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A Competency Framework for Training of AI Projects Managers in the Digital and AI Era

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Abstract

In the context of a research project supported by the Montreal Pole of Higher Education in Artificial Intelligence (PIA), we have developed a competency framework for artificial intelligence (AI) project manager in the context of Industry 4.0. This framework aims at informing organizations on the state of the art of the competencies needed by any AI project manager and thus facilitate tasks such as recruitment or performance evaluation of managers. In parallel, it also aims to guide the AI management training strategies of educational institutions and training organizations in order to design training adapted to the reality of the workplace at all levels (college, university or professional). This article reports on the methodological research process that led to the co-construction of the competency framework, the resulting competencies and the resulting discussion due to the surprising findings on the emerging skills needed in the digital and AI era. Specifically, we employed a qualitative methodology that involves conducting a strategic survey, systematic literature review, and engaging experts through interviews and focus groups. We leveraged the DACUM method to construct the competency framework, which enabled us to facilitate exchanges between participants and capture the key competencies essential for an AI project manager. The main competencies and sub-competencies identified are also presented. We conclude with a discussion of the findings and recommendations for companies and training organizations.

Keywords

Competencies, Artificial Intelligence, Digital Transformation, Technological Change, Competency Framework, DACUM Methodology, Project Manager

1. Introduction

With the rise of technology and the transformation of industries, organizations

are transforming and, increasingly becoming digital. Some are integrating several technologies, but also AI in their processes, products and services, we then talk about industry 4.0. Faced with these paradigm changes, many express the need to identify AI project management skills to accompany the change.

Our research has shown that interdisciplinarity in management training programs is not sufficiently present. Indeed, although educational institutions and training organizations are trying to keep up with the digital transformation and the fast progress in AI, the training offer in AI project management integrating technical skills, so-called 21st century digital skills, but also transversal skills- or softskills, is still insufficient. Moreover, the AI training offer mainly targets technical professionals rather than managers. The educational web page of ScaleAI[1], which lists AI training programs, the Canadian leader in AI, is a good example: it includes mostly AI training programs for technical professionals.

At the same time, the organizations that provide management competency frameworks that serve as a barometer for the profession seem to be out of step with the needs of the workplace in terms of the competencies of tomorrow's manager, particularly the IA project manager. The competencies required in IA project management are still not very present in the frameworks currently in circulation (e.g., those of the OCRHARHA, AUNEGE-FNEGE, ADMA, European framework).

In the context of our research project supported by the Montreal Pole of Higher Education in Artificial Intelligence (PIA), we have conducted a state of the art in AI project management applied to Industry 4.0 and we have developed a competency framework by mobilizing experts. The framework aims to satisfy the following needs: 1) the needs of 4.0 organizations; companies in various sectors; public and private decision makers; and 2) the needs of higher education institutions (colleges and universities), training organizations, and company professional development centers. More specifically, it aims at informing organizations on the state of the art of the competencies needed by the AI project manager and thus facilitate tasks such as recruitment or performance evaluation of managers. In parallel, it also aims to guide the AI management training strategies of educational institutions and training organizations in order to design training adapted to the reality of the workplace at all levels: college, university or professional.

In the following, we will present a state of the art of workplace training, related work, our theoretical framework, our research methodology including a methodology for designing the framework using the DACUM method, and a discussion of the process developed during our project. Particular attention will be paid to the steps that led to the development of the framework and then a synthesis of the framework will be presented. For a complete view of the framework, we recommend reading the project's research report. Finally, we will present the findings and recommendations drawn from this research.

This paper reports on the methodological research process that led to the co-

[1]https://www.scaleai.ca/fr/education-2/particuliers/.

construction of a competency framework for AI management applied to Industry 4.0, and that could inspire other related work in the future. The main competencies and sub-competencies identified are also discussed.

2. State of the Art

2.1. The Digital Transformation of the Labor Market and AI Management Training

According to the MGI (2017), AI-based task automation will replace many jobs in various economic sectors. Several studies also reveal that job losses caused by this automation will be compensated in the long term by new jobs created by AI technologies (Côté & Su, 2021). Among the new occupations that are developing are AI solution providers (Mantha et al., 2019) and a variety of AI professionals: executives, analysts, consultants, market developers, sales managers, etc., whose primary mission is to bridge the gap between information technology teams and business teams (Ticoll, 2020: p. 34). These groups of professionals are constantly called upon to update their knowledge and skills. In addition, in recent years, new skills are being sought with a strong ethical, juridical and EDI-related (equity, diversity and inclusion) dimension. Management and computer skills remain important, but new ones are being added. In Canada, as elsewhere, these jobs are expected to multiply and AI will have a significant impact on the economy (Ticoll, 2020: p. 22). Our research shows that management training, leadership and manager competencies are important in this context, and we present these various dimensions in the next sections.

2.2. Develop Skills in Leadership 4.0

In order to accommodate the changes that companies will undergo, managers will need to master certain skills related to digital and AI, which are mainly based on the use of so-called transversal or human skills, or soft skills, 21st century digital skills, as well as technical skills or hard skills.

Shao (2019) lists the skills that a manager must possess to improve the use of information technology systems by the company's employees. According to Shao (2019), many companies have made the leap to digitizing their operations that does not always produce the desired positive effects because employees do not use these technologies to their full potential. Managers can change this behavior and increase employee effectiveness through the use of technologies (Shao, 2019) if they possess certain skills such as: a leadership attitude including inspirational motivation, intellectual stimulation, interpersonal considerations. They also need to bring out leadership qualities in the "lower level" managers, who are directly in contact with the employees of the company, either by their example or through leadership training programs.

Oberer and Erkollar (2018) consider that too often, technology does not reach its full potential in companies because it is poorly mastered by members of the organization. They thus call for the emergence of a digital culture thanks to the

leadership 4.0 of managers. This leadership is characterized by certain competencies, such as the ability to: embrace change (by encouraging high-level agility between the market, customer, partners, and employees, and deliberate promotion); communicate (by creating a transparent framework for information diffusion); or have the ability to innovate (by transforming old structures through the use of multidisciplinary teams, and creative processes and flexible work environments) (Oberer & Erkollar, 2018: p. 6).

Several authors agree that humans outperform AI in terms of soft skills, such as creativity, the ability to transmit knowledge, judgment and emotional intelligence. It is then precisely these skills that managers must develop for the management of AI projects by showing a certain agility. For example, while AI can be useful in recruitment to assess the raw experience found in a CV such as degrees and previous jobs, it remains ineffective in making judgments based on intangible data, such as an individual's cultural and personality traits (Rana, 2018).

Many actors in the workplace observe that in the future, repetitive tasks of managers will disappear to be replaced by more soft skill tasks. According to a large study of 8,000 people including managers and executives in human resources, AI systems would be deemed more competent at performing technical tasks such as problem solving, budget management or performance evaluation, while human managers would be deemed more capable of performing tasks requiring soft skills such as understanding complex emotions, mentoring or creating a work culture (Oracle & Future Workplace, 2019).

AI is characterized by its predictive capabilities across a wide range of fields and sectors. It is this predictive potential of AI that is of interest to industries, companies, and managers (Kiron, 2017), but it requires a minimum of hard skills (technical skills). The manager must therefore be able to understand computer systems based on machine learning and identify anomalies if they present a problem, in order to supervise their adjustments and parameter settings. While relegating certain tasks to AI systems, managers will have to excel in activities that involve the ability to judge: "Such as mentoring, providing emotional support, and taking ethical positions" (Kiron, 2017).

2.3. Related Work on Manager Competency Frameworks

The organizations providing management competency frameworks that serve as a barometer for the profession have difficulty targeting the needs of the workplace in terms of AI project manager competencies. In fact, we note that the competencies sought in AI project management are still not very present in the existing frameworks.

The four frameworks consulted touch on project management, but not specifically AI projects: AdmA (2019), CRHA (2018), and AUNEGE-FNEGE (2019) identify the competencies needed for project managers, professionals in human resources (HR) and industrial relations (IR), and for business managers, respec-

tively. For its part, CEN (2014) presents the competencies needed for information technology (IT) professionals. Neither of these frameworks includes AI project management.

We built our framework based on the *Project Management Institute* (Alain, 2009), which decomposes project management into five groups of processes: Initiation, Planning, Execution, Control, and Closure. CEN (2014: p. 10) took a similar approach and thus categorized competencies into five domains based on ICT business processes, i.e., "plan-build-run-enable-manage". Like AdmA (2019), our team chose the DACUM (Developing A CUrriculuM) method to construct the competency framework.

Although some competencies are recognized in other project management frameworks, the particularity of our framework is that it has also identified competencies specific to AI projects[2]. This includes competencies related to sufficient understanding of what AI is; managing the data processing process; identifying the challenges of continuous training of a deployed AI solution; validating theoretical models; and evaluating the quality of data and algorithms.

Our framework also highlighted the skills needed to manage the ethical and legal issues associated with AI development, a topic of concern for many companies and individuals. This includes identifying key ethical elements; proposing solutions to ethical issues raised by the project; and understanding the legislation surrounding the development of AI solutions, especially as it relates to data management.

2.4. Related Work on Training Competencies Framework

Karsenti et al. (2020) developed a competency framework to provide a guide for graduate students to identify and develop individual competencies that are useful for finding employment after graduation and maintaining employability. This proposed framework includes eight transversal competencies that support the professional integration of graduate degree holders into scientific, academic, and non-academic environments. These transversal competencies are: 1) communication, 2) collaboration, 3) management, 4) leadership, 5) digital, media, and information literacy, 6) integrity and responsible conduct, 7) professional autonomy, and 8) creativity and innovation. Our framework also highlighted all these transversal competencies and further includes competencies in AI-related job expertise and in AI ethics which were omitted in Karsenti et al.'s research.

Briand-Lamarche et al. (2018) presented the development process of a competency framework aimed at identifying the necessary competencies for school practitioners to promote the use of research-based knowledge in their practice. This process had two objectives: 1) to identify and strengthen the competencies

[2]With the exception of the transversal competencies that have been matched with those of AdmA (2019), only one essential competency is found in another framework [Risk Management in CEN (2014)]. The specific competencies recognized in the other frameworks are numerous (64 competencies); therefore, we will not detail them here.

that support the use of research in schools among directors, pedagogical advisors and teachers, and 2) to optimize the use of research-based knowledge for school success.

In a similar state of mind, our framework aims to help institutions to develop AI management training offers adapted to the reality of the workplace at all levels (college, university or professional).

3. Theoretical Framework

In this part, we develop more on the theoretical concepts, while the previous part dealt with the concrete changes with AI management.

3.1. The Notion of Job Competency

The concept of competency has several definitions depending on the discipline considered. Thus, in guidance psychology, competency is evaluated in terms of an individual's personal and professional career path and meets a specific objective: to facilitate the integration or reintegration of a person into the labour market (Gilbert, 2006). Competencies are the know-how required to carry out a particular task; they refer to the theoretical and practical knowledge held by an individual, to "what a person knows and can do" (Gilbert, 2006: p. 69).

Moreover, the notion of competence can be the subject of a meta-analysis. In the social psychology of organizations, competence is conceived as a social construct and in the company world, it is a tool for evaluating the performance of employees (Gilbert, 2006: p. 72).

According to the Canadian Vocational Training Association (CVTA), as part of its DACUM method training program, job-competency is the demonstration by an individual that he or she possesses the ability—i.e. the knowledge, skills and interpersonal skills—to perform a professional act or task in accordance with a standard and/or any predetermined requirements. We rely on these visions of competency to develop our framework.

3.2. Model for the Construction of a Job-Competency Framework

To develop our framework, we chose to use the guides of the International Organization of the Francophonie (OIF, 2009), which support the implementation of a competency-based approach in professional training. As shown in **Figure 1**, the methodological process of the OIF guide is structured in three blocks: the labor market situation (block 1), the job situation (block 2) and pedagogical development (block 3).

The development of a job-competency framework is located in Block 2. This framework is then used to meet the needs of initial or continuing training at the college or university level in Block 3, but we do not address this block in the context of our project. Our approach takes up a large part of guide no. 2, by simplifying it and integrating elements from our respective expertise, as well as the content proposed by the experts consulted.

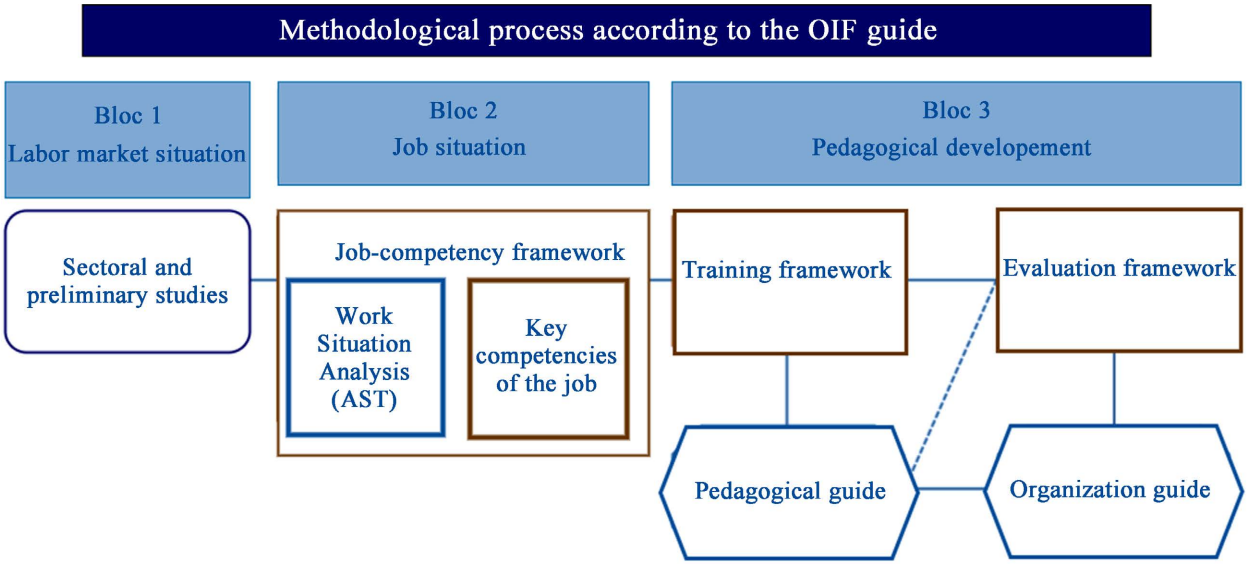

Figure 1. Methodological Process (OIF, 2009: p. 67).

3.3. The DACUM Method

According to the Canadian Vocational Training Association (CVTA):

> The DACUM method (an acronym for Developing A CUrriculuM) was developed in Canada in the 1960s. DACUM is a complete system for managing skills development. Its first component, the analysis of jobs or professions according to the DACUM method—called "DACUM analysis" or "competency framework"—is now the standard in many environments (education, government, companies, non-profit organizations, etc.) on all continents.
>
> DACUM can also be seen as:
>
> A process that integrates the use of a focus group into a facilitated storyboarding process to capture the key functions and related tasks of a profession, as well as the knowledge, skills and characteristics required. This cost-effective method allows for rapid and deep analysis of any job[3].

The DACUM method involves a 2-day workshop where a trained facilitator and a committee of experts work collaboratively to create a comprehensive graphic depiction of the duties and tasks that are performed by workers in the relevant job or occupation (Norton & Moser, 2008). This process results in the identification of a set of essential duties and tasks, which form a reliable foundation for developing college courses or company training programs (Norton, 2009). The DACUM process has found its application in various fields of study. For instance, Zundel and Needham (1996) utilized this approach to identify the essential competencies that professional foresters must possess. Similarly, DeOnna (2002) employed the DACUM process to assess a statewide training program for nurse aides. Furthermore, Yang et al. (2020) utilized this approach to create a competency

[3]https://facilitation.eku.edu/what-developing-curriculum-dacum.

profile of airline ground service staff. This is the approach we chose to co-construct the AI manager competency framework with a group of experts (see Methodology section).

The guiding principles of the DACUM method on which we rely in our project are three:

1) Expert practitioners can describe their work better than anyone else;

2) An effective way to analyze a profession is to identify and analyze the tasks that are performed by expert practitioners;

3) All tasks, to be performed correctly, require a set of knowledge, abilities and/or attitudes.

The central element of this method is that it is based on a competency-based approach, which makes it easier to transpose the job competency framework into a training framework. Indeed, all competency statements must begin with an action verb and complete the following sentence starter: "the individual must be able to...". In this regard, two important tools that we used to implement the DACUM method are Bloom's taxonomy (Bloom et al., 1956) and the Padagogical Wheel[4], which we used to help experts target essential skills.

Bloom's taxonomy, well known in education, helps teachers and educational designers to define the objectives of training aimed at the acquisition of knowledge and skills by formulating precise objectives. It is the basis of the objective-based pedagogy. It contains six levels of skill acquisition: 1) Recognize; 2) Understand; 3) Apply; 4) Analyze; 5) Evaluate; 6) Create.

The advantage of Bloom's taxonomy is that it defines the learning objectives and therefore the competencies to be achieved in terms of action verbs, which is conducive to experts highlighting the job competencies that should be included in a framework. The addition of a table of synonymous verbs to Bloom's taxonomy ensures that experts are talking about the same level of competency to be achieved.

Allan Carrington[4] created the "Padagogy Wheel " (not "pedagogical" in reference to the iPad) which lists 62 applications for tablets that can be used to place one's activity, one's task in the objectives of Bloom's taxonomy. Given the content of the project and its field of investigation, namely digital intelligence, this tool, which allows for reflection between skills and technologies, seemed to us to be an asset during the group discussions.

It has four gears or circles: 1) The one of Bloom that helps define skills through action verbs adapted to the digital age; 2) The one of action verbs; 3) The one of activities; 4) The one of technology that encourages experts to ask themselves: "How could technology serve their enunciation of skills?". Let us remember that the essential thing is not the tool or the application, but the skill to be achieved. This is where the intent of the co-construction starts and why we thought this wheel could help experts name the competencies they will find essential to being a "competent" AI project manager in complex and transforming work environments.

[4]https://designingoutcomes.com/assets/Padagogy_Wheel_Translations/Padagogy_Wheel_V4_FRE.pdf.

4. Methodological Process

As previously mentioned, the research that led to the co-construction of the competency framework aimed to identify the essential competencies of an AI project manager within an organization in a context of digital transformation in Industry 4.0 accelerated by the meteoric progress in AI. To carry out this work, we adopted a rigorous methodological posture that we present in the following paragraphs.

4.1. Methodological Posture

Our posture is based on a qualitative method that includes a strategic survey on the Internet, a systematic review of the literature, semi-structured interviews and focus groups with experts. We adopt an exploratory, inductive and prospective approach of emerging professions, which allows us to adapt to the reality of the consulted experts.

Since the work of building the competency framework is iterative, we have allowed ourselves the possibility of going back and forth between theory and the field. This is how we proceeded:

- First, the strategic survey, the literature review and the qualitative research (semi-structured interviews and focus groups) allowed us to identify a transversal analysis of the labor market situation according to the sectors of activity (block 1 of the guide of the International Organization of the Francophonie (OIF, 2009);
- The situation of emerging jobs related to AI project management in Industry 4.0 (Block 2 of the guide of the International Organization of the Francophonie (OIF, 2009); the analysis of the work situation was carried out in the context of group and individual interviews with the experts;
- The competencies of the emerging jobs related to AI project management in Industry 4.0 (block 2 of the guide of the International Organization of the Francophonie (OIF, 2009), this analysis of competencies was carried out within the group interviews, and individual interviews with the experts, with a perspective of co-construction of the competency framework.

4.2. Steps in the Development of the Framework

The qualitative research is transversal to the different stages. During the whole project, it informed in an iterative way the two blocks, i.e. the situation of the labor market and the situation of the AI project manager profession. This stage included recruiting experts; performing twenty-five semi-structured interviews with experts; data collection and thematic analysis. In particular, the data collection concluded with the production of research documents (report, knowledge synthesis, articles, etc.).

4.2.1. Block 1. Analysis of the Labor Market Situation

To analyze the labor market situation during Block 1, we conducted the follow-

ing activities:

- A literature search based on a literature review and a strategic survey;
- A presentation workshop for the project team (February 19, 2020, duration: 3 hours);
- A working workshop with Alma College (March 31, 2020, duration: 3 h);
- A working workshop with Bois de Boulogne College (April 6, duration: 3 h).

4.2.2. Block 2. Analysis of the Situation of the AI Project Manager Position

Block 2 contains two steps of the job-competency framework (see Figure 1), namely the analysis of the work situation (AST) of the job, and the identification of the key competencies of the IA project manager job.

1) Step 1. Work Situation Analysis (AST) of the job of AI Project Manager

In step 1 of Block 2, we held three working groups (WGs) with experts, all professionals, on the themes identified in the literature related to the job, the industry, and the digital transformation. Indeed, we organized these working groups (WG1 to WG3) (see the detail of WG1 as an example in Figure 2) in videoconference on Zoom for a duration of 3 hours each. These working groups included experts, some of whom made presentations to us, and we also animated Discussion Groups. The themes that emerged were: AI Project Manager Competencies (WG1); Data Governance, Cybersecurity and Ethics (WG2); Artificial Intelligence for Executives and Managers (WG3).

2) Step 2. Identification of the profession's key competencies

Step 2 of Block 2 relies in part on the qualitative research, i.e., the analytical results of the data collection (step 1) to guide the construction of the job-competency framework, in an iterative and exploratory manner.

The formulation of the competencies made it possible to identify the competencies of the job based on the following elements:

- The qualitative and thematic analysis of the interviews to identify key competencies and issues related to the activity sectors and the development of AI

Date: April 29, 2020 from 1:00 to 4:00 p.m.
Theme: skills/knowledge/abilities of a manager who works in a company/organization whose business model is based in part on AI
Day's Agenda:
1:00-1:15 pm: Expert participant roundtable & PIA-C01 project team;
1:15-1:30 p.m: AI, Big Data and IoT skills for a manager; discussant: pedagogical advisor responsible for computer programs and online training at College Bois of Boulogne.
1:30-1:45 p.m.: Digital Shift and Industry 4.0;
In charge of the project at Colab-social innovation and digital culture, Alma College;
1:45-2:05 p.m: Questions|Answers;
2:05-2:20 p.m.: Method for building the job-competency framework - Presentation of the exploratory[6] step (Teluq University team) ;
2:30-4:00: Focus group[7] on the competencies/knowledge/abilities of a manager in AI and Industry 4.0.

Figure 2. Synthetic view of the activities of Working Group 1 (WG 1) on the theme of the competencies of an AI Project Manager.

in Industry 4.0;

- The workshops to co-construct the framework with the experts.

As part of the activities related to the identification of job competencies, we used a specific methodology to animate the workshops of co-construction of the competency framework of the AI project manager. It is the DACUM (Developing A CUrriculuM) method, which is recognized for this type of exercise.

4.3. Process of the DACUM Method

4.3.1. The Roles

The team members present to conduct the online workshops took on the various roles envisaged in the DACUM method. First, we identified a facilitator who was an expert in the DACUM method: a pedagogical advisor responsible for computer programs and training (College Bois of Boulogne) who had used this method on several occasions before using it in this project. Then, as recommended in the DACUM method, we identified two facilitators to increase the fluidity of the exchanges, to deal with time management or technical problems, and also to ensure that the rules were understood by the participants (e.g., speaking up, etc.). One of the facilitators also supported the expert facilitator and the note taker so that they could transcribe all the participants' notes in the right place and not miss anything of the exchanges.

4.3.2. The Working Tools

As the pandemic presented itself at the very beginning of the project, after only one meeting with the participants from the educational institutions, we had to opt for an online exchange platform, but also a platform allowing the co-construction of the framework itself. We opted for the collaborative platform Miro, which seemed the most relevant and efficient to reproduce the brainstorming work, especially the "Post-its" tool, often used in presential. Miro makes it possible to transcribe the contents put forward by the participants, which allowed us to reproduce the brainstorming work and to carry out the exchanges envisaged in the DACUM method, by doing them online or virtually. Thus, one person was responsible for writing or organizing the items on the Post-its, and shared the screen by projecting to the participants the various ideas and notes taken on the Post-its. Participants also wrote their ideas on the Post-its. This made it possible to gather all the ideas, then to structure and classify them, and thus to visually highlight families of competencies (technical, professional and transversal) formulated by the participants. With the help of the team and the participants, we were able to group the competences, the know-how and the soft skills by similarities or differences.

In addition, we provided the experts with Bloom's taxonomy (Bloom et al., 1956) and the Padagogy Wheel to help them verify their process of stating competencies. The following instructions were given to the experts to use the Padagogy Wheel:

1) Start from Bloom's lowest level: "Recognize".

2) Then choose an action verb. The wheel offers you about ten synonyms to help you clarify your idea.

3) The 3rd circle to give ideas on the competency statement. These are sentences.

4) The 4th circle is for technologies. The applications are just suggestions, to help your ideation.

5) Then continue clockwise.

4.4. Workshops for the Co-Construction of the Competency Framework

The workshops for the co-construction of the competency framework took place over three consecutive half-days via Zoom videoconference. The Miro collaborative platform was used to co-construct the competency framework according to the DACUM method by sharing Bloom's taxonomy and the Padagogy wheel with the participants. This collaborative and iterative work of co-construction of competencies was made possible thanks to the active participation of eleven experts.

4.4.1. The First Iteration

After a round table discussion, an introduction to the proceedings of the sessions and the presentation of the members of the PIA-C01 project team present, presentations are made to the participating experts. The notion of framework, the Padagogy wheel, the DACUM method and Bloom's taxonomy were presented in synthesis to the participants in order to clarify the overall approach.

A facilitator explained to the participating experts the steps for the sessions: First, each of the experts, for 15 to 20 minutes and in an individual manner, must write a statement of competence using an action verb from the list of Bloom's taxonomy, the Padagogy wheel, and other verbs while avoiding adjectives, the verbs "to know" and "to understand". For example, the person should be able to state an "action verb" followed by a "complement" (See **Figure 3**).

The facilitator of the Miro platform then made a round table and called on each expert to propose a competency. She used the Miro platform and organized the competency statements on different colored Post-its. If the competency the expert was thinking about was already mentioned, he or she could propose another competency.

4.4.2. The Second Iteration

In this second session, with the help of the team and the experts, the objectives were to:

- Define families of competencies (large family).
- Group all the competences already identified by the experts in the previous session into families of competences (see **Figure 4**).

4.4.3. The Third Iteration

The third session was also conducted with the help of the team and the experts and consisted of the following:

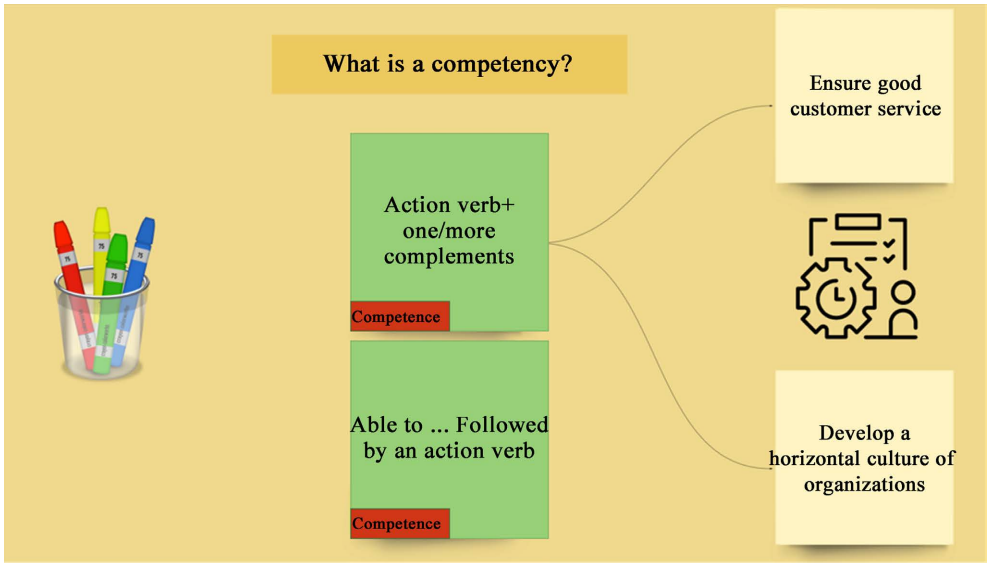

Figure 3. Model of a competency statement as presented to experts.

Figure 4. View of the Result of the Second Iteration of Co-Construction of the Framework based on the DACUM method.

1) The team's work was based on the Project Management Institute's PMBOK (Alain, 2009): this reference document on project management breaks it down into five groups of processes (Initiation, Planning, Execution, Control, Closure) and nine areas of knowledge (project integration, perimeter, schedule, costs, quality, human resources, communication, risks, purchasing). We have therefore used these elements to continue the construction of our framework.

2) We continued the refinement of the competencies; we then:

- Checked if the competencies have similar competencies. If so, we grouped them together;
- Grouped the competences into families of competences;
- Distinguish between general and specific competencies.

3) For each competency, we classified/ordered the competencies by level based on Bloom's taxonomy. For example, for the competency "Manage a project", we put verbs related to knowledge of project management first. Second, the understanding of project management. Then, the application of project management. Then, the analysis of the management, the synthesis, the evaluation of the project management. The aim is to classify the competencies from the simplest to the most complex. This allowed us to classify the competencies associated with AI

project management.

Figure 5 resulting from the final session provide an illustration of the contents and the working method associated with this co-construction of the AI competency framework.

The information collected during the facilitation of the workshops with experts was completed and refined with the qualitative data collected and analyzed previously, but also by comparison with other existing competency frameworks. This information allowed us to specify the fields of competence and to inform a second level of analysis. We essentially used the verbs of Bloom's taxonomy to identify the fields of competencies resulting from the co-construction workshops animated according to the DACUM method; for the rest, we also used action verbs synonymous with those of Bloom's taxonomy (ADIP, 2017: p. 36) and those used by other frameworks (Order of Human Resources Advisors, Order of

Figure 5. View of the result of the last iteration on governance and ethics competencies.

Administrators...) to add specific competencies that seemed relevant. In this regard, we relied on the competency framework for managers in the Quebec context (AdmA, 2019) to retain certain transversal competencies or soft skills that we deemed essential by cross-checking with the qualitative data from our empirical inquiry. We also submitted these competencies to the group of experts for validation. The transversal competencies are defined as follows:

> Transversal competencies are the general aptitudes or abilities that a practitioner must demonstrate (e.g., analytical ability) or attitudes that he or she must display (e.g., open-mindedness) when practicing his or her job or profession (AdmA, 2019: p. 4).

4.5. Validation of the Framework

The validation of the framework is an important phase; it confirms that the information collected, analyzed and interpreted corresponds to the reality of the market, the profession, the AI ecosystem and the industry. This validation aims to ensure a consensus validation with the expert committee associated since the beginning of the project; in addition to participating in the group meetings, the expert committee also provided advice and suggested resources for the literature review. This expert committee therefore validated the final version of the AI project manager competency framework.

5. Search Result: Presentation of the Framework

The framework comprises five domains. It contains the specialized and transversal competencies for an AI project manager (see **Appendix** and Tremblay, Psyché, & Yagoubi, 2023).

6. Findings and Discussion

Following our process of co-construction of the framework with a group of experts, it seemed important to us to present some findings and recommendations. These are grouped into five major fields that correlate with those of the framework: AI project management; AI-related job expertise; digital and AI technologies; AI ethics; human relations. We then present the effect of these findings on lifelong learning planning.

6.1. AI Project Management

The multiplication of business niches discussed by TechnoCompetences in 2016 (TechnoCompetences, 2016) in its study on IT competencies and training needs continues in all business domains including those outside the traditional IT sector.

Managing AI projects or projects using AI technologies adds a layer of complexity to the management of information technology (IT) projects. It is important for managers to be aware of this in order to anticipate the complexity they must manage. For example, with respect to project tracking and execution, methods such as Red-Amber-Green (RAG) status assessment are used to track task

progress and resource allocation (Jacob et al., 2021). They indicate the progress of a project via natural language processing and genetic algorithms (Nobre, 2020). In such a case, the manager must understand the methods and processes involved.

6.2. Job Expertise Related to Artificial Intelligence

Job experts are at the heart of the process (TechnoCompetences, 2016: p. 51). The analysis of the perspectives of the experts who participated in the development of the present framework shows that the management of AI projects and the anticipation of problems require the development of an expertise of the environment/sector as well as the role of AI in its transformation.

6.3. Digital and Artificial Intelligence Technologies

Data: one of the keys to success! As mentioned by TechnoCompetences (2016), digital technologies are transforming the majority of business domains, whether they are users or producers of these technologies (Tremlbay, Yagoubi, & Psyché, 2022). In addition, predictive algorithms rely strongly on data. Therefore, AI project managers are expected to understand how the algorithms work and have the necessary competencies to ensure the quality of the data, including ensuring that it is free of bias and representative.

6.4. AI Ethics

To ensure that AI systems are designed with an ethical concern, an important concern that emerged from the focus groups and which is not always assured in technical training, managers must ensure that:

- Any decision made by the AI system will respect the rights of the individual.
- Data about individuals is not biased.
- Design teams reflect the diversity of individuals.
- AI system design limits design bias.

In this regard, Jacob et al. (2021) mentioned that in project scheduling with the detailed data provided to the systems about the employees' tasks, the AI system can perform simulations to predict the project duration, management goals, and control actions. Based on this information, the system can also generate an optimal schedule for the project and assign team members to the tasks they are best suited for, so as to reduce both the cost and time required to complete the activities (Nobre, 2020). In this case, if there is automation and reallocation of certain tasks to the AI system, it is the manager's responsibility to monitor them to ensure that the process follows responsible AI management rules.

6.5. Human Relations

As we have highlighted in our competency repository, managers working with AI need to be equipped with many personal qualities in order to adapt to the new demands of their work. These include the ability to design a strategic vision,

adaptability, abilities to deal with uncertainty, judgment-based abilities, and ethical thinking skills (Jacob et al., 2021). In the face of the development of AI and process automation, managers need to cultivate more human-like skills, such as social sensitivity, empathy, emotional intelligence, and cross-cultural intelligence (Jacob et al., 2021).

Similar to the repository we developed, two repositories, CRHA (2018) and AUNEGE-FNEGE (2019) also identify the necessary people skills for project managers. For example, CRHA (2018) identifies critical thinking, curiosity, active listening, creativity, open-mindedness, written and oral communication, emotional intelligence, etc. Regarding the cross-cutting competencies of CRHA (2018), we cite relational intelligence, coaching, and communication as examples.

6.6. Discussion: Effect on Half-Life Professional Skills and Lifelong Learning

The manager is the "leader of the digital transformation", according to "Author". He must have the skills to be able to perform the job properly. Organizations must implement training to support the acquisition of skills. The manager must also take the initiative to train himself to have technical skills, managerial skills, and soft skills in other words interdisciplinary skills to be able to identify the technological environment in which he evolves. Given the rapid evolution of technologies and the growing gap with the current job system, the field experimentation approach must be privileged in order to be able to anticipate changes.

Considering our exchanges and the fact that an important observation was made concerning lifelong learning in the majority of business fields since they are transformed by technology, it seems important to design multidisciplinary microprograms (very short training), integrating other dimensions than the technical or management aspects. For example, it is important to ensure the presence of human competencies, teamwork and collaboration, in addition to the technical competencies specific to the sector. Thus, following our methodological approach (see **Figure 1**, block 3), a course entitled "Project management and digital competence in the workplace" was designed by our team based on our framework, and it integrates the following aspects, which emerged as important according to our experts, but which are also present in the Framework for Digital Competence of the Ministry of Education and Higher Education of Quebec: (ethics, creativity, diversity, management, communication, collaboration).

Regarding the training modalities, it is also recommended to design microcredential because they seem more appropriate in a rapidly evolving workplace context. These trainings are small, certification-style courses that focus on a particular area of a field or on a topic. The interest of these trainings is that it allows to acquire quickly one competence, and hone proficiency over the shortest possible time. A fast and practical way to upskill. Each time the person has completed a training course and passed an exam, he/she will gain a digital merit badge (a kind of certificate) that can be saved in his/her electronic portfolio.

It is also recommended to provide more engaging training based on experi-

mental and professional learning, e.g. short trainings, the use of active, dynamic pedagogy, or internships in companies, etc.

Moreover, it is recommended to normalize a practical component in graduate training to combat programmed obsolescence and provide an additional solution to the labor shortage (FERA, 2022). In fact, it is necessary to favor training paths that alternate between the development of ongoing competencies and highly applied projects in companies that allow students to integrate their competencies into action (FERA, 2022). This solution would combat the shortage by adding young people to the labor market on a part-time basis.

Given the particularities of the technical domain, and especially of the AI domain, which is still developing, it is recommended to continuously, regularly, and as often as possible, train oneself in order to maintain the habit and to keep one's job knowledge up to date and add other types of knowledge: technical, human, etc. As a matter of fact, the knowledge employees learned at university, the skills they acquire at work are becoming faster and faster obsolete. In 2022, the World Economic Forum estimates that the average half-life of professional skills is now just five years (WEF, 2022). In other terms, in order to overcome the side effects of a rapidly evolving workplace, especially the so-called "half-life" of professional skills, some actions have to be taken by universities and other training institutions. They have to adapt, which means that they will have to make shorter, more targeted courses, more flexible, more consistent with industry's best-practice training programs. The solution would be to conceive more micro-credentials on specific topics and interdisciplinarian, intersectoral micro programs based on competency frameworks built in co-design with industry actors or at least involving them strongly in an iterative design loop. However, our research also shows that there are some soft skills that may be more permanent in nature and that it is useful to develop for project managers as for other workers, for example: communication, team management, diversity and inclusion issues, etc.

7. Conclusion

The methodology adopted by our research team is based on a qualitative method that includes a strategic survey, a systematic review of the literature, interviews, and focus groups with experts. In order to adapt to the reality of the experts consulted, we adopted an exploratory, inductive and prospective approach of emerging professions. The DACUM method, chosen to conduct the co-construction workshops, facilitated exchanges between the participants and allowed the team to capture the key competencies needed by an AI project manager. The Miro collaborative platform allowed us to reproduce the brainstorming process online (or virtually) and to carry out the exchanges envisaged by the DACUM method.

As for the objective, it seems to us that it has been achieved, since the framework will be able to help institutions that train tomorrow's managers and technologists to develop training offers that not only take into account a combina-

tion of managerial and job competencies, but also other elements mentioned above (ethics, creativity, diversity, communication, collaboration). Of course, technical AI competencies remain important for an AI project manager, who is not a technician in the field, but as our experts have indicated, and as reflected in the framework, it is important to add human competencies (personal, interpersonal, social), including emotional intelligence and human management competencies, as well as competencies in ethical and responsible AI governance (legislation, ethical and inclusive standards), including those related to judgment, ethics.

It therefore seems essential, in the age of digital transformation and in a pandemic context, to ensure that the human dimension is integrated into the increasingly dematerialized workplace, because behind any technology, let's not forget, there are people who collaborate to define projects.

Moreover, it appears crucial for training institutions to conceive shorter, more engaging courses, more flexible, in order to overcome the side effects of a rapidly evolving workplace. In particular, constructing microprograms based on competency frameworks co-designed with industry actors allows overcoming "half-life" of professional skills. However, one must not forget the soft skills that are also important, as we mentioned above: communication, team management, diversity and inclusion issues, etc.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Competency Framework for Artificial Intelligence Project Manager

This section presents the competencies in each of the five domains: project management; AI-related job expertise; AI-related technologies; governance of an AI project and human relations. Readers interested in the specific competencies for each competency are invited to consult the project's research report, which provides more details.

A. PROJECT MANAGEMENT DOMAIN: LEADING AN IA PROJECT	B. JOB/SECTOR DOMAIN: KNOW THE JOB/SECTOR OF THE AI PROJECT	C. FIELD OF AI TECHNOLOGY: DEVELOPING TECHNICAL AND DIGITAL COMPETENCIES
A1. Initiate an AI project.	**B1. Develop job/sector expertise.**	**C1. Anticipate the problem.**
A1.1 Develop an idea (ideation).	B1.1. Popularize, explain, translate what AI is, how it works, its applications in its sector	C1.1. Have a sufficient understanding of what AI is.
A1.2 Determine the needs of the different clienteles.	B1.2 Know, list the data related to the AI project.	C1.2. Distinguish a problem that can be solved by AI.
A1.3. Carry out the impact study.	B1.3. Identify the different sources of data (sensors) in the AI project	C1.3. Translate a business problem into an AI problem.
A1.4. Carry out the opportunity study.	B1.4. Combine a variety of perspectives so that the resulting AI solution is as representative as possible of the interdisciplinarity of the experts	C1.4. Translate the business need into technical prerequisites.
A1.5. Decide on the main orientations.	B1.5. Identify and understand the processes of the company/organization where AI could bring added value	C1.5. Describe the difficulties related to the problem in an AI project.
A2. Planning an AI project.	B1.6. Articulate the principles (logic, rules...) specific to the different professions involved in AI projects	C1.6. Plan an AI project.
A2.1 Project content management (Scope)	**B2. Lead the digital transformation of the industry at level 4.0.**	C1.7. Define the different steps required to complete an AI project.
A2.2 Cost Management	B2.1. Know the industry and the sector.	C1.8. Identify the technical issues in an AI project.
A2.3 Human resources management	B2.2. Master the steps of the digital maturity of a company/organization.	C1.9. Identify the technical dependencies in an AI project.
A2.4 Risk management (CEN, 2014, p. 44)	B2.3. Define a deployment model for the digitization of the company with the different clienteles.	C1.10. Translate exchanges into common AI language.
A3. Execute an AI project.		**C2. Manage the data.**
A3.1. organize an AI project following the agile method (iteration).		C2.1. Describe the current state of an organization's data.
A3.2. Carry out an action plan.		C2.2. Select data sources for the AI project.
A3.3. Follow the different steps of the action plan.	**E. DOMAIN OF TRANSVERSAL COMPETENCIES: DEVELOP HUMAN AND RELATIONAL COMPETENCIES**	C2.3. Manage the data processing process.

Continued

A3.4. Implement project activities.	**E1. Demonstrate relational intelligence.**	**C3. Understand the algorithms.**
A3.5. Facilitate the realization of products or services.	E1.1. Adopt a human approach.	C3.1. Identify the issues of continuous training of a deployed AI solution.
A3.6. Analyze problems submitted by the team.	E1.2. Establish a transversal communication.	C3.2. Consider resources when training and releasing an AI solution to production.
A3.7. Write reports and debriefings for various clients.	E1.3. Foster collaboration.	C3.3. Be able to validate theoretical models.
A4. Monitor & control the AI project.	E1.4. Advise teams.	
A4.1. Use available project management tools, models, and resources to effectively manage the AI project.	E1.5. Understand stakeholder and team demands/expectations.	**C4. Manage the quality of the AI solution.**
A5. Close the AI project.	E1.7. Provide creative and collaborative leadership.	C4.1. Master AI solution performance metrics and their interpretation.
A5.1. Evaluate the AI project in order to assess it (post mortem to see how the process worked).	E1.8. Demonstrate emotional intelligence (AdmA, 2019, L4). E1.9. Manage innovation.	C4.2. Ensure data quality. C4.3. Ensure the quality of the algorithms.
A5.2. Transfer knowledge from project to project (post mortem).		
	E1.10. Manage diversity in all components of a project.	C4.4. Ensure the quality of the result of the algorithms.
	E2. Demonstrate interpersonal competencies and human qualities.	**C5. Identify the technological environment.**
	E2.1. Demonstrate agility in relation to the AI project.	C5.1. Carry out technological survey
D. FIELD OF GOVERNANCE OF AN AI PROJECT: MONITORING THE ISSUES OF GOVERNANCE	E2.2. Demonstrate curiosity.	C5.2. Compare the strengths and weaknesses of different technological solutions
D1. Ensure the governance of an AI project.	E2.3. Demonstrate autonomy.	C5.3. Determine the key technological elements.
D1.1 Translate the will of an organization.	E2.4. Demonstrate adaptability (AdmA, 2019, L14).	C5.4. Optimize the key technology elements.
D1.2 Define the governance of the data in the context of the AI project.	E2.5. Demonstrate argumentation ability.	**C6. Implement the AI solution in Industry 4.0.**
D1.3. Interpret the demands associated with the AI project according to the global strategy of the organization.	E2.6. Demonstrate critical thinking skills.	C6.1. Pilot the implementation of the AI solution.
D1.4. Know the ecosystem of the AI domain.	E2.7. Demonstrate computational thinking skills.	
D1.5. Master project portfolio management methods.	E2.8. Demonstrate problem solving skills.	

Continued

D2. Establish an AI project ethic.	E2.9. Manage complexity.
D2.1. Identify key ethical elements.	E2.10. Demonstrate a sense of organization.
D2.2. Gather ethical considerations from team members.	E2.11. Demonstrate proactivity.
D2.3. Propose solutions to ethical issues raised by the project.	E2.12. Know how to question oneself.
D2.4. Identify ethical issues related to the use of AI during all stages of the project.	E2.13. Demonstrate creativity (AdmA, 2019, L7).
D2.5. Identify diversity participation targets at all stages of the project.	E2.14. Demonstrate abilities to develop professionally independently and consistently.
D3. Respect the laws.	E2.15. Demonstrate openness to diversity (AdmA, 2019, L13).
D3.1. Understand the legislation surrounding the development of AI solutions	E2.16. Demonstrate integrity.
D3.2. Identify applicable personal data laws and regulations	E2.17. Demonstrate ethics.
D3.3. Identify key legal elements.	E2.18. Develop a strategic vision.
D4. Assess cybersecurity issues.	E2.19. Deal with ambiguity (AdmA, 2019, A17).
D4.1. Establish an ongoing cybersecurity monitoring specific to the AI project.	E2.20. Demonstrate judgment and consistency (AdmA, 2019, L9).
D4.2. Popularize cybersecurity issues to stakeholders.	
D4.3. Understand the cybersecurity threats and risks surrounding the AI project.	
D4.4. Be familiar with safety activities to mitigate cybersecurity risks.	
D4.5. Verify security activities throughout the AI project.	