which items belong.

Item	Excellent	Regular	Unacceptable	Class Ascertained to Each Alternative
IT1	0.661	**0.771**	0.339	Regular
IT2	**0.867**	0.706	0.133	Excellent
IT3	**0.832**	0.709	0.168	Excellent
IT4	0.688	**0.725**	0.312	Regular
IT5	0.716	**0.720**	0.284	Regular
IT6	**0.736**	0.704	0.264	Excellent
IT7	**0.817**	0.708	0.183	Excellent
IT8	**0.837**	0.704	0.163	Excellent

To visualize the outcomes, a graphical representation was created (Figure 1).

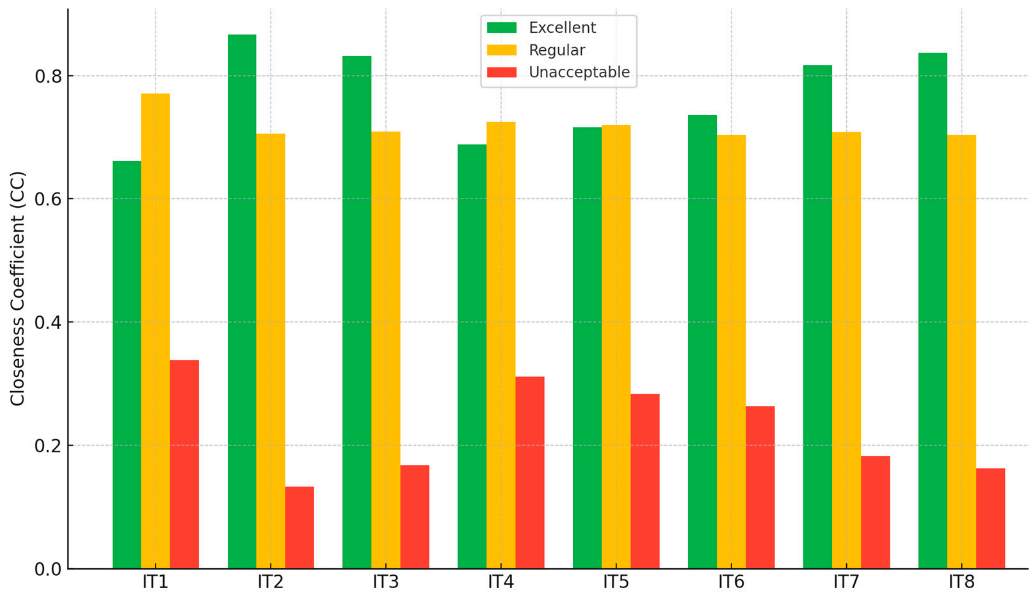

Figure 1. Closeness coefficient for each item. Source: Authors.

It is observed that out of the eight evaluated propositions, three of them were allocated in the "regular" category (IT1, IT4, and IT5). It is important to note that for IT5, the CC_i^p exhibits variation in the third decimal place, thus warranting consideration of the presence of uncertainty in the allocation of this category to the "regular" or "excellent" class.

As emphasized in the Section 3, it is important to conduct a sensitivity analysis to verify the robustness of the data. Two scenarios were tested. In the first scenario (scenario

1), students with up to 6 months in virtual internships, who were initially considered to have low ability to infer about the quality of the internships, were elevated to the moderate ability group, while the other groups remained as defined in the baseline scenario. In the second scenario (scenario 2), students with over 12 months of virtual internship, initially considered to have a high ability to infer about the quality of the internships, were elevated to the very high ability group, while the other groups remained as defined in the baseline scenario. Table 18 displays the results obtained for the sensitivity analysis.

Table 18. Sensitivity analysis considering changes in the respondents' ability to infer about the quality of the virtual internships.

Item	Baseline Scenario			Scenario 1			Scenario 2		
	E	R	U	E	R	U	E	R	U
IT1	0.661	0.771	0.339	0.653	0.775	0.347	0.654	0.768	0.346
IT2	0.867	0.706	0.133	0.865	0.703	0.135	0.865	0.702	0.135
IT3	0.832	0.709	0.168	0.824	0.711	0.176	0.830	0.706	0.170
IT4	0.688	0.725	0.312	0.687	0.724	0.313	0.683	0.720	0.317
IT5	0.716	0.720	0.284	0.710	0.716	0.290	0.711	0.716	0.289
IT6	0.736	0.704	0.264	0.737	0.705	0.263	0.731	0.700	0.269
IT7	0.817	0.708	0.183	0.807	0.710	0.193	0.817	0.703	0.183
IT8	0.837	0.704	0.163	0.828	0.702	0.172	0.831	0.700	0.169

Note: E (excellent), R (regular) and U (unacceptable).

The results of the sensitivity analysis highlight the robustness of the findings, as there were no changes in the allocation classes for the alternatives.

The findings suggest a greater focus from companies on three important aspects for the development of students and, consequently, the company itself. To enable students to apply, gain a better understanding, and delve deeper into specific topics learned during their undergraduate course (IT1), companies can design experiential projects. These projects should be tailored to align with students' academic backgrounds and interests, allowing them to bridge theoretical knowledge with practical scenarios. This approach not only reinforces classroom learning but also empowers students to delve deeper into subjects of personal relevance.

Another strategy to improve IT1 is to assign experienced professionals as project mentors can provide invaluable guidance to students. Mentors can offer insights, suggest relevant resources, and facilitate discussions that encourage students to explore and apply concepts in real-world contexts. This mentorship relationship not only enriches students' understanding but also nurtures their ability to navigate complex topics. This is related to IT6, IT7, and IT8, which were classified as "excellent", suggesting that companies can use this to enhance IT1.

Regarding IT4 ("virtual internship offered me a better understanding about how an organization works"), companies can involve virtual interns in cross-departmental collaborations. Interns can contribute to projects that require interactions with various departments, offering them insights into the interconnectedness of different functions within the organization. This exposure helps students grasp how their roles contribute to the larger organizational framework.

Another potential improvement action for IT4 is conducting virtual workshops that illustrate the organization's structure, processes, and interdependencies. These workshops can include presentations from department heads, virtual tours of various divisions, and interactive sessions that allow students to ask questions. Such initiatives enable students to gain a holistic understanding of the organization's operations.

Considering IT5 ("virtual internship improved my understanding of market dynamics"), hosting virtual webinars and talks featuring industry experts can expose students to the intricacies of market dynamics. Experts can discuss topics such as competition among companies, the impact of economic variables on the industry, and emerging trends. These sessions provide a platform for students to broaden their perspective and gain insights into real-world market scenarios.

Another strategy is assigning market analysis projects to virtual interns aiming to actively engage them in studying market dynamics. By analyzing industry trends, competitors, and economic indicators, students can develop a deeper understanding of how market forces influence a company's strategies and performance. This firsthand experience enhances their ability to navigate the complexities of market dynamics.

Enhancing virtual internships to cater to students' needs for practical application, deeper comprehension, and insight into organizational and market dynamics requires a multifaceted approach. By integrating experiential projects, mentorship, cross-departmental involvement, organizational workshops, industry talks, and market analysis projects, companies can create a holistic and enriching virtual internship experience. These strategies bridge the gap between theoretical learning and practical implementation, ensuring that students derive maximum benefit from their virtual internship opportunities and are well-prepared to contribute effectively to the professional world.

The improvements in IT1, IT4, and IT5 are aligned with aspects highlighted in the academic literature, where it is argued that internships, regardless of their modality, constitute a unique and crucial stage in students' development. After years of classroom learning, students are exposed to the real world in the workplace and are expected to put into practice concepts or theoretical examples learned during their undergraduate studies [3,5,6].

In general, while IT1 is related to actions aimed at bringing internship activities closer to the content learned during undergraduate studies, IT4 and IT5 are associated with students gaining insights into the reality of a company. IT4 focuses more on internal aspects, while IT5 pertains to external aspects of the organization. The results presented in this study can be valuable for internship supervisors in companies and higher education institutions, enabling them to guide students during this pivotal phase of learning and personal and professional development that will impact their entire careers.

4.2. Developing a Procedure to Assess Virtual Internships Using Fuzzy TOPSIS Class

In addition to providing insights into potential actions for the enhancement of virtual internships, it was also considered that this study could offer a methodological contribution to the field. The logic employed here can be replicated to consider specific groups of interns, aiming to understand the characteristics of their developmental experiences. Furthermore, this methodology could be applied for analysis in other countries, enabling subsequent comparative studies and the dissemination of best practices. In this way, a procedure was formalized (Figure 2) advocating for the Fuzzy TOPSIS Class method as a significant tool for generating consolidated information that can support improvements in internship activities and even broader discussions.

Fuzzy methods have emerged as valuable tools in situations characterized by sparse or limited information [23,34]. In such scenarios, traditional crisp methods may struggle to provide accurate insights due to the inherent ambiguity and imprecision present in the data. Fuzzy logic, with its ability to handle uncertainty and vagueness, offers a robust approach to decision-making and analysis [35]. This becomes particularly pertinent when examining virtual experiences, such as internships and work, where the nature of interactions, performance evaluations, and skill development may not be fully captured by conventional crisp methods.

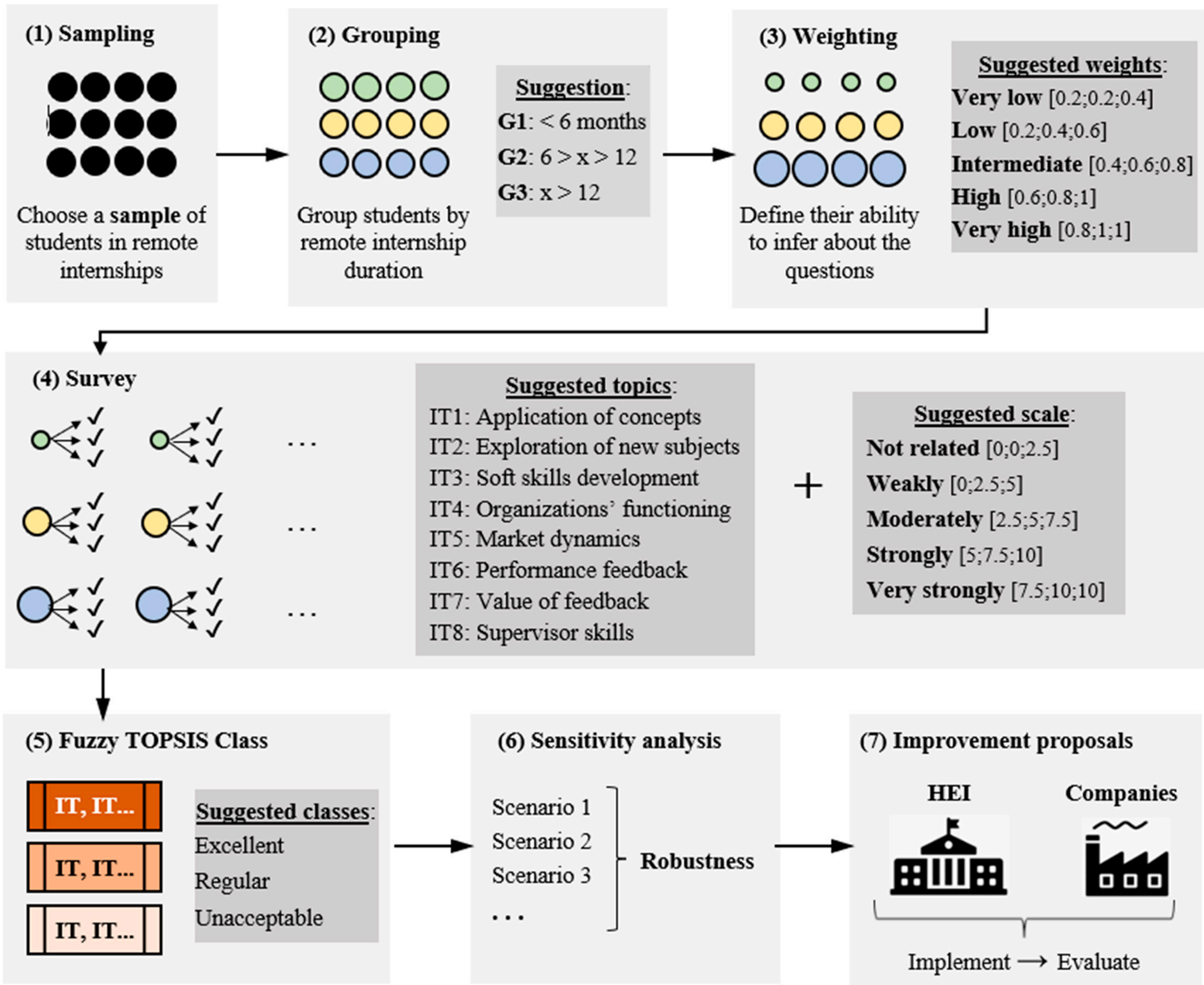

Figure 2. Procedure to assess remote internships. Source: Authors.

Uncertainty is an inherent characteristic of real-world data, often stemming from various sources such as measurement errors, subjective judgments, or incomplete observations [36]. Fuzzy methods excel in situations where uncertainty is pervasive, as they allow for the representation and manipulation of vague or partially known information [37]. As the context of virtual experiences introduces additional layers of uncertainty, such as the diverse array of virtual interactions and evolving virtual work dynamics, employing fuzzy methods becomes paramount. By embracing fuzziness, researchers can effectively model the intricacies of virtual learning, internships, and work, accounting for the uncertainty associated with the data generated in these contexts.

When delving into the realm of virtual experiences, deepening our understanding is crucial for informed decision-making and effective policy implementation. Fuzzy methods provide a framework to comprehensively capture the nuanced nature of virtual interactions, enabling researchers to uncover valuable insights that may remain concealed by traditional crisp approaches. By utilizing fuzzy logic, researchers can navigate the complexity of virtual experiences, shedding light on the multifaceted aspects of internships and work conducted in virtual settings.

Furthermore, extending research efforts to different contexts holds immense potential for uncovering how socioeconomic and cultural factors intersect with virtual learning and activities. Replicating studies across diverse settings enables us to discern the impact of varying cultural norms, economic conditions, and technological infrastructure on the efficacy of virtual experiences. Fuzzy methods offer the flexibility needed to accommodate the intricacies of different contexts, facilitating cross-context comparisons that can inform the development of adaptable strategies for virtual learning and internships. By embracing fuzziness and conducting cross-context research, we pave the way for a more comprehensive understanding of virtual experiences, leading to tailored approaches that optimize their outcomes in various socio-cultural environments.

5. Conclusions

Internships serve as pivotal junctures in the developmental journey of students, bridging the gap between academic learning and real-world application. As conduits of experiential learning, internships provide a unique opportunity for students to transition from the controlled confines of the classroom into the dynamic realm of the professional workforce. With the evolving landscape catalyzed by the global pandemic, the adoption of virtual internships has surged, ushering in a paradigm shift in the way students engage with practical learning experiences.

In the context of Brazilian organizations, the proliferation of virtual internships has gained momentum, driven by the imperatives of the pandemic and sustained by the advantages it offers. This burgeoning trend underscores the need to holistically understand the quality of virtual internships and their impact on students' learning and skill acquisition. This research endeavors to illuminate this domain by delving into students' perceptions of the quality of virtual internships within Brazilian organizational settings.

The focal points identified by students for enhancing virtual internships encompass pivotal aspects that resonate within both higher education institutions and corporate entities. The findings emphasize the importance of companies focusing on key aspects to enhance students' development and the company's growth. To improve students' application of knowledge, tailored experiential projects aligning with their backgrounds should be designed, facilitated by experienced mentors for guidance. Additionally, involving interns in cross-departmental collaborations and conducting virtual workshops can enhance understanding of organizational functioning. To augment comprehension of market dynamics, hosting expert webinars and assigning market analysis projects are effective strategies, enabling students to gain practical insights and navigate real-world scenarios.

This study extends its contribution beyond the realm of empirical investigation. Methodologically, it introduces a novel procedure utilizing a multicriteria decision-making framework to assess virtual internships. By incorporating the tenets of fuzziness, this methodology strives to capture the inherent vagueness and complexity that characterize the multifaceted landscape of virtual internships.

The implications of this research ripple beyond the confines of academia. The outcomes bear relevance for internship supervisors within companies and higher education institutions alike, empowering them with actionable insights to guide students through a transformative phase of learning and personal growth. As students navigate the formative stages of their careers, the repercussions of this research resonate in shaping the trajectory of their professional journey.

While this study provides valuable insights into students' perceptions of virtual internships in Brazilian organizations, certain limitations warrant consideration. Firstly, the research is confined to a specific geographical context, namely Brazilian organizations, which may limit the generalizability of the findings to other cultural and socioeconomic settings. Additionally, the study focuses on students' self-reported perceptions, which may introduce potential for response bias or subjectivity. The reliance on a survey-based approach also restricts the depth of qualitative exploration that could provide richer insights into the nuances of students' experiences. Furthermore, the research primarily emphasizes students' perspectives, and future studies could benefit from incorporating the viewpoints of internship supervisors and organizational representatives.

To address these limitations and further contribute to the field, future research could adopt a comparative cross-cultural approach, exploring how students' perceptions of virtual internships vary across different countries and contexts. This could shed light on the role of cultural factors and socioeconomic influences in shaping internships' effectiveness. Employing mixed-methods research designs, such as combining surveys with in-depth interviews or focus groups, could provide a more comprehensive understanding of students' experiences and shed light on underlying factors driving their perceptions. Additionally, investigating the long-term impacts of virtual internships on students' career trajectories and professional development would offer valuable insights into the lasting effects of such experiences. Furthermore, examining the role of technology and its influence on virtual internship experiences could provide a deeper understanding of how digital platforms shape communication, collaboration, and skill development. Overall, future research endeavors should aim to extend the scope and depth of inquiry to provide a comprehensive understanding of the multifaceted dynamics surrounding virtual internships and their implications for both students and organizations.

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