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SHORT PAPER

Industrial Engineering Student Competency Mediation Model: Analysis from the Perspective of Educational Psychology

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ABSTRACT

This paper proposes a new managerial skill called contextual search, which is the ability to study the national and international socio-economic reality and which is the basis for decision making and planning. Therefore, the objective of this study is to analyze the predictive influence between contextual research, decision making, and planning skills in Industrial Engineering students of a private university in Lima, Peru. The sample included 150 students pursuing an industrial engineering career: 84 men (56%) and 66 women (44%). The age of the participants ranged from 16 to 31 years (mean age 19.77; standard deviation 4.50). The results showed that all three skills were significantly related and predicted simultaneously. Nevertheless, it identified that the decision-making skill mediates the predictive relationship between context finding and planning. Thus, it is understood that future industrial engineers can plan well if they have previously developed the context-finding and decision-making skills.

1 INTRODUCTION

Since the 1980s, competency-based education (CBE) has been promoted. By 2004, CBE had been implemented in only 175 universities in Europe, with the aim of optimizing teaching quality [1]. This pedagogical approach directs the academic program toward the development of effective professionals in the field of work [2]. Moreover, in Peru, CBE has been implemented with the support of the national system of educational evaluation and accreditation (in Spanish "Sistema Nacional de Evaluación y Acreditación de la Calidad Educativa" or SINEACE) [3], guaranteeing compliance with the current University Law (Law No. 30220) [4]. However, it cannot be denied that the EBC has been implemented with a greater emphasis on the most-in-demand careers, including industrial engineering. In Peru, this professional

career has grown significantly since 1996 [5]. For example, in 2018, industrial engineering ranked among the most-in-demand occupations, being chosen by 20.5% of students over the age of 17 [6]. In the framework of career development, in 2021 in Peru, industrial engineers were considered competent professionals called to boost the economy of companies and support health programs [7]. For these reasons, in 2022, in the city of Lima (the capital of Peru), it is one of the most attractive careers for young people [8], who peraue technical studies favoring the industrial sector [9].

1.1 The skills of industrial engineers in the context of COVID-19

According to CBE, universities develop curricula to produce effective professionals who apply their knowledge, being able to "know" and "do" [1]. Thus, in engineering careers, skilled professionals are trained to apply their knowledge in the new-industries sector [10]. However, due to the pandemic, in Peru, there is now a need to train industrial engineers who demonstrate skills such as creativity, collaborative work, digital skills, self-learning, communication, self-motivation, problem solving [11], informed decision making, versatility, analytic vision, planning, etc. [12]. Among these competencies, the present study focuses on the managerial competencies of decision making and planning, but a new competency called contextual search is proposed.

The management competency *contextual research* is proposed for several reasons. One reason is the change that the pandemic has generated in the industrial sector, where there is a demand for engineers who can ensure the operability and efficiency of the company [11]. This shows how the context influences organizational performance [13] and human resource management in the face of new demands [14]. The second reason is that it is necessary for engineers to study contexts in order to contribute to organizational performance. In this sense, since the last decade, in the context of Industry 4.0, there has been a demand to develop interdisciplinary strategies for research [15]. This has allowed the study of context, which had been neglected in business research, to receive more attention in management [16]. The third reason is that university education has begun to pay attention to context in knowledge production through research programs aimed at improving the quality of professional performance [5]. The fourth reason is that there is a lack of research on the impact of context on business [17]; but contexts are known to test business resilience [13]. According to these arguments, context research is proposed as the skill related to the socio-economic study of the national and international environment for effective business management. Thus, by studying context, future industrial engineers will understand the global impact of proposed solutions [10] and ensure business resilience [13] by strengthening and preserving critical human resources [14].

This new managerial competence would be the basis for decision making and planning. And in the context of competence-based management, it would contribute to organizational performance [18]. Furthermore, in the context of digitalization, it is urgent that engineers study the context of the market and the globalized economy to optimize their work [19]. Moreover, research contributes to decision making and competitive advantage [20]. *Decision making* is the second managerial skill of interest in this study. It consists of the ability to choose based on organizational goals [21]. This can be achieved in universities by applying strategies that guarantee the quality of the decision-making process; thus, students take into account the dynamism of the organizational context (moving away from their personal interests) [22]. In addition, the third managerial skill to be studied is "*planning*" Planning allows obtaining optimal results in the performance of the company [18]. This competency requires

knowledge of organizational goals in order for engineers to decide on and execute future initiatives [23]. This promotes the formation of professional leadership and the positioning of the company [18].

1.2 Post–COVID-19 industrial engineering career curriculum

Faced with the challenges of the post-pandemic, engineers must be trained in problem solving. They must take into account the technological development and the dynamics of the new global market [24]. To do this, future engineers must develop the traditional skills of mathematics, computer science, and additional skills [25]. But they must also cultivate decision making, planning, and contextual research skills. These skills will enable future industrial engineers to be entrepreneurs [12], to feel capable of building businesses, and to foster employability [26]. Among these skills, the proposed context research competency can be developed through research, national reality, and history courses, which are often replaced by specialty courses. The development of this competence is possible in the Peruvian context because the current university law requires that universities innovate in curriculum proposals according to national and international demands [4]. This makes sense, as social changes make it difficult for universities to have stable curricula, mainly in engineering [24]. Thus, by innovating curricula in the post-pandemic, industrial engineers will be able to lead companies with an innovative vision, understanding the context and deciding quickly in the productive sector [7].

In Peru, SINEACE ensures that universities implement curricula that develop research, innovation, and technology [3]. These curricula aim to train professionals with general and specialized skills [5]. Engineers are even trained through virtual educational programs [27]. To this end, introductory courses are set up to develop basic cognitive skills [25], professional skills [5], cross-cutting skills such as digital skills [28], planning, decision–making, and leadership [12]—skills that, in the post-pandemic context, engineering students continue to develop through hands-on activities [29].

1.3 Main contributions

In summary, for future industrial engineers, it is necessary to form professional skills that allow them to meet a set of challenges of this digital era [27], technological advances and permanent competitiveness [19]. Therefore, the present study aims to analyze the predictive influence between the contextual skills of research, decision–making, and planning among industrial engineering students in a private university in Lima (Peru).

This paper is organized as follows. The methodological aspects of this study are described in Section 2., the main results are presented in Section 3, and a discussion is provided in Section 4.

2 MATERIALS AND METHODS

The present research is developed according to the quantitative-correlational predictive methodology, in which a mediation model was tested [30]. In addition, the managerial skill context search was proposed as an input variable, decision making as a mediating variable, and planning as an output variable. This tested the study of context as a core competency of classical managerial skills such as planning and decision making.

2.1   Participants

A sample calculation was performed for finite populations, with a 95% confidence level and a 5% margin of error in a population of 242 students. Therefore, it was decided to survey 150 industrial engineering students. Of this total, 84 were male (56%) and 66 were female (44%). The age of the participants ranged from 16 to 31 (Mean = 19.77; Standard deviation [SD] = 4.50).

2.2   Instruments

The self-perceived competence scale here assesses managerial skills. It consists of 12 items: 4 for contextual search, 4 for decision making and 4 for planning, with response options on the 7-dimensional Likert scale (1 = totally disagree to 7 = totally agree). In the first stage, the scale was validated by expert judgment [31] by three teachers specialized in engineering, university education, and psychology. In the second step, statistical validity and reliability were analyzed. Table 1 shows that validity using exploratory factor analysis (EFA) and the Kaiser-Meyer-Olkin (KMO) test was 0.89, showing optimal validity levels when above 0.50 [32]. In addition, reliability analysis with Cronbach's Alpha confirmed acceptable levels of reliability for each of the subscales (context finding, decision making, and planning) [33]. In other words, Cronbach's Alpha had acceptable values, above 0.70 but below 0.90, which means that there was no redundancy or duplication of items [34, 35]. In addition, the item-total correlation shows values above 0.30, confirming that the subscales are reliable [33].

Table 1. Validity and reliability of the instrument

Optimal Values	Validity		Reliability	
	KMO	Bartlett's Test	Cronbach	Item-Total
	≥ 0.50	$p < 0.05$	≥ 0.70	≥ 0.30
Context research			0.76	0.46–0.67
Decision making	0.89	0.000	0.72	0.32–0.71
Planning			0.80	0.41–0.55

Note: The validity was analyzed by EFA, and it was observed that the Kaiser-Meyer-Olkin sample adjustment test (KMO) was 0.89, Bartlett's Sphericity Test was significant ($\chi^2 = 1221.700$, df = 210, $p < 0.001$). And the Cronbach's alpha and total item values show excellent levels of reliability.

2.3   Ethical procedures

Our study was coordinated with the industrial engineering career director. The self-perceived competence scale was applied, respecting the criteria of ethical research [36]. The anonymity of the participants was preserved in accordance with the Personal Data Protection Act (No. 29733) [37]. Regarding the participants considered minors in Peru (16 and 17 years old), their participation was accepted according to the Civil Code of Children and Adolescents (No. 27337), which establishes that they are autonomous decision makers to participate by providing information in the surveys [38]. In this way, the data obtained were used only for the purposes of the study.

3 MAIN RESULTS

3.1 Relations between variables

Relationships between variables were analyzed according to Pearson's r, assuming Cohen correlation criteria [39] for social studies (light, $r = 0.10–0.23$; moderate, $r = 0.24–0.36$; strong, $r = 0.37$ or more). The results showed that for context research, decision – making, and planning (see Table 2). The context research was significantly related to decision making ($r = 0.31$***) and planning ($r = 0.39$***). In addition, decision making was significantly related to planning ($r = 0.42$***).

Table 2. Relationship between the three variables

	Variables	Mean	SD	1	2
1	Research context	5.74	1.20		
2	Decision making	5.25	1.03	0.31***	
3	Planning	5.17	0.97	0.39***	0.42***

Note: *, **, *** show significant relationships: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ (bilateral).

3.2 Linear regression

By identifying significant relationships, multiple linear regression analysis was performed to estimate the predictive value between the variables under study [30]. Thus, multiple linear regression analysis provides beta coefficients (β), which unlike the correlation coefficients (r) that represent the association between variables, explain how one variable anticipates the presence of another variable. Thus, Table 3 shows that context search (β = 0.31***, $p < 0.001$) predicts decision making and explains 11% of the variance ($R^2 = 0.11$). Context search (β = 0.39***, $p < 0.001$) predicts planning and explains 19% of the variance ($R^2 = 0.19$). Decision making (β = 0.42***, $p < 0.001$) predicts planning and explains 21% of the variance ($R^2 = 0.21$). The linear regression analyses show that there is a predictive sequence between the skills and further confirm that they are related to each other and simultaneously have the potential to be part of a mediation model.

Table 3. Linear regressions predicting managerial skills

Predictor Variable	Output Variable	
Context research	Decision making	
	$R^2 = 0.11$	β = 0.31***
Decision making	Planning	
	$R^2 = 0.21$	β = 0.42***
Context research	Planning	
	$R^2 = 0.19$	β = 0.39***

Note: β is the prediction coefficient. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

3.3 Mediation model

Figure 1 aims to analyze the mediation model, where Baron and Kenny's [40] steps were used. According to this model, it is stated that context search is influenced by decision making to predict the planning variable. The mediation model between context search, decision making and planning, confirmed with Sobel's Test [41] (statistic test = 3.25; standard error = 0.04; $p < 0.01$) that the effect of context search (predictor variable) on planning (dependent variable) decreases (from $\beta = 0.39^{***}$ to $\beta = 0.30^{***}$). Indicating that context search predicts planning when it is mediated for decision making (mediating variable). This means that industrial engineering students should study context as a basis for making decisions and thus be able to plan effectively.
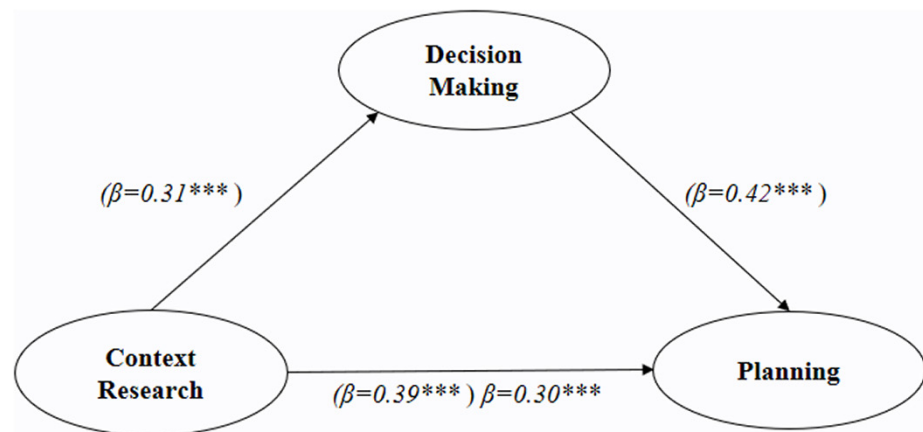

Fig. 1. The model confirms the mediation of decision making between context search and planning. We observe that the first beta coefficient for context search is 0.39***, but when mediated by decision–making. it is reduced to 0.30***

Note: *** indicates significant predictions (***$p < .001$).

4 DISCUSSION

The objective of the study was to analyze the predictive influence between the skills of contextual search, decision–making, and planning by industrial engineering students of a private university in Lima, Peru. According to this objective, it is evident that the skills are positively related, showing that the development of one is associated with the increase of another and vice versa. This confirms Tripathi's studies, which found that knowledge of the environment promotes a forward-looking vision. This is the essence of decision making [18]. This also confirms the studies of Hitt, who states that decision making sets the future actions of an organization [20]. Also, the results are supported by the studies of Steyn, who considers planning to be essential for achieving organizational goals [23]. In addition, the contextual search skill can be considered appropriate as a proposition. However, although the analyses identify significant relationships, this may be due to the fact that these skills are inherent to each other. Furthermore, it is assumed that context always influences organizational performance [13]. This leads to the need to confirm the results in different samples or with different research methodologies.

Second, the analysis of the mediation model [32] shows that context research is essential for future decisions in business planning. It turns out to be the basis for decision making and planning. This explains why, for industrial engineers, it is

important to understand the national and international context to make strategic decisions [20]. Moreover, decision making naturally influences planning competence. Thus, the development of these skills will contribute to the achievement of institutional goals [25]. This invites reflection in view of the scarcity of research on the impact of context in business [17]. This generates the need to train professionals with research skills [5], based on topics oriented towards knowledge of national and international reality.

In the post-pandemic context, industrial engineers will lead companies with new production approaches [7]. This is related to the mediation model, because to achieve this leadership in the post-pandemic context, they must study the context before planning. Therefore, it should be emphasized that planning skills will be effective if the industrial engineer is able to study the context, reflect on it, and make decisions with this more objective view. Furthermore, this helps to understand why some engineers who study the socio-economic reality in detail do not plan effectively, because they lack the ability to decide objectively. Or, conversely, engineers who make quick decisions without considering contextual changes are detrimental to business performance. Finally, it is clear that these three skills must be developed to ensure an optimal profile for industrial engineers. On the other hand, the need to implement university program proposals for the training of general and specialized skills is reaffirmed [4], but university program proposals that train specialized professionals are criticized [5].

5   CONCLUSIONS

In conclusion, this article has highlighted that the contextual search skill (as proposed) is essential for effective decision making and planning. Furthermore, all three skills are predictive of each other. Nevertheless, the decision-making skill requires contextual search in order to plan. Therefore, it can be concluded that future industrial engineers can plan effectively if they study the socio-economic reality and make decisions based on this knowledge. However, this study reaffirms the need to develop university programs with core training topics such as research or national and international reality, thus forming reflective skills in future professionals. Finally, this study needs to be complemented by researching samples other than from the city of Lima (Peru); therefore, it is suggested that the sample and research techniques be expanded to obtain broader findings.

6   ACKNOWLEDGMENTS

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