NOVA IMS Information Management School

MGI

Mestrado em Gestão de Informação
Master Program in Information Management

People Analytics as a driver of Knowledge-Based Organizations

How can we measure the knowledge created in organizations through People Analytics?

João Pedro de Oliveira e Costa

Dissertation presented as partial requirement for obtaining the Master's degree in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

PEOPLE ANALYTICS AS A DRIVER OF KNOWLEDGE-BASED ORGANIZATIONS

by

João Pedro de Oliveira e Costa

Dissertation presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Knowledge Management and Business Intelligence

Advisor: Prof. Guilherme Victorino

Co Advisor: Prof. Roberto Henriques

November 2022

ABSTRACT

Knowledge and People are the main assets of organizations that want to be efficient in their processes. Due to the characteristics of these assets, their volatility, and the difficulty in managing the interoperability between them, they present themselves as challenges for organizations. This study aims to create a structured process that allows to manage and measure the knowledge generated within an organization through the evaluation of intellectual capital in Communities of Practice (CoPs). This analysis tends to promote a better understanding of the relationship between human capital and the knowledge generated through the evaluation of some Human factors (HF) in the learning and value creation processes. The evaluation of this knowledge has as a final objective the creation of new strategies that allow to increase the structural capital within an organization, in order to promote new measures of organizational knowledge management based on a People Analytics (PA) methodology.

KEYWORDS

Organizational Knowledge; Value Creation; People Analytics; Communities of Practice; Knowledge Management; Intellectual Capital;

INDEX

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

CoP	Community of Practice
CoPs	Communities of Practice
PBL	Problem-Based Learning
VC	Value Creation
HF	Human Factors
HR	Human Resources
KM	Knowledge Management
PA	People Analytics
PM	Performance Measurement
RA	Relational Analytics
VC	Value Creation

1. INTRODUCTION

1.1. BACKGROUND AND PROBLEM IDENTIFICATION

Nowadays, the process of creating and disseminating knowledge has an increasing impact on productivity, since it presents itself as a driver of knowledge management and intellectual capital. Intellectual capital is composed by human capital, structural capital and relational capital. With this in mind, it has been verified that there is a lack of standard metrics for the evaluation and measurement of intellectual capital within the organizations (Barão, A., de Vasconcelos, J. B., Rocha, Á., & Pereira, R., 2017). Given the growing importance of the concept of intellectual capital, more and more organizations are starting to realize that the knowledge that resides in their human capital is important in the creation of value, as a way to leverage organizational knowledge (Caruso, S. J., 2016).

In the article "Intellectual capital and knowledge management effectiveness" (Marr, B., Gupta, O., Pike, S., & Roos, G., 2003) it is mentioned that Knowledge Management (KM) is recognized as an important driver for obtaining, growing and sustaining Intellectual Capital in organizations. The intellectual capital aggregates a set of knowledge resources that represent the total organizational knowledge, such as skills, internal procedures, processes, organizational structure and organization's relationships. This knowledge requires management processes, in order to make possible the continuous treatment of this information. This managed knowledge, which is contemplated in knowledge processes and initiatives, requires human intervention to be leveraged, and to create value for the organizations (Abeysekera, I., 2021).

In this context, Communities of Practice (CoPs) are considered important vehicles of knowledge diffusion and promote the application of an organization's intangible assets in different contexts or environments including project management activities and process improvements (Venkatraman, S., & Venkatraman, R., 2018). To assess and measure the knowledge generated, organizations have promoted the creation of these communities that through the interactions of their members, allow to analyze structures, relationships and flows of knowledge, as well as promote the creation of KM strategies. In this way, these communities end up being fundamental elements from the perspective of knowledge management, being the link between human capital and organizational knowledge. In several sectors, there has been an increasing focus on the creation of these communities, progressively helping to improve their performance (Wenger, E., 2009).

One of the greatest difficulties for organizations has been to demonstrate the benefits of these communities of practice in the KM strategies they intend to define. These challenges are related to difficulties in explaining explicitly the link between KM and business strategies. Even with the introduction of KM initiatives through communities of practice, organizations still do not present methods to evaluate the contribution of these activities and their impact on business improvements. One of the solutions for organizations to communicate the benefits of KM strategies is through performance metrics, which can help promote greater knowledge regarding the organizational context and promote reforms needed to address existing challenges (Venkatraman, S., & Venkatraman, R., 2018).

To understand more and better the relational structures formed by communities of practice it is increasingly important to know the human factors (HF) associated with each individual and how they

behave in group work, allowing to conjugate not only who the individuals in a given organization are but also what they know. People Analytics (PA) can promote complementarity between the two main assets of an organization, knowledge and people, through a set of processes and methods that allow to evaluate the behavior of individuals, human capital and organizational performance (Marler, J. H., & Boudreau, J. W., 2017). The correlation between People Analytics (PA) and Knowledge Management (KM) is still underdeveloped and studied. Based on Organizational Intelligence Institute, Knowledge Management (KM) is one of the topics where People Analytics (PA) is less developed since it is identified as one of the topics where there is less value associated with HR Intelligence capabilities HR practices, programs and processes (Falletta, D. S., 2014).

This study intends to build a structured process to evaluate and measure the knowledge generated in Communities of Practice (CoPs) of an organization that uses knowledge as the main asset for value creation. This analysis allows to suggest measures to leverage organizational knowledge, based on the existing human capital of the organizations. The results of this research derive from the existing relationships between the performance indicators and the interactions/information flow generated by the participating members of these communities, allowing to answer the following problem: How can we measure the knowledge created in organizations through People Analytics (PA)?

1.2. STUDY OBJECTIVES

The General Objective of this research is to validate and measure the knowledge created in an organization through the creation of a structured process that enables to understand the behavior of the CoPs. Through the results obtained it is intended to promote the development of strategies that allow to close the existing gaps presented above as well as suggest a redefinition of the existing structure taking into account the behaviors identified by students as drivers and promoters of group work that enables the creation of added value that is a generator of knowledge. These Communities of Practice (CoPs) should promote the creation of new Knowledge Management (KM) strategies possible to be generalized to the organization's population. This process tends to promote the correlation of HF with the performance of individuals in CoPs, generating a set of metrics and indicators that can be used in the future whenever one wants to measure the knowledge generated in an organization.

The structured process behind this study involves identifying some human factors that are particularly relevant to the organizational workplace and evaluating their importance in the different cycles of value creation, being able to verify existing gaps and promote measures to create more value based on the identified human attributes.

This study is based on an organization from the education sector and the results are associated with the behavior of students enrolled in a given curricular unit. The results of this study will be associated with CoPs created in a school environment and organization, aimed at solving problems associated with case studies arising from the themes addressed in this specific curricular unit. The universe used for this research and for methodological processes, will correspond to the students enrolled in that curricular unit in the academic years of 2020/2021 and 2021/2022, with the final universe being only associated with the students from this universe who agreed to answer the questionnaire.

This study aims to answer the Specific objectives defined below:

- Development of a questionnaire to measure the performance of the individuals of Communities of Practice (CoPs) during the Learning Process and knowledge creation;
    - This questionnaire is applied to students enrolled in a certain curricular unit in the academic years of 2020/2021 and 2021/2022 to assess their performance throughout the semester working in CoPs. Thus, is possible to evaluate all the moments associated with the learning process and knowledge creation, linking these same moments to the way students usually behave and evaluate their performance in usual group work.
- Monitor the behavior of the different Communities of Practice (CoPs) through Performance Measurement (PM);
    - Through the questionnaire, it is evaluated how students consider their performance over the curricular unit and validated correlations and similarities it has with the students' characteristics and behaviors in group work.
- Evaluate and measure the knowledge created inside Communities of Practice (CoPs);
    - The knowledge is validated by the value that each of the students belonging to each of the CoPs says they have acquired throughout the different topics covered. The several stages of the value creation cycle are identified in the questionnaire and the behavior of the students in each of these stages determines/indicates the knowledge generated/created. The knowledge generated will be associated with the value of learning made possible by community involvement and networking.
- Understand the relevance of human factors (HF) and the importance of measuring them when learning, sharing and generating new knowledge;
    - Verify the influence and consequent impact that HF have on the different cycles of value creation, promoting interoperability between the two greatest assets of organizations, people and knowledge, this being the starting point to be able to identify possible strategies that aim to promote greater value creation from the knowledge generated. In this study will be introduced a component that aims to study the HF associated with the behavior of individuals from each of the Communities of Practice (CoPs). To study these factors, will be used methods based on a People Analytics (PA) methodology.
- Generalization of knowledge created to the organization’s population through Knowledge Management/People Analytics strategies.
    - Based on the results of the questionnaire and the methodology used, possible strategies are indicated that allow combining Knowledge Management (KM), People Analytics (PA) and different cycles of the VC framework where the starting point is based on human factors, through indicators associated with these factors. These strategies are encouraged by an analytical view of student behavior and aim to create greater added value for organizations, especially in knowledge-based organizations, looking ahead to a new alternative to the evaluation of the knowledge generated.

2. STUDY RELEVANCE AND IMPORTANCE

This study intends to create a process that allows the association between People Analytics (PA) and Knowledge Management (KM), which, based on previous research, had few processes and strategies developed simultaneously. Knowledge Management (KM) and Organizational Learning are the two main areas where People Intelligence and People Analytics (PA) are less developed due to definitional problems that do not allow the creation of Knowledge Management initiatives (Falletta, D. S., 2014).

This study will introduce a PA component in the evaluation of the behavior of the different groups under analysis, which will differentiate it from already developed studies and research. In this case the characteristics of individuals from the different communities and the way they work together will be interpreted in conjunction with the different cycles of value creation based on the Value Creation Framework of Etienne Wenger, Beverley Trayner and Maarten de Laat (Wenger, E., Trayner, B., & de Laat, M., 2011). In this way, it is possible to understand not only who are the individuals of a given community of practice, but also the capacity that these individuals have to generate knowledge, *"Measure Who They Know, Not Just Who They Are"* (Haavel, A.,2019). The PA component introduced in this study is based on six human factors, performance, engagement, leadership, workplace relational dynamics, organizational development support, and learning and knowledge creation identified in the study "Sentiment analysis in organizational work: Towards an ontology of people analytics"(Gelbard, R., Ramon-Gonen, R., Carmeli, A., Bittmann, R. M., & Talyansky, R, 2018). With this in mind, is possible to verify their behavior in another environmental context and to understand the impact they will have on the learning process and knowledge creation.

This research aims to promote a greater correlation and dependence between the structure of an organization and the flow of information generated. In this study, the CoPs correspond to the different groups that were created taking into account the specificities of the curricular unit used for this purpose. Each of the members had a specific role in the community of practice, there could be exchanges and it was not very static throughout the time in which the curricular unit took place.

Just as in other sectors or applications, schools can also be considered organizations trying in some way to face challenges associated with KM. In this particular sector, the learning process turns out to be not only the means to an end but also what is really intended, and therefore the importance of creating CoPs is relevant in this context. This study aims to contemplate two dimensions that CoPs aggregate in the educational environment, internal and external perspectives. Regarding the internal perspective, these are CoPs created in a school environment as part of the organizational structure of a given curricular unit and their participation is inherent to the development of the curricular unit itself. Regarding the external perspective, the behavior of these CoPs and their behavior can be somehow interconnected with other CoPs in other environments and sectors, as is the case of other knowledge-based organizations. In this way, CoPs in an educational context have been relevant drivers in the chapter of learning and knowledge creation, "*Schools, classrooms and training sessions still have a role to play in this vision, but they have to be at the service of the learning that happens in the world*" (Wenger, E., 2009).

3. LITERATURE REVIEW

3.1. KNOWLEDGE MEASUREMENT IN ORGANIZATIONS

The main knowledge management processes in organizations are primarily focused on knowledge creation and knowledge transfer activities, increasingly promoting intelligence and competencies in the organizational workplace. Mainly in knowledge intensive organizations is fundamental the continuous availability and development of domain expertise (Barão, A., de Vasconcelos, J. B., Rocha, Á., & Pereira, R., 2017). Knowledge Intensive Organizations are aimed at making the most effective and efficient use of the knowledge, so they can promote their processes and survive. These organizations use knowledge-based tasks such as recognizing patterns in organizational behavior. These activities take place involving a network of relationships between people, sources of information and organizational needs (de Vasconcelos, J. B., Kimble, C., Miranda, H., & Henriques, V., 2009). The difficulty existing in organizations in measuring the knowledge generated in internal processes and the inexistence of processes that allow to reinforce the importance of relational capital in the development of intellectual capital, allowed the creation of solutions that tried to overcome these limitations over the years. Thus, the assessment and measurement of knowledge are increasingly important drivers to reach organizational excellence.

Organizations contemplate tangible and intangible capital. Tangible capital is the one that can be measured because it has a structured nature, intangible capital comes from the interpersonal relationships between individuals of an organization and it is presented in an unstructured form. Unlike tangible capital, intangible assets are not primarily considered in organizations, however, if they are framed and detected as amounts, they may be subsequently observed and measured (Hubbard, D. W., 2010). The intellectual capital, intangible capital, of an organization includes all intangible assets such as human, structural and relational capital. These intangible assets can add value to organizations at the level of knowledge, can also bring benefits in terms of efficiency and effectiveness of the processes that despite being informal and hardly captured in a structured way can also add more value to them (Adams, M., & Oleksak, M., 2010).

Nowadays, intellectual capital is increasingly sustained as the basis that supports and promotes organizational learning processes. As previously identified, the intellectual capital has in its composition human capital, structural capital and relational capital, being the relational capital the one that constitutes more limitations to the organizations due to its unstructured nature. Based on “Net Work A Practical Guide to Creating and Sustaining Networks at Work and in the World” (Anklam, P., 2007) and “The knowledge evolution: Expanding organizational intelligence” (Allee, V., 1997) it is given the indication that human capital aggregates the knowledge, skills and competence of the members of a given organization. It is also described that structural capital is associated with the connections and dependency relationships between the individuals of an organization and the existing structure, supported by the existing methodological processes. Finally, it is described that relational capital aggregates the value of internal relationships and interactions between individuals within an organization.

3.1.1. Knowledge Measurement using Communities of Practice

Organizations in several sectors have been focusing on the development of communities of practice as a driver to improving their performance and productivity (Wenger, E., 2009). These communities are defined as "*groups of people that share a concern or a passion and learn how to do it better as they interact regularly*" (Lave, J., & Wenger, E., 1991). The CoPs are also defined as a "*learning partnership among people who find it useful to learn from and with each other about a particular domain they use each other's experience of practice as a learning resource* "(Wenger, E., Trayner, B., & de Laat, M.,2011).

A Community of Practice (CoP) distinguishes itself from other networks by promoting its own identity around common interests that are shared by all members. At the same time that common interests are shared, the members build relationships that allow them to learn from each other, sustaining a continuous learning process. CoPs have been applied in many contexts, such as in business, organizational design, government, education, professional associations, development projects, and civic life (Wenger, E., 2009).

The measurement of knowledge generated in CoPs and the value generated for an organization are mainly evaluated through Performance. Knowledge Management Performance can be measured through Activity Indexes, Storytelling, Result Survey or Network Analysis (van der Mei, M., & Jansen, S., 2010). Activity Indexes are described as activities focused on knowledge transfers between people through a knowledge system. Storytelling is described as a method that is focused on members who tell stories about the benefits they achieved by participating in the community. It is also described that Result survey uses a set of predefined questions to which a score can be assigned, these questions asked to the members of a community of practice give insight in the results of the community. Finally, it is mentioned that Network Analysis gives insight into the structural properties of the networks of which a community of practice consists.

3.1.1.1. Intellectual Capital Method

One of the first approaches measuring the knowledge generated in CoPs was based on the application of performance metrics method through the SECI Model. The SECI Model is a model that promotes Knowledge Creation and Sharing in organizations based on four different phases, Socialization, Externalization, Combination and Internalization (Nonaka, I., & Toyama, R., 2003). This method used to measure knowledge in Communities of Practice (CoPs) through SECI Model was mainly focused on measuring intellectual capital (Smits, M., & de Moor, A.,2004). This method allows to measure intangible resources such as knowledge and the components that surround it by listing some quantitative indicators linked to Nonaka's knowledge stages and categories. The association made between Nonaka's methodology and the concept of intellectual capital involves the similarity between Human Capital, and Tacit Knowledge on the one hand, and between Structural Capital, intangible resources in an organization, and Explicit Knowledge on the other hand (Smits, M., & de Moor, A.,2004).

Socialization consists of sharing knowledge through social interactions, to measure the impact of the Socialization stage in KM processes, indicators such as direct communication links, non-assigned working time and regulated socialization are applied using this method. In the Externalization stage, the tacit knowledge is converted into explicit knowledge through documentation or brainstorming

sessions, and according to the Intellectual Capital Method to measure the impact of this phase the concept of Conceptual Knowledge is evaluated through metrics such as the number of bytes of project documents, as well as the percentage of time allocated to project meetings. In the Combination stage the knowledge is extended, this stage contemplates the process of recombining discrete pieces of explicit knowledge into a new form. According to the Intellectual Capital Method to measure the impact of this phase the systemic Knowledge is evaluated and it can be evaluated by the number of categories in KB destined to project documents and by the number of items in KB. Internalization converts or integrates shared and/or individual experiences and knowledge into individual mental models, in this stage, the operational knowledge is evaluated, and metrics such as years of experience or frequency of use of KB are used according to the method presented above.

3.1.1.2. Knowledge Management Systems Metrics

According to the article "Communities of Practice Approach for Knowledge Management Systems" (Venkatraman, S., & Venkatraman, R., 2018), it is indicated that the emergence of Big Data technologies and data mining techniques, from a general perspective, could be used to detect patterns in CoPs. These patterns, often difficult to measure, can be captured through performance metrics that allow measuring the explicit knowledge generated in these communities.

Previous studies have recommended the use of performance measurement metrics in Communities of Practice such as System Metrics, Output Metrics and Outcome Metrics. System metrics measure the number of contributions and contribution rate over time, Output Metrics measure the number of problems resolved and the time taken to resolve them and Outcome Metrics measure the improvement in quality/efficiency of a business process or a group project (Venkatraman, S., & Venkatraman, R., 2018).

3.1.1.3. Cycles of value creation in Communities of Practice

To understand the behavior of the generation of new knowledge, consequent evaluation of this knowledge and creation of value in Communities of Practice (CoPs), the Value Creation (VC) framework was created. In this framework five cycles of value were identified, each of which, due to its characteristics, evidence different behaviors to be monitored, metrics and indicators.

This framework is supported by the concept of Value Creation (VC) and it is indicated that it is characterized by the value of learning made possible by community involvement and networking. This framework is focused on the value that CoPs create when they are used for social learning activities such as sharing information, creating knowledge or stimulating change (Wenger, E., Trayner, B., & de Laat, M.,2011).

This framework contains five value cycles where value creation occurs within each of these cycles. The cycles defined in this framework include Immediate Value where activities and interactions are evaluated, Potential Value where the knowledge capital created based on activities and interactions is evaluated, and knowledge capital can have different forms such as human capital, social capital, tangible capital, reputational capital or learning capital. This framework also includes the Applied Value cycle, this cycle intends to measure the impact that the generated knowledge capital had, intending to verify if it was or was not applied in practice. The Realized value represents a cycle that intends to verify and measure performance improvements. Finally, the Reframing Value cycle, this

cycle is intended to measure and evaluate the impact of reframing strategies and goals as well as the reconsideration of the learning process and knowledge creation.

The Immediate Value corresponds to the first cycle of this framework, in this phase member's activities, exchanges and community interactions are measured.

In this stage, and based on the Value Creation (VC) framework (Wenger, E., Trayner, B., & de Laat, M., 2011), the following questions are addressed:

- "*What happened and what was my experience of it?*"
- "*What were significant events? What happened?* "

The Potential Value corresponds to the second cycle of the VC framework, in this phase the Knowledge Capital is measured, corresponding to the potential of the value to be realized later. Knowledge Capital is divided in Personal Assets, Relationships and Connections, Resources, Collective intangible assets and transformed ability to learn.

In this stage, and based on the Value Creation (VC) framework (Wenger, E., Trayner, B., & de Laat, M., 2011), the following questions are addressed:

- "*What has all this activity produced?*"
- "*How has my participation changed me?* "

The Applied value corresponds to the third cycle of the VC framework, it is related with the application of Potential Value in a specific situation as changing a procedure or implementing an idea.

In this stage, and based on the Value Creation (VC) framework (Wenger, E., Trayner, B., & de Laat, M., 2011), the following questions are addressed:

- "*What difference has it made to my practice/life/context?*"
- "*Where have I used the knowledge acquired in the community of practice?*"

The Realized value corresponds to the fourth cycle of the VC framework, in this phase, the performance improvements based on the application of knowledge capital are measured.

In this stage, and based on the Value Creation (VC) framework (Wenger, E., Trayner, B., & de Laat, M., 2011), the following questions are addressed:

- "*What difference has it made to my ability to achieve what matters to me?*"
- "*What aspects of my performance has my participation in community of practice affected?*"

The Reframing Value corresponds to the fifth cycle of the VC framework, and it is based on the reformed understanding of learning and success criteria.

In this stage, and based on the Value Creation (VC) framework (Wenger, E., Trayner, B., & de Laat, M., 2011), the following questions are addressed:

- "*Has it changed my understanding and definition of what matters?* "
- "*Has a new framework evolved or been created as a result of this new understanding?"*

3.1.2. Knowledge Measurement using People Analytics

Through the study of individuals in Communities of Practice (CoPs), namely the evaluation of their behavior, by creating metrics that allow measuring the knowledge of these members within different organizational structures and analyzing the interactions between individuals, it will be possible to promote the complementarity between the concepts of Knowledge Management (KM) and People Analytics (PA).

In this context, Organizations must be able to identify and understand some of the tools that people can utilize to enhance knowledge sharing throughout the organization (Caruso, S. J., 2016). Organizations, in order to contemplate both assets, people and knowledge, promoted the creation and implementation of Knowledge Management Systems to promote knowledge sharing and learning activities, this implementation was allied to a model based on a key variable "skill", thus promoting the combination of Knowledge Management and people analytics (Hafeez, K., & Abdelmeguid, H.,2003).

Considering the study “Sentiment analysis in organizational work: Towards an ontology of people analytics” (Gelbard, R., Ramon-Gonen, R., Carmeli, A., Bittmann, R. M., & Talyansky, R, 2018), the concepts of learning and knowledge creation is considered one of six human factors constructs that together allow the preponderance of PA in organizations to be assessed and measured. Learning may take different forms, such as learning from failure, learning from success, learning from direct or learning from indirect experience. With this in mind, it is increasingly important for organizations to have processes in place to assess and determine who knows and how accurate knowledge is. These six constructs identified above, address the factors of performance, engagement, leadership, workplace relational dynamics, organizational development support, and learning and knowledge creation and are defined as particularly relevant to the organizational workplace.

3.1.2.1. People Analytics

People Analytics (PA) promotes greater internal knowledge in organizations, helping them to understand their workforce, departments, organizational structure, work groups, departments and individuals, through the analysis of personal data and behaviors, attributes and performance (Pape, 2016). One of the focuses of PA is associated with organizational research. Organizational research can be defined as a “*set of studies or experiments conducted to address a specific, one-off organizational question*” (Kaur and Fink, 2017). Through organizational research, it is possible to define metrics, allowing to investigate the most relevant topics of an organization, mainly organizational performance.

As indicated above in the study “Sentiment analysis in organizational work: Towards an ontology of people analytics” (Gelbard, R., Ramon-Gonen, R., Carmeli, A., Bittmann, R. M., & Talyansky, R, 2018), some research was carried out based on organizational research. This research was based in the application of people analytics using some HF that are particularly relevant to the organizational workplaces as performance, engagement, leadership, workplace relational dynamics, organization developmental support, and learning and knowledge creation.

Taking into account the study mentioned above “Sentiment analysis in organizational work: Towards an ontology of people analytics” (Gelbard, R., Ramon-Gonen, R., Carmeli, A., Bittmann, R. M., & Talyansky, R, 2018), it is possible to identify that the concept of Performance aggregates different

behaviors such as Creativity, Innovation, Service quality, Efficiency, Effectiveness and Organizational citizenship behaviors.

In the study, it is described that Creativity is manifested by the originality of ideas and the detailed level of elaboration, Innovation is manifested by the implementation of new ideas and Service quality is manifested by the quality of services provided by the organization's members. Efficiency is evaluated by the quality of the tasks performed and if they were carried out within the time, Effectiveness is evaluated by the number of objectives achieved, and Organizational citizenship behaviors measure the ability to help each other within an organization. The concept of Engagement is described in the study as being based on a motivational force that supports an activity or work, this concept includes topics such as Identification, which can correspond to the feeling of belonging to an organization, and Satisfaction, which can correspond to an emotional reaction to the tasks performed in the organization. It is mentioned that the concept of Leadership can be analyzed and measured through factors such as the analysis of the feedback that is given by leadership positions in the development of activities or tasks, management of expectations and task-oriented behaviors.

It is also described in the above study that the concept of Workplace relational dynamics is based on the existing links between individuals in an organization and on their importance and influence on the way they act in the workplace, involving concepts such as trust, relational connection or communication. It is mentioned that Organizational support is associated with the perception that each member of the organization has an organization corresponding to their effort and contribution, this concept can be evaluated through measures of employee development, behavioral support, such as demonstrated trust or value, and means support that encompasses resources and tools. The concept of Learning and knowledge creation aims to measure different manifestations such as Learning from failure, learning from success, learning from direct experience, learning from indirect experience, Knowledge Exchange and Knowledge Combination.

3.1.2.2. Relational Analytics

The term Relational Analytics (RA) is a derivation from People Analytics (PA) less focused on the analysis of attribute data of the members of an organization and more focused on the interactions between the different members. RA is a concept that allows to promote the connection between People Analytics (PA) and Knowledge Management (KM) through the existence of organizational network analysis, "*Measure Who They Know, Not Just Who They Are*" (Haavel, A., 2019).

Taking into account the article "Measure Who They Know, Not Just Who They Are" (Haavel, A.,2019), RA can be understood as the science of human social networks, being able to transfer the communications established between individuals, as is the case of interactions between individuals from different departments, for example. Relational analytics is composed of six different signatures that support this methodology, Ideation, Influence, Efficiency, Innovation, Silos, and Vulnerability.

In the article mentioned above, it is described that Ideation can be observed in organizational networks through the connections that an individual has in his network or outside it. If an individual only communicates with individuals from the same network, he is likely to be able to generate fewer new ideas, even if he presents himself as a creative individual, unlike an individual who communicates with different networks, this communication allows for broader perspectives and new ideas. Influence can be verified in organizational networks by the number of connections that an individual has, and a

greater influence is verified if these connections are also influence in the respective networks, thus being able to disseminate ideas faster and to a greater number of individuals. Efficiency is associated with internal density of the networks, which indicates that the teams work well together, and if at the same time it is verified that the external connections to a network do not alternate, it means that there is constant help at the level of resources and support to the network, which promotes the efficiency of processes. Innovation can be verified in organizational networks with not much internal density of the networks, which indicates that the individuals of each of the networks may have different perspectives on the most productive themes and debates, if these individuals of these networks have a considerable number of connections. Silos are associated with cases where each network has a high density, and only one or two members of each network contact other networks. Vulnerability can be verified in organizational networks in cases where there is dependence on only one or two members of the organizational structure so that the flow of information remains constant, and the absence of these members can put the organization of these members in a situation of vulnerability, especially if these are indispensable for communication with entities outside the organization.

3.1.3. Knowledge Measurement concepts in the proposed research

As identified in the objectives of this research, this research is intended to result in the elaboration of a structured process that allows an organization to combine two of its main assets, knowledge and people, and thus be able to promote the creation of additional value.

In a knowledge-based firm, intellectual capital aggregates around it a significant part of the accessible capital of an organization (Abeysekera, I., 2021). Given its importance, this concept stands as a central element of the research. The intellectual capital of an organization integrates the resources that together represent the organizational capital. As mentioned in previous topics, Intellectual capital is divided into human capital, structural capital and relational capital. Human capital aggregates the experience and skill sets of the individuals in an organization, on the other hand, structural capital aggregates internal procedures, processes, and internal organizational structures, and finally the relational capital represents the value of social relationships within organizations (Barão, A., de Vasconcelos, J. B., Rocha, Á., & Pereira, R., 2017).

This organizational knowledge requires management activities, in order to make possible the continuous treatment of this information. To promote these activities, a focus on human intervention is necessary. Human capital is essential to make the link between knowledge generated and value created. (Abeysekera, I., 2021). In this way, it becomes vital the preponderance of the evaluation and analysis of human capital since it is people who can make the connection between the existing intellectual capital and the creation of value in organizations through KM strategies. With this in mind, it is possible to verify that all of this works in a circuit and with interdependencies, from organizational knowledge to value creation. That is, the greater the human capacity to enhance and create knowledge, the greater the value and, as a consequence, the greater the existing organizational knowledge.

Thus, the proposed research has as its mission to try to strengthen the circuit identified above in order to leverage value creation and its cycles based on human factors (HF). This study is based on the identification of existing correlations between some of the human factors (HF) identified in the study "Sentiment analysis in organizational work: Towards an ontology of people analytics" (Gelbard, R., Ramon-Gonen, R., Carmeli, A., Bittmann, R. M., & Talyansky, R, 2018), and the different cycles of the

Value Creation (VC) framework (Wenger, E., Trayner, B., & de Laat, M., 2011). This process will allow the verification of the role that People Analytics (PA) can play in the value creation process, and as a consequence in the creation of organizational knowledge.

The validation of these correlations starts with Communities of Practice (CoPs). This concept of CoPs as identified above is perceived to make a valuable contribution to the sharing and diffusion of knowledge by connecting people. CoPs and KM strategy establish a connection since together provide the key structures to support learning, sharing, and stewarding knowledge. (Venkatraman, S., & Venkatraman, R., 2018). The use of these CoPs in this research is related to their relevance as important vehicles for knowledge diffusion and promotion of organizations' intellectual capital (Venkatraman, S., & Venkatraman, R., 2018), and thus can serve as a reference for the evaluation of the correlations mentioned above.

4. METHODOLOGY

4.1. METHODOLOGICAL APPROACH

In order to accomplish this investigation and validate future results, data from CoPs will be used. In this case, the subset of individuals, used for this research and for methodological processes, corresponds to the students enrolled in a specific curricular unit in the following academic years: 2020/2021 and 2021/2022. The final universe of students used to evaluate the results of the research corresponds only to those students who agreed to answer a questionnaire.

This study is supported by methods, as is the case of the steps for the creation of the questionnaire applied to the CoPs and its design, and the evaluation of the performance of the created segments by the variables collected. The methods identified before and measurement instruments will be built, the metrics applied evaluated, with the specific objective of creating a process based on a result survey that promotes the measurement of performance and association of these with HF of group work behavior to evaluate the knowledge generated.

To collect the information from each of the CoPs, a Result Survey was developed to measure and evaluate the knowledge generated throughout the different problems developed and solved in the curricular unit, based on information about the learning process and the creation of new knowledge. The information generated by this questionnaire applied to the communities of this specific curricular unit will be used as a sample to understand the behaviors of organizations that use knowledge as one of their main assets.

From a methodological point of view, the process which supports this investigation is based on a questionnaire that aggregates the behavior of individuals from the different communities in the usual group work taking into account HF that are particularly relevant to the organizational workplace and their performance in the different cycles of value creation taking into account the PBL methodology. After obtaining the answers, a descriptive analysis of the collected data is made, focusing on the evaluation of the behaviors based on an analysis of the segments created through a cluster analysis, taking into account the variables from the different events. The different clusters created will be based on different starting points and will transpose the conjugation of the different factors in the different stages of knowledge creation, allowing the evaluation of their relevance in each one of them, enabling the outlining of strategies. These strategies essentially target the organizational structure and the VC cycles, and aim to constitute drivers that bring added value to the organizational context in which they are inserted.

4.2. ORGANIZATIONAL CONTEXT

As previously mentioned this research aims to present a methodological process that aims to serve as an indicator for the evaluation of the knowledge generated in organizations where knowledge is considered a priority asset. This study uses information from an organization in the education sector that like many other organizations in other sectors has increasingly presented challenges associated with KM processes.

Taking into account the study “Communities of Practice: A brief introduction” (Wenger, E., 2009), the perspective of CoPs affects educational practices along three dimensions:

- Internally: Organization of experiences and events based on academic learning, taking into account the participation in communities of practice around subjects defined in this context;
- Externally: Correlation between students' experience with other communities of practice outside the academic environment, especially in an organizational context;
- Over the lifetime of students: Existence of communities of practice that serve the continuous learning needs of students over time. These communities should promote topics that enable a continuous interest in the topics they promote.

The communities used in this study were created at the beginning of each of the academic years referenced for the research. These communities of practice act in accordance with a strategic methodology called Problem-Based Learning (PBL). This term was first developed in the study “Approach to Medical Education” (Barrows, H. S., & Tamblyn, R. M., 1980) and was defined as a very specific approach to education in medicine, supported by tools designed to facilitate a specific teaching-learning process. PBL uses a strategy that uses open-ended problems to mirror real problems, this way these problems allow students to transfer the knowledge generated and skills beyond the classroom.

The result survey used to measure the value generated at the knowledge level intends to evaluate the students' behavior throughout the different problems and confront this behavior with the way each member of these group communities deals with group work, which is supported by a set of HF. The value of the knowledge generated will contemplate the difference between the situation of the CoPs before and after the learning process.

It is important to mention that the period under analysis was marked by a pandemic context that often made it impossible to have a closer contact between the members of the CoPs. The classes were given in a hybrid regime, with the possibility of choice among the students for the regime they wished to attend, mostly virtual or mostly face-to-face.

4.3. RESULT SURVEY

The questionnaire that was developed has as its main objective to measure and evaluate the knowledge generated in the communities that were created. This questionnaire intends to serve as a knowledge base to analyze the behavior of the members of the existing CoPs.

The knowledge generated by the communities is evaluated by taking into account the five cycles of value creation that support the VC Framework (Wenger, E., Trayner, B., & de Laat, M., 2011), being possible through the questions presented, to assess and measure the opinion that each of the students had about their performance and the community they represent. Thus, it may be possible to draw conclusions that allow verifying the impact of the level of immediate value generated, the value potentially generated, the value effectively applied, realized, beyond the value that corresponds to the reformed understanding of learning and success criteria. The information associated with each cycle

can be compared with the individual characteristics that each student has in usual group work, these characteristics are associated with different human factors that support a PA methodology.

The value creation identified, and the knowledge generated comes from the value of learning made possible by community involvement. The acquired learning is evaluated by taking into account the accumulated experience of the students along the different problems that were faced and analyzed, taking into account a PBL methodology, which is structurally associated to the curricular unit that serves as the basis for this research. In methodological terms, the value created is intrinsically associated with the knowledge generated as it corresponds to the value made possible by community involvement and networking. This involvement intends to promote the creation of new knowledge in order to address and solve the problems presented through the PBL methodology.

The questionnaire also contemplates the aspect associated with the analysis of some human factors indicated in the study "Sentiment analysis in organizational work: Towards an ontology of people analytics" (Gelbard, R., Ramon-Gonen, R., Carmeli, A., Bittmann, R. M., & Talyansky, R, 2018), as support for a vision of PA in organizations.

Thus, it will be possible to validate the importance of the management of human factors in the creation of value by the different CoPs through the validation of the preponderance of these factors in the different cycles of value creation. This value creation derives from the learning acquired at the level of the different themes that were developed through the PBL methodology. These factors will end up defining what students normally value or not in group work, this opinion being supported by the behavior and individual characteristics of each student.

4.4. DATA COLLECTION AND ANALYSIS

The questionnaire was made available to all the students who enrolled in a given curricular unit in the last two school years that correspond to the years 2020/2021 and 2021/2022, and the final universe of answers is only associated with the students who accepted to be part of this research.

The questionnaire developed was conducted on Qualtrics. As previously mentioned, this questionnaire is divided in two parts, PA indicators analysis and KM evaluation through the value creation cycles. The questionnaire's ultimate goal is to assess the value generated by the different communities and to understand how this can be related to the individual characteristics of students and the way they adapt to group work.

This questionnaire starts with more general questions that allow to characterize the population under study and then the two aspects explained above are introduced, starting in a more general way through the evaluation of the different human factors and the identification of the students' behavior in group work, until the detail of each student's behavior as a member of a CoP, through the verification of the value of the acquired learning, in each one of the cycles of value creation.

The first part of the questionnaire covers general introductory questions about the individuals of each CoPs, such as age, gender or employment status.

In the second phase of the questionnaire, some questions are asked about the configuration of Knowledge Management classes and the constitution of the different CoPs, as well as information regarding the different problems.

The following topics represent the approaches that are verified in this stage of the questionnaire:

- Configuration of the CoPs created to solve problems throughout the semester;
- Configuration of meetings held throughout the semester to solve problems;
- The problem considered the most complex and difficult to solve;
- The number of meetings necessary to develop and solve the most complex problem.

In the third phase of the questionnaire, some questions are asked about the way an individual works in a group, how interact and behave with other members, as well as some of the main characteristics of an individual that can influence group work. At this stage, some questions related to some of the components of People Analytics and Relational Analytics are applied to the questionnaire. These questions are supported by some of the human factors identified in the study "Sentiment analysis in organizational work: Towards an ontology of people analytics" (Gelbard, R., Ramon-Gonen, R., Carmeli, A., Bittmann, R. M., & Talyansky, R, 2018).

The following topics represent each one of the areas that are measured within the People Analytics methodology:

- Drivers of group dynamics;
  - Students' behavior in group work is verified according to their ability to communicate, connectivity, psychological safety and organization.
- Engagement Indicators;
  - The importance of group identification, sense of belonging, trust and leadership have on the motivational level of the students.
- Performance;
  - Performance measurement (PM) which is related with the students' usual performance in group work, and is divided into factors such as Creativity, Innovation, Efficiency and Effectiveness.
- Type of Learning;
  - Verification of how students acquire more knowledge, through the following types of learning: Learning from failure, Learning from success, Learning from direct experience and Learning from indirect experience.
- Knowledge Creation Environment.
  - Factors that, in the students' view, most value the sharing and creation of knowledge in group work. The factors considered are the division of roles during the learning process, promotion of recurrent meetings or regular exchange of ideas.

After validating the human factors associated with the usual performance in group work of the members of the communities of practice, there follows specifically a focus on the problems developed through the PBL methodology within a specific curricular unit, and in the detail of each of the cycles of value identified in the VC Framework (Wenger, E., Trayner, B., & de Laat, M., 2011).

In the fourth phase of the questionnaire, some questions are directed to measure the immediate value of knowledge generated through the level of participation in the CoP, the level of engagement and the level of interactions between the members.

Indicators for this cycle refer directly to community activities. These indicators are measured in this stage:

- Meetings Attendance;
- Members Interaction;
- Intensity of the Interactions;
- Quality of the Interactions;
- Relevance of the Interactions;
- Importance of the experience in the creation of new knowledge;
- Interactions with other CoPs.

In the fifth phase of the questionnaire, some questions are asked to measure the potential value of knowledge through the validation of skills acquired over the different problems, emotional responses to different challenges, the resources generated and the ability to transfer the knowledge generated in CoP to other contexts.

Forms of knowledge capital identified in the questionnaire:

- Personal assets (human capital);
  - Personal value of participation in a CoP.
- Relationships and connections (social capital);
  - Ability to ask questions;
  - Social relations and connections.
- Resources (tangible capital);
  - Pieces of information, documents, tools and procedures.
- Collective intangible assets (reputational capital);
  - Reputation of the CoP.
- Recognition of the strategic relevance of the domain;
- Transformed ability to learn (learning capital).
  - Transfer of CoP experience to other contexts.

Given the different concepts identified above, these are the indicators that are measured in this stage:

- New Skills Acquired;
- Number of References;
- Size of Files;
- CoP Evolution;
- Participation in the CoP.

In the sixth phase, some questions are asked to measure the applied value of knowledge by identifying how the knowledge acquired in the CoP was applied in practice. These indicators are measured in this stage:

- Influence of the participation in CoP to the ability to manage and use new knowledge;
- Reuse of Knowledge.

In the seventh phase, some questions are asked to measure the realized value of knowledge, through the identification of changes in behavior and performance promoted by the participation in the CoP. In this cycle are used metrics of performance that are related to the potential contributions of communities and networks. These indicators are measured in this stage:

- Changes in Personal Performance;
- Importance of the feedback during the Learning Process;
- Use of generated knowledge to make suggestions or leverage changes in other CoP.

In the eighth and last phase, some questions are asked to measure the reframing value of knowledge, with knowledge generated in the CoP for the development of new studies and new approaches and perspectives. In this cycle, it is possible to validate indicators that show signs of change that can translate into success for both participants and their environment. These indicators are measured in this stage:

- Community Aspirations;
- New learning agenda;
- New discourse about value;
- New vision.

Taking into account what is described in the VC Framework (Wenger, E., Trayner, B., & de Laat, M., 2011), data can be collected for each cycle and provide useful information. However, it should be noted that indicators act as proxies and assumptions for value creation, taking into account that observations in one cycle may be indications that justify the behavior of another cycle of the framework.

After the implementation of the questionnaire and the collection of responses, the information analysis will take place. This analysis will be mainly descriptive, where the different phases of value creation and their association to the identified human factors will be taken into account. This analysis will also be supported by an analysis of clusters, which will allow to verify patterns in the students' behavior and, together with this information, to ensure strategies to improve the performance of the communities of practice throughout the learning process for each group identified in each of the cycles of value creation.

5. RESULTS AND DISCUSSION

5.1. UNIVERSE OF ANSWERS

After the questionnaire had been implemented in Qualtrics and the students' answers had been registered, this information was extracted so that the analysis of the results could be carried out. According to the teachers responsible for the curricular unit that was used in this study, the number of students who answered the questionnaire was considered significant to explain the behavior of the communities of practice that were created, responses from 145 students who enrolled in this curricular unit in the academic years of 2020/2021 and 2021/2022 were considered.

5.2. VARIABLES UNDER STUDY

The questionnaire is divided into 8 blocks that aim to assess different variables according to the theme each one addresses. It will be on these variables that the data analysis will be done.

1. General Questions - In this first phase of the questionnaire, general questions are asked. These questions allow the characterization of the universe of students who decided to answer the questionnaire in terms of age, gender, country of residence and employment situation.

Variable	**Description**
Age	Student's age
Gender	Student's gender
Country	Student's country of residence
Employment	Indication whether students are working or not
Employment_Status	Indication of students' employment status (full-time, part-time)

Table 1 - General Questions variables

2. Configuration of the curricular unit and CoPs - In this second phase of the questionnaire, some questions are asked about the configuration of the curricular unit classes and the constitution of the different CoPs, as well as information regarding the different problems addressed.

Variable	**Description**
Group_Number	Indication of the working group
Members_Number	Number of members of the working group
Change_in_Members	Indication whether the number of members has changed or not
Classes	Indication of changes in the number of members of the working groups
Meetings	How the students attended the curricular unit classes (mostly online or at home)
PBL_Detail	Indication of the problem that students found most complex to develop or solve
Complex_PBL	The number of meetings necessary to develop and solve the most complex problem

Table 2 - Configuration of the curricular unit variables

3. People Analytics/ Human factors - In this third phase of the questionnaire, some questions are asked about the way students work in a group, how they interact and behave with other members, as well as some of their main characteristics that can influence group work. In this phase human factors associated with the members of each CoP are identified, these factors are intrinsically related to group dynamics, engagement indicators, performance, type of learning and knowledge creation environment.

Variable	**Description**
Individual_or_Group	Type of work that students prefer (Individual or Group)
Group_Dynamics_1	Importance of the feedback from other members
Group_Dynamics_2	Importance of managing expectations
Group_Dynamics_3	Importance of communication based on the accuracy and relevance of the information
Group_Dynamics_4	Importance of connectivity between all members based on the relationships created between them and the characteristics of each one
Group_Dynamics_5	Importance of the division of tasks according to the knowledge that each member has of the subject under study
Group_Dynamics_6	Importance of taking into account the emotional responses, such as feelings of satisfaction or identification, of each member throughout the development of the tasks
Group_Dynamics_7	Importance to have control over all the topics that should be analyzed and how they should be analyzed a priori
Engagement	Process of team interaction and discussion of ideas most valued by students
Performance_1	Students' level of creativity
Performance_2	Students' level of innovation
Performance_3	Students' level of efficiency
Performance_4	Level of quality in the delivery of results by students
Performance_5	Students' level of motivation by objectives
Performance_6	Student leadership level (active voice)
Performance_7	Level of exchange and sharing of ideas with other students
Performance_8	Students' need to have all topics on control
Performance_9	Students' level of reaction under pressure
Type_of_Learning	Learning Methodology
Knowledge_Creation_1	Level of valorization of the exchange of ideas to create knowledge on a regular basis
Knowledge_Creation_2	Level of valorization of a high number of rounds to discuss ideas in the process of learning and knowledge generation
Knowledge_Creation_3	Level of the valorization of the division of roles in the learning and knowledge generation process

Table 3 - People Analytics/Human factors variables

4. Immediate Value - In this fourth phase of the questionnaire, some questions are asked to measure the immediate value of knowledge generated through the level of participation in the CoP, the level of engagement and the level of interactions between the members. In this phase indicators associated with the level of participation, level of activity, level of engagement and quality of interactions are evaluated.

Variable	**Description**
Number_of_Meetings	Number of meetings held by the group
Meetings_Attendance	Number of meetings attended
Hours_assigned	The Average duration of the meetings
Members_Interaction	Indication if there were interactions with the whole group or only interactions with a part of the members
Intensity_Applied	Indication if the intensity of the connections was the same or if it was different among all members
Level_of_Intensity_1	The Intensity level of interactions (Level of engagement)
Level_of_Quality_1	The Quality level of interactions (Debates on important issues)
Level_of_Relevance_1	Relevance level of interactions
Level_of_Experience_1	Importance level of practice into the learning space
Interact_other_CoP	Indication of the existence of interactions with members of other CoP
Intensity_other_CoP_1	The Intensity level of interactions with members of other CoP (Level of engagement)
Quality_other_CoP_1	The Quality level of interactions with members of other CoP (Level of engagement)

Table 4 - Immediate Value variables

5. Potential Value - In this fifth phase indicators associated with the level of skills acquired, changes in perspective, level of trust, documentation and reputation of the community are evaluated.

Variable	**Description**
Skills	Indication of whether or not students have acquired new skills throughout the learning process
New_Skills	Skills Acquired
Attitude	Indication of whether or not a participation in the CoP has changed students' attitudes to solving similar problems
Attitude_Topics_1	Motivation level as a driver of attitude change
Attitude_Topics_2	Confidence level as a driver of attitude change
Attitude_Topics_3	"Sense of Importance" level as a driver of attitude change
Ask	Indication of whether or not CoP participation has improved the ability to question
Ask_Topics_1	Trust level as a factor that contributed to improving the ability to ask questions
Ask_Topics_2	Commitment Level as a factor that contributed to improving the ability to ask questions
Number_of_References	Number of references used during the learning process and the creation of new knowledge
Size_of_Files	Size of files shared with other members of the CoP
CoP_Evolution	Indication of whether there has been a positive evolution of the work of the CoP over the different problems
Evolution_Topics_1	Contribution level of the recognition of the strategic relevance of the domain to the evolution of the CoP status
Evolution_Topics_2	Contribution level of the perceived significance of CoP membership to the evolution of the CoP status
Evolution_Topics_3	Contribution level Feedback from teachers or members of other groups to the evolution of the CoP status
Learning_Capital_1	Indication of whether the participation in the CoP allowed the transfer of the experience acquired to other contexts
Learning_Capital_2	Indication of whether the participation in the CoP allowed to see new learning opportunities

Table 5 - Potential Value variables

6. Applied Value - In this sixth phase, some questions are asked to measure the applied value of knowledge by identifying how the knowledge acquired in the CoP was applied in practice. At this stage, indicators associated with the level of innovation put into practice are identified through the identification of new ways of doing things, new perspectives and new concepts.

Variable	**Description**
Difference_in_KM	Indication whether the participation made a difference in the ability to manage and create new knowledge
Skills_Acquired	Indication whether the skills acquired in the CoP work were reflected at a practical level
Reuse_of_Knowledge_1	Level of reused knowledge in promoting process change
Reuse_of_Knowledge_2	Level of reused knowledge in the implementation of new ideas and perspectives
Reuse_of_Knowledge_3	Level of reused knowledge to give new suggestions, solutions and insights

Table 6 - Applied Value variables

7. Realized Value - In this seventh phase, some questions are asked to measure the realized value of knowledge, through the identification of changes in behavior and performance promoted by the participation in the CoP. In this phase, indicators associated to the level of personal performance are identified.

Variable	**Description**
R_Value_1	Indication of whether or not CoP a participation has improved the ability to find relevant knowledge
R_Value_2	Indication of whether or not participation in the CoP allowed for more efficient presentation of results
R_Value_3	Indication of whether or not the feedback given during the learning process allowed to be more precise in the following research
Other_CoP	Indication whether the knowledge generated was used to leverage or suggest changes to other CoP

Table 7 - Realized Value variables

8. Reframing Value - In this eighth phase, some questions will be asked to measure the reframing value of knowledge, with knowledge generated in the CoP for the development of new studies and new approaches and perspectives. At this stage, indicators associated with the level of aspirations of the CoP are identified.

Variable	**Description**
RF_Value_1	Indication of whether or not students have in mind a new learning agenda based on the problems developed
RF_Value_2	Indication of whether or not students have in mind a new discourse about the additional value that can be extracted from the research done on the developed problems
RF_Value_3	Indication of whether or not students have in mind the investigation of another vision of the problems developed based on the generated knowledge
RF_Value_4	Indication of whether or not students will apply the knowledge generated in the learning process in the development of future frameworks or processes

Table 8 - Reframing Value variables

5.3. DESCRIPTIVE ANALYSIS

The second phase of the methodological process is based on the detailed analysis of the phenomenon under study, based on an approach that is mostly descriptive. This analysis can also be seen as an analysis of the main inputs, inputs given by students in the answers to the questionnaire, being later validated the final output corresponding to the verification of value creation. The descriptive analysis developed aims to support the research objectives.

The descriptive analysis is based in a first phase on an exploratory analysis in order to understand in detail the phenomenon under study and characterize the universe of responses to prepare a future segmentation. In this study the correlation values between the variables were verified in this first phase, the distribution of each variable was also verified as well as the behavior of each one using graphical elements of data visualization.

Afterwards a clustering methodology was used, where each phase of the questionnaire was verified, as is the case of the segmentation of the universe of students within the different cycles of value creation. The clustering methodology used in this study was related to the use of a Partitioning Clustering Algorithm in this case a hard partitioning algorithm called K-means, where each observation can only belong to a single cluster. In this segmentation stage, the main objective is to create homogeneous groups of customers with similar behaviors inside the clusters, and very different from the customers in the other clusters. In the cluster definition process, some properties like standardization and principal component analysis were used. There were variables with completely different units and scales. To not overestimate or underestimate the weight of any variable, it was applied standardization in the clustering process, in this way it is possible to put variables in the same scale by dividing these variable values by the standard deviation. The use of principal component analysis was used as a method of initialization for the cluster seeds. The principal components setting initializes seeds on an evenly spaced grid in the plane of the first two principal components.

By using the k-means partition algorithm, the number of clusters can be specifically chosen by the user. This method will be used to define clusters associated with CoP details, Human factors associated with the usual group work that are divided into group dynamics, knowledge creation in group work and group work performance. Clusters will also be defined according to the different cycles of value creation that are divided into Immediate Value, Potential Value, Applied Value, Realized Value and Reframing value.

Given the complexity and length of the questionnaire, as well as the number of variables that compose it, the cluster analysis performed has different starting points associated with each step of the questionnaire, from the most general to the highest level of detail. The variables associated with each step are the segmentation variables, in some particular cases more than one step are aggregated into a single starting point. From each of the different starting points the impacts of the other variables are verified for the importance they have in each segmentation, through their importance in the description of each cluster. This division is also due to the methodology explained above since it is important to verify the isolated situation of each of the methodological strands, this detail would be lost if all the stages were aggregated into a single starting point of segmentation of the universe under study.

5.3.1. General Questions

The universe under study is composed of 145 students, these students have in common the fact that they have attended the curricular unit used for this research classes in one of the last two academic years, where a part of the final assessment in the curricular unit resulted from problem-solving in CoPs through the PBL methodology.

The universe of students living outside Portugal, although within the analysis perimeter, does not present relevant impacts on the analysis of the behavior of communities of practice as it is only limited to 4 students, thus country of residence will not be used as a segmentation variable. It is verified that 97% of students who agreed to answer the questionnaire are currently living in Portugal.

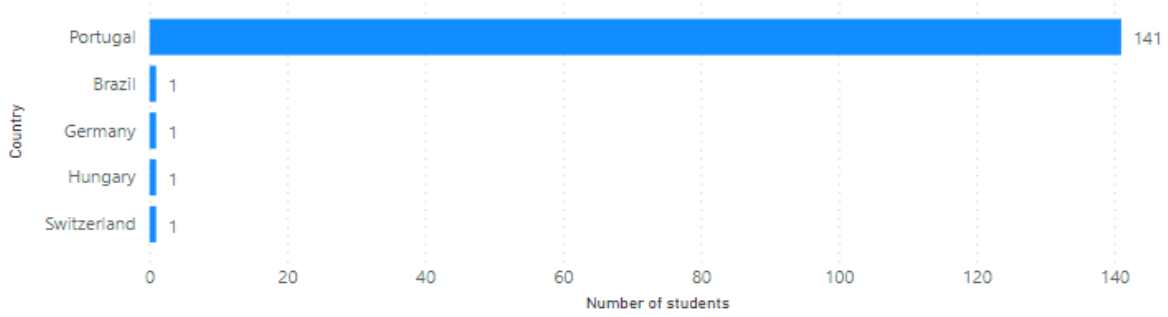

Figure 1 - Number of students by country

The average age of students who agreed to answer the questionnaire is 27 years old, and most of them are in a full-time employment situation. The variable associated to the students' gender shows a tendency of balance in what concerns to male and female students, although 28 more male students answered the questionnaire than female. The groups of individuals that tend to generate a higher level of knowledge are also associated with more advanced ages, the experience factor is considered relevant to explain this trend. The degree of employability varies in the direction of age, as for older ages there is a greater proportion of full-time employability status.

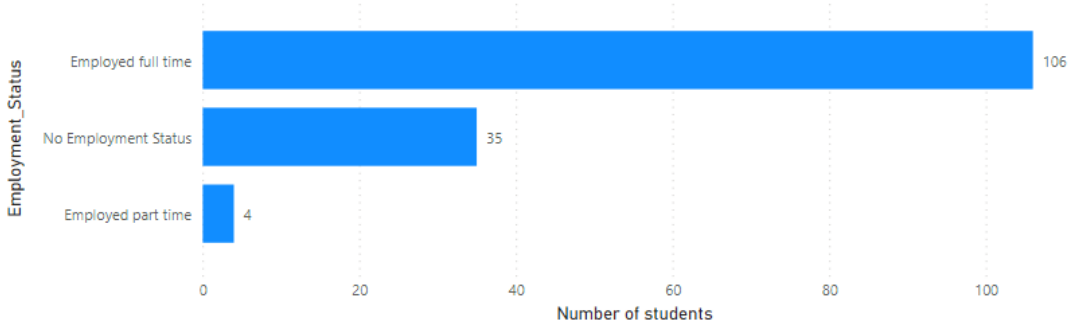

Figure 2 - Number of students by Employment Status

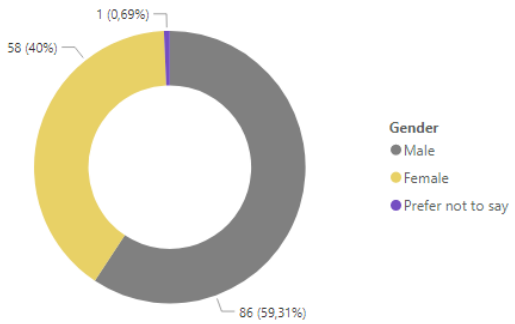

Figure 3 - Number of students by gender

5.3.2. CoP Details

Given the pandemic situation of the last 2 years, classes took place in a hybrid regime, due to this situation the interactions of the students and the knowledge generated during the classes and meetings were influenced by a regime that was not 100% face-to-face. The vast majority of students who answered the questionnaire attended classes online, the meetings were also mostly online, and the observed values take into account this type of regime. Most of the individuals belonged to CoPs with 3 to 5 members, these communities were mostly static work groups, only in less common situations there were entries and exits throughout the semester, changing their dimension.

With regard to the configuration of the different problems using the PBL methodology, the vast majority of students, around 75% of students, report having needed an average of 2 to 4 meetings to resolve the topic they consider more complex. The students indicated that the most difficult PBL problem to solve was the first to be carried out in the curricular unit, followed by the second, considering the last problem the easiest to solve. This trend reveals an adaptation of the students to the PBL methodology and an improvement in the performance status of the different CoPs, since the difficulty of each problem tends to be equivalent.

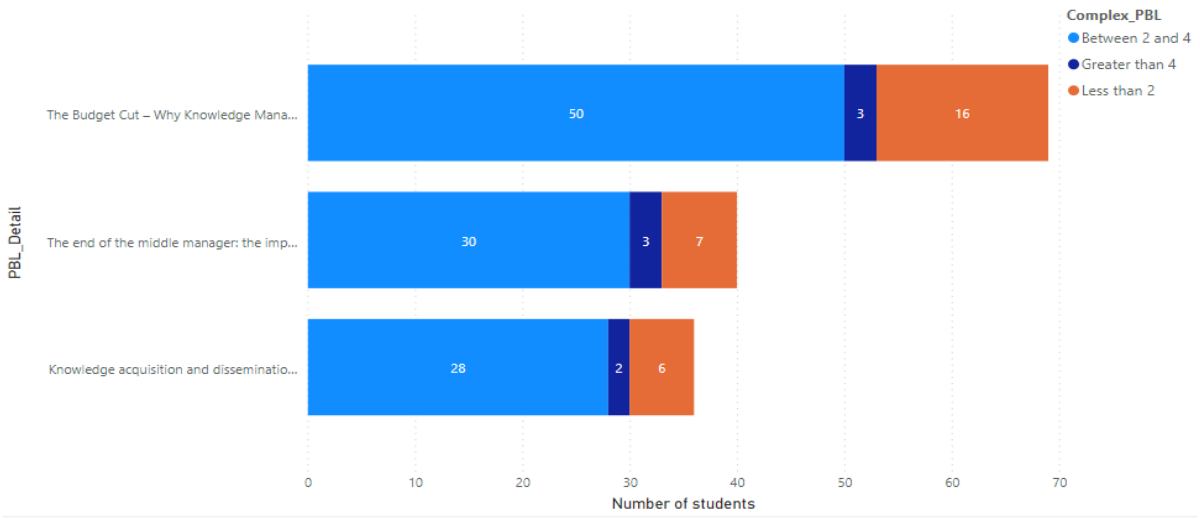

Figure 4 - Most difficult problem and the number of meetings necessary to solve it

5.3.2.1. CoP Details in Value Creation

In order to understand the influence of the curricular unit configuration and the details of each community in the cycles of value creation, a segmentation of the students was carried out having as a starting point the variables associated with the curricular unit configuration. In addition to the variables mentioned, were added variables addressed in the first topic of the questionnaire associated to more general issues. In this way, it is possible to verify through a cluster analysis how these variables are positioned when combined with the others, namely with those corresponding to the different cycles of value creation. This information is verified by the characteristics of each cluster, taking into account which variables characterize each cluster taking into account the starting point.

The variables that contemplate this starting point do not go into detail about group behavior and do not go specifically into the detail of each individual in the different moments of learning and value creation. These variables only explain the distribution of each community of practice and methodological configuration of the curricular unit, having been added variables such as employment status, age and gender.

The country variable has not been included as it shows practically the same value for the different students, with the exception of four students. The employment variable was not used in this segmentation exercise because it has a similar behavior to the employment status variable. For reasons associated with the data quality of the questionnaire itself, the variable associated with the group number related to each student was not used. The details associated with the complexity of the questionnaire, having been previously analyzed, were not considered relevant to the segmentation created.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be three. In the explained definition process the internal standardization method was used, the ordinal variable coding was set to “Rank” and the nominal to “GLM”, it was also specified “Princomp” as the method to use to compute the initial cluster seeds.

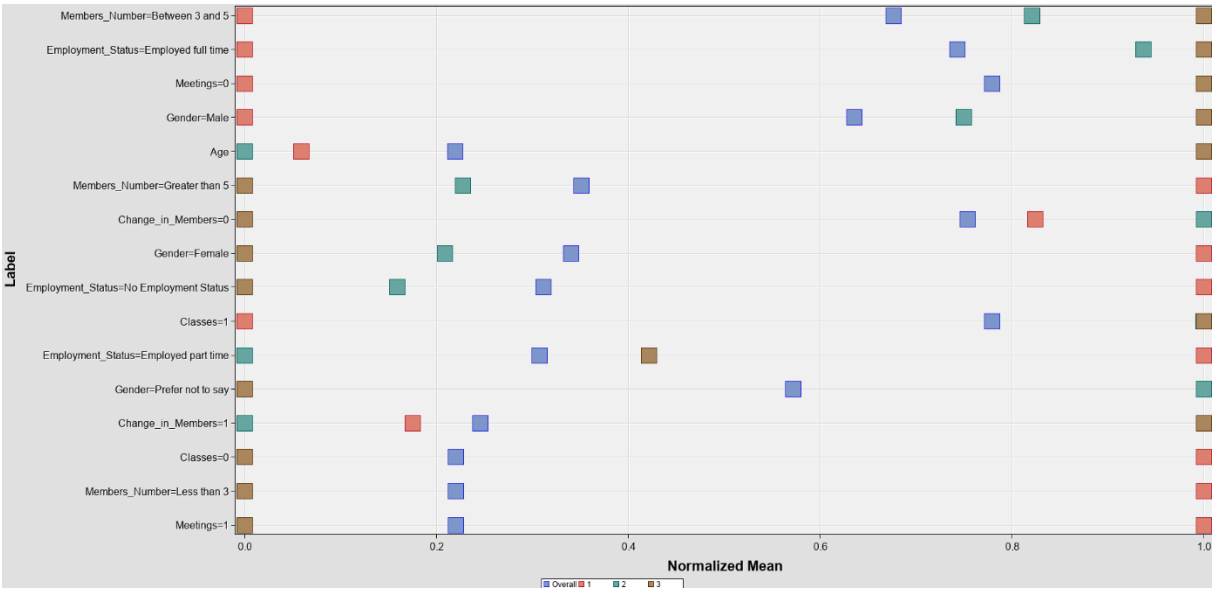

Figure 5 - CoP Details Input Means Plot

Cluster 1 - This cluster is mainly composed of students who belonged to CoPs with either very large or very small dimensions, with this inconsistency in terms of size associated with possible entries or exits. It is a cluster associated with a group of students who are mostly not working full-time. In this cluster, the predominant gender is female, and the age is close to the average. At the level of immediate value, is a cluster that presents high levels of quality and intensity of interactions between members of the same community. The same behavior is verified in interactions with other CoPs in terms of the quality of interactions. In terms of potential value, this group also presents high values in the topics of evolution and attitude. Students who mostly have face-to-face meetings and classes.

Cluster 2 - Cluster that presents the behavior closest to the identified average, having as its main characteristic the fact that the students of this cluster did not have in the composition of their CoPs significant cases of entry or exit of other members. Students who mostly have online meetings and classes, this cluster is also composed mainly of students of younger ages. At the level of immediate value, there are consistent levels of intensity of interactions between members of the same community, without any relevant value, however, it is also verified that the quality of interactions with other communities is certainly not a strong point of this segment, also because these students are mostly online, which makes this interaction not so natural. At the potential and realized value levels, values consistent with the mean are verified.

Cluster 3 - Cluster characterized by students who are mostly older than the verified average, most of whom are full-time employees, this group has mostly online classes and meetings, and the groups where they are inserted vary between 3 and 5 students, although in some cases there are entries and exits of members. At an immediate level, it is important to highlight the high value of the level of experience and intensity that these students brought to the interactions they had in the learning process and knowledge creation. At the potential level, some values imply an improvement in the status of communities of practice over time and at the applied level, there are considerable levels of reuse of knowledge.

It is important to reinforce for older ages the impact of the level of experience in interactions between members of a community of practice. It is possible to verify that the groups that changed their composition or size over time do not present significant differences in terms of potential or immediate knowledge.

5.3.3. People Analytics - Human factors

5.3.3.1. Correlations and other relevant aspects

Through the verification and analysis of the correlation matrix between the indicators associated with the HF and the different cycles and the descriptive analysis of some of the factors that contemplate these factors, it was possible to identify some behaviors, explained below.

Some of the behaviors verified taking into account the indicators associated with HF in the different VC cycles:

- It is verified that obtaining feedback from other members in a group work is considered the dynamic with the highest correlation with the value of knowledge created over the different cycles of value creation;

- It is verified that for students in a group work, having control over all the topics, that should be analyzed and how they should be analyzed a priori, is presented as a factor/dynamic that least students find relevant. This factor does not configure a model to be adopted in CoPs when it is not associated with the division of tasks according to the knowledge that each member has about the topics under study. This model can be possibly adopted and brings great benefits when it is associated with the division of tasks, this is verified in the positive impact that these two premises together have on the cycles of value creation for students who find them relevant, since this division and the fact that each member has knowledge about all tasks can configure knowledge sharing;

- It is verified the importance of the valorization of exchanging ideas to create knowledge on a regular basis in group work, being more correlated with the different topics associated with higher values of knowledge generated in a continuous and gradual way, being more important for students than a greater number of rounds to discuss ideas in the learning process and knowledge generation and the division of roles in the learning and knowledge generation process;

- Performance indicators tend to vary their degree of importance according to the stage of the value creation cycle. However, it is identified that the fact that students usually share and exchange ideas in other contexts and group work becomes a relevant indicator, as higher values of this indicator correspond to greater relevance of the knowledge generated. In realized value and in potential value, the indicators of value creation highlight a greater correlation with the performance of students according to their motivation according to the objectives outlined;

- Students who prefer to work in groups are associated with higher values of generated knowledge, compared to those who prefer to work individually;

- It is verified that the indicators associated with PA are more correlated with the cycle of immediate knowledge and value generation and therefore should be taken into consideration since influencing the first cycle of value creation will impact the rest of the knowledge generation chain;

- The level of experience, the importance of experience in the creation of new knowledge, is considered the one that most impacts the level of value generated immediately, as it is the one that has a higher average value in this category;

- At the level of engagement, the factor that triggers the greatest value at all levels of knowledge generated is the connection between members based on trust and communication, rather than identification with the group/sense of belonging and leadership and task orientation;

- In terms of the type of learning preferred by students, the factor that triggers the greatest value at all levels of knowledge generated is direct experience learning (time spent on the firm portal);

- At the level of the engagement indicator associated with the people analytics variables, it is observed that students who prefer to work individually value the indicator "Identification with the group and feeling of belonging" more than students who prefer to work in a group, who value more the indicator "Group dynamics based on connectivity between members, trust and communication". In this way, it is observed that students who prefer to work individually have as their main premise the integration into a group that allows them to promote a sense of belonging, while students who prefer to work in groups, value more a group that allows them to develop their communication skills by building trust. As a complement, it is verified that students who prefer to work individually, and especially those who tend to value the indicator "Identification with the group and feeling of belonging" present themselves as having a reduced value in the performance indicator "I like to be an active voice in the delineation of tasks and processes" when compared to other types of engagement and students who prefer to work in groups. Thus, it is observed that students who are in this category will improve their level of knowledge generated when they find a group that, due to its characteristics, makes them feel an important part in the design of processes, allowing them to develop communication skills.

5.3.3.2. Group Dynamics

One of the HF used in this study to measure the possible impact on the value created was group dynamics. To validate the preponderance or not of the different indicators associated with group dynamics, the different segments formed by these variables were validated, and these variables will be the starting point for clustering. All the questionnaire variables associated with group dynamics were used in this segmentation exercise.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be three. In the explained definition process the internal standardization method was used, the ordinal variable coding was set to “Rank” and the nominal to “GLM”, it was also specified “Princomp” as the method to use to compute the initial cluster seeds.

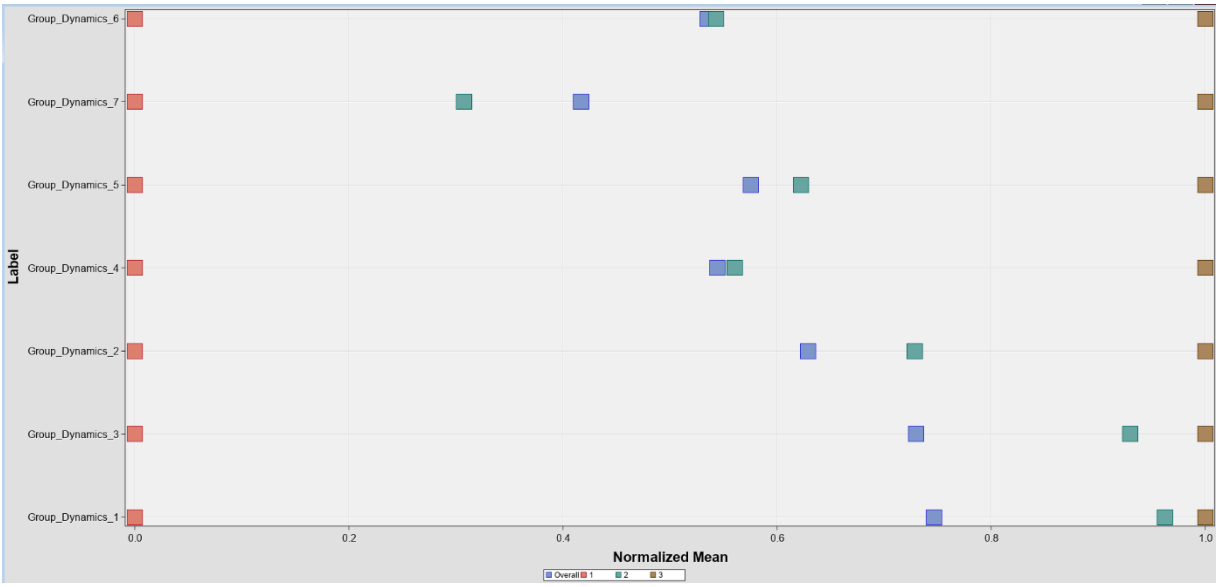

Figure 6 - Group Dynamics Input Means Plot

Cluster 1 - Cluster characterized as having the lowest values in terms of group dynamics indicators, mainly in the dynamics associated with the importance of feedback from other group members, management of expectations, and the importance of communication based on the relevance of information. At the level of immediate value generated, there are reduced values of quality/relevance and intensity in interactions during the learning process and generation of new knowledge. In terms of potential value, there are reduced values associated with indicators that measure the evolution of the community of practice over time. In this way, and although this group represents only 23% of the universe under evaluation, it is possible to identify that low values associated with group dynamics are reflected in a lower capacity to generate relevant knowledge in communities, with implications at the level of immediate value.

Cluster 2 - Cluster that presents the values closest to the verified average, representing the majority of the population. At the level of group dynamics, there are high values related to dynamics associated with the importance of feedback from other group members and the importance of communication based on the relevance of information. The cluster presents low values in the dynamics associated with the need to have all topics under control. In terms of immediate value, consistent values of quality, relevance and intensity in interactions stand out. At a potential level, this cluster stands out for students who show a positive evolution of the status of their communities of practice motivated mainly by members of other groups and teachers. At the level of applied value, there are high values of knowledge reuse. Thus, this cluster is mainly characterized by students, who value the individual characteristics of each one and prioritize the existing connections between them.

Cluster 3 - Cluster that presents the highest values in the indicators of group dynamics. This segment represents 26% of the universe under evaluation and in terms of group dynamics, it is verified that students value the importance of having all topics under control through knowledge sharing as well as the division of tasks according to the knowledge that each student has about each topic. At an immediate level, the relevance of information as well as the importance of the experience factor in interactions is verified.

It is possible to observe that the behavior of a large part of the population shows medium-high values in terms of group dynamics. This behavior is motivated by the importance of connections between individuals based on the characteristics of each one, which promotes impact at the level of immediate value, with a medium-high value associated with the quality, relevance and intensity of interactions. A large part of this group of students, which represents the majority of the population, shows positive values of knowledge reuse and shows a positive evolution of the status of the different CoPs, the main driver reported is based on the importance of feedback from teachers and other students. It is observed that higher indicators of value creation and subsequent knowledge are associated with group dynamics that promote the creation of knowledge such as the exchange of ideas on a regular basis, the division of tasks and roles throughout the learning process and the appreciation of a high number of rounds to discuss ideas and brainstorm. It is also verified that group dynamics has a greater impact on the cycles of Immediate, Potential and Applied VC.

5.3.3.3. Knowledge Creation

Similarly, to the indicators associated with the different group dynamics, the factors associated with the environment surrounding knowledge creation were isolated so that the different clusters created could be validated taking into account these indicators at the starting point. All the questionnaire variables associated with knowledge creation were used in this segmentation exercise.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be three. In the explained definition process the internal standardization method was used, the ordinal variable coding was set to "Rank" and the nominal to "GLM", it was also specified "Princomp" as the method to use to compute the initial cluster seeds.

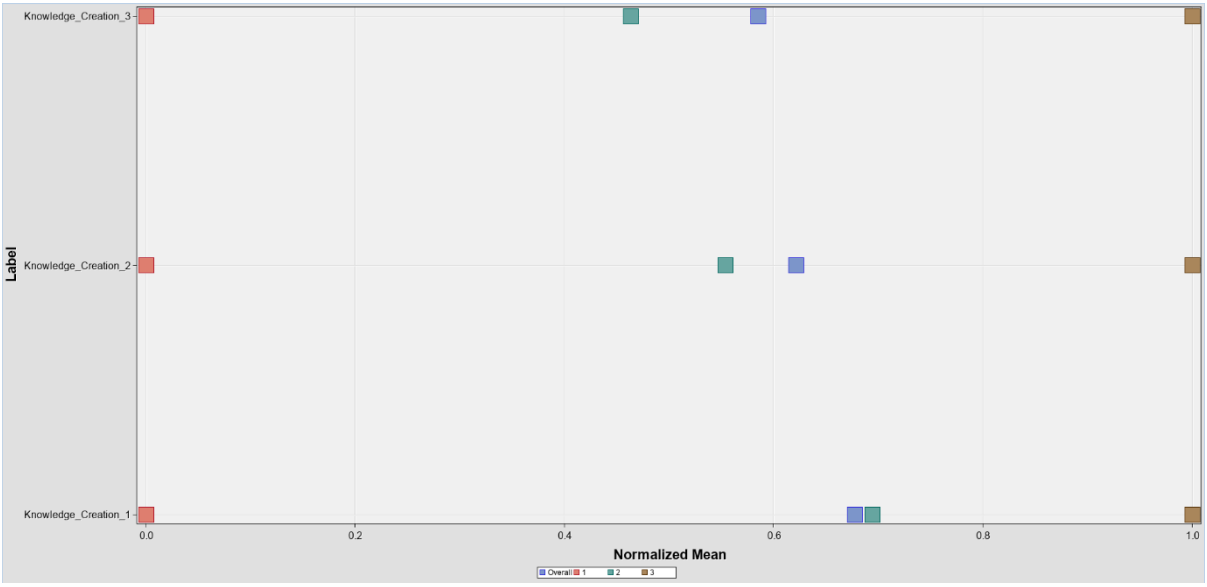

Figure 7 - Knowledge Creation Input Means Plot

Cluster 1 - Cluster characterized as having the lowest values in terms of knowledge creation indicators. This cluster is mainly characterized by students who, for the most part, do not value the exchange of knowledge-based ideas on a regular basis, and who do not value innovative ideas and new alternatives in meetings. They are students who, at the level of immediate value creation, demonstrate a lack of quality, intensity and relevance of interactions. At the potential level, they are characterized as students who indicate that they have not changed their attitude/behavior throughout the learning process and knowledge creation, being associated with low levels of motivation.

Cluster 2 - Cluster that presents the values closest to the verified average, representing 40% of the population. Cluster that is mainly characterized by students who, in terms of applied value, encourage the reuse of Knowledge to give new suggestions, solutions and insights and who, in terms of performance, value the exchange of ideas with other students. At immediate value levels, the intensity and relevance of interactions and potential indicators of evolution and change of attitude during the learning process and creation of new knowledge are verified.

Cluster 3 - Cluster that presents the highest values in the indicators of knowledge creation. At performance levels, there are very high indicators of the exchange of ideas with other students, which

translates into the level of immediate value in the quality/relevance of interactions, which is revealed through consistent interactions with other communities.

The students with the lowest values in the indicators associated with knowledge creation, i.e. students who do not consider relevant the surrounding environment for knowledge creation, are students who do not value or consider irrelevant the feedback from other members of the community within the group dynamics. These students mainly value at the level of engagement the identification with the group and feeling of belonging, being a requirement for an adaptation to the group so that only afterwards can group dynamics be promoted, which will influence the immediate level of the value creation process and consequently the acquired potential. The vast majority of students consider the surrounding environment for knowledge creation a relevant in a usual group work, which is verified by mostly medium-high values in the indicators associated with this topic.

5.3.3.4. Performance

It was also validated the creation of clusters based on different performance indicators, this segmentation aims to verify the different groups that these indicators form in the set of other variables, by analyzing this segmentation it will be possible to understand the different groupings that are mapped between these indicators and the different cycles of value creation. All the questionnaire variables associated with performance indicators were used in this segmentation exercise.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be three. In the explained definition process the internal standardization method was used, the ordinal variable coding was set to “Rank” and the nominal to “GLM”, it was also specified “Princomp” as the method to use to compute the initial cluster seeds.

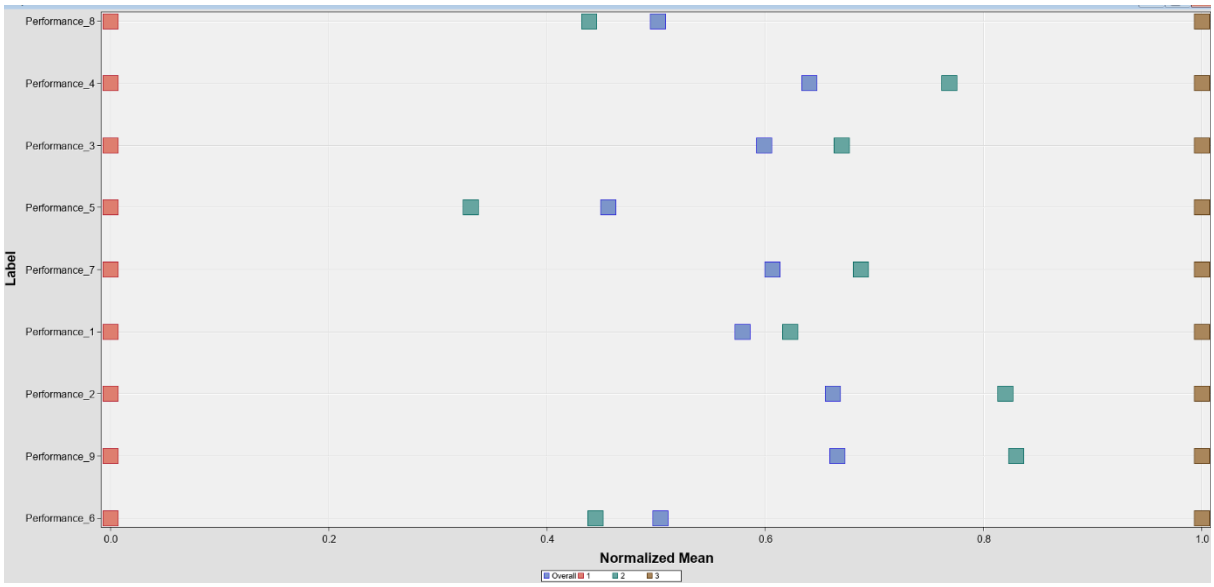

Figure 8 - Performance Input Means Plot

Cluster 1 - Cluster characterized as having the lowest values in terms of performance indicators. This cluster is mainly characterized by students who do not usually value the exchange of ideas and insights with other students, as well as the appreciation of innovative ideas in meetings, it is also a group that in terms of dynamics is characterized by not reacting particularly well to pressure. In this way, this

segment is also related to the low probability of creating relevant knowledge, since the group dynamics that characterize these individuals are associated with students who do not value this type of work (group work), not considering the opinion or characteristics of the other group members relevant, as well as sharing knowledge on a regular basis. These students are correlated with low values of the immediate level created, since they show low values regarding the relevance/intensity and quality of interactions. This is also reflected at the potential level, since they demonstrate lower levels of motivation than the rest of the students, this lack of motivation is indicated as a driver that explains the possible non-change of attitude throughout the learning process and creation of new knowledge.

Cluster 2 - Cluster that presents the values closest to the verified average, representing 42% of the population. This cluster is mainly characterized by intermediate levels of intensity of interactions at the immediate level of knowledge generated. In terms of performance indicators, the behavior of the population shows quite considerable values in terms of indicators that value motivation for goals, sharing ideas with other students, and promoting the existence of each one having an active role in the delineation of tasks. In this cluster, there are also group dynamics that value group work and knowledge creation, which then reveals itself in consistent/intermediate levels of quality/relevance and experience in interactions. At a potential level, it is verified that in this cluster students reveal that the sense of importance was an important driver in their attitude change throughout the learning process and knowledge creation, with a very high value in this indicator.

Cluster 3 - Cluster that presents the highest values in the indicators of performance. High performance values are mostly related to the exchange of ideas and insights with other students, namely in the sharing of innovative ideas at meetings, also verifying that in terms of performance this group is characterized by extremely high completion rates of tasks on time. In this way, this group of students mostly considered creative, presents dynamics that indicate the creation of relevant knowledge, since they value the creation of knowledge on a regular basis in their group work and management of expectations. These indicators are translated at the level of creation of immediate knowledge with high values of intensity and quality of interactions and potential level where for these students there is a continuous change of attitude based on high values of motivation.

From a general point of view the behavior of the universe under study, are verified group dynamics that value group work and knowledge creation, which then reveal itself in consistent/intermediate levels of quality/relevance and experience in interactions. At a potential level, it is verified that the sense of importance was an important driver in their attitude change throughout the learning process and knowledge creation, with a very high value in this indicator.

5.3.3.5. Combination of Human factors

After validating the segments created in an isolated manner, the same assumptions were validated but jointly, reflecting the conjunction of performance indicators, knowledge creation environment and dynamics associated with group work. To these indicators were added other indicators associated with the type of learning acquired and level of engagement, which are also part of the methodology used which is related to human factors.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be three. In the explained definition process the internal

standardization method was used, the ordinal variable coding was set to “Rank” and the nominal to “GLM”, it was also specified “Princomp” as the method to use to compute the initial cluster seeds.

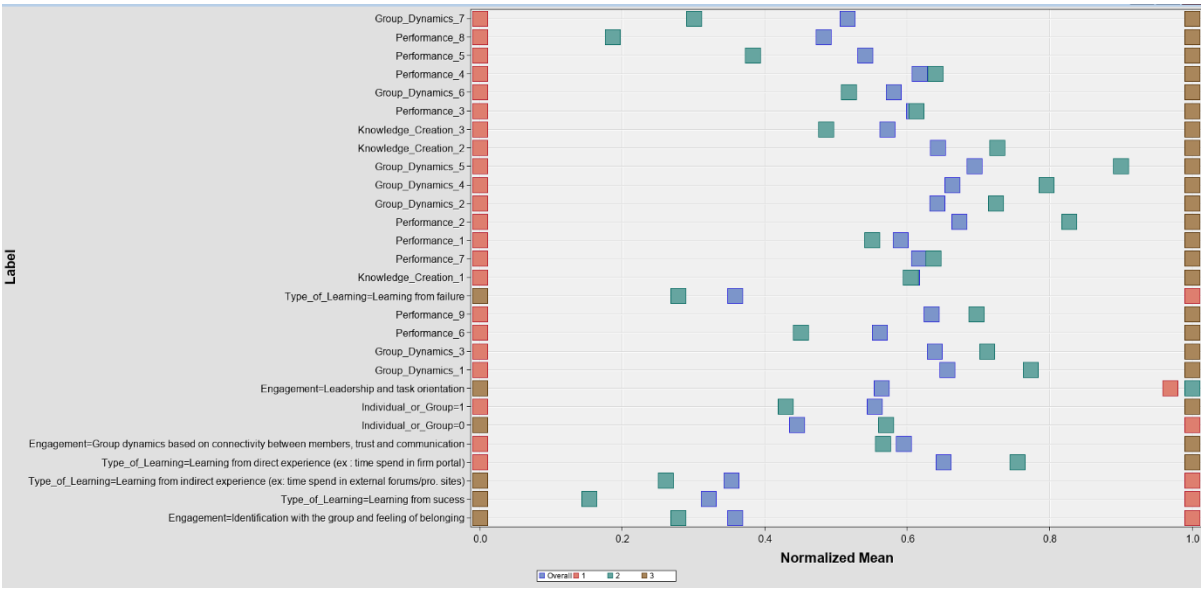

Figure 9 - Combination of Human factors Input Means Plot

Cluster 1 - Cluster characterized as having the lowest values in terms of PA and HF indicators. They are students who mostly prefer to work individually than in groups, in addition, this group is also characterized by usually obtaining knowledge of the acquired experience, mostly from successes or failures, and for the importance that the elements give to the identification they have with the group where they are inserted. There are below average values in terms of group dynamics, performance and knowledge creation, such as the low importance of feedback from other students in the same group, as well as the importance of communication based on the relevance of information, and the lack of sharing ideas or insights with other members. At the level of immediate value generated, there are reduced values of quality/relevance and intensity in interactions during the learning process and generation of new knowledge. In terms of applied value, there are still low values of knowledge reuse in the promotion of new ideas or processes, which aims to indicate low levels of knowledge generated.

Cluster 2 - Cluster that presents the values closest to the verified average. In this cluster, there is an appreciation of the most direct and immediate experience in the acquisition of new knowledge and leadership and task orientation in the processes of group interaction at the level of discussion of ideas. At the level of group dynamics, there are high values regarding the importance of the division of tasks, taking into account the knowledge that each member has about the subject under study. As far as performance is concerned, the importance of having all topics under control is undervalued. In terms of immediate value, considerable values of relevance and intensity of interactions are verified, despite, for the most part, being applied only within each community of practice, verifying low values of quality of interactions with other communities of practice. In terms of potential value, there are continuous improvements in terms of the evolution of the status of the community of practice throughout the process, which aims to indicate relevant generated knowledge values.

Cluster 3 - Cluster that presents the highest values in the indicators of people analytics. In this cluster, group dynamics based on connectivity between members, trust and communication are mostly valued,

as well as the acquisition of knowledge from immediate experience. At the level of immediate knowledge, there are high values of quality and intensity of interactions. Regarding the potential level, high values of motivation are seen as a determining factor for attitude change.

It is possible to verify that 63% of the study universe indicate that they prefer to work in a group than individually and the remaining 37% indicate that they prefer to work individually. Students who prefer to work individually portray a lower value of knowledge generated at all stages of the value creation cycle. To a large part of the universe under study, there is an exchange of ideas, brainstorming and frequent contact, as well as the division of tasks according to the characteristics of each one and the assignment of different roles. It is also verified for a large part of the universe, the valorization of the creation of value at the immediate level, insofar as promotes the quality, intensity and relevance of interactions, and this behavior is verified in interactions within and outside each of the communities of practice. In this group of students, there are also consistent values of knowledge reuse, so it can be seen that the immediate value was potentially relevant and was effectively applied, mainly in the sharing of new suggestions, solutions and insights.

5.3.4. Cycles of Value Creation

Similarly, to the segmentation exercise performed in the context of the configuration and characteristics of the curricular unit and human indicators, a similar analysis was also replicated with the different value creation cycles. In each cycle separately a cluster analysis was performed having its own and unique variables as a starting point for the segmentation exercise, thus making it possible to verify for the different values verified which other variables are associated.

5.3.4.1. Immediate Value

A cluster analysis was also carried out taking as a starting point the variables of the questionnaire associated with the immediate level of value creation. All the questionnaire variables associated with Immediate Value were used in this segmentation exercise.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be three. In the explained definition process the internal standardization method was used, the ordinal variable coding was set to “Rank” and the nominal to “GLM”, it was also specified “Princomp” as the method to use to compute the initial cluster seeds.

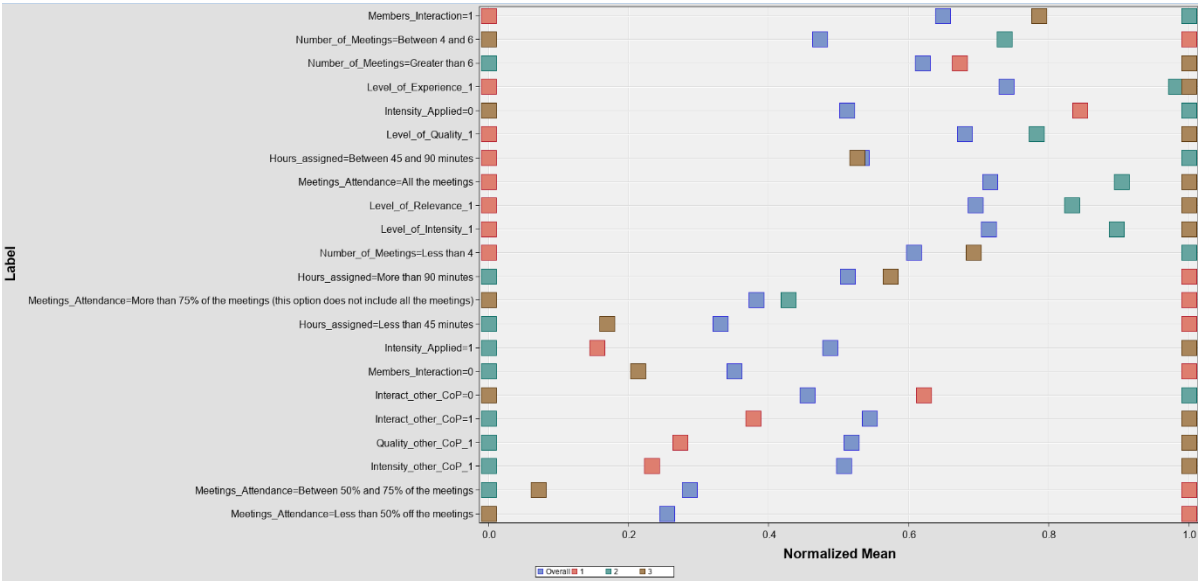

Figure 10 - Immediate Value Input Means Plot

Cluster 1 - Cluster characterized by students who have some interaction with other communities, although they seem to be contacts of little relevance due to the poor quality and intensity of the connections, it is also verified that the relationships between these individuals differ in their intensity. This cluster has low levels in terms of quality, intensity and relevance of connections. In terms of the meetings held, this group stands out as having presented a considerable number in this category, with a large fluctuation in the workload of these meetings without any defined standard and with an attendance that is also not very consistent. In terms of potential value, it is a cluster that presents low values in terms of the importance of the recognition of the strategic relevance of the domain for the consistent evolution of the community of practice status, as well as low values in terms of existing motivation. At the level of applied value, it also presents low rates of knowledge reuse in other processes. There is also a low value in this segment in terms of the people analytics indicator “I try to bring a set of original and innovative ideas to present at meetings".

Cluster 2 - Cluster characterized by students who have little or no interaction with other communities. This cluster presents levels above the verified average in terms of intensity and relevance of the connections. In terms of the meetings held, this group stands out with a not so high number, rarely exceeding 6 meetings, with a workload that varies between 45 and 90 minutes and where members participate in most of the meetings.

Cluster 3 - Cluster characterized by students who have great interaction with other communities of practice. This cluster presents the highest levels verified in terms of intensity and relevance of the links. In terms of the meetings held, this group stands out with a varied and inconsistent number, with durations close to average, neither too short nor too long, and where members participate in almost all meetings. There is also a high value in this cluster in terms of the people analytics indicator "I value the exchange of ideas in the learning process and knowledge creation".

It is verified that a large part of the students of the universe under study participated in all the meetings, or at least 75% of the meetings held during the semester. Around 85% of students indicate

that throughout the semester they held at least four meetings within their communities of practice, with most of the meetings lasting between 45 and 90 minutes or more than 90 minutes. Only 10% of the universe under study says they have not interacted with all members of their community of practice.

Students who reveal a lower quality, intensity and relevance of interactions are students who tend to have greater difficulty in applying the knowledge generated, which is verified through the low values of reuse of acquired knowledge. It is verified that only about half of the universe under study indicates having interacted with members of other communities of practice during the learning process and knowledge creation. Thus, the greater the interaction with other communities of practice, the greater the immediate value that students can generate, since it increases the dynamism of interactions and the volume of interactions and their quality.

The lowest values in the items of immediate value are associated with students who also have reduced values in the items of potential value, since they indicate that they have not gained enough skills in the context of communities of practice. These students indicate that this behavior is mainly related to low levels of motivation and the difficulty of recognizing the strategic relevance of the domain. Students who show higher values in items of immediate value are students who will more easily have the potential to generate skills that will allow them to reuse knowledge and apply it in other contexts.

5.3.4.2. Potential Value

A cluster analysis was carried out using as a starting point the variables of the questionnaire associated with the Potential level of value creation. The Skills variable was not used in the segmentation exercise for having a similar behavior to the New Skills variable, the same applies to the output of the Attitude, Ask and CoP_Evolution variables for having an identical behavior to the Attitude_Topics, Ask_Topics and Evolution Topics variables, respectively.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be four. In the explained definition process the internal standardization method was used, the ordinal variable coding was set to “Rank” and the nominal to “GLM”, it was also specified “Princomp” as the method to use to compute the initial cluster seeds.

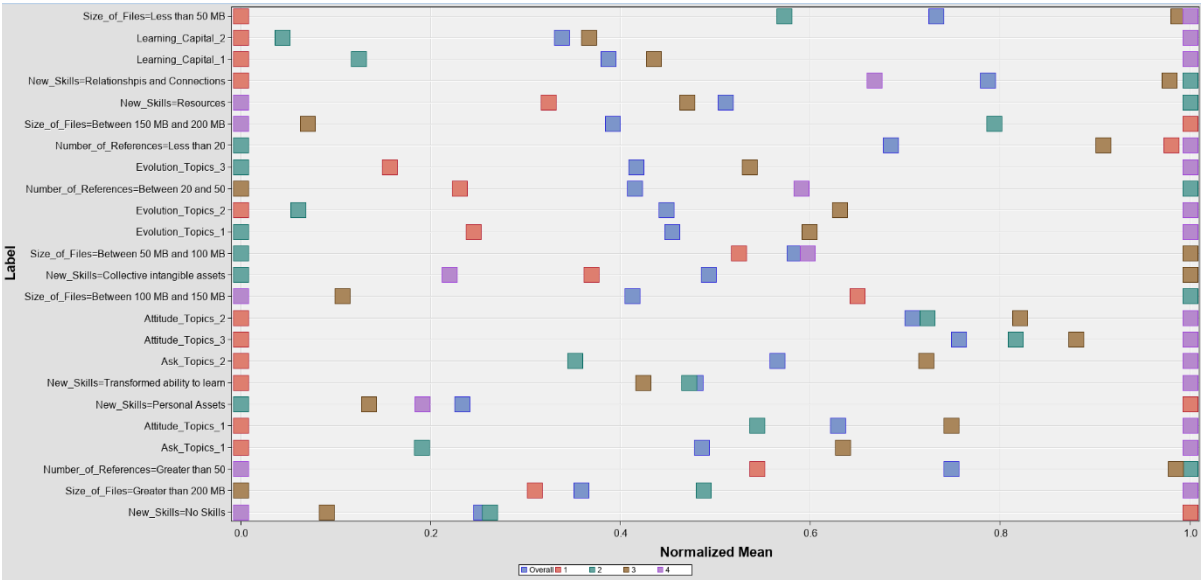

Figure 11 - Potential Value Input Means Plot

Cluster 1 - Cluster characterized by the use of a not very large number of references in the presentation of results and mainly during the learning process and creation of new knowledge, with the size of files presented variable. It is a cluster that also has a very low value associated with the parameters of learning capital, thus being presented as a cluster with a low value of generated knowledge and with possible difficulties to generate future knowledge, based on the work developed. There is also little evolution during the learning process and knowledge creation, since this group of students is associated with low values in terms of attitude evolution throughout this process, being also associated with low levels of commitment, trust and development of new skills. At the level of applied value, it also presents low rates of knowledge reuse.

Cluster 2 - Cluster characterized by the use of a large number of references and a very considerable size of files, being therefore mainly related to the development of new skills in the field of resources, relationships and connections. It has not very high learning capital values, however, it is a group of students that shows high values of attitude change throughout the process, having confidence and sense of importance as main drivers.

Cluster 3 - Cluster characterized by the use of a variable number of references and a not very considerable size of files, being mainly associated with the development of new skills related to collective intangible assets. It presents values of learning capital, evolution, attitude and ability to ask above average. At the level of applied value, it also presents high rates of knowledge reuse.

Cluster 4 - Cluster characterized by the use of a reduced number of references and a very variable size of files, being mainly associated with the development of new skills related to the transformed ability to learn and relationships and connections. It is the cluster that presents the highest values of learning capital, evolution, attitude and ability to ask questions. At the level of applied value, it also presents high rates of knowledge reuse. It also presents high values of efficiency in terms of realized value.

The universe under study is characterized by an apparently low number of references used in the learning process and in knowledge creation, where the majority of students say they have used less than 20 references. The same behavior can be seen at the level of the size of the files, where the vast

majority of students say that during the different topics they collected less than 100MB, when it comes to the size of the files saved.

Students who are segmented taking into account the highest values of potential value are mainly associated with the development of new skills related to the transformed ability to learn and relationships and connections. These students present the highest values of learning capital, evolution, attitude and ability to ask questions. At the level of applied value, these students present high rates of knowledge reuse and high values of efficiency in terms of realized value.

5.3.4.3. Applied Value

A cluster analysis was carried out using as a starting point the variables of the questionnaires associated with the applied level of value creation. All the questionnaire variables associated with Applied Value were used in this segmentation exercise.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be three. In the explained definition process the internal standardization method was used, the ordinal variable coding was set to “Rank” and the nominal to “GLM”, it was also specified “Princomp” as the method to use to compute the initial cluster seeds.

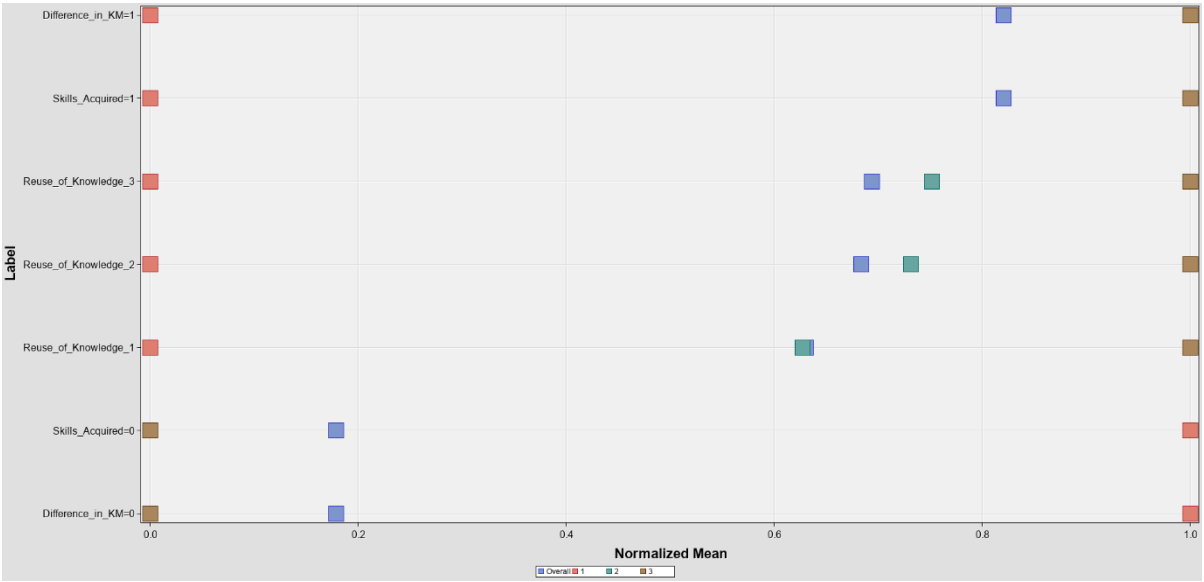

Figure 12 - Applied Value Input Means Plot

Cluster 1 - Cluster that has a lower value in all the items related with the measurement of the applied value of knowledge by identifying how the knowledge acquired in the community of practice was applied in practice. This restricted cluster is associated with students that did not apply the knowledge in practice, since they consider that they did not have new skills acquired. In terms of potential value, this group of students is associated with low values of trust and commitment as drivers of attitude change.

Cluster 2 - Cluster that presents the values of applied value closest to the average, verifying that the reuse of knowledge arises mainly from the perspective of promoting new suggestions and insights. In terms of potential value, we can see medium-high values in the topics of attitude and evolution, in addition to this, at an immediate level, there are consistent levels of quality.

Cluster 3 - Cluster with the highest values of applied value, students belonging to this cluster are students who tend to apply the knowledge acquired in the community of practice. In terms of potential value this group of students is associated with high values in indicators of evolution and change of attitude during problem-solving, and ability to question, being a group characterized by the new skills acquired and the benefit they brought to the ability to manage and use new knowledge. There are also high values of quality of interactions at the level of immediate value associated with this cluster, as well as at the level of realized value, since the greater the realized value, through improved performance and understanding of topics from the perspective of future sharing of the even greater will be its possible reuse.

At the level of effectively applied value, only 18% of the students in the universe under study say they have not applied the skills acquired in the creation of new knowledge, and half of these students say that their participation in the practical community did not translate into any type of practical effect. The lower values associated with the applied value are also related to indicators that are reduced at a potential level, since these students, when referring to having gained few skills, will have difficulty in replicating them at a practical level.

5.3.4.4. Realized Value

A cluster analysis was carried out using as a starting point the variables of the questionnaire associated with the Realized level of value creation. All the questionnaire variables associated with Realized Value were used in this segmentation exercise.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be three. In the explained definition process the internal standardization method was used, the ordinal variable coding was set to “Rank” and the nominal to “GLM”, it was also specified “Princomp” as the method to use to compute the initial cluster seeds.

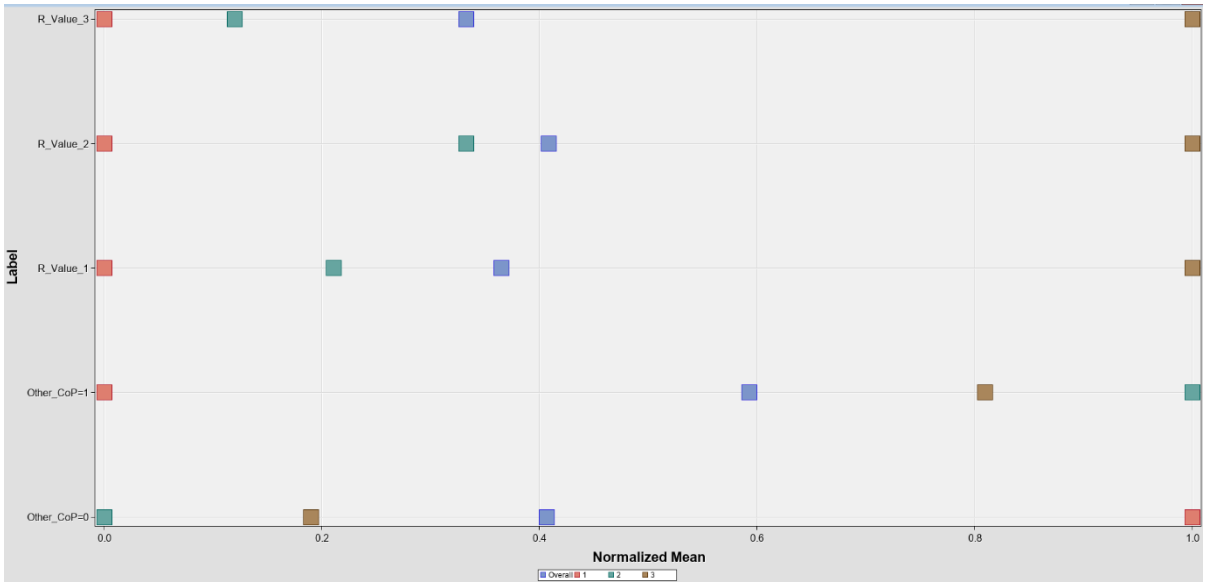

Figure 13 - Realized Value Input Means Plot

Cluster 1 - Cluster that has a lower value in most of the items related to changes in behavior and performance by the participation in the community of practice. This cluster is also related to students that have little or no interaction with other communities of practice and without quality.

Cluster 2 - Cluster that contains the values associated with the realized value that are more consistent with the average presented, is a cluster where there is relevance in sharing the knowledge generated with other communities of practice. The association of this cluster with the quality and intensity of interactions with other communities of practice at the level of immediate value is verified.

Cluster 3 - Cluster with the highest values of realized value, students belonging to this segment improved their performance in terms of effectiveness and efficiency of results, as well as the ability to find relevant results in their research through their participation in the CoP. They are also students that considered the feedback given by teachers or communities of practice relevant. In terms of potential value, this cluster is correlated with the group of students who consider that the most important driver for improving the status of the community of practice is the recognition of the strategic relevance of the domain, are also students that associate motivation with a determining factor of attitude change. In terms of applied value, this is a cluster that is related to consistent values of knowledge reuse, namely associated with the premise of “new ways of doing things”.

The lowest values of the realized value are associated with students who mostly do not have any kind of contact with members of other communities of practice. On the other hand, higher realized value results are associated with higher levels of performance in the presentation of results and in the efficiency of processes that allow substantially relevant information to be found. These levels of performance are associated with students that consider the recognition of the strategic relevance of the domain as relevant, being this recognition a motivational factor for the improvement of processes that promote greater efficiency and effectiveness.

5.3.4.5. Reframing Value

A cluster analysis was carried out using as a starting point the variables of the questionnaire associated with the Reframing level of value creation. All the questionnaire variables associated with Reframing Value were used in this segmentation exercise.

The k-means algorithm was used to define the clusters, and the conclusion was reached that the number of clusters to be used would be four. In the explained definition process the internal standardization method was used, the ordinal variable coding was set to “Rank” and the nominal to “GLM”, it was also specified “Princomp” as the method to use to compute the initial cluster seeds.

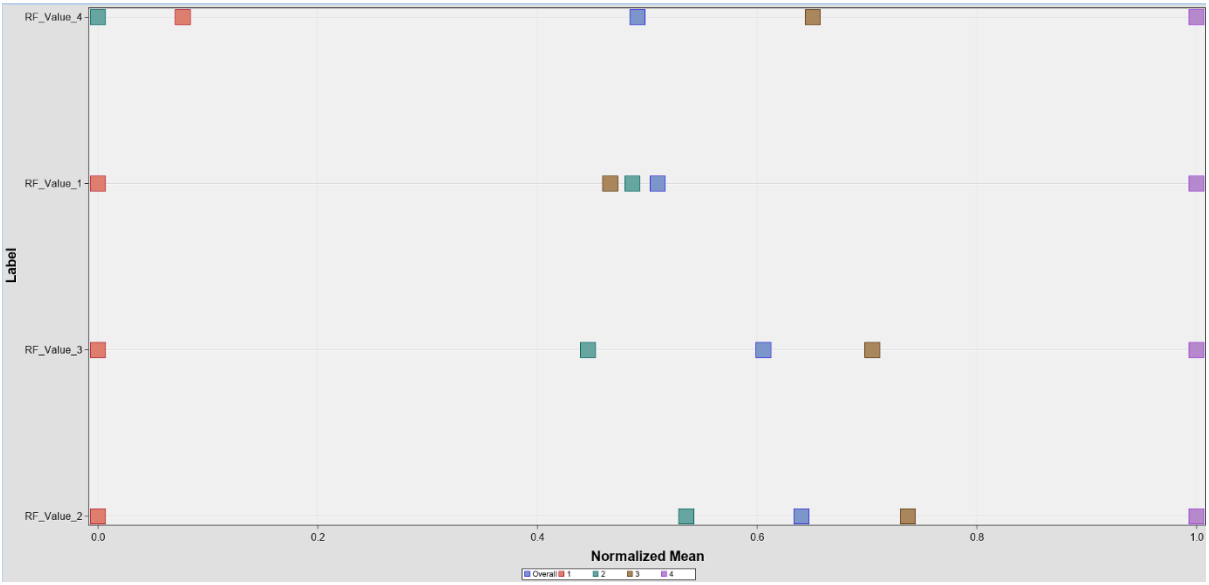

Figure 14 - Reframing Value Input Means Plot

Cluster 1 - Cluster that has a lower value in most of the items related to community aspirations, corresponding to the group of students who do not aspire to develop the problem further in other areas and who do not have a learning agenda on the topic. However, it is a group that somehow ponders the application knowledge generated in future processes. In terms of potential value, it is a cluster that has as characteristics the fact that its attitude has changed little throughout the different topics addressed, this is also associated with low levels of motivation and sense of importance.

Cluster 2 - Cluster that intends to identify and analyze in more detail the topics covered throughout the learning process and knowledge creation, although with some levels of uncertainty. Most of the students in this cluster say they have no interest in applying the knowledge generated in future processes. In terms of realized value, it is a cluster that is defined by low values of knowledge reuse.

Cluster 3 - Cluster with values slightly above the average identified in almost all indicators, it is however identified that in one of them it has a value below the average, "I have in mind a new learning agenda based on the research done on the developing problems". In this way, this group of students has in mind the study in detail of the problems developed through the analysis of the same from other aspects and application of the knowledge generated in other processes, but still do not have in mind with a great degree of certainty the definition of a new learning agenda on the research. In terms of applied value, this cluster is associated with a great ability to reuse knowledge in implementing new ideas and concepts, changing processes and obtaining new insights.

Cluster 4 - Cluster with the highest values of reframing value, students in this cluster tend to apply the knowledge generated in new processes or frameworks based on the study of problems in other areas and based on different dimensions, trying to extract the greatest possible value. In terms of potential value, this cluster is associated with the existence of trust and commitment within communities.

The vast majority of students have in mind the study in some detail of the problems developed through the analysis of these from different perspectives, and the application of the knowledge generated in other processes, but still do not have in mind a great degree of certainty the definition of a new learning agenda on the research.

6. CONCLUSIONS

6.1. UNIVERSE UNDER STUDY AND COP CONFIGURATION

The vast majority of students who answered the questionnaire attended classes online, the meetings were also mostly online, and as previously mentioned, the observed values take into account this type of regime. Most of the individuals belonged to CoPs with 3 to 5 members, these communities were mostly static work groups, only in less common situations there were entries and exits, changing their dimension. The universe of students living outside Portugal, although within the analysis perimeter, does not present relevant conclusions as the universe is restricted to four students, and as indicated in the results section, the variable associated with the country of residence was not used in the cluster analysis, due to its behavior and distribution.

It is verified that the topic approached through the PBL methodology that brought the most difficulty to the students was the first to be presented, and the easiest was the last to be presented. In this way, it is verified that, in general, there is a positive evolution of the communities throughout the semester in which this curricular unit takes place, since it demonstrates the adaptability of students to the PBL methodology and group work, taking into account that the difficulty of each problem does not change. It is also possible to verify that the groups that changed their composition or size over time do not present significant differences in terms of potential or immediate value created. Even if the impact is residual, changes in communities of practice should be little encouraged in this or other contexts depending on the flexibility of the structure according to the internal or external context.

Regarding the relationship between the configuration of the CoP and the creation of immediate value, it is observed that students who have face-to-face classes, as well as some meetings in this regime tend to generate more knowledge, so there is a higher relevance of interactions and intensity, between members of the same community or in contact with other communities. The fact that the meetings are face-to-face, as well as the classes means that there is a higher power of interaction, through direct contact with other students and the gain of new skills associated with interpersonal relationships, always emphasizing that only these characteristics are contemplated in a restricted group of the universe. Considering this, it is possible to verify the importance of the added value that physical contact can bring to the value creation process in the organizational context.

Taking into account the regime in which CoPs are inserted and the universe of students under study, it is possible that the communities having a practically static structure and even in some cases with some exits or entries maintain the same level of value creation, which indicates that the communities of practice, in general, were well defined. It is important to note that the configuration of the CoP according to the objective under study is the starting point for the creation of value in a sustained manner, capable of supporting moderate changes in the organizational structure of the community as people entering and leaving the community or other organizational structural changes. At the level of the external context, when assessing the behavior of the CoP we have to take into account the surrounding pandemic context that involves the academic years under analysis. It is verified that students who interacted preferably face-to-face indicated higher values in the indicators associated with the cycles of knowledge creation namely at the immediate level, although there is no great discrepancy for the virtual context, it is verified the added value of the face-to-face interaction. In this way and in an organizational context, there is an immediate and potential increase in value that can

be generated by having face-to-face interactions, which promotes the quality and intensity of the relationships created between members within the same community and in contact with members of other CoPs.

6.2. People Analytics and Performance Measurement

At the level of engagement and evaluation of this factor, students consider the “Group dynamics that are created from the connections between members” to be more relevant in terms of group work. Students who primarily value the engagement factor “Identification with the group and feeling of belonging” are students who are associated with a preference for individual work, as it is observed that students who prefer to work individually have as their main premise the integration into a group that allows them to promote a sense of belonging, while students who prefer to work in groups value more a group that allows them to develop their communication skills by building trust.

Students who are in this category “Identification with the group and feeling of belonging” will improve their level of knowledge generated when they find a group that, due to its characteristics, makes them feel an important part in the design of processes, allowing them to develop communication skills. These students are also associated with low levels of motivation, which will lead to reduced potential values of generated knowledge and difficulties in reusing knowledge. On the other hand, the engagement factor associated with "Leadership and task orientation" is not directly correlated with any generated knowledge trend, as it keeps its distribution constant across all generated value segments. The fact that more students value the factor "Group dynamics that are created from the connections between members" means that most CoPs in this universe of students are at a level that tends to promote the immediate level of value creation and therefore leverage the rest of the knowledge generation chain. In the context of knowledge evaluation in organizations, it is important to consider this level of engagement as the basis and starting point for leveraging the knowledge generated from the extraction of value from the learning process.

Students reveal that the way they most easily acquire knowledge derives mostly from direct experiences, it is also associated with higher average levels of generated knowledge acquired throughout the value creation cycle, it is verified that the experience at the immediate level is prioritized over the historical experience, namely the experience that comes from success or failure.

At the level of group dynamics that students consider relevant in a workgroup, students consider less relevant the fact that they need to have control over all the topics necessary to address a priori. The fact that students find this topic less relevant does not mean that it is not an important input to value creation. It is verified that although only a restricted group considers important to have knowledge about all the topics addressed a priori, and that it is not considered a mandatory dynamic for a good evolution of a community of practice, when it is associated with the division of tasks according to the knowledge that each member has about the topics under study brings visible benefits at the level of knowledge generated. Since the division of tasks and the fact that each member has knowledge about all tasks can configure knowledge sharing, this behavior occurs mainly in interactions where the sharing of experiences from other contexts is valued. It is also verified that high values in the indicators associated with group dynamics promote the students' ability to argue, by improving their ability to ask questions, this improvement is preferably associated with drivers such as trust and commitment.

The topics considered most relevant are related to the importance of feedback from other members and communication based on the relevance of information. Students who report lower values in terms of the HF that support the dynamics of a work group, such as poor management of expectations, low levels of communication and connection between members and low levels of need to obtain feedback, are students that reveal low levels of immediate value creation. The low levels of immediate value are verified by the low level of intensity, quality and relevance of the connections between individuals. At the level of the potential value that these students can generate, this is effectively low, since these students have low rates of evolution of the status of the communities of practice where they are inserted. The indicators that show low levels of communities' evolution have an impact on the level of knowledge effectively applied in other contexts since it is verified that these students have low indicators of knowledge reuse.

6.2.1. New strategies based on People Analytics Indicators

Regarding the HF associated with knowledge creation, is possible to identify that students who do not value the exchange of knowledge-based ideas on a regular basis, and who do not value innovative ideas or new alternatives in meetings, are students with low values associated with the immediate level of value creation and demonstrate a lack of quality, intensity and relevance of interactions. At the potential level, they are characterized as students who indicate that they have not changed their attitude/behavior throughout the learning process and knowledge creation, being associated with low levels of motivation. This group of individuals represents only about 20% of the universe under study and these students are students who practically do not interact with other communities.

With regard to performance indicators and PM, it is verified that, at an immediate level, the poor quality, intensity and relevance of interactions is associated with students who, in terms of performance in work groups. These students indicate that they do not react particularly well to pressure and that they do not value the exchange of ideas and the communication with others, they are also students that do not always fulfill the proposed objectives with total quality and who reveal not to look for innovative ideas to share in meetings and promote group dynamics. At a potential level, it is verified that these students, compared to the total universe under study, are the ones who consider the motivation factor less important in the acquired skills. High performance values are mostly related to the exchange of ideas and insights with other students, namely in the sharing of innovative ideas at meetings, also verifying that in terms of performance this group is characterized by extremely high completion rates of tasks on time. In this way, this group of students mostly considered creative, presents dynamics that indicate the creation of relevant knowledge, since they value the creation of knowledge on a regular basis in their group work and management of expectations. These indicators are translated at the level of creation of immediate knowledge with high values of intensity and quality of interactions and potential level where for these students there is a continuous change of attitude based on high values of motivation.

Through the evaluation of the different aspects that validate the PA indicators, it is verified that the HF associated with the characteristics of individuals and the way they usually work in work groups influence the way they can leverage the value generated within communities. Taking into account the universe of the study, and from a general point of view, it can be seen that the values of the evaluation of the topics of PA and HF present values that are mostly consistent, which positively influences the value chain associated with the knowledge generated. There is, however, a set of the universe under

study, which, although restricted, requires the implementation of new strategies that take into account the existing weaknesses at the levels of HF to increase the level of knowledge generated.

Despite the consistent values verified in the indicators associated with some HF, some organizational and communities of practice gaps can be supported by strategies that seek complementarity between HF, the external and internal environment of the organization, and the value creation cycles. These strategies can be generalized to other organizational contexts that value learning and knowledge supported by the existence of communities of practice.

Possible strategies and measures to consider taking into account the patterns and behaviors identified in the analysis:

- Take into account students who usually prefer individual work, since under CoP they tend to potentially create less value. It is observed that students who are in this category will improve their level of knowledge generated when they find a group that, due to its characteristics, makes them feel an important part in the design of processes, allowing them to develop communication skills. In the methodological delineation and creation of CoPs this factor, if isolated, allows the verification of students who show a preference for individual work, trying to incorporate them into groups that promote their sense of belonging and involve them in group dynamics;

    - In the organizational context can be promoted engagement activities and activities that promote the integration of individuals in CoPs, with a focus on members who prefer to work individually. When these individuals are in a workgroup context, they first value an identification with the group and feeling of belonging that allows them to develop feelings of belonging and confidence that in the future promote their motivation and that allows them to develop communication skills that improve interactions and the sharing of relevant knowledge.

- Promote the integration of the experience factor in each one of the communities, this factor is undoubtedly essential for the creation of relevant knowledge. If there are CoPs with small focuses of experience on the topics addressed in other contexts, a priori improvements can be seen in terms of the knowledge generated. Although only a restricted group considers important to have knowledge about all the topics addressed a priori, when it is associated with the division of tasks according to the knowledge that each member has about the topics under study brings visible benefits at the level of knowledge generated. Since the division of tasks and the fact that each member has knowledge about all tasks can configure knowledge sharing, this behavior occurs mainly in interactions where the sharing of experiences from other contexts is valued. With regard to the organizational context and depending on the surrounding context, priority should be given to the inclusion of the factor associated with experience, as a mobiliser and driving force behind group dynamics that promote the use and creation of relevant knowledge;

- Whenever possible, meetings and classes should be promoted in person, so there is a higher relevance of interactions and intensity, between members of the same community or in contact with other communities. The fact that the meetings are face-to-face, as well as the classes, means that there is a higher power of interaction, through direct contact with other

students and the gain of new skills associated with interpersonal relationships. At the level of the organizational context, the preponderance, even if sometimes residual, of the existence of a contact that promotes greater proximity outside the virtual regime with a view to promoting the creation of immediate value may be taken into consideration;

- Although the changes in the members of the CoPs have not proved to be a determining factor for the level of knowledge generated or the change and behavior of this indicator, as it is a factor with limited expression in this universe, the change in the dimension of the communities is something that should be avoided as much as possible. The entry or exit of a member by affecting the established group dynamics will, in a way, contribute to a delay in the learning process and creation of new knowledge. A timely structuring of the CoP and their adaptation to the internal organizational context and the surrounding environment allows the structure to react positively to changes that may arise, such as new members leaving or joining;

- Definition of objectives along the different topics/problems, since it is indicated by the students that one of the drivers that least contributes to their evolution and the groups where they are inserted is the motivation factor, which will later affect the potential value acquired. In the indicators associated with group dynamics and associated HF, these students are identified as not considering the feedback from other students relevant. In terms of performance, they do not bring new ideas/insights and innovative solutions to meetings, which identifies a gap between students and topics to be addressed. It is verified the importance at the organizational level of the definition of objectives that guide the motivation of the members of the different communities, allowing to confront the perspective of the recognition of the strategic relevance of the domain and the existing motivation of each one of the members.

6.3. CYCLES OF VALUE CREATION

6.3.1. Immediate Value

Students who show higher values in items of immediate value are students who will more easily have the potential to generate skills that will allow them to reuse knowledge and apply it in other contexts. The experience factor in the interactions carried out between students was the factor that, at an immediate level, presented higher values on average, in this way we can identify the importance of experience and the contribution that individuals can bring from other contexts to the environment of communities of practice in the way of sharing knowledge and reusing it. Students who usually react negatively to pressure tend to obtain a reduced value of immediate knowledge, these students also tend mostly to prefer individual work over group work, not considering the opinion or characteristics of the other relevant group members, as well as sharing knowledge on a regular basis.

When comparing two sub-universes of the universe under study, in one of which all members interact with other communities of practice and the other does not. It is observed that although both produce high average values in terms of interactions, the group that has contacts with other communities of practice has greater quality/intensity values and relevance of interactions, verifying that only the experience factor remains very similar since they come from history and not from existing interactions. It is important to mention that the contact with other communities of practice is not by itself and in

an isolated way of evaluating the performance of a given community of practice or of an individual who belongs to a community of practice, it is a factor that can promote additional value generated.

CoPs in which the interactions between individuals have the same level of intensity, where there are no discrepancies at the level of group dynamics and where the bonds are stronger, are groups that present greater relevance and quality of interactions. However, according to the universe under study, the most favorable behavior for the creation of knowledge will be the variation in the intensity of the connections, according to the role of each individual in the community and their characteristics. Always taking into account the reference to a minimum limit of homogeneity of the interactions and promoting cohesive groups in which there is no great discrepancy in behavior.

Some steps can be taken to leverage immediate value at the organizational level through the use of CoPs:

- A primary focus on the evaluation of immediate knowledge is revealed as important, as it is verified through the responses of the students that low values related to the interactions traced within and outside each of the communities will have an impact on the possible reuse of knowledge and skills effectively acquired. This focus has to take into account the strategic relevance of the domain as a source of motivation to promote interactions between individuals;

- Since a large number of students have not interacted with members of other CoPs and this dynamic is fundamental to promote added value at an immediate level, dynamics should be included throughout the different problems performed, in case of using a PBL methodology, that encourage interconnections between the different communities of practice;

- Although there is no total discrepancy in terms of quality, relevance and intensity of interactions between the number of hours assigned on average for each meeting, it is verified that the ideal is not to opt for the extremes "more than 90 minutes" or "less than 45 minutes " since the group of students that, on average, has average durations between 45 and 90 minutes generally presents potentially more relevant values at an immediate level. This bucket should serve as a bucket for the ideal threshold to take into account. It is important to mention that these time intervals are intrinsically associated with a PBL methodology and specific themes, so they may require a longer or shorter period in other contexts.

6.3.2. Potential Value

At the potential level, the vast majority of students say they have felt improvements at the level of the evolution of their communities through the gain of new skills related to the transformed ability to learn, resources and especially skills at the level of relationships and connections. It is also verified that the great majority of the students say that their participation in the CoP changed their attitude toward solving similar problems and improved their ability to ask questions.

Although it is expected that the larger the size of the files and the number of references used, the greater the ability to reuse and generate knowledge, what we see is that taking into account the universe under study these two factors do not contemplate relevant impacts to the knowledge effectively applied afterwards. This impact can also be verified by the 15% of students who indicate that the skills they have gained the most came from resources (references, files) and where there are

lower levels of applied knowledge compared to other types of students who say they have gained skills mostly by other factors.

Students who show they have acquired more skills throughout the different topics covered are those who have greater potential to be able to apply them in other contexts, and the higher the realized value, the easier it is to share knowledge and transfer it to other contexts. The segment of students that constitutes the highest potential value also has as characteristics the fact that these students indicate that their participation in the community during the semester made them more competent/efficient in presenting results. Thus, it is verified the importance of gaining new skills throughout the process, which is why it is an essential factor in creating more and better knowledge.

Some steps can be taken to leverage potential value at the organizational level through the use of CoPs:

- Promote the integration of the "feedback" factor in an organizational context. Students who indicate that they have not acquired new skills throughout the learning process are the students who on average have difficulties generating immediate knowledge through below average levels of relevance, intensity and quality of interactions. For these students, the human factors that trigger the low levels associated with interactions should be identified, and it is found that these students usually tend not to consider getting feedback from other members in workgroup situations as relevant/important. The feedback factor turns out to be a determining factor in students who show higher values at the potential level, since these students consider feedback from teachers or even from other groups to be of total importance for the development of new skills and the evolution of the CoP.

6.3.3. Applied Value

The higher values associated with applied value are associated with high values in indicators of evolution and change of attitude during problem-solving, and ability to question, being a group characterized by the new skills acquired and the benefit they brought to the ability to manage and use new knowledge. There are also high values of quality of interactions at the level of immediate value associated with this segment, as well as at the level of realized value, since the greater the realized value, through improved performance and understanding of topics from the perspective of future sharing of the even greater will be its possible reuse.

The lower values associated with applied value are also related to indicators that are reduced to a potential level or are potentially irrelevant, since the fewer new skills acquired, the lower their reuse through practical application. In terms of potential value, this segment with lower value applied in a practical context is associated with low values of trust and commitment as drivers of attitude change.

Some steps can be taken to leverage applied value at the organizational level through the use of CoPs:

- Identify what is behind the fact that some students do not apply the acquired knowledge and skills in practice. It is verified that most of them are students who prefer to work individually and who do not find in their communities favorable conditions for the reuse of knowledge. They are mostly students who say they have not acquired sufficient skills, identifying drivers as a lack of commitment and trust in their workgroups, which translates into students who are associated with low levels of potential value. One of the possible strategies to be implemented

will be the implementation of PA strategies in order to identify how these students value group work and allocate them to a CoP where they identify themselves in order to promote the gain of skills and the application of these in the creation of new knowledge. These strategies can include the implementation of questionnaires to individuals before the creation of work groups and CoPs, in order to assess how each individual considers the fact of having to work in groups, based on the different HF that may influence their performance.

6.3.4. Realized Value

The realized value of a CoP can be measured by the ability of its community members to suggest or leverage change based on the acquired knowledge in other communities or members of other communities. Students with lower realized value are students who tend to have more difficulties in applying the knowledge generated in topics outside the scope, future frameworks or processes, the lowest values are associated with students who mostly do not have any kind of contact with members of other communities of practice. On the other hand, and at the level of reframing value, what can be seen is that students with more favorable indicators at the level of realized value are students who mostly have in mind the new learning agenda based on the research done on the developed problems.

Some steps can be taken to leverage applied value at the organizational level through the use of CoPs:

- Although it is not a factor that creates high discrepancies at the effectively realized level, contact and interaction are differentiating and discriminating factors in the creation of knowledge, since it is leveraged when shared. In this way, throughout the development of these problems, the creation of synergies between the different groups should be valued in order to allow the knowledge to be transferred naturally between different members of each of the communities of practice. These synergies may be oriented the resolution of a given topic with members of different communities of practice in order to promote interdisciplinarity. Therefore, in organizational contexts it is important to take into account that the gain of skills that promote the value corresponding to the learning effectively applied in generated knowledge is often related to different visions and perspectives of the same phenomenon, allowing to leverage the knowledge. The interaction with other CoPs allows in some way to fill this gap and should be encouraged;

- The immediate level of value, identified by the characteristics of interactions and the importance of the learning process in the acquisition of new skills, should be taken as the main focus in the evaluation of realized value. It is verified that the greater the Learning Capital acquired, the greater the value effectively realized. Learning Capital can be measured by the ability to transfer the knowledge acquired throughout the learning process to other contexts, something that is promoted through leverage the reuse of knowledge.

6.3.5. Reframing Value

It is identified that students with less tendency to approach the themes in another way, interdisciplinarity, belonging to communities with less future aspirations, are also students with low values of learning capital, since they have difficulty in translating the knowledge generated to other contexts. Factors related to the difficulty of asking questions internally, derived from the lack of trust within the community of practice, are also evidenced.

The highest values of reframing value are associated with students who tend to apply the knowledge generated in new processes or frameworks based on the study of problems identified in other areas and based on different dimensions, trying to extract the greatest possible knowledge value. In terms of potential value, this segment is closely associated with the existence of trust within communities of practice. This segment is also related to high levels of performance in terms of realized value.

Some steps can be taken to leverage applied value at the organizational level through the use of CoPs:

- It is verified that students who have low levels of efficiency, related, for example, to difficulties in completing the tasks in the proposed timings, are students who tend to have more difficulties in approaching the themes from another perspective, not being a priority for these students as well as developments or a constitution of a new learning agenda. In this way, it is important to validate the students' level of efficiency and how they deal with pressure so that students who have more difficulties are part of communities of practice that enhance the improvement of these gaps. Thus, in organizational contexts, it is important to take into account the importance of performance indicators since they are essential to assess whether or not a community of practice has the ability to generate reframing value. The individuals who tend to show greater efficiency and effectiveness in the processes of collaboration and group work are able to have more time available to address issues from another perspective and the constitution of a new learning agenda. Having identified these characteristics a priori, this universe in deficit should be taken into consideration. It becomes necessary to promote initiatives that allow the creation of a new learning agenda that combines different measures associated with the investigation of topics from different perspectives or the elaboration of additional discourses about the additional value that can be extracted from the research done.

6.4. Implications for Knowledge Management Practitioners

As mentioned throughout the introductory chapters, organizations have experienced difficulties in putting into practice methods and processes to assess and measure the contribution of KM initiatives to the business strategy. These challenges are mainly related to the difficulty in measuring intellectual capital, namely the lack of standard performance metrics to evaluate relational and human capital. Performance indicators related to human factors are a bit vaguer and often depend on a person's subjective opinion.

Some organizations have used the support of knowledge management systems to measure their performance in terms of KM activities. The metrics taken into account are essentially related to System Metrics, Output Metrics and Outcome Metrics. System metrics measure the number of contributions over time, Output Metrics measure the number of problems resolved and Outcome Metrics measure the improvement in quality/efficiency of a business process or a group project.

This research, whose organizational context was the education sector, allowed to assess and evaluate the introduction of human factors (HF), intangible assets, in the context of measuring performance and the process of creating organizational value and knowledge. The introduction of some HF that are particularly relevant to the organizational workplace, such as performance, engagement, leadership, workplace relational dynamics, organization developmental support, and learning and knowledge creation, constitutes the inclusion of a People Analytics (PA) methodology in the context of this research.

Taking into account the results of this research, it can be seen that the values of the evaluation of the topics related to HF present values that are mostly consistent, which positively influences the value chain associated with the knowledge generated. Thus, and taking into account the results presented, the introduction of this type of indicators may also constitute in other organizational contexts, namely in organizations that already have KM initiatives, a way to leverage the organizational knowledge generation chain and constitute a driver for the promotion of knowledge-based organizations.

The structured process developed in this research, which allowed correlating human indicators with the different cycles of value creation using CoPs, can be a complement to what has been developed by some organizations in the context of the metrics they have implemented in knowledge management systems. The results of this research are based on the existence of CoPs where KM initiatives were developed. As verified throughout the research, especially in the introductory chapters, organizational knowledge is enhanced by the existence of CoPs that create and disseminate knowledge. In this way, the application of these metrics and the amplification of intellectual capital will have more value within CoPs.

Through the results generated in this process, it is possible to verify the importance of HF in the value creation process. These conclusions, presented in previous topics, may be relevant in the adoption of this type of methodology for its transversal context.

Conclusions that may influence the adoption of this methodology in other organizational contexts:

- Importance of the integration of the feedback factor in an organizational context. The introduction of this factor in other organizational contexts can leverage the existing potential value, and should be taken into consideration in KM initiatives and procedures;

- The individuals who tend to show greater efficiency and effectiveness in the processes of collaboration and group work are able to have more time available to address issues from another perspective and the constitution of a new learning agenda. It is verified that individuals who have low levels of efficiency, related, for example, to difficulties in completing the tasks in the proposed timings, tend to have more difficulties in approaching the themes from another perspective. The early evaluation of the efficiency and effectiveness of internally developed processes can be a factor that allows the leveraging of reframed value and intellectual capital;

- The gain of skills that promote the value corresponding to the learning effectively applied in generated knowledge is often related to different visions and perspectives of the same phenomenon, allowing to leverage the knowledge. The importance of interdisciplinarity in working groups in organizational contexts should be taken into consideration to enhance organizational knowledge;

- It was identified that individuals who prefer individual work to group work are less able to generate knowledge and create value, since they are able to generate fewer skills than they could by exchanging ideas or disseminating knowledge. These individuals present personal indicators that reveal a lack of motivation, confidence and commitment and value the factor "Identification with the group and feeling of belonging". In other words, when these

individuals are in a workgroup context, they first value an identification with the group and feeling of belonging that allows them to develop feelings of belonging and confidence that in the future promote their motivation and allow them to develop communication skills that improve interactions and the sharing of relevant knowledge. Thus, in organizational contexts these factors must be taken into account, these types of indicators must be observed and analyzed within organizations, since they have practical implications for knowledge creation;

- At the level of the organizational context, the preponderance, even if sometimes residual, of the existence of a contact that promotes greater proximity outside the virtual regime with a view to promoting the creation of immediate value may be taken into consideration. In some moments face-to-face contact should be promoted as it allows the development of a greater number of skills at the level of personal assets and thus be another factor that can promote organizational knowledge;

- In an organizational context and depending on the surrounding context, priority should be given to the inclusion of the factor associated with experience in group work, as a mobiliser and driving force behind group dynamics that promote the use and creation of relevant knowledge. Thus, and in the context of defining new KM measures at the organizational level, the experience factor should be taken into account since it positively influences the value effectively generated through the positive influence it has throughout the learning process;

- The definition of objectives that guide the motivation of the members of the different work groups at an organizational level should be taken into consideration, allowing to confront the perspective of the recognition of the strategic relevance of the domain and the existing motivation of each one of the members. The engagement factor varies in the same direction and reveals similar importance for value creation and consequent organizational knowledge.

7. LIMITATIONS AND RECOMMENDATIONS FOR FUTURE WORKS

Given the pandemic situation of the last 2 years, classes took place in a hybrid regime. It is important to mention that the interactions of the students and the knowledge generated during the classes and meetings were influenced by a regime that was not 100% face-to-face, so the observed values would be interpreted differently depending on the surrounding scenario. Most of the students attended the curricular unit classes and participated in the CoP meetings in a virtual way, without physical contact and proximity between the different students. As previously mentioned, the knowledge creation and the learning process are conditioned to the surrounding context, therefore it is necessary to take into account that the main conclusions of the research are conditioned to the pandemic context. Thus, it would be important in future research to apply the same methodology but in a post-pandemic phase and taking into account a context that promotes a more recurrent contact in a less virtual way so that the results can be compared, and new conclusions and strategies defined.

Beyond the pandemic context, it is important to mention the data quality issues related to one of the fields of the questionnaire. The field that indicated which community of practice each student belonged to did not show any type of consistency, and many students chose to answer that they did not remember, referring only to the year who enrolled in the course. Thus, it was not possible to verify particular cases within some CoPs and the focus became essentially on the individual as a member of a CoP. Taking this into account, it would also be useful to see the perspective of the community as a whole, which would enable further analysis based on the methodology of Relational Analytics (RA), being able to identify factors in each CoP such as Ideation, Influence, Efficiency, Innovation, Silos, and Vulnerability. The research developed has as a starting point the characteristics associated with the individual of a specific CoP, its learning and the internal environment context, especially the organizational one, and the external context, making a generalization of the impact on value creation associated with the set of individuals and not to each one of the different CoPs in an individualized way. In future research it would be a gain to analyze the same variables but taking into account the segmentation of each of the communities of practice trying to find patterns in each of the groups, trying to promote each of the groups as the starting point of the analysis.

A similar analysis could be carried out in another organizational context, in this case in one or more other knowledge-based organizations from or associated with sectors, which differ from the education sector, where the concepts that have been elaborated and developed in this research can be reused with regard to the variables associated with human factors and value creation. This analysis would have an important contribution to prove the importance of human indicators and individual characteristics in value creation, taking into account the different cycles of value creation. However, it should be noted that this research was based on a PBL methodology that aimed to develop skills associated with critical thinking, collaboration and communication in order to solve the problems presented for this purpose, and the results of the research were limited to the value created in the three problems presented in the curricular unit under study. Thus, in the exercise of reusing this analysis for other contexts, it is important to take into account the maintenance or not of the learning and knowledge management regime, having in mind that if it is replicated in its entirety it would be important to adopt the PBL methodology in a corporate way or a similar methodology if it is not implemented.

8. BIBLIOGRAPHY

Abeysekera, I. (2021). Intellectual Capital and Knowledge Management Research towards Value Creation. From the Past to the Future. Journal of Risk and Financial Management, 14(6), 238. https://doi.org/10.3390/jrfm14060238

Abramson, R. G., Su, P.-F., & Shyr, Y. (2012). Quantitative metrics in clinical radiology reporting: A snapshot perspective from a single mixed academic-community practice. Magnetic Resonance Imaging, 30(9), 1357–1366. https://doi.org/10.1016/j.mri.2012.04.018

Adams, M., & Oleksak, M. (2010). Intangible capital -putting knowledge to work in the 21STcentury organization. Santa Barbara, California: Praeger.

Allee, V. (1997). The knowledge evolution: Expanding organizational intelligence. Butterworth-Heinemann.

Anklam, P. (2007). Net work: A practical guide to creating and sustaining networks at work and in the world. Elsevier/Butterworth-Heinemann.

Barão, A., de Vasconcelos, J. B., Rocha, Á., & Pereira, R. (2017). A knowledge management approach to capture organizational learning networks. International Journal of Information Management, 37(6), 735–740. https://doi.org/10.1016/j.ijinfomgt.2017.07.013

Barrows, H. S., & Tamblyn, R. M. (1980). An Approach to Medical Education. 16.

Bertone, M. P., Meessen, B., Clarysse, G., Hercot, D., Kelley, A., Kafando, Y., Lange, I., Pfaffmann, J., Ridde, V., Sieleunou, I., & Witter, S. (2013). Assessing communities of practice in health policy: A conceptual framework as a first step towards empirical research. Health Research Policy and Systems, 11(1), 39. https://doi.org/10.1186/1478-4505-11-39

Brouwer, P., Brekelmans, M., Nieuwenhuis, L., & Simons, R. (2012). Communities of practice in the school workplace. Journal of Educational Administration, 50(3), 346–364. https://doi.org/10.1108/09578231211223347

Buckingham Shum, S., Ferguson, R., & Martinez-Maldonado, R. (2019). Human-Centred Learning Analytics. Journal of Learning Analytics, 6(2). https://doi.org/10.18608/jla.2019.62.1

Caruso, S. J. (2016). A Foundation For Understanding Knowledge Sharing: Organizational Culture, Informal Workplace Learning, Performance Support, And Knowledge Management. Contemporary Issues in Education Research (CIER), 10(1), 45–52. https://doi.org/10.19030/cier.v10i1.9879

Cooper, A. (2014). Learning Analytics Interoperability – The Big Picture in Brief. 11.

de Vasconcelos, J. B., Kimble, C., Miranda, H., & Henriques, V. (2009). A Knowledge-Engine Architecture for a Competence Management Information System. 20.

Falletta, D. S. (2014). In Search of HR Intelligence: Evidence-Based HR Analytics Practices in Higii Performing Companies. 12.

Gelbard, R., Ramon-Gonen, R., Carmeli, A., Bittmann, R. M., & Talyansky, R. (2018). Sentiment analysis in organizational work: Towards an ontology of people analytics. Expert Systems, 35(5), e12289. https://doi.org/10.1111/exsy.12289

Haavel, A. (2019). Better People Analytics: Measure Who They Know, Not Just Who They Are. 22.

Hafeez, K., & Abdelmeguid, H. (2003). Dynamics of human resource and knowledge management. Journal of the Operational Research Society, 54(2), 153–164. https://doi.org/10.1057/palgrave.jors.2601513

Hubbard, D. W. (2010). How to measure anything—Finding the value of intangibles in business (2nd ed.). Hoboken, New Jersey: John Wiley & Sons, Inc.

Kent, C., & Cukurova, M. (2020). Investigating Collaboration as a Process with Theory-driven Learning Analytics. Journal of Learning Analytics, 7(1). https://doi.org/10.18608/jla.2020.71.5

Khamis, M. A., Ngo, H. Q., Nguyen, X., Olteanu, D., & Schleich, M. (2020). Learning Models over Relational Data Using Sparse Tensors and Functional Dependencies. ACM Transactions on Database Systems, 45(2), 1–66. https://doi.org/10.1145/3375661

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge University Press. https://doi.org/10.1017/CBO9780511815355

Lee, L., Reinicke, B., Sarkar, R., & Anderson, R. (2015). Learning through Interactions: Improving Project Management through Communities of Practice. Project Management Journal, 46(1), 40–52. https://doi.org/10.1002/pmj.21473

Liu, L., Akkineni, S., Story, P., & Davis, C. (2020). Using HR Analytics to Support Managerial Decisions: A Case Study. Proceedings of the 2020 ACM Southeast Conference, 168–175. https://doi.org/10.1145/3374135.3385281

Marler, J. H., & Boudreau, J. W. (2017). An evidence-based review of HR Analytics.

Marr, B., Gupta, O., Pike, S., & Roos, G. (2003). Intellectual capital and knowledge management effectiveness. Management Decision, 41(8), 771–781. https://doi.org/10.1108/00251740310496288

Mavri, A., Ioannou, A., & Loizides, F. (2021). Value creation and identity in cross-organizational communities of practice: A learner's perspective. The Internet and Higher Education, 51, 100822. https://doi.org/10.1016/j.iheduc.2021.100822

Nicolaescu, S. S., Florea, A., Kifor, C. V., Fiore, U., Cocan, N., Receu, I., & Zanetti, P. (2020). Human capital evaluation in knowledge-based organizations based on big data analytics. Future Generation Computer Systems, 111, 654–667. https://doi.org/10.1016/j.future.2019.09.048

Nistor, N., & Fischer, F. (2012). Communities of practice in academia: Testing a quantitative model. Learning, Culture and Social Interaction, 1(2), 114–126. https://doi.org/10.1016/j.lcsi.2012.05.005

Nonaka, I., & Toyama, R. (2003). The knowledge-creating theory revisited: Knowledge creation as a synthesizing process. 9.

Pape, T. (2016). Prioritising data items for business analytics: Framework and application to human resources. European Journal of Operational Research, 252, 687–698.

Parise, S. (2007). Knowledge Management and Human Resource Development: An Application in Social Network Analysis Methods. Advances in Developing Human Resources, 9(3), 359–383. https://doi.org/10.1177/1523422307304106

Peeters, T., Paauwe, J., & Van De Voorde, K. (2020). People analytics effectiveness: Developing a framework. Journal of Organizational Effectiveness: People and Performance, 7(2), 203–219. https://doi.org/10.1108/JOEPP-04-2020-0071

Ralević, P. V. (2015). Increasing organizational performance by human resource management. Tehnicki Vjesnik - Technical Gazette, 22(2), 263–269. https://doi.org/10.17559/TV-20130905124436

Shannak, R. O. (2009). Measuring Knowledge Management Performance. 13.

Smits, M., & de Moor, A. (2004). Measuring knowledge management effectiveness in communities of practice. 37th Annual Hawaii International Conference on System Sciences, 2004. Proceedings of The, 9 pp. https://doi.org/10.1109/HICSS.2004.1265570

The International Journal of Human Resource Management, 28(1), 3–26. https://doi.org/10.1080/09585192.2016.1244699

van der Mei, M., & Jansen, S. (2010). Performance measuring in communities of practice: A method and case study. 2010 Fourth International Conference on Research Challenges in Information Science (RCIS), 607–618. https://doi.org/10.1109/RCIS.2010.5507290

Venkatraman, S., & Venkatraman, R. (2018). Communities of Practice Approach for Knowledge Management Systems. Systems, 6(4), 36. https://doi.org/10.3390/systems6040036

Wenger, E. (2009). Communities of practice. Communities of Practice.

Wenger, E. (2010). Communities of Practice and Social Learning Systems: The Career of a Concept. Em C. Blackmore (Ed.), Social Learning Systems and Communities of Practice (pp. 179–198). Springer London. https://doi.org/10.1007/978-1-84996-133-2_11

Wenger, E., Trayner, B., & de Laat, M. (2011). Promoting and assessing value creation in communities and networks: A conceptual framework. 63.

Zilvinskis, J., Willis, J., & Borden, V. M. H. (2017). An Overview of Learning Analytics: An Overview of Learning Analytics. New Directions for Higher Education, 2017(179), 9–17. https://doi.org/10.1002/he.20239

9. APPENDIX

9.1. QUESTIONNAIRE

Agreement:

Knowledge and People are two of the main assets of organizations that want to be efficient in their processes. Due to the characteristics that these assets have, their volatility and the difficulty in managing the interoperability between them, they present themselves as challenges for organizations. This study aims to create a structured process that allows to manage and measure the knowledge generated within an organization through the evaluation of behaviors in Communities of Practice using People Analytics. To collect the information from each of the CoPs, a questionnaire was developed to measure and evaluate the knowledge generated throughout the different problems (PBL methodology) developed and solved in the curricular unit of Knowledge Management, based on information about the learning process and the creation of new knowledge. The information generated by this questionnaire applied to the CoP of the curricular unit of Knowledge Management will be used as a sample to understand the behaviors of organizations that use knowledge as one of their main assets. It is important to note that the CoPs represent the different working groups that were created in the curricular unit of Knowledge Management. All questions presented are mandatory and take about 10 minutes to be answered. Thank you for your participation.

a) I agree to participate in this investigation by answering this questionnaire
b) I do not agree to participate in this investigation

1. In this first phase of the questionnaire, general questions will be asked.

1.1. Enter your Age

1.2. Enter your Gender
a) Male
b) Female
c) Non-binary / third gender
d) Prefer not to say

1.3. In which country do you currently reside?

1.4. Are you currently working?
a) Yes
b) No

1.5. Enter your employment status (if in 1.4. “Yes” is selected)
a) Employed full-time
b) Employed part-time

2. In this second phase of the questionnaire, some questions will be asked about the configuration of Knowledge Management classes and the constitution of the different CoPs, as well as information regarding the different problems.

2.1. My Knowledge Management group number (group-number-year, ex: "group-11-2020")

2.2. The number of members of my group was:
   a) Less than 3
   b) Between 3 and 5
   c) Between 3 and 5

2.3. The number of members in my group has changed over the different problems:
   a) No, the number of members was always the same
   b) Yes, there were members that left the CoP
   c) Yes, new members have been added to the CoP

2.4. I attended Knowledge Management classes:
   a) Mainly on campus
   b) Mainly at home

2.5. The meetings held during the resolution of the different problems were:
   a) Mainly Online
   b) Mainly Presential

2.6. The problem that I considered the most complex and difficult to solve was:
   a) The Budget Cut – Why Knowledge Management is more relevant than ever in times of COVID-19
   b) The end of the middle manager: the importance of KM for the learning organization
   c) Knowledge acquisition and dissemination through Communities of Practice

2.7. The number of meetings necessary to develop and solve the most complex problem was:
   a) Less than 2
   b) Between 2 and 4
   c) Greater than 4

3. In this third phase of the questionnaire, some questions will be asked about the way you work in a group, how you interact and behave with other members, as well as some of your main characteristics that can influence group work.

3.1. I prefer to work and deliver results:
   a) Individually
   b) In group

3.2. Drivers of group dynamics (1 corresponds to "Strongly disagree" and 7 corresponds to "Strongly Agree")
    a) In group work, I consider important to get feedback from other members
    b) In group work, I consider important the management of expectations
    c) In group work, I consider important communication based on the accuracy and relevance of information
    d) In group work, I consider important a connectivity between all members based on the relationships created between them and the characteristics of each one
    e) In group work, I consider important the division of tasks according to the knowledge that each member has of the subject under study
    f) In group work, I consider important to take into account the emotional responses, such as feelings of satisfaction or identification, of each member throughout the development of tasks
    g) In group work, I consider important to have control over all the topics that should be analyzed and how they should be analyzed a priori

3.3. In the process of team interaction and discussion of ideas I value more:
    a) Identification with the group and feeling of belonging
    b) Group dynamics based on connectivity between members, trust and communication
    c) Leadership and task orientation

3.4. Performance in group work (1 corresponds to "Strongly disagree" and 7 corresponds to "Strongly Agree")
    a) I consider myself creative
    b) I try to bring a set of original and innovative ideas to present at meetings
    c) I usually complete tasks on time
    d) I usually fulfill the proposed objectives with quality
    e) I'm motivated by goals
    f) I like to be an active voice in the delineation of tasks and processes
    g) I usually share and exchange ideas with my colleagues
    h) I consider important to have all my topics under control, in order to avoid unexpected situations
    i) I usually react positively under pressure

3.5. I usually get more knowledge from:
    a) Learning from failure
    b) Learning from success
    c) Learning from direct experience (ex: time spend in the firm portal)
    d) Learning from indirect experience (ex: time spend in external forums/pro. sites)

3.6. Knowledge Creation Environment (1 corresponds to "Strongly disagree" and 7 corresponds to "Strongly Agree")

a) I value the exchange of ideas to create knowledge on a regular basis
b) I value a high number of rounds to discuss ideas in the learning process and knowledge generation
c) I value the division of roles in the learning process and knowledge generation

4. In this fourth phase of the questionnaire, some questions will be asked to measure the immediate value of knowledge generated through the level of participation in the CoP, the level of engagement and the level of interactions between the members.

4.1. During the learning process and knowledge creation the number of meetings held by my group was:

a) Less than 4
b) Between 4 and 6
c) Greater than 6

4.2. During the learning process and knowledge creation I attended:

a) Less than 50% off the meetings
b) Between 50% and 75% of the meetings
c) More than 75% of the meetings (this option does not include all the meetings)
d) All the meetings

4.3. The average duration of the meetings was:

a) Less than 45 minutes
b) Between 45 and 90 minutes
c) More than 90 minutes

4.4. I interacted with every member of the group throughout the learning process and knowledge creation

a) No
b) Yes

4.5. Intensity of my interactions (0 corresponds to "No intensity level" and 7 corresponds to "High intensity level")

a) Level of Intensity (Level of Engagement)

4.6. Quality of my interactions (0 corresponds to "No quality level" and 7 corresponds to "High quality level")

a) Level of Quality (Debates on important issues)

4.7. Relevance that interactions had on me (0 corresponds to "No relevance level" and 7 corresponds to "High relevance level")

a) Level of Relevance (Relevance of interactions in knowledge creation)

4.8. Importance of my experience in the creation of new knowledge (0 corresponds to "No importance level" and 7 corresponds to "High importance level")

a) Level of Importance (Importance of practice into the learning space)

4.9. I interacted with members of other CoP throughout the learning process and the creation of new knowledge

a) No
b) Yes

4.10. Intensity of my interactions with members of other CoP (0 corresponds to "No intensity level" and 7 corresponds to "High intensity level") (if in 4.9. "Yes" is selected)

a) Level of Intensity (Level of Engagement)

4.11. Quality of my interactions with members of other CoP (0 corresponds to "No quality level" and 7 corresponds to "High quality level") (if in 4.9. "Yes" is selected)

a) Level of Quality (Debates on important issues)

5. In this fifth phase, some questions will be asked to measure the potential value of knowledge through the validation of skills acquired over the different problems, emotional responses to different challenges, the resources generated and the ability to transfer the knowledge generated in CoP to other contexts.

5.1. I acquired new skills throughout the learning process and the generation of new knowledge

a) No
b) Yes

5.2. The new skills acquired were mainly related to: (if in 5.1. "Yes" is selected)

a) Personal Assets
b) Relationships and Connections
c) Resources
d) Collective intangible assets
e) Transformed ability to learn

5.3. The participation in a CoP changed my attitude when dealing with similar problems

a) No
b) Yes

5.4. Drivers that contributed to my attitude change (0 corresponds to "No contribution level" and 7 corresponds to "High contribution level") (if in 5.3. "Yes" is selected)

a) Motivation
b) Confidence
c) Sense of Importance

5.5. The participation in a CoP improved my ability to ask questions
    a) No
    b) Yes

5.6. Drivers that contributed to the improvement of my ability to ask questions (0 corresponds to "No contribution level" and 7 corresponds to "High contribution level") (if in 5.5. "Yes" is selected)
    a) Trust
    b) Commitment

5.7. During the learning process and the development of new knowledge the number of references used was:
    a) Less than 20
    b) Between 20 and 50
    c) Greater than 50

5.8. During the learning process and the development of new knowledge the size of the files I shared with other members of the group was:
    a) Less than 50 MB
    b) Between 50 MB and 100 MB
    c) Between 100 MB and 150 MB
    d) Between 150 MB and 200 MB
    e) Greater than 200 MB

5.9. In my opinion there was a positive evolution in the learning process and in the creation of new knowledge throughout the different PBL
    a) No
    b) Yes

5.10. Drivers that contributed to the evolution of the CoP status (0 corresponds to "No contribution level" and 7 corresponds to "High contribution level") (if in 5.9. "Yes" is selected)
    a) Recognition of the strategic relevance of the domain
    b) Perceived significance of CoP membership
    c) Feedback from teachers or members of other groups

5.11. Participation in the CoP (1 corresponds to "Strongly disagree" and 7 corresponds to "Strongly Agree")
    a) The participation in the CoP allowed me to transfer the acquired experience to other contexts
    b) The participation in the CoP allowed me to see opportunities for learning that I did not see before

6. In this sixth phase, some questions will be asked to measure the applied value of knowledge by identifying how the knowledge acquired in the CoP was applied in practice.

6.1. The participation in CoP has made a difference in my ability to manage and use new knowledge
    a) No
    b) Yes

6.2. I applied the skills acquired in the creation of new knowledge (if in 6.1. “Yes” is selected)
    a) No
    b) Yes

6.3. Situations where the generation of new knowledge was motivated by my use of assets generated at the CoP (0 corresponds to "No knowledge reused level" and 7 corresponds to "High knowledge reused level”) (if in 6.2. “Yes” is selected)
    a) Reuse of knowledge to promote the change of procedures (New ways of doing things)
    b) Reuse of knowledge to implement new ideas and perspectives
    c) Reuse of Knowledge to give new suggestions, solutions and insights

7. In this seventh phase, some questions will be asked to measure the realized value of knowledge, through the identification of changes in behavior and performance promoted by the participation in the CoP.

7.1. Personal Performance (1 corresponds to "Strongly disagree" and 7 corresponds to "Strongly Agree”)

    a) The participation in the Community of Practice improved my ability to achieve relevant knowledge
    b) The participation in the Community of Practice allowed me to be more efficient in the presentation of results
    c) The feedback given during the Learning Process allowed me to be more accurate in the following research

7.2. I used the knowledge generated in my CoP to leverage or suggest changes to other CoP

    a) No
    b) Yes

8. In this eighth phase, some questions will be asked to measure the reframing value of knowledge, through the use of knowledge generated in the CoP for the development of new studies and new approaches and perspectives.

8.1. Community Aspirations (1 corresponds to "Strongly disagree" and 7 corresponds to "Strongly Agree")

a) I have in mind a new learning agenda based on the research done on the developed problems
b) I have in mind a new discourse about the additional value that can be extracted from the research done on the developed problems
c) I have in mind the investigation of another vision of the problems developed based on the generated knowledge
d) I will apply the knowledge generated in the learning process in the development of future frameworks or processes

9.2. SEGMENT PROFILE OUTPUT

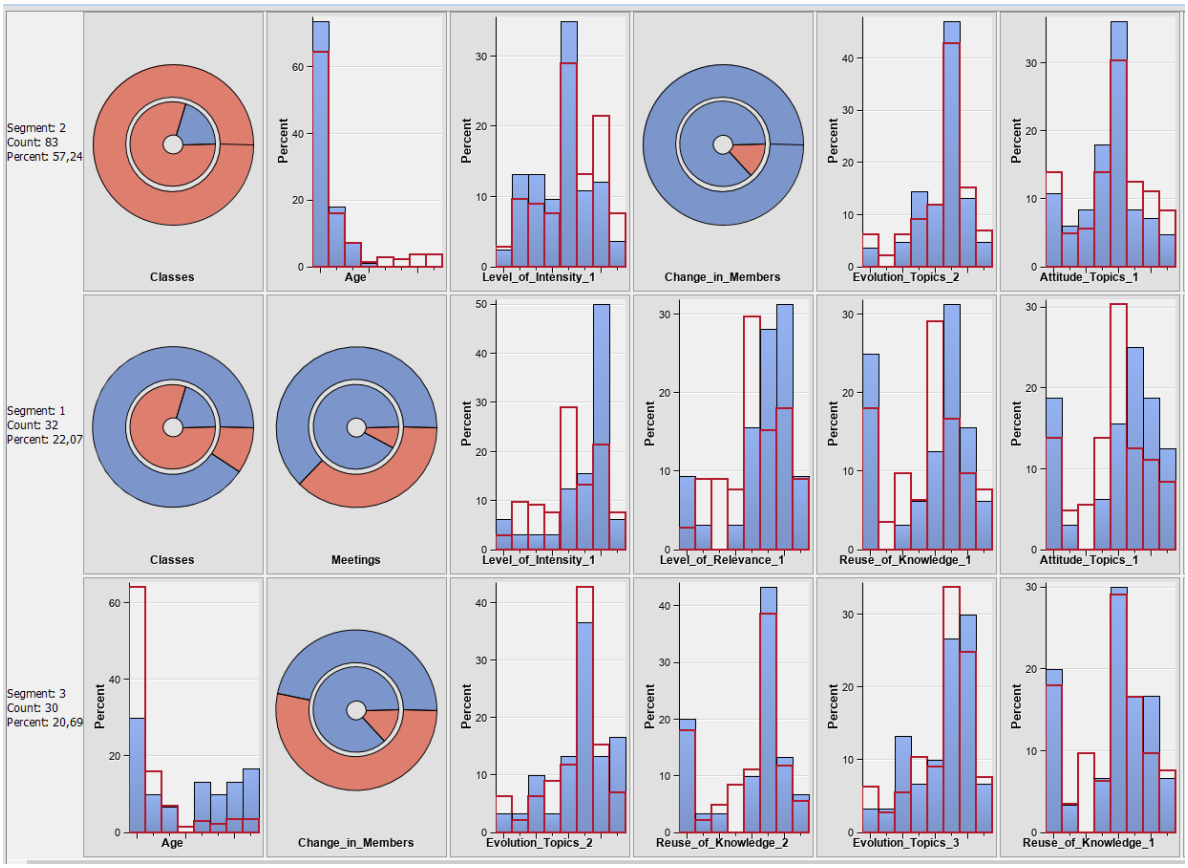

Figure 15 - CoP details Segment Profile Output

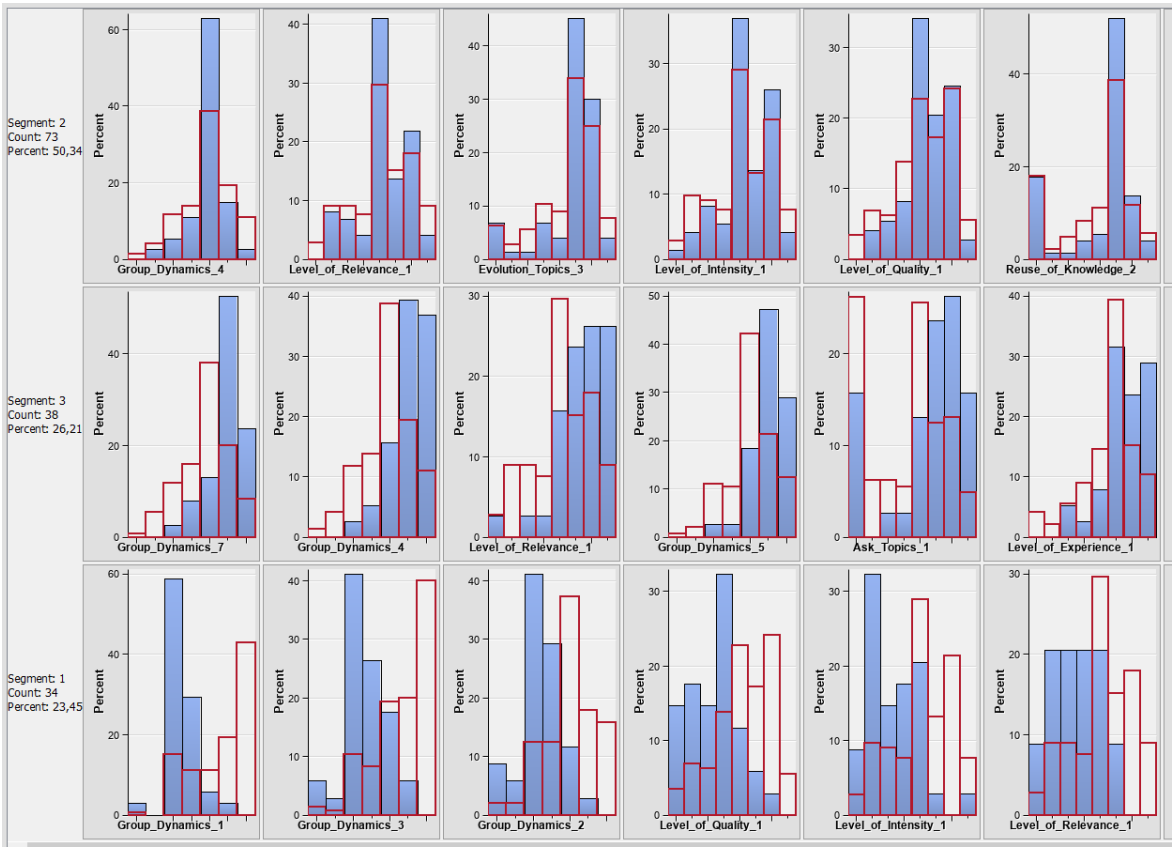

Figure 16 - Group Dynamics Segment Profile Output

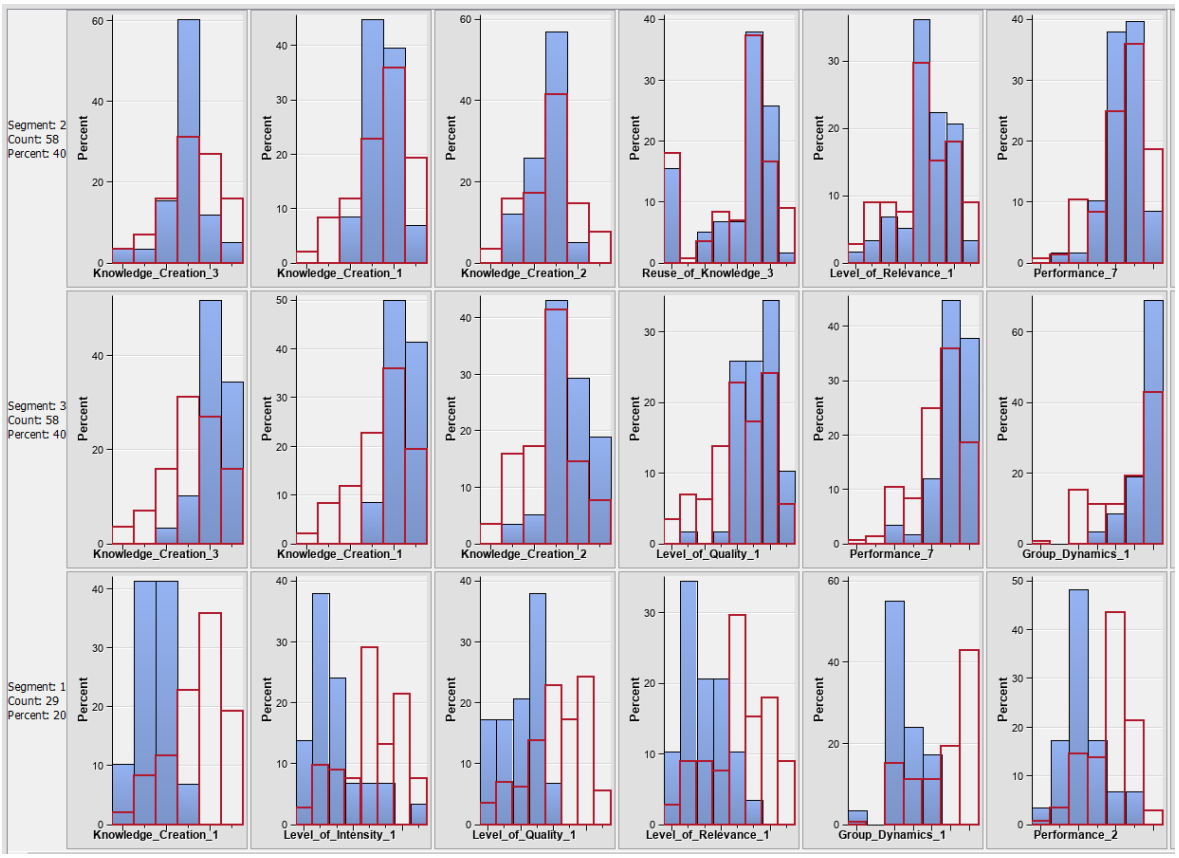

Figure 17 - Knowledge Creation Segment Profile Output

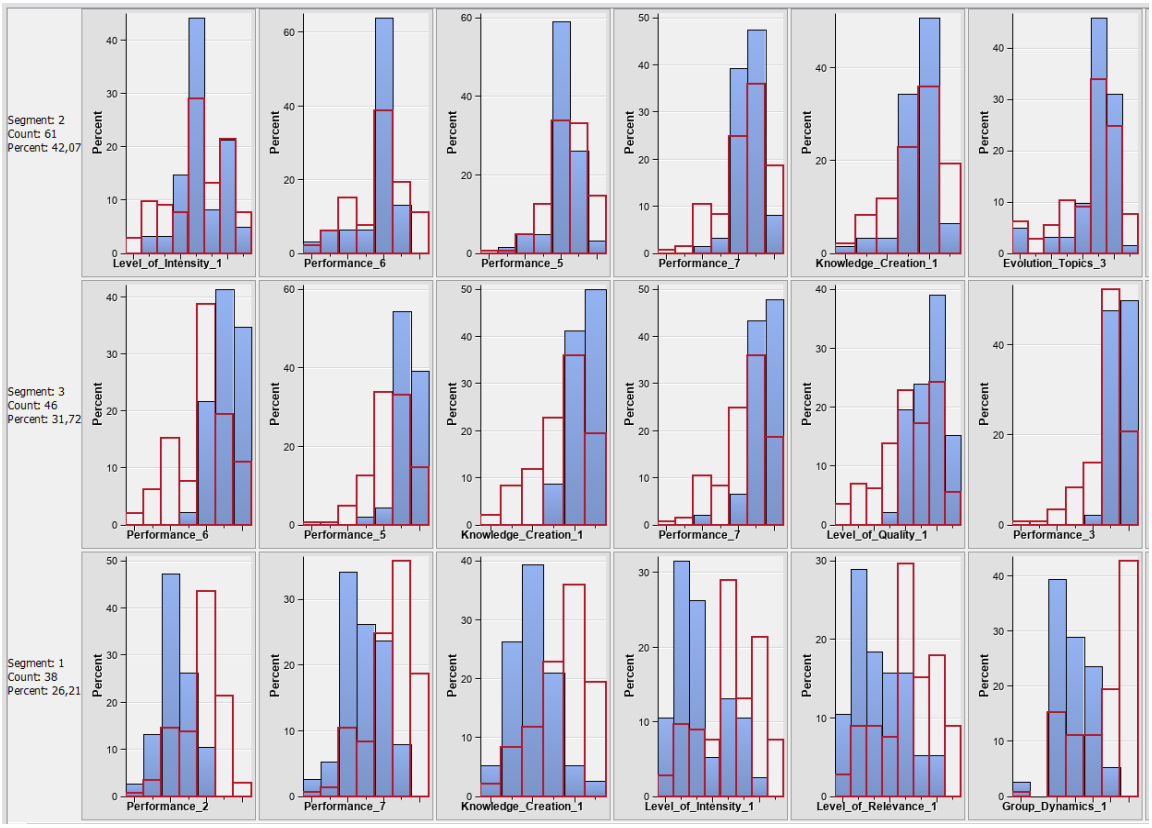

Figure 18 - Performance Segment Profile Output

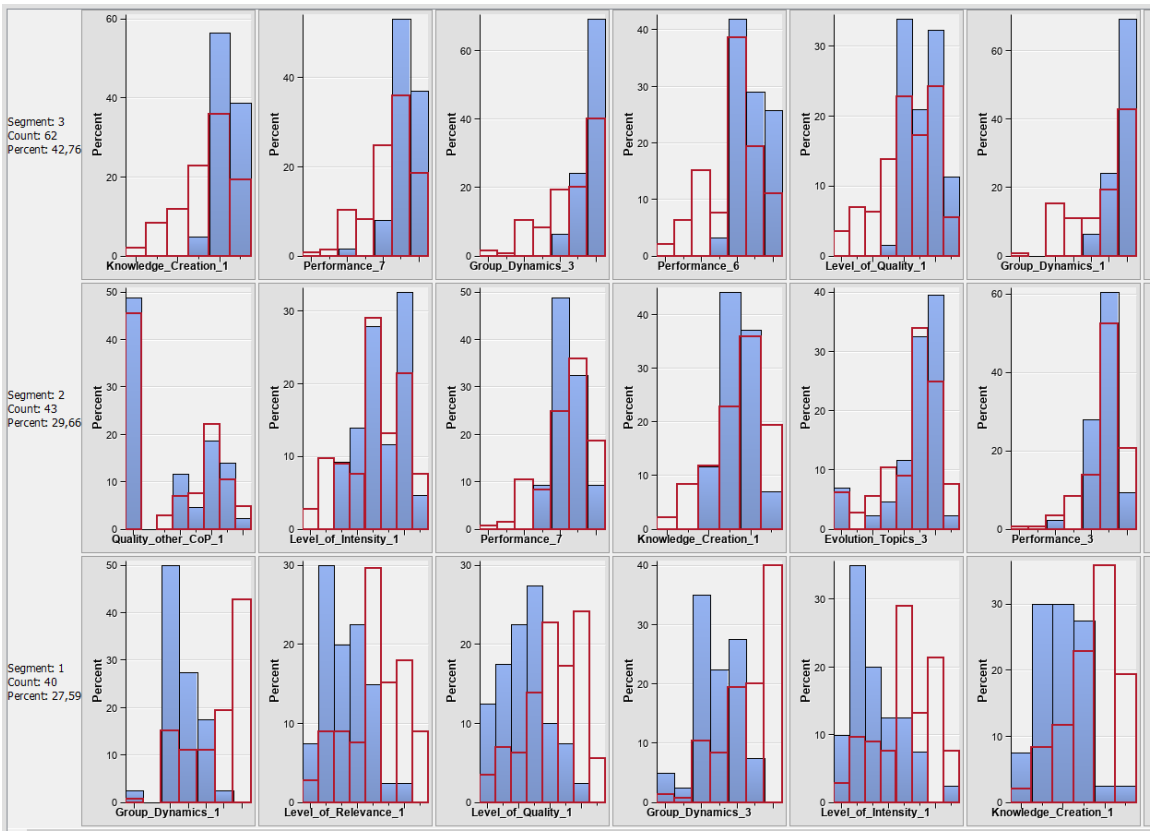

Figure 19 - Combination of Human factors Segment Profile Output

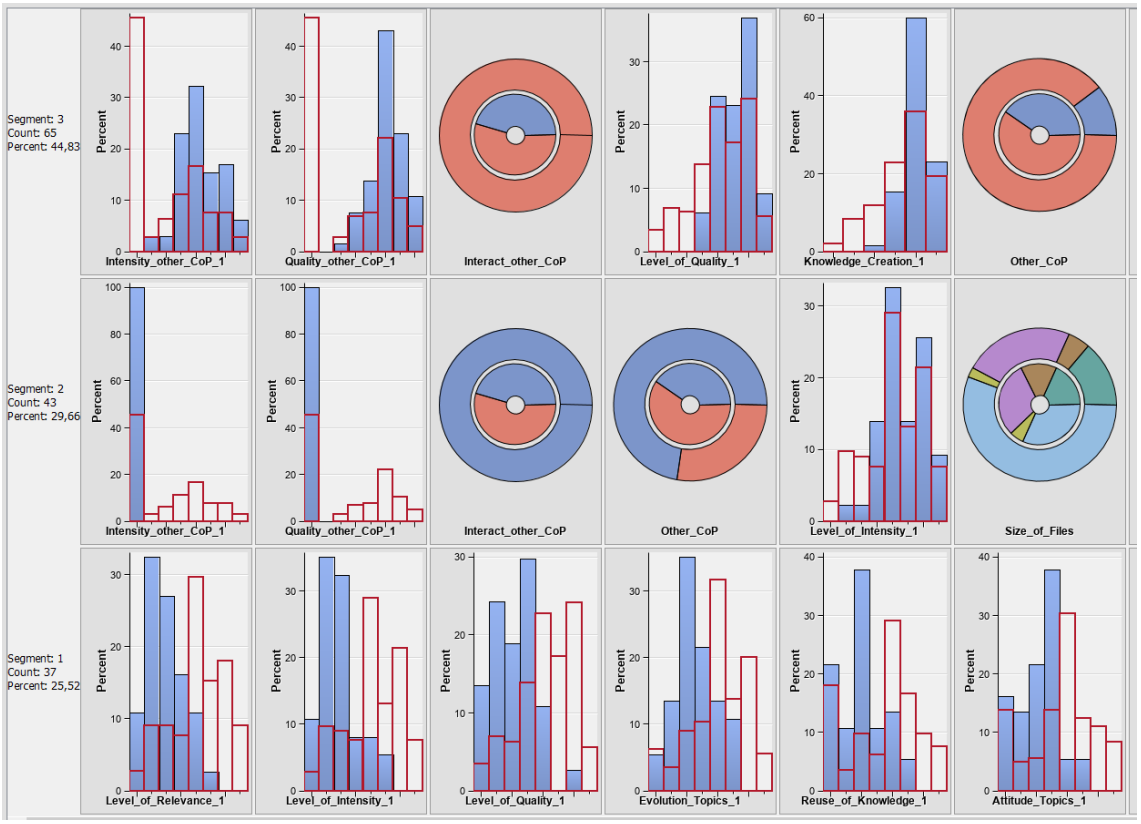

Figure 20 - Immediate Value Segment Profile Output

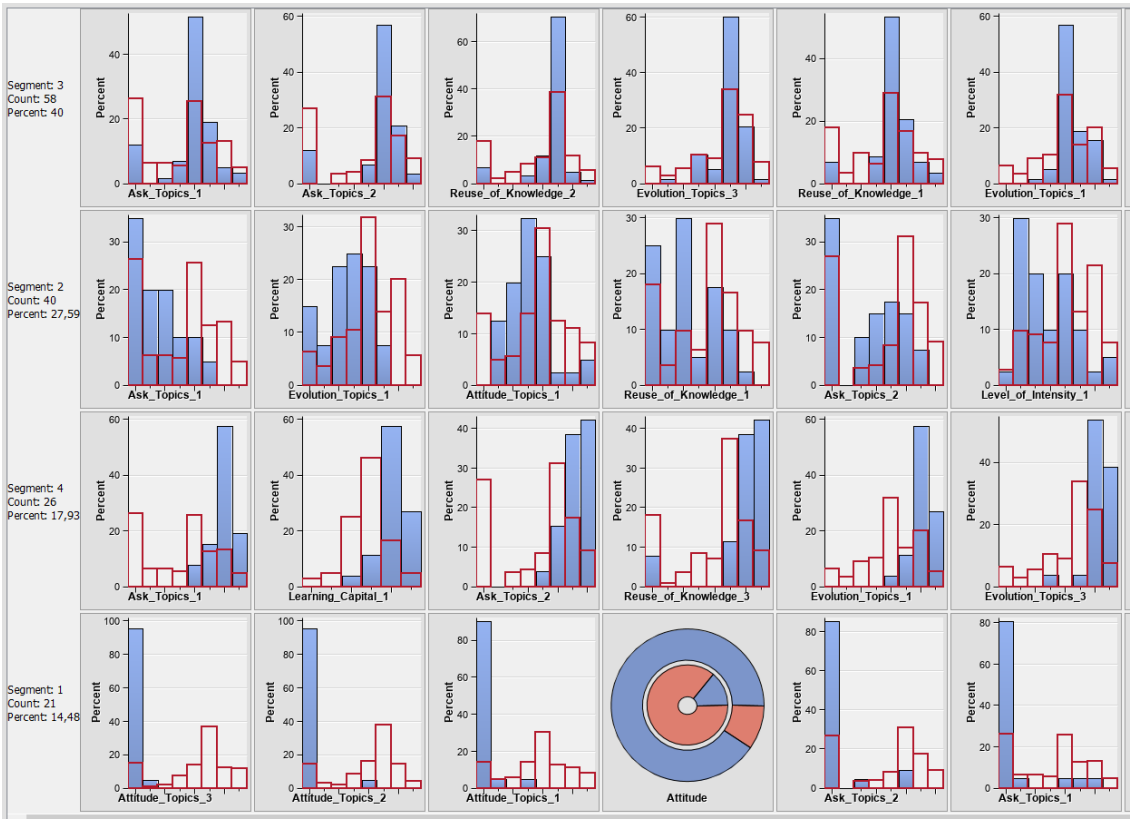

Figure 21 - Potential Value Segment Profile Output

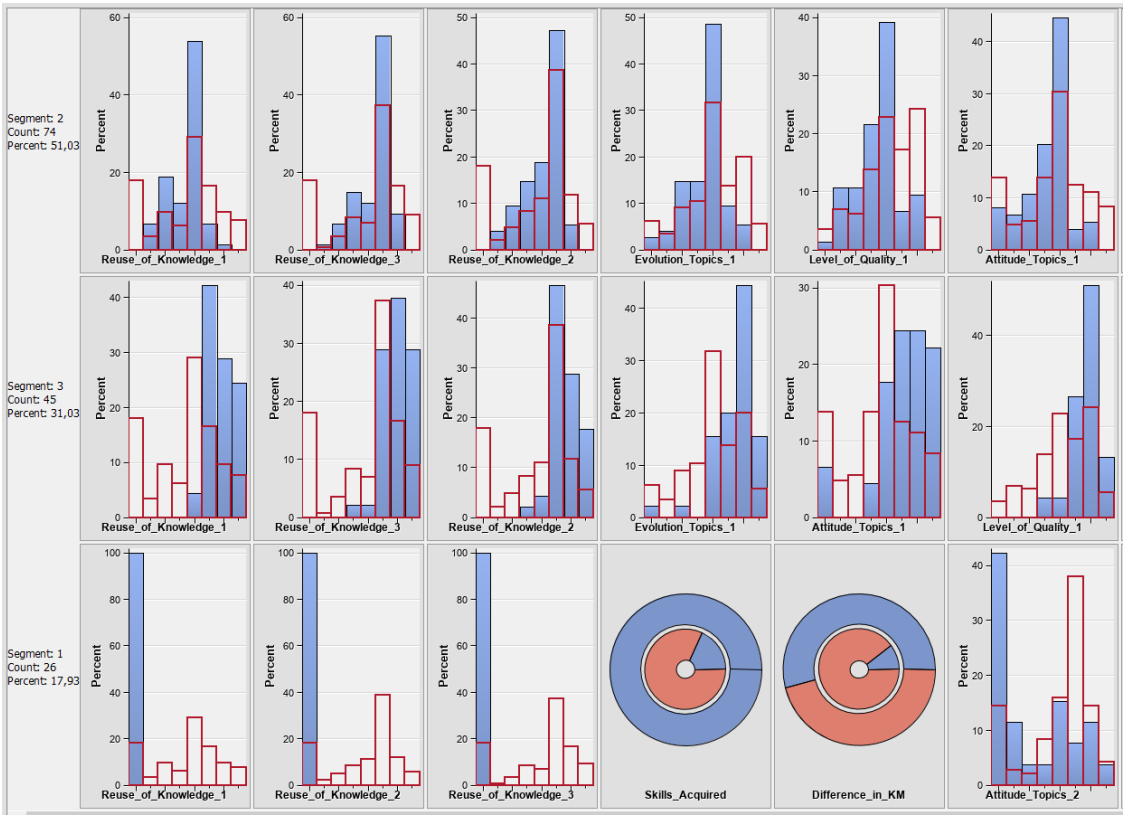

Figure 22 - Applied Value Segment Profile Output

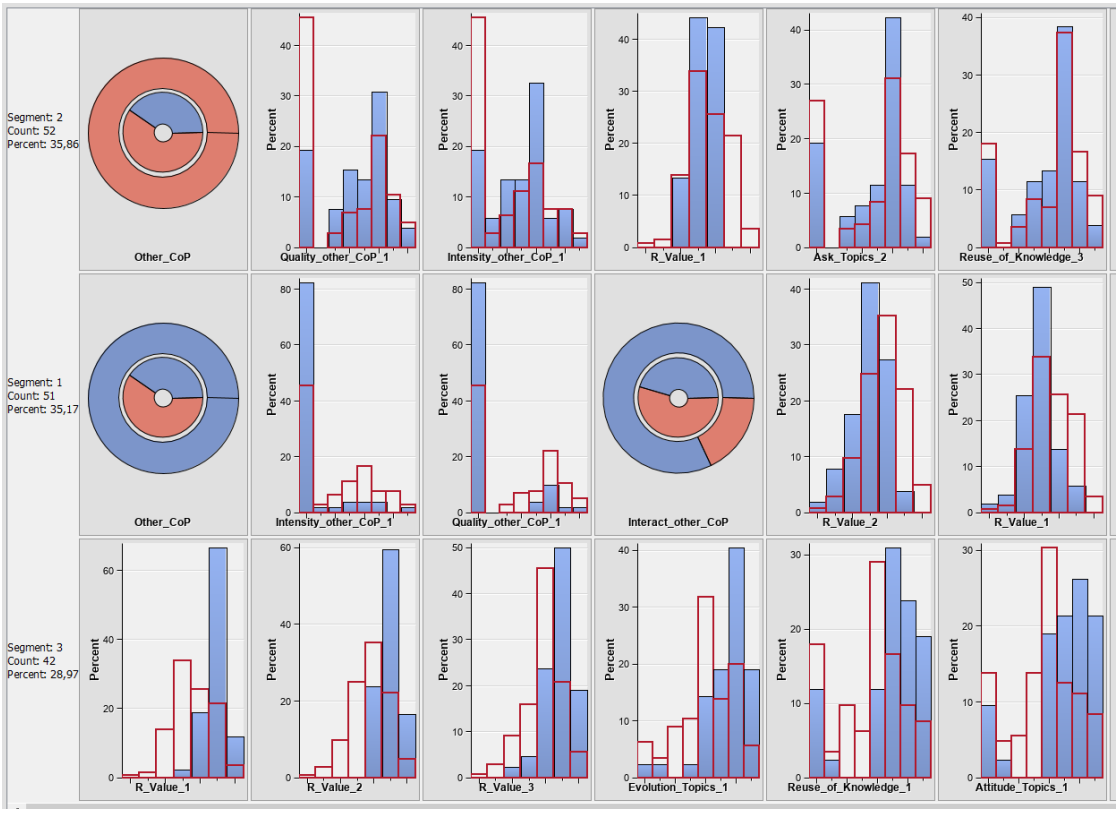

Figure 23 - Realized Value Segment Profile Output

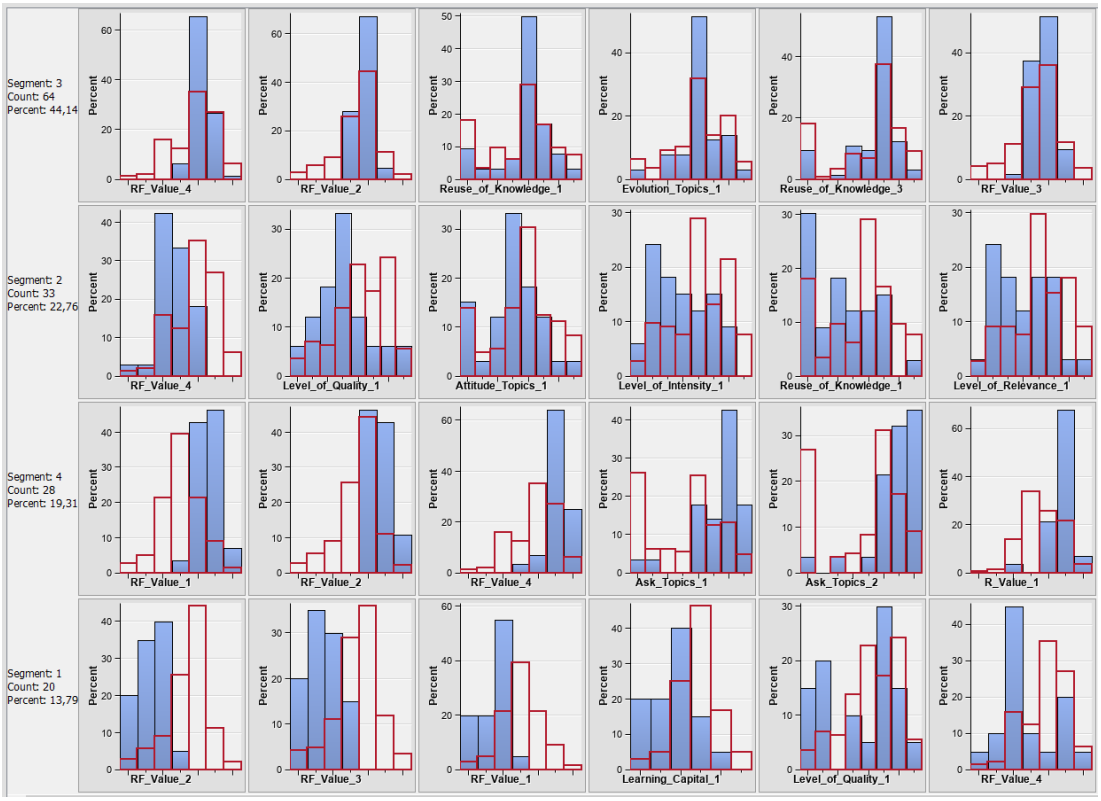

Figure 24 - Reframing Value Segment Profile Output