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# The Influence of Knowledge Management on the Attitudes and Perceptions of Graduate Students Toward Learning at a Public University According to the Knowledge Spiral

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**ABSTRACT**

The objective of this research was to demonstrate the influence of knowledge management on the attitudes and perceptions toward learning among students enrolled in an Industrial Engineering doctoral program of a public university. The study follows the knowledge spiral model and adopts an applied and quantitative approach with a quasi-experimental, explanatory design. The sample consists of all the doctoral students enrolled in the program, and the study uses a census sample of 22 students. Although two specific hypotheses presented negative results, the study finds that the attitudes and perceptions of students toward the combination and internalization of knowledge have exceeded expectations, albeit with a lower baseline than initially proposed. However, the study suggests that there is still room for improvement in knowledge management practices.

**Keywords:** knowledge management, learning, combination, internalization, baseline.

## INTRODUCTION

In educational institutions, it is crucial to accumulate knowledge, especially when involving scientific research. Universities are the major source of knowledge production, and this generation must make the most of it by not only disseminating knowledge but also by strategically accumulating and sharing it with the academic-scientific community. This is supported by Medina et al. (2020): *La necesidad no solo de crear sino de compartir el conocimiento generado en las universidades, como entidades fundamentales en este accionar y transformadoras de procesos sociales, económicos, políticos y culturales, se ha convertido actualmente en una realidad imperiosa* [there is an urgent need to create and share knowledge produced in universities, as entities for transforming social, economic, political, and cultural processes, to meet the demands of modern times] (p.43).

Universities, whether public or private, are institutions that generate knowledge. This is especially true when it comes to graduate units, where students have accumulated knowledge not only from their professional experience but also from their undergraduate education (Castellanos et al., 2021). In the context of a doctoral program, students share their experiences and learn from the case studies presented by professors throughout their academic programs. However, this knowledge is often tacit and is lost at the end of the semester when students leave the classroom, as it has not been combined with the explicit knowledge taught during coursework. This results in new students missing out on a valuable source of knowledge that would aid in their learning. If this situation persists in the classroom, a knowledge gap may arise, leading to lower expectations and a struggle to acquire new knowledge.

When it comes to an educational system that has appropriate management indicators, it is reasonable to expect that the managers of the organizations that make up such an educational system would invest their resources in creating knowledge (Nonaka

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& Takeuchi, 1995). Such knowledge can then be effectively managed to attain optimal levels of learning for their customers, i.e., the students who are part of these educational organizations (Medina et al., 2020). Therefore, the application of models that focus on knowledge management is justified. Specifically, the knowledge spiral developed by Japanese researchers I. Nonaka and H. Takeuchi considered in this study. This model emphasizes the connection between tacit and explicit knowledge, and how they interact to generate a knowledge spiral. Thus, the purpose of this research is to demonstrate the influence that knowledge management has on the attitudes and perceptions of learning of students in a doctoral program at a public university. To achieve this goal, the following hypotheses have been proposed:

- Knowledge management has a significant influence on the attitudes and perceptions toward organizational culture among the students of the Industrial Engineering doctoral program of the graduate unit of a public university, based on Nonaka and Takeuchi's model.
- Knowledge management has a significant influence on the attitudes and perceptions toward socialization among the students of the Industrial Engineering doctoral program of the graduate unit of a public university, based on Nonaka and Takeuchi's model.
- Knowledge management has a significant influence on the attitudes and perceptions toward externalization among the students of the Industrial Engineering doctoral program of the graduate unit of a public university, based on Nonaka and Takeuchi's model.
- Knowledge management has a significant influence on the attitudes and perceptions toward knowledge combination among the students of the Industrial Engineering doctoral program of the graduate unit of a public university, based on Nonaka and Takeuchi's model.
- Knowledge management has a significant influence on the attitudes and perceptions toward internalization among the students of the Industrial Engineering doctoral program of the graduate unit of a public university, based on Nonaka and Takeuchi's model.
- Knowledge management has a significant influence on the attitudes and perceptions toward information and communication technologies among the students of the Industrial Engineering doctoral program of the graduate unit of a public university, based on Nonaka and Takeuchi's model.

**Knowledge**

Throughout history, human beings have consistently sought to learn about different aspects of life and various events that occur during their stay on this planet. As a result, knowledge has become a crucial element of learning that is essential for the development of mankind. In this regard, Mendoza and Solíz (2022) state that *El conocimiento es una facultad y aptitud que se utiliza al pensar, consiste en la interacción de un individuo con la realidad a través de sus sentidos, esta información la procesa con el objetivo de utilizarla después* [knowledge is a faculty and aptitude that is used when thinking; it consists of an individual's interaction with reality through their senses, and this information is processed to be used later] (p.85). This highlights the importance of knowledge in achieving the high levels of technology that we have today. Additionally, while it is natural to share knowledge, it is equally important to understand how to manage it effectively.

**Knowledge Creation and the Knowledge Spiral**

Nonaka and Takeuchi (1995) propose two dimensions for the creation or generation of knowledge: epistemological and ontological. The former deals with the nature of knowledge, which is categorized into tacit and explicit knowledge. The latter expresses the creation of knowledge in an individual context, which then moves to an organizational context, passing through the group and even reaching the inter-organizational level.

In terms of the Epistemological dimension, the nature of knowledge plays a crucial role in the creation of knowledge. According to Nonaka and Takeuchi (1995), there are two forms of knowledge, tacit and explicit. To define tacit knowledge, it is necessary to understand how human beings acquire knowledge through their own experience, as tacit knowledge is generated by taking into account experience, which is a natural subjective knowledge (Villasana et al., 2021). On the other hand, explicit knowledge is based on facts and theories and can be codified, copied, and disseminated more easily to others (Villasana et al., 2021). The interaction between tacit knowledge and explicit knowledge is reflected in the knowledge spiral model, which uses the epistemological dimension as a reference point.

According to Nonaka and Takeuchi (1995), the ontological dimension is relevant in the creation of

knowledge. The knowledge related to an organization starts from an individual and then progresses through the group, organizational, and inter-organizational levels, leading to the solidification of the organization's knowledge. Castellanos et al. (2021) reinforce this notion by stating that social knowledge can transform individual knowledge into optimal results by systematizing knowledge into files, portfolios, procedures, practices, techniques, processes, and rules.

This study employs the knowledge spiral model, which is based on a cyclical scheme of knowledge production comprising four key moments: Socialization, Externalization, Combination, and Internalization. This cycle generates a chain of articulation between the respective cycles, allowing adequate learning levels for the organization's individuals (Nonaka & Takeuchi, 1995).

**Knowledge Management**

Business organizations, particularly those in the education sector, establish their leadership by utilizing a crucial element: knowledge management. Proper management involves efficiently handling all the resources and factors involved in the educational process, with the primary goal of ensuring student satisfaction through effective learning and retention of knowledge (Grützner, 2019). This is where knowledge management plays a significant role in promoting educational innovation in institutions by facilitating optimal administration of resources such as human capital, technology, and working capital, among others. This allows for the creation of added value in the teaching-learning process, emphasizing knowledge and fulfilling the primary objective of every higher education institution (Rodríguez & Zerpa, 2019).

Effective knowledge management is crucial for the proper administration of resources and factors. It also involves capturing, creating, and sharing knowledge at individual, group, organizational, and even inter-organizational levels. Educational institutions can benefit from implementing knowledge management models, which help convert tacit knowledge into explicit knowledge. This, in turn, positions these institutions as leaders not only in education but also in their respective commercial sectors of development (Medina et al., 2020).

**Learning**

It is the primary responsibility of a teacher to ensure that their students acquire knowledge and skills in the classroom. However, the students' retention of the information they have learned is equally important. This is because it guarantees the effectiveness of the pedagogical work done in the classroom. Moreover, learning enables individuals or groups of individuals to acquire knowledge and skills that can lead to changes in their behavior, thinking, and emotions (Grützner, 2019).

**Attitudes and Perceptions Toward Learning**

The education sector's academic literature suggests that most people believe attitudes and perceptions play a significant role in learning. As learners, people have tested the impact of their feelings about the teacher, classmates, their abilities, and the assigned tasks on their learning. Positive attitudes and perceptions optimize learning, while negative ones have the opposite effect. Therefore, it is the responsibility of both the teacher and the student to maintain positive attitudes and perceptions, or to change negative ones when necessary (Marzano & Pickering, 2005). Regarding this variable, the student must be motivated about the topic to be addressed. Attitudes and perceptions directly affect the students' learning; if they do not feel confident, there is a probability that they will not learn effectively. Therefore, motivation is a fundamental element for student learning in all scenarios; the best learning scenario will be one where knowledge is managed (Alas & Álvarez, 2020).

**Attitudes and Perceptions Toward Socialization**

In the first phase of knowledge conversion, tacit knowledge is acquired by individuals through various forms of experience sharing. This can also happen when trainees observe and imitate their teachers. Such knowledge is acquired when people participate in directed workshops, team training, or by paying attention to a master class given by an expert (Demuner, 2021). Socialization is crucial not only because it marks the beginning of the knowledge conversion process, but also because it enables teams to learn how to make decisions that lead to better results in the organizational sectors where the knowledge spiral model is applied (Linares et al., 2014).

**Attitudes and Perceptions Toward Externalization**

During the second phase of the knowledge conversion process, tacit knowledge is transformed into explicit knowledge. To achieve this, individuals engage in reflective analysis, collectively creating analogies, metaphors, diagrams, or models that allow them to codify knowledge into various documents or videos (Grützner, 2019). This process

begins with interactions between the actors of an organization, which generates models and enables them to share knowledge. The ultimate goal is to obtain explicit conceptualizations that are then validated so that individuals can understand not only the form but also the substance of the content of the processed information. This information then becomes reference material (Demuner, 2021).

**Attitudes and Perceptions Toward Combination**

Although the previous stages are significant, the combination of those stages is equally important. It is at this point that new explicit knowledge is generated through the application of the previous knowledge. Therefore, up to this point, the achieved knowledge has not been properly categorized, even though it has been placed in models that can be appropriately located in a knowledge context (Grützner, 2019).

First, this explicit knowledge must be classified, to do so, it is essential to use appropriate techniques such as compilation and synthesis. Subsequently, this information undergoes analysis and is subjected to feedback among the members of the organization based on the established levels and departmental areas. Finally, the obtained knowledge is documented so that it can be reviewed and authorized whenever required (Demuner, 2021).

**Attitudes and Perceptions Toward Internalization**

During the process of knowledge conversion, explicit knowledge obtained is transformed into tacit knowledge. This conversion takes place from the explicit knowledge of the organization and is extended to the tacit knowledge of each individual. Therefore, each person needs to experience this explicit knowledge through personal activities, such as “learning by doing”, which generates knowledge acquisition and personal motivation (Demuner, 2021). Generally, in this phase, knowledge retention is achieved through the application of what has been learned to see its effectiveness in the process of knowledge conversion. This phase is not only the culmination of the conversion process but also the beginning of a new cycle of the knowledge spiral, from the internalized tacit knowledge that serves as something new to learn and improve (Grützner, 2019).

**Attitudes and Perceptions Toward Organizational Culture**

Organizations, whether they are public or private, develop unique customs and values over time. These customs and values, combined with the contributions of their collaborators, contribute to the formation of their own distinctive organizational culture. Educational institutions, for instance, have both collaborators (administrative staff and teachers) and customers (students). The customs and values of these institutions and their members result in a highly unique organizational culture that sets them apart from other institutions (Yopan et al., 2020). More specifically, the social practices that exist within educational institutions (values and customs) are also present in the classroom, where the exchange of knowledge between teachers and students helps to create a distinct organizational culture (Rivera et al., 2018).

**Attitudes and Perceptions Toward Information and Communications Technologies**

Keeping up with the latest developments in information and communication technologies has become increasingly important for organizations and educational institutions. This is more noticeable and significant when virtual classes are just as effective as face-to-face classes. According to various studies, the use of information and communication technologies in education is becoming an essential part of the learning process, especially at the university level (Azañedo, 2022). In this study, professors’ use of information and communication technologies is an interesting contribution to knowledge management, which can lead to better learning outcomes for students. This discussion originated from the use of learning and knowledge technologies (Moya, 2013).

## METHODOLOGY

The research follows a quantitative approach using an experimental design in the quasi-experimental classification. Knowledge management is taken as an independent variable based on the knowledge spiral, while attitudes and perceptions toward learning are considered dependent variables. The quasi-experimental design was chosen to ensure at least internal validity, and the subjects or groups were formed before the experiment (Vara, 2007). In this research, the design with posttest only and intact groups was considered, which includes an experimental and a control group. However, since there is no control group in this study, it is called “design with an experimental group and posttest only”. This is a limiting factor that will be explained later regarding the sampling selection (Hernández et al., 2006).

For this study, a control group was not available, so a comparative baseline was established by the researcher. The baseline had a 75% success rate (quartile 3). For instance, if one of the variables had a response range of 0 to 100 points, the hypothesis test would assume that the sum of all the answers related to that variable in each survey is equal to or greater than the 75th percentile (quartile 3), which is equivalent to 75 out of 100 points. This was based on the results obtained from the research instrument.

The students of the doctoral program in technological and knowledge management, at the postgraduate unit of a public university, were the unit of analysis. The population that was studied consisted of students enrolled in the course "Management of Technological Innovation in Industrial Processes" of the doctoral program. An infinite population was considered since new students will enroll every academic semester.

The sample was comprised of the students enrolled in the course "Management of Technological Innovation in Industrial Processes" of the doctoral program of a public university during the 2021-II semester. The total sample size was 22, who were selected using non-probabilistic and convenience sampling since it is a small sample. Although this is a research limitation, a thorough statistical analysis was performed to determine the inferences for the study population (Otzen & Manterola, 2017).

The data collection technique used in this study was a survey. The research instrument used was a questionnaire that aimed to measure the influence of knowledge management on attitudes and perceptions toward learning, based on Nonaka and Takeuchi's model. The questionnaire had 26 questions classified into six different dimensions. The reliability of the questionnaire was tested using Cronbach's alpha and a score of 0.945 was obtained, which is considered an excellent level of reliability (Hernández et al., 2006).

Regarding the validity of the research instrument, two types of validity were considered: content validity and construct validity. Content validity was used to evaluate the variables to be measured, while construct validity assessed whether the instrument reflected the literature of the variables (Vara, 2007). The results of the content validity were based on the opinions of experts in scientific methodology and knowledge of the variables studied. Three fundamental characteristics were considered: pertinence, relevance, and clarity. Table 1 shows the content validity results.

In terms of construct validity, a factor analysis statistical technique was used, which yielded a Kaiser-Meyer-Olkin sample adequacy measure of 0.482. Additionally, Bartlett's test of sphericity was performed, and its significance level was found to be less than 0.05. Using the SPSS statistical software, the principal component analysis method was applied, and factor extraction was performed, followed by rotation using the varimax method. For assigning items to factors, factor loadings greater than or equal to 0.35 were considered. The results showed that 6 factors, namely internalization (F1), combination (F2), organizational culture (F3), socialization (F4), externalization (F5), and information and communication technologies (F6), accounted for 75.45% of the total variance. To analyze the data collection, descriptive statistics was used to determine the variability and distribution of the data. Afterward, inferential statistics were used for hypothesis testing. First, the normality of the data was tested, and then either the Student's t-test or Wilcoxon's t-test was applied, depending on the case, given that the sample was small, less than 30 (Walpole et al., 2012).

## RESULTS

Table 2 shows the results of the descriptive analysis, which includes 6 dimensions: attitudes and perceptions toward organizational culture (APOC), attitudes and perceptions toward socialization (APS), attitudes and perceptions toward externalization (APE), attitudes and perceptions toward

**Table 1**. *Content Validity.*

| Pertinence | Relevance | Clarity |
|---|---|---|
| Average *p*-value = 0.014<br>Average *p*-value < 0.05 | Average *p*-value = 0.014<br>Average *p*-value < 0.05 | Average *p*-value = 0.014<br>Average *p*-value < 0.05 |
| The measurement instrument has content validity according to the binomial test because the result is less than the significance level of 0.05. | | |

Source: Prepared by the author.

combination (APC), attitudes and perceptions toward internalization (API), and attitudes and perceptions toward information and communication technologies (APICT). The mean and median values for these variables are quite similar, indicating an overall representation of the data set. The standard deviation values are relatively small, resulting in a coefficient of variation between 6.36% and 14.63%, which suggests that the data is not widely dispersed. Two of the six dimensions have a slightly left-skewed distribution, while the other four have a right-skewed curve. The kurtosis values range from −0.16 to −1.34, indicating that the curves are slightly flattened.

Table 3 shows the results of the Shapiro-Wilk statistical test applied to each dimension to determine data normality, as the sample size is less than 30 (Otzen & Manterola, 2017). A non-normal distribution of data is observed in the APC and API dimensions, thus requiring a non-parametric treatment for their inferential analysis. On the other hand, the APOC, APS, APE, and APICT dimensions have a normal distribution of data, thus requiring a parametric treatment for hypothesis testing.

Table 4 presents the statistical hypotheses for each dimension and the results of the inferential statistical analysis of the hypothesis testing carried out in the research. The research methodology proposes a comparative baseline for the posttest measurement, where a response of 75% success (quartile 3) is expected based on the information obtained.

In Table 4, the results for the dimension of organizational culture show a *p*-value of 0.000 which is less than the significance level of 0.05. This means that $H_0$ is rejected and $H_1$ is accepted, in other words, the researcher's hypothesis is supported. Therefore, it can be concluded that there is a significant influence of knowledge management on the attitudes and perceptions toward organizational culture among the students of the doctoral program of Industrial Engineering at a public university. This conclusion is drawn considering a baseline of 75% and a significance level of 5%, based on the knowledge spiral.

The processed data shows that the sample mean obtained (17.33) is higher than the proposed baseline (15.00) for this study. This indicates that the

**Table 2**. *Descriptive Statistics for the Dimensions Studied.*

| Statistics | Dimensions | | | | | |
|---|---|---|---|---|---|---|
| | APOC | APS | APE | APC | API | APICT |
| Mean | 17.333 | 8.684 | 8.381 | 25.474 | 28.954 | 12.353 |
| Median | 17.000 | 8.000 | 8.000 | 26.000 | 29.500 | 12.000 |
| Standard Deviation | 1.591 | 0.820 | 0.804 | 2.969 | 4.236 | 0.786 |
| Coefficient of Variation | 0.091 | 0.094 | 0.096 | 0.116 | 0.146 | 0.063 |
| Q1 | 16.000 | 8.000 | 8.000 | 23.500 | 26.000 | 12.000 |
| Q3 | 19.000 | 9.000 | 9.000 | 28.000 | 32.000 | 13.000 |
| Skewness | 0.400 | 0.580 | 0.920 | −0.260 | −0.170 | 0.100 |
| Kurtosis | −1.140 | −1.340 | −0.160 | −1.340 | −0.850 | −0.650 |

Source: Prepared by the author.

**Table 3**. *Data Normality.*

| Dimensions | Shapiro-Wilk (α = 0.05) |
|---|---|
| Attitudes and Perceptions of Organizational Culture | 0.028 |
| Attitudes and Perceptions of Socialization | 0.000 |
| Attitudes and Perceptions of Exteriorization | 0.000 |
| Attitudes and Perceptions of Combination | 0.165 |
| Attitudes and Perceptions of Internalization | 0.652 |
| Attitudes and Perceptions of Information and Communication Technologies | 0.022 |

Source: Prepared by the author.

minimum expectations for applying knowledge management in the attitudes and perceptions toward organizational culture among the students of the doctoral program of Industrial Engineering of the graduate unit of a public university have been met, based on the knowledge spiral. The same conclusion applies to the other five dimensions. However, when it comes to combination and internalization dimensions, the inferential statistical results suggest that the researcher's hypothesis has been rejected. This means that the minimum expectations for applying knowledge management in these two dimensions have not been met. Therefore, Table 5 presents a new comparative baseline equivalent to 50% to observe the behavior of the dimensions where the researcher's hypothesis was rejected.

Based on the results presented in Table 5, it can be inferred that for both dimensions, a *p*-value of 0.000 was obtained, which is less than the significance level of 0.05. This indicates that the null hypothesis ($H_0$) is rejected and the alternative hypothesis ($H_1$) is accepted. Therefore, the researcher's hypothesis is confirmed, and it can be concluded that knowledge management has a significant influence on the attitudes and perceptions toward knowledge combination among the students of the doctoral program of Industrial Engineering at a public university, based on the knowledge spiral model, at a significance level of 5%.

The processed data shows that the sample mean obtained (25.47) is higher than the proposed baseline (17.50) for this study. This indicates that knowledge management has a significant influence on the attitudes and perceptions toward internalization among the students of the doctoral program of Industrial Engineering at a public university, according to the knowledge spiral, at a significance level of 5%. Additionally, the mean score (28.95) of the processed data in this dimension is higher than the proposed new baseline (20.00).

## DISCUSSION

### A. Concerning the Rejected Hypotheses

#### Attitudes and Perceptions Toward Combination

It was found that the minimum expectations were not met when using a baseline of 75%. Therefore, a new hypothesis was proposed with a lower baseline of 50% and a significance

**Table 4**. *Hypothesis Testing by Dimension with a Comparative Baseline Equal to 75% of the Total Value of the Items.*

| Dimensions | Statistic Hypothesis (Baseline = 75%) | Statistic Test Applied (α = 0.05) | *p*-value | Statistical Decision |
|---|---|---|---|---|
| APOC | $H_0$: u = 15.00<br>$H_1$: u ≥ 15.00 | Wilcoxon Test | 0.000 | Reject $H_0$ |
| APS | $H_0$: u = 7.50<br>$H_1$: u ≥ 7.50 | Wilcoxon Test | 0.000 | Reject $H_0$ |
| APE | $H_0$: u = 7.50<br>$H_1$: u ≥ 7.50 | Wilcoxon Test | 0.000 | Reject $H_0$ |
| APC | $H_0$: u = 26.25<br>$H_1$: u ≥ 26.25 | Student's t-Test | 0.904 | Reject $H_0$ |
| API | $H_0$: u = 30.00<br>$H_1$: u ≥ 30.00 | Student's t-Test | 0.869 | Reject $H_0$ |
| APICT | $H_0$: u = 11.25<br>$H_1$: u ≥ 11.25 | Wilcoxon Test | 0.000 | Reject $H_0$ |

Source: Prepared by the author.

**Table 5**. *Hypothesis Testing by Dimension with a Comparative Baseline Equal to 50% of the Total Value of the Items.*

| Dimensions | Statistic Hypothesis (Baseline = 50%) | Statistic Test Applied (α = 0.05) | *p*-value | Statistical Decision |
|---|---|---|---|---|
| Attitudes and Perceptions Toward Combination | $H_0$: u = 17.50<br>$H_1$: u ≥ 17.50 | Student's t-Test | 0.000 | Reject $H_0$ |
| Attitudes and Perceptions Toward Internalization | $H_0$: u = 20.00<br>$H_1$: u ≥ 20.00 | Student's t-Test | 0.000 | Reject $H_0$ |

Source: Prepared by the author.

level of 5%. Results showed that knowledge management has a significant influence on the attitudes and perceptions toward the combination of knowledge among the students of the doctoral program of Industrial Engineering at a public university, based on the knowledge spiral model.

Based on the processed information, the sample mean obtained (25.47) was higher than the baseline goal proposed (17.50) for this study. This confirms the findings previously stated. While the results were favorable when a lower baseline was used, it does not necessarily mean that the initial goal has been reached.

Therefore, it is justified to focus on improving knowledge management practices, especially concerning knowledge combination. As suggested in the literature, this can be achieved by implementing strategies such as encouraging conversations through consultation and qualified discussion forums (Ramos, 2015) during the knowledge conversion phase, which involves sharing explicit knowledge.

**Attitudes and Perceptions Toward Internalization**

It was found that the minimum expectations were not met when using a baseline of 75%. Therefore, a new hypothesis was proposed with a lower baseline of 50% to account for a new scenario and a significance level of 5%. Results showed that knowledge management has a significant influence on the attitudes and perceptions toward knowledge internalization among the students of the doctoral program of Industrial Engineering at a public university, based on the knowledge spiral.

The data processing indicated that the sample mean (28.95) was higher than the proposed goal baseline (20.00), demonstrating the effect of the independent variable on the dependent variable. While the results were favorable when a lower baseline was used indicating that the attitudes and perceptions of students toward knowledge internalization based on the knowledge spiral exceeded expectations, the initial goal was not met.

The literature suggests that, when explicit knowledge is transformed into tacit knowledge through new models or projects, it can be internalized effectively. Therefore, it is justified to improve the guidelines related to the application of knowledge management in the internalization of knowledge. In this regard, students can participate in activities of social projection or university extension to expose their research work and internalize the knowledge of the documents in their own experience (Ramos, 2015).

**B. Concerning the Accepted Hypotheses**

**Attitudes and Perceptions Toward Organizational Culture**

Using a baseline of 75% and a significance level of 5%, it was found that knowledge management has a significant influence on the attitudes and perceptions toward the organizational culture among the students of the doctoral program of Industrial Engineering at a public university, based on the knowledge spiral.

The data processing showed that the sample mean obtained (17.33) was higher than the proposed goal baseline (15.00). This suggests that the minimum expectations for applying knowledge management were met in this dimension.

Based on the results from the information provided by the students enrolled in the doctoral program, implementing a knowledge management model can strengthen the institution. Organizational culture plays a fundamental role in this process, as it encompasses values, principles, lifestyles, and the institutional mission and vision, which are put into practice within the graduate unit and transferred to university classrooms where teachers interact with students. This plays a crucial role in the teaching-learning process (Yopan et al., 2020).

**Attitudes and Perceptions Toward Socialization**

Using a baseline of 75% and a significance level of 5%, it was found that knowledge management has a significant influence on the attitudes and perceptions toward the socialization of knowledge among the students of the doctoral program of Industrial Engineering at a public university, based on the knowledge spiral.

The data processing showed that the sample mean obtained (8.68) was higher than the proposed goal baseline (7.50). This suggests that the minimum expectations for applying knowledge management were met in this dimension.

Based on the results from the information provided by the students enrolled in the doctoral

program, it was found that they were able to comply with the basic characteristic of socialization: sharing knowledge. This was accomplished by sharing their professional and work experiences orally or in writing, contributing to the development of organizational knowledge in the classroom and the academic sector. This innovative knowledge will advance the field of industrial engineering and contribute to the growth of the academic community (Medina et al., 2020).

**Attitudes and Perceptions Toward Exteriorization**

Using a baseline of 75% and a significance level of 5%, it was found that knowledge management has a significant influence on the attitudes and perceptions toward the externalization of knowledge among the students of the doctoral program of Industrial Engineering at a public university, based on the knowledge spiral.

The data processing showed that the sample mean obtained (8.38) was higher than the proposed goal baseline (7.50). This suggests that the minimum expectations for applying knowledge management have been met in this dimension.

Based on the results from the information provided by the students enrolled in the doctoral program, it was found that it is possible to transform tacit knowledge into explicit knowledge, in compliance with the externalization process. The diverse casuistry exposed during the development of the classes has been documented with adequate methodologies inside the classroom and complemented with a brainstorming session. All this lays the foundation for innovative academic-scientific projects (Villasana et al., 2021).

**Attitudes and Perceptions Toward Information and Communication Technologies**

Using a baseline of 75% and a significance level of 5%, it was found that knowledge management has a significant influence on the attitudes and perceptions toward information and communication technologies among the students of the doctoral program of Industrial Engineering at a public university, based on the knowledge spiral.

The data processing showed that the sample mean obtained (12.35) was higher than the proposed goal baseline (11.25). This suggests that the minimum expectations for applying knowledge management have been met in this dimension.

Based on the results from the information provided by the students enrolled in the doctoral program and its subsequent analysis, it can be concluded that they have successfully adopted the use of information and communication technologies to interact effectively online amidst the current health situation. The students have utilized digital platforms, videoconferencing, and other applications to enhance their teaching and learning experience, meeting the minimum requirements for higher education, specifically at the postgraduate level. In doing so, they have been able to acquire knowledge and strengthen their professional skills in innovative educational environments (Azañedo, 2022).

**C. Concerning Previous Studies**

There are coincides between this research and that of Tortolero (2021) regarding the dimension of attitudes and perceptions toward organizational culture. According to Tortolero (2021), there is a significant relationship between organizational culture, leadership, and ICT with knowledge management. Organizational culture has the highest correlation with knowledge management, as perceived by the collaborators. The statistical evidence using Spearman's Rho test shows an excellent value of 0.921. In other words, having a good cultural foundation is essential to obtain an adequate knowledge management process. The human factor is crucial in this process, and if it is not willing to change or share knowledge, it is difficult to generate new knowledge.

Regarding the dimension studied in this research, the results show that sharing knowledge among doctoral students is crucial for learning and creating new knowledge. This aligns with the reference attached and is sustainable with the participation of the classroom teacher who creates an appropriate organizational climate that encourages knowledge sharing (Nonaka & Takeuchi, 1995).

There are coincides between this research and that of Sanz (2017) regarding the dimension of attitudes and perceptions toward socialization. Sanz (2017) stated that his research highlights the importance of tacit knowledge and how it emerges through social relationships between

individuals. The majority of the collaborators were able to obtain the information they needed by asking the most appropriate person. Only 10.71% of the respondents found it difficult to acquire the information by interacting with their colleagues, which indicates that a significant number of employees are willing to share "their expertise" with their colleagues.

In this research, the perception of doctoral students regarding socialization aligns with the above-mentioned quote, indicating the importance of generating knowledge through natural human behavior: socialization. Individuals must share their tacit knowledge gained through personal experiences with their peers. This sharing of knowledge is key to the beginning of knowledge conversion, as stated in the knowledge spiral (Nonaka & Takeuchi, 1995).

There are coincides between this research and that of Sanz (2017) regarding the dimension of attitudes and perceptions toward externalization. The author emphasizes the importance of uncovering tacit knowledge, which is vital for the development of an explicit knowledge management system, considering that this is only a part of making such knowledge fully accessible, as tacit knowledge has to be codified or become explicit to be disseminated. However, the mere existence of tacit knowledge is not enough. It is essential to create appropriate processes that respect the modeling of knowledge generation and facilitate the conversion of tacit knowledge into explicit knowledge. In our research, doctoral students have a perception of externalization that is similar to what is expressed in the aforementioned reference. They understand that it is crucial to express their tacit knowledge at a group level in the classroom, and this requires the implementation of codes, processes, or models that enable the standardization of modern schemes of effective communication (Nonaka & Takeuchi, 1995).

The results regarding the dimension of attitudes and perceptions toward knowledge management and scientific production in universities found in this research differ from those of Espinoza (2021). The mentioned author found a strong positive correlation of 0.574 between knowledge management and scientific production in universities in Tacna. Furthermore, a correlation coefficient of 0.553 between the combination process and knowledge management was found, specifically, through the publication of research results, systematized technological platforms, and registration of products, with the research activity dimension represented by duly referenced publications. This suggests that the exchange and combination of knowledge among individuals is essential for its conversion into scientific production. However, the results obtained from the perception of students enrolled in the doctoral program did not match the previous findings. It was observed that the minimum learning level was not reached, and appropriate educational strategies need to be implemented to generate new forms of explicit knowledge for its transformation into a combination of adequate knowledge. In a next measurement, the process of knowledge combination can be successful by applying such strategies (Nonaka & Takeuchi, 1995).

The results regarding the dimension of attitudes and perceptions toward internalization found in this research differ from those of Espinoza (2021). In Espinoza's research, it is evident that the use of knowledge management through the internalization process, which includes the use of methodologies in the group and research results, directly influences the scientific production of universities in Tacna.

Although three key phases have been observed in the knowledge conversion process so far, the importance of internalization cannot be overlooked. It is through internalization that explicit knowledge becomes tacit knowledge and can be compared with the maximum expression of the learning obtained.

However, the results found for the dimension analyzed did not reach the initial baseline proposed in the research according to the perception of the doctoral students. This does not mean that it is unattainable, as new educational strategies can be applied in the future based on the experiences gained. In a next measurement, the process of knowledge internalization can be successful by applying such strategies (Nonaka & Takeuchi, 1995).

The results regarding the dimension of attitudes and perceptions toward information and communication technologies found in this research are similar to those by Melo (2018). According to Melo's research, this dimension positively influences the teaching-learning process, since it improves teaching practices and the students' training. At the same time, it triggers a qualitative change in the university higher education

system, which has a multiplier effect at social and cultural levels across the country.

To integrate ICT in higher education, a methodological strategy is required that involves senior management, students, teaching, and administrative staff, supporting the application of technology. Information and communication technologies play a vital role in improving learning levels in the educational sector, especially in knowledge management. This dimension is a powerful tool for the teaching-learning process, allowing teachers and students to interact, share knowledge, and be part of the knowledge conversion process, shaping the knowledge spiral. Thus, leading to the accumulation of knowledge on the one hand, and to the retention of knowledge on the other, in order to achieve professional competitiveness among students (Nonaka & Takeuchi, 1995).

## 4. Proposed Knowledge Management Model

As outlined in Figure 1, the proposed model comprises five key aspects: processes, technology, people, organization, and information.

In the doctoral program of Industrial Engineering, specifically the subject "Technological Innovation Management in Industrial Processes", each of the processes related to knowledge management was discussed, considering the moments in the conversion of knowledge and following a suitable structural sequence. Table 6 displays the sequence for the respective processes.

## CONCLUSIONS AND RECOMMENDATIONS

- Regarding dimension 1, it is concluded that knowledge management significantly influences the attitudes and perceptions toward organizational culture among students in the Industrial Engineering doctoral program of the graduate unit of a public university, based on the knowledge spiral. This conclusion is drawn using a baseline of 75% and a value of α = 5%. The results of the statistical test show a *p*-value of 0.000, which is less than the significance level of 0.05. Therefore, the null hypothesis ($H_0$) is rejected, and the alternative hypothesis ($H_1$) is accepted.
- Regarding dimension 2, it is concluded that knowledge management significantly influences the attitudes and perceptions

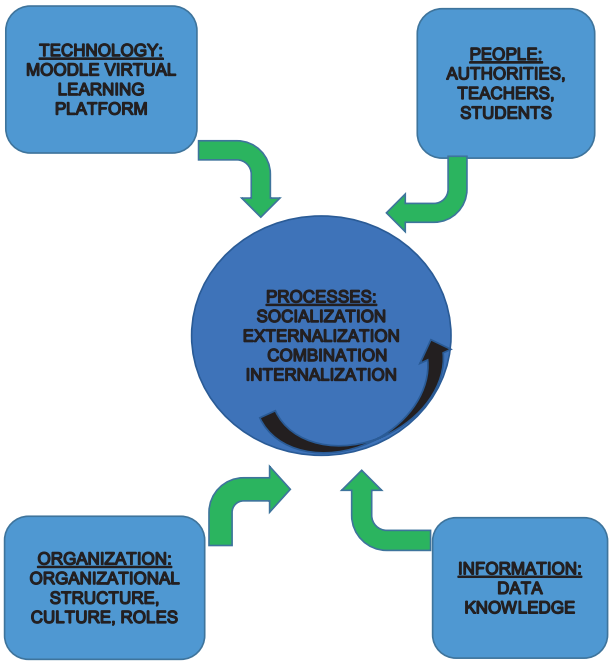


***Figure 1***. Model Diagram.

Source: Prepared by the author, adapted from Nonaka and Takeuchi's model (1995).

**Table 6**. *Structural Sequence for Processes.*

| Stages | Inputs | Activities | Outputs |
|---|---|---|---|
| Socialization | – Experiences<br>– Case Studies<br>– Videoconferences | – Session Presentation<br>– Knowledge Sharing | – Tacit Knowledge<br>– Experiences |
| Externalization | – Moodle Platform<br>– Videoconferences | – Workshops (forums) for discussion<br>– File Sharing Repositories | – Explicit Knowledge<br>– Documents Drafted |
| Combination | – Scientific Research<br>– Documented Experiences<br>– Videoconferences<br>– Moodle Platform | – Knowledge Exchange<br>– Business Roundtable with Experts in Innovation Projects | – Explicit Knowledge<br>– Project Feedback |
| Internalization | – Explicit Knowledge<br>– Webinars<br>– Videoconferences<br>– Moodle Platform | – Generate New Knowledge<br>– Retain Knowledge Learned Through Application | – Tacit Knowledge<br>– Innovation Project |

Source: Prepared by the author, adapted from Nonaka and Takeuchi's model (1995).

toward socialization among students in the Industrial Engineering doctoral program of the graduate unit of a public university, based on the knowledge spiral. This conclusion is drawn using a baseline of 75% and a value of α = 5%. The results of the statistical test show a *p*-value of 0.000, which is less than the significance level of 0.05. Therefore, the null hypothesis ($H_0$) is rejected, and the alternative hypothesis ($H_1$) is accepted.

- Regarding dimension 3, it is concluded that knowledge management significantly influences the attitudes and perceptions toward externalization among students in the Industrial Engineering doctoral program of the graduate unit of a public university, based on the knowledge spiral. This conclusion is drawn using a baseline of 75% and a value of α = 5%. The results of the statistical test show a *p*-value of 0.000, which is less than the significance level of 0.05. Therefore, the null hypothesis ($H_0$) is rejected, and the alternative hypothesis ($H_1$) is accepted.
- Regarding dimension 4, it is concluded that knowledge management has no influence on the attitudes and perceptions toward combination among students in the Industrial Engineering doctoral program of the graduate unit of a public university, based on the knowledge spiral. This conclusion is drawn using a baseline of 75% and a value of α = 5%. The results of the statistical test show a *p*-value of 0.904, which is higher than the significance level of 0.05. Therefore, the alternative hypothesis ($H_1$) is rejected, and the null hypothesis ($H_0$) is accepted.
- Regarding dimension 5, it is concluded that knowledge management has no influence on the attitudes and perceptions toward internalization among students in the Industrial Engineering doctoral program of the graduate unit of a public university, based on the knowledge spiral. This conclusion is drawn using a baseline of 75% and a value of α = 5%. The results of the statistical test show a *p*-value of 0.869, which is higher than the significance level of 0.05. Therefore, the alternative hypothesis ($H_1$) is rejected, and the null hypothesis ($H_0$) is accepted.
- Regarding dimension 6, it is concluded that knowledge management significantly influences the attitudes and perceptions toward information and communication technologies among students in the Industrial Engineering doctoral program of the graduate unit of a public university, based on the knowledge spiral. This conclusion is drawn using a baseline of 75% and a value of α = 5%. The results of the statistical test show a *p*-value of 0.000, which is less than the significance level of 0.05. Therefore, the null hypothesis ($H_0$) is rejected, and the alternative hypothesis ($H_1$) is accepted.
- Regarding dimension 4, it is concluded that knowledge management significantly

influences the attitudes and perceptions toward combination of knowledge among students in the Industrial Engineering doctoral program of the graduate unit of a public university, based on the knowledge spiral. This conclusion is drawn using a baseline of 50% and a value of α = 5%. The results of the statistical test show a *p*-value of 0.000, which is less than the significance level of 0.05. Therefore, the null hypothesis ($H_0$) is rejected, and the alternative hypothesis ($H_1$) is accepted.

- Regarding dimension 5, it is concluded that knowledge management significantly influences the attitudes and perceptions toward internalization of knowledge among students in the Industrial Engineering doctoral program of the graduate unit of a public university, based on the knowledge spiral. This conclusion is drawn using a baseline of 50% and a value of α = 5%. The results of the statistical test show a *p*-value of 0.000, which is less than the significance level of 0.05. Therefore, the null hypothesis ($H_0$) is rejected, and the alternative hypothesis ($H_1$) is accepted.
- The implementation of the proposed knowledge management model in the graduate unit of the public university is recommended. Doing so will make it possible to verify the usefulness of the model in improving the learning level of university students. It will also confirm the key role of the university in generating knowledge and making it available to the community.
- The application of educational strategies that focus on the processes of knowledge combination and internalization in order to improve the guidelines related to knowledge management is recommended. Effective sharing of knowledge is important, but it is equally important to retain and apply this knowledge to meet the learning challenges faced by university students.
- This study should be considered as support for the university academic-scientific community. It can help guide further research on knowledge management, particularly as it relates to the learning of university students at postgraduate and undergraduate levels. Learning is not enough; it is also important to retain and apply what has been learned in the university classrooms.
- Strengthening the training related to information and communication technologies, specifically in the use of the virtual platform, is recommended for students of the graduate unit. This will help present the friendly and useful characteristics of this platform regarding the integral learning for the respective academic programs that the students have. It is important for the creation and conversion of knowledge, which is key to academic and professional training in line with today's competitive world.

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