# Managing Knowledge About Future of Work: A Model for Higher Education Institutions

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**Abstract:** The Fourth Industrial Revolution is causing considerable changes to the world of work. The interaction between technology and work, which takes many forms such as digitalization, automation, and augmentation, is happening quickly and broadly, impacting economic sectors left almost untouched by previous industrial revolutions. In this scenario, Higher Education Institutions (HEIs) must be able to foresee changes to prepare future professionals to match the needs of this new digital age. The professionals that are being prepared today need to learn a new set of skills related to emerging and disruptive technologies, such as Artificial Intelligence, the Internet of Things, and Big Data. In this paper, we propose a Knowledge Management model to help manage the HEIs' teaching staff knowledge about the future of work, specifically, the expected skills and competencies to be highly demanded from professionals in the future. Therefore, we performed a brief review of related work about Knowledge Management in the context of HEIs, Management of Future-oriented Knowledge, and the application of the Delphi method to studies concerning the Future of Work. Considering this previous work, we propose a Knowledge Management model that combines the European Foundation for Quality Management (EFQM) Excellence Model framework with a Delphi process that is used during the Knowledge Generation step of the Knowledge Management process. The proposed model considers that professors are experts in their areas of concentration and, as such, are capable of helping their HEIs with their knowledge that can be used to improve the courses' curricula. The model also considers that HEIs can help professors make this knowledge explicit, then store, transfer, and apply it. We provide detailed information about how to apply the model, how to deal with potential application problems and the model limitations. The proposed Knowledge Management model can help HEIs to keep up with the trends of demands of the labor market.

**Keywords:** Knowledge Management, Future-oriented Knowledge, Higher Education Institutions, Delphi Method, EFQM Excellence Model

## 1. Introduction

The fourth Industrial Revolution involves the combined use of several technologies such as artificial intelligence, robotics, bio, and nanotechnology, in the most diverse areas of human production, from Medicine to Law, including Education, and Industry (Schwab, 2017).

As the automation of tasks that hitherto required humans, including non-repetitive cognitive tasks such as those that constitute many white-collar jobs, a severe, broad, and fast-paced change in the skills that are demanded from workers is taking place. Several studies, following Frey & Osborne's (2017) seminal work, estimate that, depending on the country, 35-85% of existing jobs have a high risk of being automated in the next decades (Lima *et al.*, 2021).

In this context, it is paramount that society trains new professionals according to the current and expected demands of the labor market. Here, Higher Education Institutions (HEIs) play a central role and need the tools to update their courses' curricula properly with the teaching staff being able to support this change with their knowledge. As such, the goal of this paper is to propose a Knowledge Management (KM) model to help manage the HEIs' teaching staff knowledge about the future of work, more specifically, about the skills and competencies that are expected to be highly demanded from professionals in the future.

## 2. Related work

This section aims to provide examples of how KM is applied within HEIs, how KM can benefit from Future-Oriented Technology Analysis (FTA) techniques, and how the Delphi method can provide insight into the future of work. We do not intend on making a comprehensive literature review and primarily expect to extract from the literature some supporting evidence of the effectiveness of these tools.

### 2.1 Knowledge Management in HEIs

A Knowledge Management System (KMS) is a category of Information System used in organizations to manage knowledge with the help of IT-based systems and provide support to processes involving the creation, storage, retrieval, transfer, conversion, protection, and application of knowledge (Oumran *et al.*, 2021).

KMSs can help HEIs in decision-making processes, and oversee and evaluate educational activities (Oumran *et al.*, 2021). Organizational, technological, or environmental factors contribute to hinder their adoption despite the perceived advantages for KMSs. The perception of the usefulness of KMS, the existence of IT infrastructure, financial support, and proper training in using the system are some of the most important factors to facilitate its adoption among potential users (Oumran *et al.*, 2021).

Moscoso-Zea *et al.* (2019) apply KMSs in HEIs, presenting what they described as "a hybrid information infrastructure for business intelligence and analytics". Their goal was to implement a KMS based on educational data warehouses for analytics and data visualization. The authors supported the idea of knowledge management associated with Big Data techniques and argued that the two main challenging factors related to data analysis are both the immense volume of information generated every day and the fact that various existing information systems are distributed, isolated from another and heterogeneous, a problem known as *islands of information*. As a result, the authors advocate for a centralized, hybrid infrastructure of enterprise architecture and business intelligence analytics for KM in education.

A good example of how the application of KM can be useful to HEIs can be found in the article by Hoffmann *et al.* (2019). Using a data model based on the Brazilian Higher Education Census, the author proposed the implementation of organizational knowledge management about school dropouts, helping managers to control evasion. The authors not only show how KM can be useful to support decision-making processes but also highlight how KMSs may perform a relevant role in the context of HEIs.

Pinto (2014) discusses the role of KM in HEIs, presenting a framework to improve knowledge sharing and collaboration in a HEI. This framework integrated KM practices – such as Communities of Practice, Best Practices, and Learned Lessons – with what the author called a Knowledge System (KS). The KS consisted of a corporative portal with a set of KM tools – as Knowledge Repositories, Knowledge Maps, and Learning Systems – which gave support to the aforementioned KM practices. The author's proposal shows how technological tools may aid KM practices and processes.

Although many examples of how KM is applied within HEIs were found, the usefulness of KM as a means to improve higher education courses' curricula appears to have not been fully explored. We support the idea that KM can be a powerful tool to achieve this end, but, as a more robust framework to guide the HEI's staff and improve the curricula towards the satisfaction of the labor market's ever-changing needs is required, we shall propose a KM model which serves best this particular end.

### 2.2 Managing future-oriented knowledge

HEIs should provide useful courses to their students and make them resilient to labor market changes. Combining KM with Future-Oriented Technology Analysis (FTA) can empower the management of HEIs' Intellectual Capital (IC). IC can be simply defined as the sum of all knowledge in an organization that creates a competitive advantage (Alvino *et al.*, 2021; Ferenhof *et al.*, 2015; Junior *et al.*, 2019; Nahapiet & Ghoshal, 1998). FTA techniques are used to discover the forces driving the future and their processes, resulting in better-informed decision-making (Junior *et al.*, 2019).

FTA Techniques such as Alternative Scenarios, for example, provide insights into HEIs decision-making. They show situations in which the current management would be inefficient, presenting possible mitigation paths.

FTA may be used for identification, creation, acquisition, storing, transfer and use of organizational knowledge, generating feedback for KM processes, and IC improvement (Nascimento *et al.*, 2021).

Junior *et al.* (2019) proposed a framework to combine a strategy for KM with three main dimensions: KM Processes, IC, and FTA Strategies. The first one is focused on the identification, acquisition, creation, storage, sharing, and use of organizational knowledge (Map Value Propositions). The second focuses on the structuring of tangible and intangible knowledge of the organization, or the Intellectual Capital (Support KM Processes Structuring). Finally, the third focuses on methods that may contribute to the structuring of the KM processes, as well as the formation of a body of knowledge necessary for decision-making (Generate Support Information to the Decision-making). According to Junior *et al.* (2019), a benefit of using KM and FTA together is to make organizations more resilient.

In other work, Castro *et al.* (2019) propose a model that combines concepts of FTA, Participatory KM (PKM), and Technological KM (TKM) to assist the decision-making process and also improve the organizational IC. The proposed model uses FTA techniques to collect *data*, which is processed as *information*, then analyzed as *knowledge*. This knowledge is managed using TKM or PKM depending on whether it refers to new technologies or other subjects. The learning from such KM processes is used to identify opportunities and support the decision-making process.

The application of FTA in HEIs can provide forecasts about the future of work and assess the impact of future labor market scenarios on higher education. Institutions must be equipped with a set of appropriate tools – including management models and KM frameworks – to foresee and adapt to future change. Our proposed KM model deals with the need for a KM tool to manage future-oriented knowledge.

### 2.3 Delphi and the future of work

Delphi is a method designed to make forecasts of a subject through the consensus between experts from the required disciplines in an anonymous controlled debate, as their opinions are most likely to be correct (Gordon, 1994). To do so, the experts are identified and invited to answer a questionnaire anonymously, to collect their perceptions about the future of that subject. Then, the answers are analyzed and synthesized by researchers, starting what is called phase two of Delphi. They present the results as feedback for the participants. Experts with extreme opinions considering the average answers are asked to provide the reasons for their position. The results are synthesized again and feedbacked in the third phase of Delphi, presenting to all participants the reasons for the extreme positions. The participants, then, are asked to reassess their position considering the reasons presented, refuting them if necessary. The second and third phases can be repeated many times until a consensus is reached.

To assess the future of work, previous research invited experienced teachers and managers in a field. Chiu *et al.* (2015), for example, invited 13 teachers with more than 10 years of experience in design education or personnel from design-related industries. The main goal of their study was to build a set of indicators to assess students' competitiveness in design courses by forecasting the core competencies needed for professionals in that field. To build the Delphi, they analyzed other research papers and investigation reports to collect a set of possible competencies to construct the questionnaires. Then, they summarized the findings and classified the competencies into two distinct categories: general competency (individual generic competencies that anyone could achieve, like communication or leadership) and professional competency (specific competencies needed by professionals of a field to do their jobs, like knowledge and experience in some technique related to that field of work). Finally, they built a questionnaire with those two categories of competencies and sent it to experts, that did one round of phases two and three of the Delphi protocol to achieve consensus. As a result, they have identified a set of 65 competencies listed by experts as core competencies for the design worker.

The same methodology was used by Pérez-Pérez *et al.* (2018), which forecast changes in Additive Manufacturing by 2030 using a Delphi with more than 100 Spanish experts. The questionnaire was constituted with some future scenarios, and the experts needed to answer with their concordance level about the probability of that future scenario coming true. The scenarios were formulated by the authors with their perception of possible future scenarios. Then, they simplified the scenarios listed previously and sent them to experts, who did one round of phases two and three of the Delphi protocol to achieve consensus. The results were able to show the aspects, technologies, and areas with the greatest growth potential.

Fadhil *et al.* (2021) built an employability model using the fuzzy Delphi method. First, they found the soft skills defined in Literature to prepare for the Delphi survey. Then, they invited 345 experienced managers, team leaders, and workers from the Technology Industry Sector in Malaysia to participate in the Delphi to assess the skills that will impact the capability of future job-seekers to get and retain their jobs. The Delphi questionnaire was built with a set of hypotheses that could be supported or not by the experts, and the respondents could answer and revisit their answers at any time during the Delphi process. Using the Delphi results, the authors developed a framework with an instrument to measure the critical soft skills that influence employability and collect data from Industry to provide an employability model based on soft skills.

Our work taps into the HEIs' teaching staff knowledge about the future of work by using Delphi's method. The HEI's staff holds all the knowledge necessary for the courses to adapt and be "future-proof", outlining the expected skills and competencies to be highly demanded from professionals in the future, and based upon the described methodologies of previous works about Delphi and the future of work we may derive detailed explanation on how professors should carry out the task of generating this knowledge. Therefore, we provide in this work a step-by-step guide on how to apply the Delphi method within a KM process mainly after the suggestions made by Gordon (1994).

## 3. The Knowledge Management Model

In this section, we present our proposal of a model to manage the knowledge of HEIs' teaching staff about the future of work. The proposed KM model should (i) aid the HEI's teaching staff to improve higher education courses' curricula in terms of adherence to the future demands of the labor market through KM, (ii) help manage future-oriented knowledge for the HEI to be able to foresee and adapt to labor market future changes, and (iii) generate knowledge making use of the teaching staff's knowledge about the future of work. Our proposed model combines the European Foundation for Quality Management (EFQM) Excellence Model with a Delphi process.

The presentation of this model is divided into two parts: in the first part, we present the Knowledge Management Process (KMP) explaining each one of its four steps, and in the second part we give a more detailed description of how Delphi can be used during the Knowledge Generation step of the KMP.

### 3.1 The Knowledge Management Process

The EFQM Excellence Model is described by Calvo-Mora *et al.* (2015) as a framework to implement the principles and practices of Total Quality Management (TQM). The authors show that the EFQM Excellence Model can be used to design and implement knowledge management processes, and explain how to integrate the EFQM Excellence Model framework, process methodology, and the so-called "supplier/partner management" in the KMP.

As the EFQM Excellence Model is reportedly the best-known reference in Europe when introducing and improving TQM systems (Calvo-Mora *et al.*, 2015), we decided to base our KMP on it. In addition, this new approach may take advantage of the integration between the KMP and the EFQM Excellence Model and help provide HEIs with a means of implementing TQM. Figure 1 synthesizes the whole process.

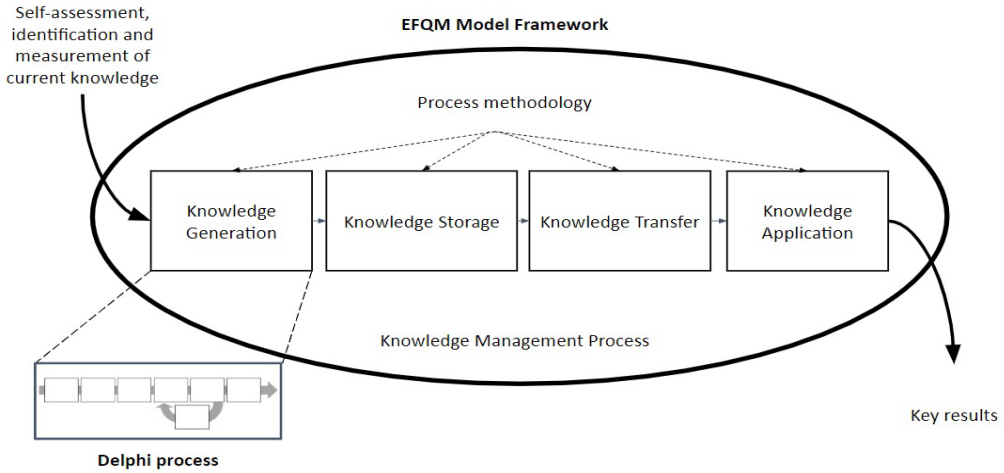


**Figure 1:** EFQM Model Framework KMP, after Calvo-Mora *et al.* (2015).

The original KM process is preceded by a self-assessment using the methodology present in the EFQM Excellence Model (Calvo-Mora *et al.*, 2015). The organization, or the HEI in our case, should first set out its objectives in terms of what knowledge it needs before the process starts. Our KMP adapts the original proposition, consisting only of the following four-step described below: generation, storage, transfer, and application. While Calvo-Mora *et al.* (2015) were concerned about generalizing the process to be applied, we already know that our work aims to help the management of the HEI staff knowledge about the skills and competencies expected to be highly demanded from professionals in the future. With this in mind, the self-assessment analysis prescribed by the EFQM Excellence Model may be performed as a way to provide those involved in the process with a complete background about the institution itself, i.e. what is done, who does it, and where it is done (Calvo-Mora *et al.*, 2015).

### *3.1.1 Knowledge Generation*

This step is intended to fill the knowledge gap about the skills and competencies of future workers. Our process will specifically resort to internal knowledge creation as a means to generate it. We hypothesize the HEI teaching staff to give more accurate predictions of what these skills and competencies are likely to be. Nevertheless, a method to expound the teaching staff's tacit knowledge and transform it into explicit knowledge is needed. The Delphi method is the method of choice to create the knowledge needed for the KMP to continue. As the application of the Delphi method is rather complex, being somewhat of a process within a process, a more detailed explanation of how we propose it to be applied in this step is given below in subsection 3.2.

### *3.1.2 Knowledge Storage*

Once the Knowledge Generation is done, it is time to store its results. This step is about building what is called "organizational memory" by Calvo-Mora *et al.* (2015). The self-assessment analysis conducted before the Knowledge Generation step and the results of the Delphi process must be stored in a way that they can be easily accessed and maintained. Here, we suggest the people involved to discuss which way works the best, but a very simple solution that may prove adequate would be to create a cloud storage folder with Dropbox or Google Drive and share it with the desired members of the teaching staff. The storage of the results produced should serve as a guide to future executions of the KMP while allowing a comparison between current and previous executions.

### *3.1.3 Knowledge Transfer*

This step is where the transfer of the stored knowledge occurs, i.e. knowledge should reach the HEI teaching staff through information or experience if it is non-formalized, tacit knowledge. The original KMP makes use of the EFQM Excellence Model to facilitate the transfer of knowledge and do it in a more efficient manner (Calvo-Mora *et al.*, 2015). However, this might or might not work depending on whether or not the institution has already implemented the EFQM Excellence Model, especially. The institution may inform the teaching staff by organizing meetings or workgroups. Assembling a workgroup is a particularly interesting idea as the group can

be informed and discuss how to apply the new knowledge generated, leading the way to the last step of the KMP, the Knowledge Application step.

*3.1.4 Knowledge Application*

The Knowledge Application is the last step of the process, where the knowledge must be applied and used efficiently. The execution of the KMP can be time-consuming, but its results pay off as the new knowledge generated, if correctly stored and effectively transferred, can have great value for the institution, making it more efficient, more competitive, or improving the quality of the services it provides. However, if nothing is done to apply this knowledge, all the progress done will be lost and the benefits will be equal to zero.

The main objective of our KMP is to manage the HEI teaching staff's knowledge about the future of work. To apply this knowledge in our case is to compile what changes are necessary for the HEI courses' curricula to improve adherence to the future demands of the labor market, and implement these changes. The teaching staff may find out that the courses are already adherent to the labor market reality, and provide the student with the necessary skills and competencies needed or suggest changes in the curricula, such as updating technology or methodology taught, or even the addition or extinction of an entire course.

**3.2 The Delphi process**

The Delphi method is the method of choice to generate knowledge with the help of the HEI's teaching staff. As previously mentioned, the method can be simply described as a controlled debate among specialists to build consensus, and it is commonly used as a forecasting method. Anonymity and feedback are two irreducible elements of the Delphi method (Gordon, 1994), but the exact way the method is conducted may vary for a plethora of reasons. For our KMP, we suggest following the steps presented in Figure 2. The course's coordinator or a similar professional of the HEI's management staff can supervise the process. A professor can also be selected to have this role. Finally, an external expert in KM or Future Studies could act as a consultant to facilitate this process.

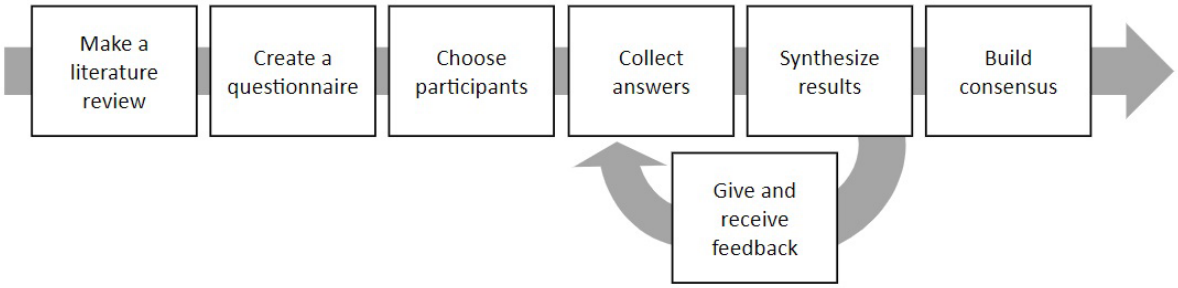


**Figure 2:** Delphi Process Steps.

*3.2.1 Make a literature review*

The purpose of the literature review is to survey (i) skills, (ii) competencies and (iii) future scenarios related to employability and higher education to serve as a basis to elaborate a questionnaire. As a means to provide the necessary evidence to solve a practical problem, we recommend the Rapid Review protocol to be followed as described by Cartaxo *et al.* (2018). A research question can be formulated as "What competencies are most relevant to pursuing a career in education?". Reading the literature can be a distributed process through which knowledge can be produced by the teaching staff. Also, the literature can be compiled by a single individual that presents its main results to the professors.

*3.2.2 Create a questionnaire*

Once the literature review is ready, it is necessary to prepare a questionnaire that will be answered by the participants. This questionnaire can be about both hard skills (course-specific technical skills) and soft skills (more generic and perhaps common skills to the higher education institution as a whole) necessary to future professionals, make a competency assessment or deal with future scenarios for employability and the future of work in the context of higher education.

The questionnaire can be made up of multiple-choice questions, Likert scales, short answers, or essay-like answers. The making of the questionnaire must be oriented by the literature review results. As for its implementation, we suggest that digital tools be used both in recording the answers and in their subsequent analysis. Google Forms is a great example of a tool that will help both in the elaboration of questionnaires and in the visualization and feedback of the results.

*3.2.3 Choose participants*

The key to a successful Delphi study lies in the selection of participants (Gordon, 1994). Participants must have prominent knowledge to answer the formulated questions and contribute with valuable ideas. It is desirable to include experts with different backgrounds to increase the potential for new ideas to arise and to instigate discussion. The experts must also be committed to the debate, and submit their answers until all rounds come to an end. If it is difficult to list potential participants, the ones selected can be used to recommend others. The number of participants may vary, but most studies use panels of 15 to 35 people (Gordon, 1994). Nevertheless, fewer people can be selected due to restrictions on the number of faculty members available or willing to take part in the research. We suggest the panel consist of, at least, five participants which can include the teaching staff as well as external professionals with considerable knowledge about the labor market of the course being analyzed. Despite Delphi being a statistically non-representative study, its results may be unhelpful if the panel is composed of few and unqualified people. As some of the participants are expected to abandon the debate, it is recommended to deliberately select more participants than what is considered enough.

*3.2.4 Send the questionnaire and collect answers*

The collection of answers is done after each round of the Delphi method. We suggest that responses be submitted digitally, participants are given an adequate amount of time to complete the questionnaire, and the means of communication remain the same. Another suggestion is to agree with the participants on the deadlines for sending responses, or to disclose a schedule that is accepted and followed by everyone. Forms can be sent by email, but those involved should be blind copied so that the anonymity of the participants is not compromised. The questionnaire may be tested before with a small group of participants that will not take part in the real debate to make questions less prone to misinterpretation or test possible answers.

*3.2.5 Synthesize results*

The synthesis of the results follows the stage of collecting answers. The way these answers will be synthesized and consecutively presented varies according to the questionnaire format, but it is recommended that aggregations be used (arithmetic means, medians, most frequent answers or lists of most frequent answers, etc.) together with strategies for data visualization (graphs, tables, lists, etc).

*3.2.6 Give and receive feedback*

In this step, participants are presented with the answers given in the previous round and, based on these answers, can change their answers or justify them. A professor who has offered a suggestion that is different from those of his peers may try to convince them otherwise. No participant should feel discouraged to disagree or pressured to agree with others, as anonymity ensures that an unpopular but well-founded opinion is not omitted, and it also guarantees the issuer the possibility to change his or her opinion without any judgment being made. Therefore, maximum attention should be paid to how feedback is given and received to avoid bias in responses and discomfort among participants. We suggest at least three iterations (i.e., rounds of discussion and synthesis of results followed by feedback) to take place before moving on to the next and final step.

*3.2.7 Build consensus*

The last step is consensus building. After all of the rounds have finished, it is necessary to take a step similar to what was being done when synthesizing results from previous rounds. The final product can have different formats (a report, a dashboard, etc), but it is recommended to include a log of the literature review execution, a copy of the questionnaire used, and the resultant consensus. A more detailed view of the evolution of the discussions may be included in the final text. It is also recommended to present results in a summarized and visual fashion, making use of graphs, tables, lists, figures, and diagrams instead of textual explanations whenever possible.

## 4. Discussion

The objective of this work was to help HEIs' courses to meet both present and future demands of the labor market. We supported the idea that this objective could be achieved through the application of a KM process,

making use of knowledge from the HEI's teaching staff. The proposed model combines FTA with KM and a TQM framework, the EFQM Excellence Model, providing HEIs with an artifact to achieving the goal of improving their courses' curricula.

KMPs do not make sense if they are not developed systematically. It is critical for HEIs to continuously generate and assimilate knowledge and new capabilities to remain competitive. Therefore, Total Quality Management as a management philosophy put into practice through the reference framework offered by the EFQM Excellence Model can serve as a context and support for the start-up and later development of a KMP (Calvo-Mora *et al.*, 2015).

A series of obstacles can occur that complicate the implementation of a KMP in the context of HEI, such as the integration of KM in daily activities, the cost of the information technologies, or the difficulty of some employees to adapt to or accept new orientations. Therefore, the KMP design must be supported by organizational structure, processes, and cultural values.

The Delphi method has some disadvantages that must be discussed. Firstly, the method depends on experts' availability and engagement to participate in all the rounds proposed. Some work is necessary for institutions to engage their participants, showing the importance of the contribution of Delphi to build some collective knowledge about the future of their courses, making it possible to assess and adjust courses that are not going in the right direction according to results found.

Sometimes, though, it's not possible to assure the participation of experts on all rounds of classical Delphi. In that case, a Real-Time Delphi could be applied. In Real-Time Delphi, experts receive the Delphi questionnaire and can see all other answers at any given moment. The participants can also revisit their answers at any time during the Delphi, changing opinions or justifying them. The Real-Time Delphi allows a reduction in the need for the synthesis of results as it only needs to be done at the end of the process. Thus, the duration of the "*Send the questionnaire and collect answers*" step, and the budget and time costs related to the synthesis process tend to be shortened, while participation rates tend to increase.

## 5. Final remarks

The impacts of the fourth Industrial Revolution will continue to be felt in the different areas of our lives, including Work. The Future of Work is closely related to the Future of Education, with formal education being a central element of development for the professionals of the future. Still, the importance of higher education courses is strongly dependent on the capacity of HEIs to update their curricula. This work proposed a KM model that helps the teaching staff of HEIs to evaluate what will be the essential skills and competencies for the employability of their students in the future.

This work was made to provide HEIs with the necessary tools to achieve the objective of improving their courses' curricula in terms of adherence to the labor market's present and future demands. For us it is clear that a match between the skills and competencies developed inside HEIs and the ones the market needs is of utter importance for both institutions and students alike, producing transcending developments that may benefit a whole country's economy. To support HEIs achieve this perfect match between education and the labor market is what we have done.

Since our model is yet to be tested, the next step is to apply the proposed model within an HEI and evaluate its effectiveness in helping HEIs to make improvements to their courses. We are looking forward to compiling what hard skills will be needed to make competent IT professionals in the next 5 years and apply our methodology to improve Computer Engineering courses.

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