ISSN 2683-345X

journal homepage: http://ijiemjournal.uns.ac.rs/

International Journal of Industrial Engineering and Management

Volume 13 / No 4 / December 2022 / 225 - 238

Original research article

UpSkill@Mgmt 4.0 – A digital tool for competence management: Conceptual model and a prototype

T. Bastos[a], J. Salvadorinho[a,b,*], L. Teixeira[a,b]

[a] *Department of Economics, Management, Industrial Engineering and Tourism (DEGEIT), University of Aveiro, Aveiro, Portugal;*
[b] *Institute of Electronics and Informatics Engineering of Aveiro (IEETA), University of Aveiro, Aveiro, Portugal*

ABSTRACT

The human factor is considered fundamental to the industrial digital upgrade, but it must be at the center of this innovation, through the mitigation of turnover and skills needs. One of the strategies to promote employee retention, is by promoting training (associated with skills management). Therefore, the main objective of this paper is to present the modeling and prototyping of a disruptive tool that allows an easy visibility of employee competencies (employee´s gaps) while emphasizing their preferences to promote the voice behavior. This device aims to foster individual organizational development, providing greater agility and employee involvement in organizations.

ARTICLE INFO

Article history:
Received May 10, 2022
Revised October 8, 2022
Accepted October 18, 2022
Published online October 24, 2022

Keywords:
HRM 4.0;
Workforce Engagement;
Skills Management;
Voice behavior

*Corresponding author:
Juliana Salvadorinho
juliana.salvadorinho@ua.pt

1. Introduction

Industry 4.0's core goal is to fulfill individual requirements by shifting the industrial paradigm from mass manufacturing to customized production, using significant technological advancements [1].

This transformation will also affect the labor market and human resource management (HRM) [2]. If for one hand, it brought improvements to human factors, as for example collaborative robots that allow a reduction in the physical effort of the workers [3], on other hand, production processes are becoming increasingly complex, placing new demands on staff competences [4]. Adjustments in the educational process of future workers are essential [5]. Training, besides making employees more capable, is also one of the four pillars of engagement. Based on these two premises, the preponderance of training in the digital paradigm is clear [6].

In addition to this, and according to Salvadorinho & Teixeira [7], the industry 4.0 environment is characterized by high volatility, which impacts also the human resources level. There is a greater propensity for turnover, which triggers in organizations an immense need to outline knowledge management structures. People take with them knowledge that, for organizations, can represent a huge loss. Since companies will continue to have people, it is therefore essential

Published by the University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia.

http://doi.org/10.24867/IJIEM-2022-4-315

to create strategies that address these obstacles [8] through processes such as engagement [9].

New paradigm changes may result in mistrust (by employees), a sense of being dominated, and a fear of losing their jobs [10]. Besides this, can occur job dismissals for low-skilled jobs and the needed shift toward more high-skilled complex jobs, which require a more intense emphasis on constant learning [11], [12].

New emerging technologies can play a major role in helping HRM practices and in promoting engagement, through the training component. Some software already works with competency management, by showing the "gaps" of the collaborators, and some of them even show who have superior performance and potential indexes, however, the possibility of allowing the employee to communicate his/her preferences is still lacking in terms of skills.

Thus, the purpose of this paper is to present a prototype of a tool (using also modelling to show functionalities) that meets the needs described above. This tool will allow employees to identifies the differences between their competencies and those required for the job, facilitating HRM activities such as appraisal. It will also allow employees to have a voice behavior[1], putting their preferences for the competencies that they want to develop and for those ones they want to use in their work. These two aspects can be very useful for HRM practices, such as individual development plans and training, and can be a promotor of engagement.

Thus, this paper is structured as follows: section 2 focuses on presenting a theoretical basis of some concepts such as: fourth industrial revolution, the role of human resource management and workforce engagement; section 3 intends to present the technological solution from a modeling point of view, as in a prototype. Thus, it consists of several subchapters, namely the preliminary study to obtain the requirements, the objectives and methods for the modeling and prototype built, the system modeling using use case and class diagrams, the presentation of the prototype interfaces together with interaction diagrams and, finally, the comparation between our solution and others already existents. Section 4 presents the discussion and final remarks. Section 5 and 6 presents the implications and contributions and limitations and future work, respectively.

2. Theoretical Background

2.1 The fourth industrial revolution and the role of human resource management

Industry 4.0 may be characterized as production systems performed by smart and autonomous machines that can interact and cooperate with each other [13]. The fourth industrial revolution has reshaped the integration of the physical and cyber worlds in organizations, and it is a present trend in the manufacturing sector using technologies such as cyber-physical systems (CPS), Internet of Things (IoT), and cloud computing [14]. This concept is enhanced by introduction of nine pillars of technology: Industrial Internet of Things (IIoT); Big Data; Horizontal and vertical integration of systems; Simulations; Clouds; Augmented Reality; Autonomous Robots; 3D printing and Cyber Security [15], [16].

Human resource management (HRM) is considered as a strategic method to efficiently develop very motivated and capable personnel to meet a company's goals [17], [18].

Because conventional and administrative HR duties would be automated as part of industry 4.0 transformation, HR directors must become even more innovative and strategic. Recruiting, training, and development are just a few of the HR operations that will face major changes [19]. Piwowar-Sulej [18] shows some changes that new technologies can have on the HRM elements described above in three categories of employees, according to the level of skilled, for example in what concerns training and development, all categories should have training in the use of new technologies, employees in the highly skilled category should have customized training, using artificial intelligence, and, in virtual reality, the latter also applies to medium skilled employees.

Future factories will be optimally adapted for employees with varying preferences, competences, and abilities, and will be powered by technologies that consequently empower and engage the workforce [20].

Hecklau et al. [21] proposed a set of competencies for the digital paradigm (Technical, methodological, social, and personal abilities are listed as needed employee competencies in the holistic framework for managing human resources for Industry 4.0), aggregating them on a radar chart, where the employee

[1] This term is defined in [47] as a behavior that falls into challenging the status quo to improve rather than just criticize.

can see their differences for a given role (the set of competencies must be weighed for each role beforehand).

The competencies required by entities at various stages of industry 4.0 implementation necessarily yields distinct results. Surprisingly, it appears that as the maturity of Industry 4.0 advances, soft skills are becoming increasingly crucial. The fact that it is easier to teach managers and workers in the field of hard skills (they can achieve a suitable level of these capacities relatively quickly) and, on the other hand, training the needed soft skills be a far more challenging procedure that takes more time, can explain the tendency above mentioned [22].

2.2 Workforce engagement: concept and applications

Urrutia Pereira et al. [23] findings also offer an intriguing perspective on the link between job satisfaction and turnover. In an industrial setting, these professionals with the privilege of being able to "choose" their workplace, it becomes even more crucial to formulate strategies that value other factors. For example, when the organization and leader support learning, there is a decrease in the desire to seek a new job.

According to Rothmann [24] work engagement is defined as "a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication and absorption". For each worker, the firm is not only a location where he does his job, but also a place where he lives, because he passes more than half of his active hours, working and forming strong relationships with coworkers [8]. With the engagement of highly skilled people, adoption of industry 4.0 technology and processes will considerably boost a firm's innovation capability [17].

Aromaa et al. [25] states that the four pillars of engagement are: knowledge sharing and collaboration, visualization of information participatory design and training.

Technology platforms have already been developed with the goal of increasing engagement, some of them using gamification. An example of this is the work of [26] which developed a platform with the goal of promoting collaboration between workers, using gamification as a way to motivate its usage.

The future socially sustainable factory must become a knowledge-sharing and adaptive learning environment that promotes individualized competence growth and learning as human operators labor to achieve the company's and production goals [27]. Diedericks and Rothmann [28] states that workplace engagement is critical to the success of IT workers. Positive emotions, such as joy, happiness, care, and curiosity, are experienced when people participate in challenging activity for which they have adequate physical, intellectual, and emotional energy and that matches their interests, strengths, and values.

Below are described the most popular applications existing in the market, which aim to align in the context of skills management and, at the same time, to contribute to the promotion of work engagement.

Leapsome® is an HR platform that integrates features to promote the employee engagement, performance management, and individuals' development. Goal management, performance evaluations, employee engagement surveys, 360-degree feedback, recognition, one-on-one meetings, employee onboarding, and learning are some artifacts that the platform provides to enable and grow people [29], [30].

BizMerlinHR® offers comprehensive employee records, onboarding tools, performance management, feedback, applicant tracking software (ATS), employee recognition, goal management, and employee performance reviews [31].

AG5® is a skills management platform that enables HR and operations managers to manage all professional and personal skills of all employees across the workforce, thus making it easy to see which employees are the most qualified, identifying the level of proficiency and availability for each employee. The application also allows easy skills assessments to be made [32].

Spidergap® is an application for developing 360-degree feedback surveys. Employee-focused feedback reports assist staff in determining areas that need the most improvement and in moving forward with their personal growth. The performance of other employees is asked about in the response. Spidergap® reports display recommendations from other employees about how a worker might enhance his performance [33].

BizneoHR® is a collection of HR solutions that includes several modules to address topics including hiring, assessments, tracking time and attendance, managing vacation time, training, organizational charts, and KPIs. a program that addresses all aspects of the employee lifecycle, including recruitment, identification, training, and satisfaction [34].

CompetencyCore® is a talent management technology that offers tools to assist users in identifying talent requirements, assessing employee skills, and

addressing skill gaps. Users may set job requirements, create interview guides for certain job positions, and monitor employee growth. The evaluation and development module aids users in identifying skill shortages in the workforce, setting development targets and goals, and suggesting learning materials [35].

3. Development of a digital tool for competence management: Conceptual model and a prototype

3.1 Contextualisation, goals and methods

The digital paradigm is characterized by a volatile environment, where technology presents itself as being preponderant in the achievement of customization. The human factor accompanies this volatility with an increase in turnover, which may jeopardize organizational knowledge, such as the allocation of tasks. Thus, it is necessary to have mechanisms that facilitate the task of supervisors in what concerns the allocation of people to tasks, as well as mechanisms that support the retention of employees, through the promotion of labor engagement.

For the conceptualization of the technological tool a prior study was conducted so that the system requirements were recognized. In a first moment a literature review (including scientific papers and human resource documents) was carried out, creating a primary version of the requirements. Then, with the support of three organizational entities, a focus group was coordinated, where the version of the requirements coming from the literature was validated and changed, undergoing an upgrade. Specifically, the focus group took place in two moments, with a duration of about one hour and fifteen minutes each, and counted with the participation of people from academia and industry, involving three companies: one in the metal-mechanic sector, another in the chemical sector, and another that operates in the furniture retail sector.

In terms of bringing together the literature review and focus group perspectives, the following requirements for application were found: (1) the **first requirement** highlighted concerns the possibility for the employee to see his or her competence profile. To satisfy this requirement it was necessary to create a structure of competence levels, and to this end, a structure with 3 levels (Beginner, Intermediate, Advanced) was proposed and validated with the partner companies. In what was heard by the focus group, the entities do not have the list of competencies of each employee, they only have if the operator is qualified to perform a particular function; (2) The **second requirement** is to allow employees to enter a preference for the competencies they most like to use and develop; (3) the **third requirement** is based on the possibility of the employee to check the existing gap between what is the expected profile for a particular role and his/her profile for it. This idea is based on the model proposed by Hecklau[21], where the authors describe a list of competencies for the digital revolution and add that in radar chats (certain competence has a determined level for each function) to allow an easier way to see the gap between the employee's competencies and the desirable profile. In what was taken from the focus group, the companies found the idea of radar charts interesting, adding that it would be important for the employee to self-assess (their competencies), thus obtaining three overlapping charts (one of a specific job profile and two that refer to the employee profile, one from the employee's point of view and one from the manager's point of view); and (4) The **fourth requirement** concerned helping the supervisor to assign people to roles. This was feasible using a skills matrix. In the focus group there was a high acceptability regarding the notation of circle charts to understand who the most capable employees are to perform certain roles. The idea was stressed that it would be interesting for leaders to have access to a talent analysis that would allow them to understand the operators with the best performance rate and the highest potential.

The major focus of the tool is to provide greater agility when it comes to human resource management practices, facilitating practices such as assessment, training, and individual development. Specifically, at the employee level, the tool will also allow a substantial increase in workforce engagement. In figure 1 it is possible to find out a summary of the result of the previous study regarding the requirements of the technological tool.

As already presented, this study aims to present a conceptual model and prototype of a tool capable of supporting workforce competency management, contributing to better human capital administration. In a first phase, and after the preliminary study described above, the requirements and structure of the database will be modeled using unified modeling language (UML). Based on this, some interfaces, prototyped in Adobe XD will be exhibited to illustrate the main requirements. These will be accompanied with interaction diagrams, in UML notation, to show the connection between the front-end and the database.

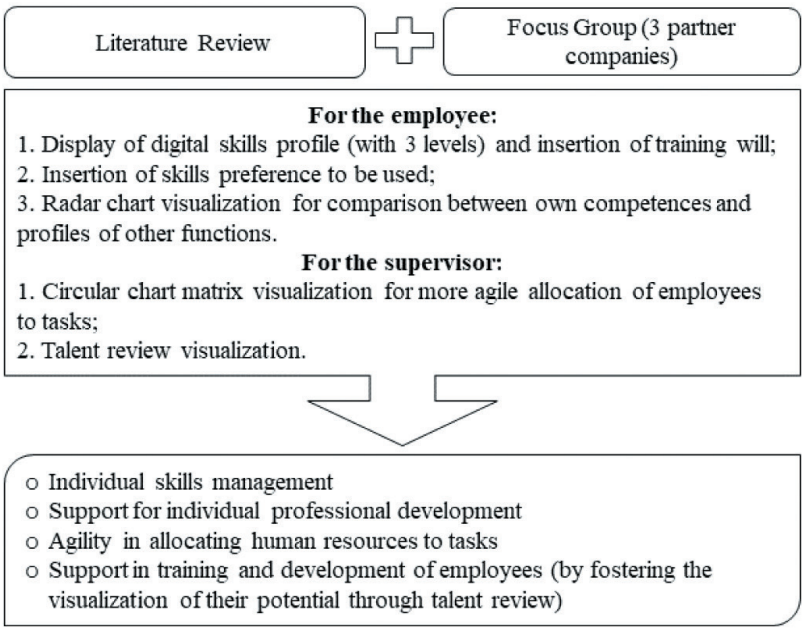

Figure 1. Methodology to identify the requirements of the technological tool and potential benefits associated with it

It should be noted that in this study were also consider participatory design - user-centered design - when the users validate the artifacts in all stages, having a strong participation in the requirements collection.

3.2 Description of the solution from a conceptual perspective: A model

After the creation of the concept for the tool, described in a previous work, a list of requirements was reached, as shown in table 1.

Next, to create a conceptualization model of the solution, the UML use case and class diagrams were used. In use-case diagrams, the use cases and actors define what the system performs and how the actors interact with it [36]. While the class diagram represents the structuring of data in order to answer to the functionalities defined by the use-case [37].

The actors in this system will be the employee, the supervisor and HR Responsible. The first use case concerns to allow the employee to visualize his/her competencies in progress bars, for each competency, a structure of three slots is filled by manager and the employee what is your proficiency level for each skill. The system should also allow the employee to enter

Table 1. Requirements for the technological tool for each actor

Entity	Requirements
Employee	- View skills manager evaluation in progress bars (with a structure of 3 levels) - Enter the preference of skills that want to develop - Enter the preference by using a particular skill - Visualize the gap between his/her skills, and the skills needed to perform a certain function (radar chart) - Visualize the potential that the company associates to him/her - Enter his/her self-assessment regarding his/her job skills
Supervisor	- Visualize the most suitable employees to perform each function - View profiles of each employee - Evaluate the team members - View indicators such as the quantity of employees that does the better match (between competence and function profile), the quantity of employees by competence level and potential level, the quantity of employees in training, the quantity of employees who intend to develop a certain competence, check how many employees there are for each level in a certain competence - View the talent review (report that shows, from the population, the employees who stand out the most and, therefore, the functions said to be the most important)
HR Responsible	- Insert skill levels and description - Enter, or update, the requirements that each job should demand

two types of preferences concerning skills, the first one relates to the skills that they want to develop (the Figure 6 in the chapter 3.3 illustrates the interface for this requirement) and the second one regarding to those they want to use, and those preferences should be notified to the team supervisor. To give a better notion about the employee's position in the function, the tool should show the gap between employee skills, and the skills needed to perform a certain function. The observation done by the employee would be done with resourceful to radar charts. Which concerns to the potential, other requirement should be the possibility for employees to observe the potential that the manager attributes to them. The last requirement related to actor "employee" is to introduce his/her self-assessment regarding his/her job skills.

The second actor of the system is the supervisor. Concerning to supervisor, the system should demonstrate whose employees are most suitable to perform each function. This visualization will be done through a skills matrix. This will include a pie chart for each employee in each role. This chart will be calculated based on weighted averages (each competence has a weight for a specific role, described in more detail above). There will be a multiplication between the weight of the competence in the role and the required level of the same. The sum of all these multiplications will give the score of the role. Similarly, a score will be made for the employee in the function, differing only in the change in the level of competence (this score will be the employee's proficiency level and not the ideal of the function). As a result of the division of the two scores described above, the percentage of the circular graph area that will be filled will be extracted. To sum up, we have the variables:

- x_i, corresponding to the weight that the competence has in the function
- y_i, corresponding to the level that the employee has in the competence
- z_i, corresponding to the level of proficiency of the ideal profile to perform the function

So, the percentage of the area of the circular graph for each function to fill in is equal:

$$\% = \frac{\sum_i^n x_i y_i}{\sum_i^n x_i z_i}$$

Note that, to formulate the employee radar chart beyond explained, it is crucial to have a functionality that allow supervisor to evaluate the collaborator using the scale of three levels for each competency. View indicators are also important and should be considered in the system. The last use case related to supervisor is the possibility of view the talent review (a report that shows, from the population, the employees who stand out the most and, therefore, the functions said to be the most important). Here there is a graph of two axes in which one corresponds to the potential evaluated by the manager and the second to the performance, this is evaluated by the same formula used in determining the painted area in the skills matrix, detailed above, the only difference is that in the performance the result is a value between 0 and 1. This interface is represented below in chapter 3.3, in Figure 9.

Figure 2 presents the use-case diagram as described above.

To store all this information, there is a need to create a data scheme. For this, the authors have resorted to UML class diagram (Figure 3). This tool focus is the management of competencies, and for this reason there is a need to create a class to store information about them. In this class the name and description of the competency are stored. To support the three-level structure for each competence, there is a need to store descriptive texts to explain what is intended for a particular level within the competence, hence the need to create the class *Level_description*. The competencies will be aggregated into knowledge areas. As far as the collaborator is concerned, it has the following attributes, Name, Number, NIF and BI. Since managers are also collaborators, the unary link was established, because collaborators can have a supervisor and a supervisor can lead several collaborators. Regarding the link between employees and skills, there was a need to create five links between these two classes, with associative classes to store different information. In the first connection, the *Training_or_not* class was created, to indicate whether the employee is in training for a given competence. In the second connection, the *PreferenceLevel_Improve* class was created, to store information about whether the employee intends to improve his or her level of proficiency in each competence. In the third connection, with the *PreferenceLevelUse* class, the intention is to indicate whether the employee intends to use that competence. In the fourth connection, the class created was *ManagerLevel*. This class intends to store the level that the manager gives to the employee in each competence. And finally, in the fifth link, the goal is to store the level at which the employee reviews himself in that competence (his self-assessment). These 5 links serve to answer all the necessary information regarding the employee and his/her competencies. To create teams, to allow

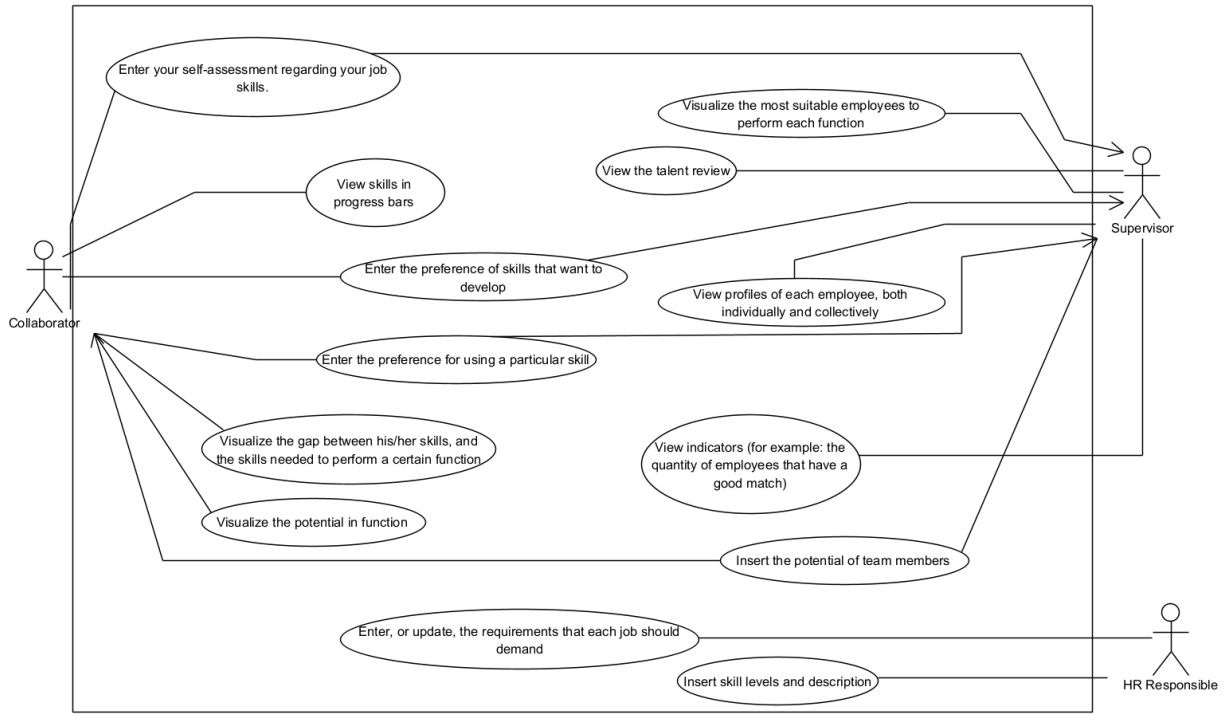

Figure 2. Use-case diagram with requirements for the technological tool using UML

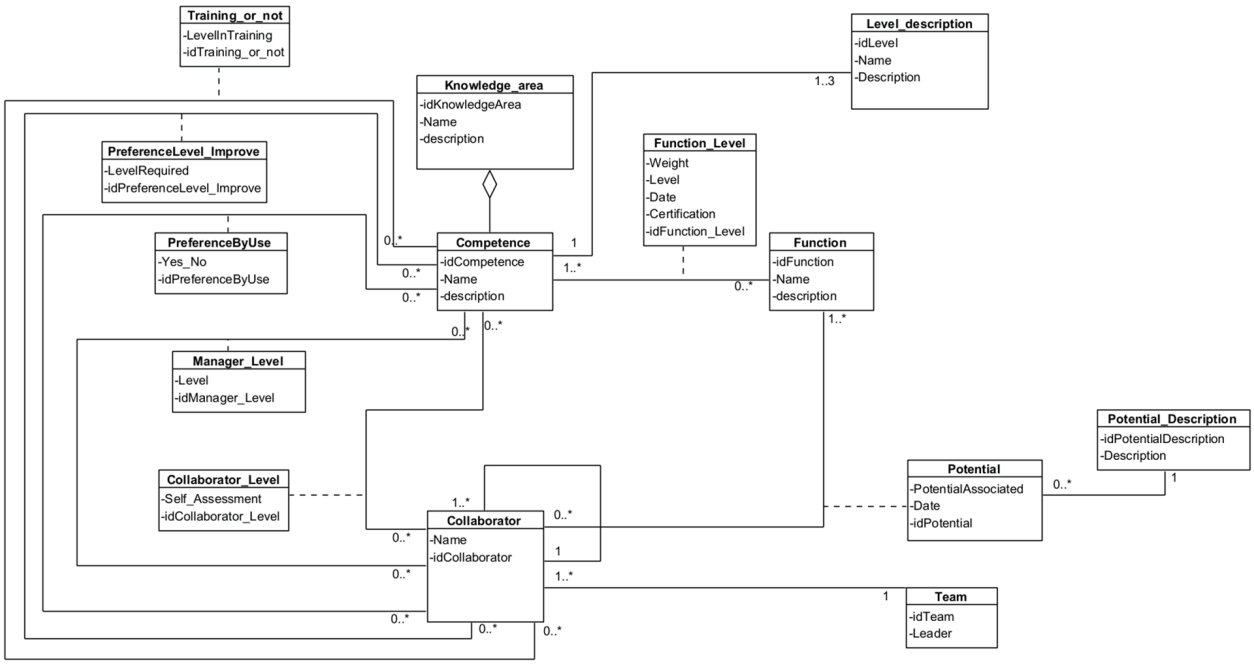

Figure 3. Class diagram for the technological tool using UML

managers information about their employees, there is a need to create the class team to associate the employees with. All these skills and employees must be linked to another pillar in this database, the role. Therefore, this class links to Employee, because each one is associated with one or more roles. From this association arises the potential class that indicates the potential that the manager gives to the employee in its function. To facilitate the interpretation of the assigned potential, the *PotentialDescription* class was created to store descriptions for the various potentials. Functions have competencies that can be transversal to several functions, hence the association between these two classes. Linking these functions to the class that holds the level by function for that competence and the weight that the competence requires in the function, to facilitate the creation of the skills matrix described above.

3.3 Description of the solution from a user perspective: A Prototype

To show the type of data the tool intends to show, the interface corresponding to the employee overview is shown in figure 4. Here data such as number of skills per level, number of skills per type, how many skills he is developing and how many he intends to develop, or which functions he is best suited for, are displayed.

In figure 6, is represented the interface that allows each employee to insert preference of skills that want to develop. Here the employee can click in each bar slot to change them from white color to grey color (the color grey indicates the intention to develop the corresponding level). In the Figure 5 is visible a sequence diagram for this interface. When the employee communicates the intention, the system will get the *idCompetence* and the *idCollaborator* to identify the competency to create the instance of associative class *PreferenceLevel_Improve*. After match the collaborator and the competency, it is important to perceive which is the degree that manager assigns to it, and whether the employee is training for a specific level. If the employee is not in training and the required level is the next level after the manager's assessment, then the slot is grayed out. As an alternative to this condition to color the slot, there is another one composed of two sub conditions, first, the employee's demand has to be higher than the level that follows the one assigned by the manager (i.e. the desired level has to be two above the one assigned by the manager) and the second sub condition, the employee has to be in training for a certain level, this level being the one that follows the manager's assessment.

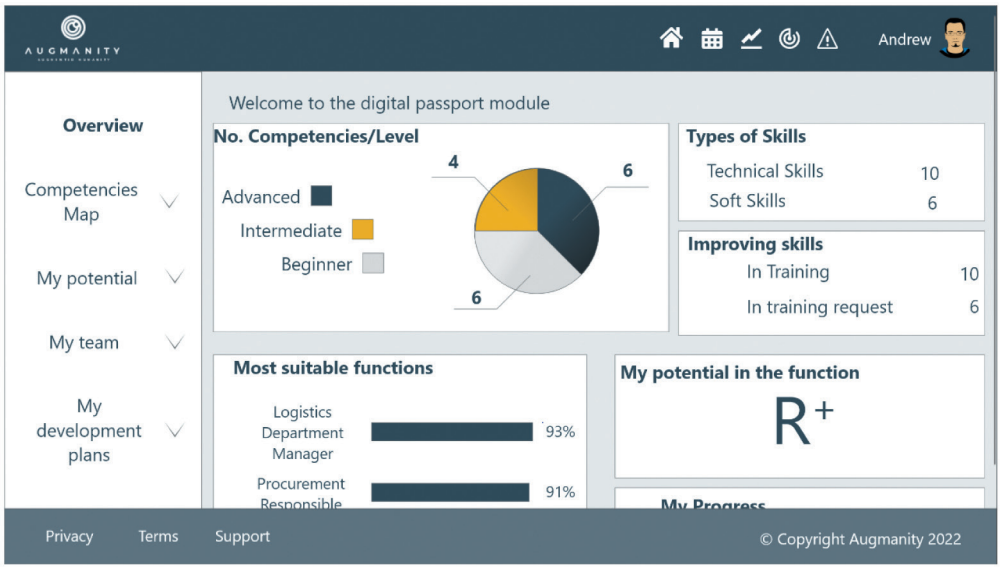

Figure 4. Interface to the overview of employee profile

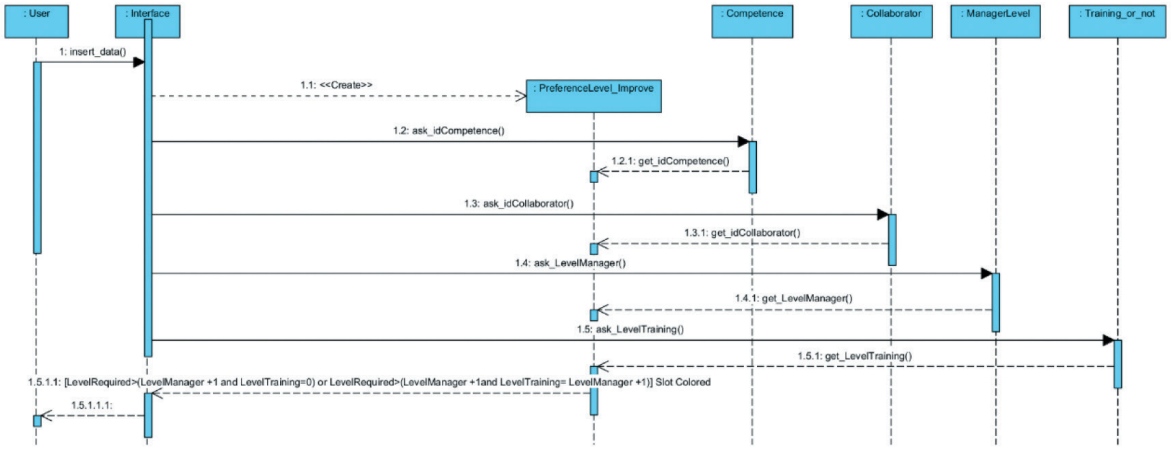

Figure 5. Sequence Diagram to the interface designed to allow the collaborator to indicate their preferences to develop certain skills

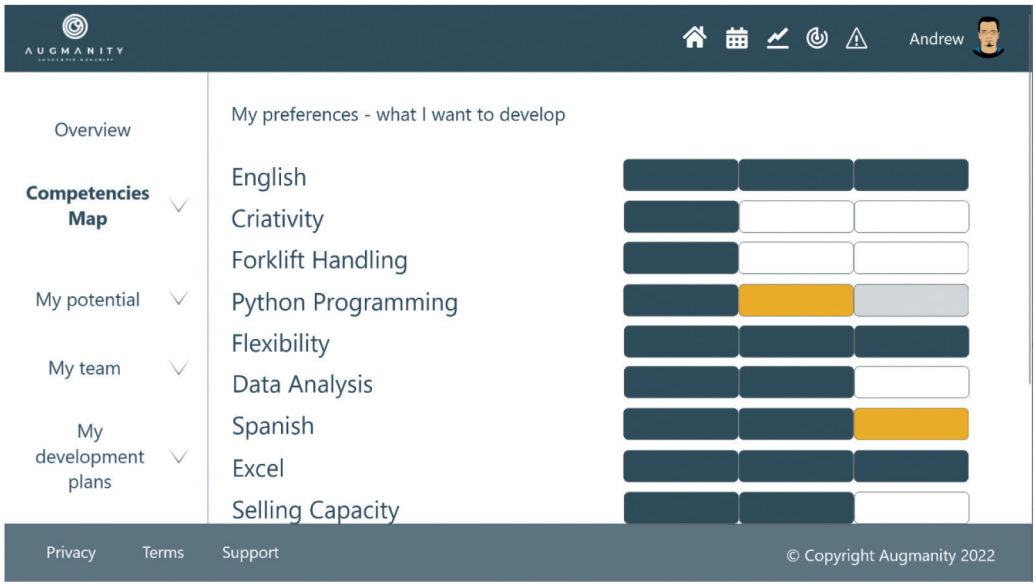

Figure 6. Interface designed to allow the collaborator to indicate their preferences to develop certain skills prototyped in Adobe XD

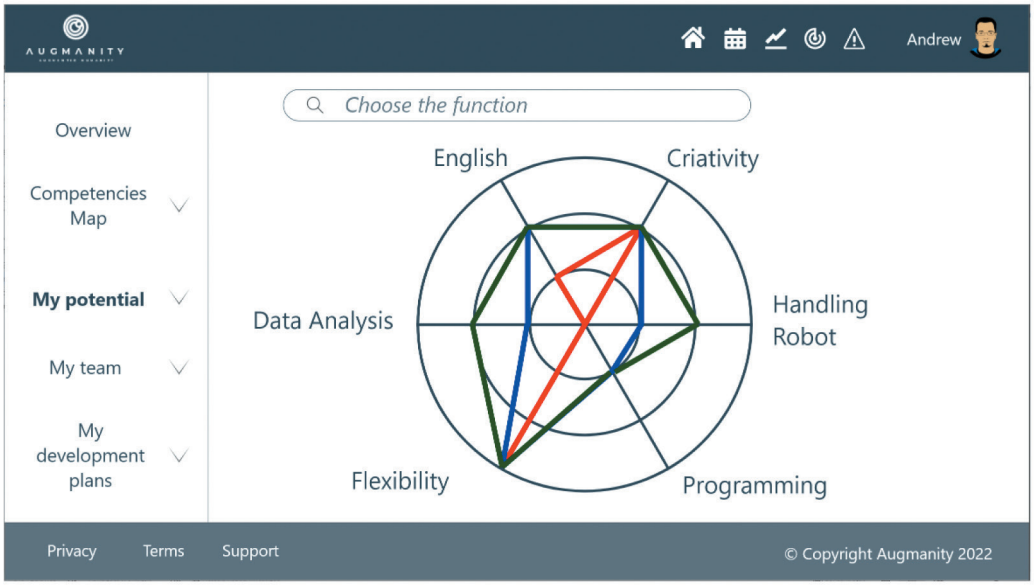

Figure 7. Interface designed to show the employee profile from three perspectives

For the requirement of the employee's visualization of the competencies in the role, this interface was designed, represented in figure 7. Here is visible the spider graph. Around the larger circle of the graphic, it is possible to see the competencies required for the job. Within the circle you can see three lines, which connect different degrees of proficiency for the competencies around the circus, so the various lines represent the ideal profile in the function in green, the employee's self-assessment in blue and the supervisor's assessment in red.

For the requirement to exhibit the talent review, the interface shown in figure 9 was designed. To suppress this requirement a graph with two axes was drawn up those frames the employee according to his or her potential and performance. For this, it will be necessary to go to the database to get the *idCollaborator* of all the people allocated to the team and the function to which they are allocated to be able to extract the potential that is associated with their function. In the performance chapter, after finding the role, it is necessary to understand which competencies, and for each competency it is necessary to know what the ideal level for the role requires to be removed and the weight that this competency has in the range of competencies of the role. Then it is also important to understand what level the employee has in the competency to be able to calculate the performance (ex-

plained in chapter 3.2). Figure 8 depicts the interaction between the interface and the database, through a sequence diagram.

Figure 10 shows the interface corresponding to the skills matrix. In this interface you can see two filters, a first one corresponding to the team, in case the supervisors who have more than one filter the one they want to see and then another filter to allow the selection of a specific role, if they do not intend to see the generic matrix represented in the interface. When no filter is added, the interface shows the various team members and their roles, painting the circular graph area according to the formula explained above.

All the remaining features of the prototype were designed using the same graphic style and interaction diagrams were developed for the remaining communications between the interfaces and the database.

3.4 Our solution vs. market apps: benchmarking

To try to compare the solution arrived at with others that exist on the market, a benchmarking of these apps was carried out. Table 2 summarizes the comparation between the requirements reached and applied in the tool proposed and some existing apps.

Applications like Leapsome®, BizMerlinHR®, AG5®, bizneoHR® and CompetencyCore® have a level structure for each competency [38]–[42]. When concerns to communicate preferences for use, the communication of these is still not very vis-

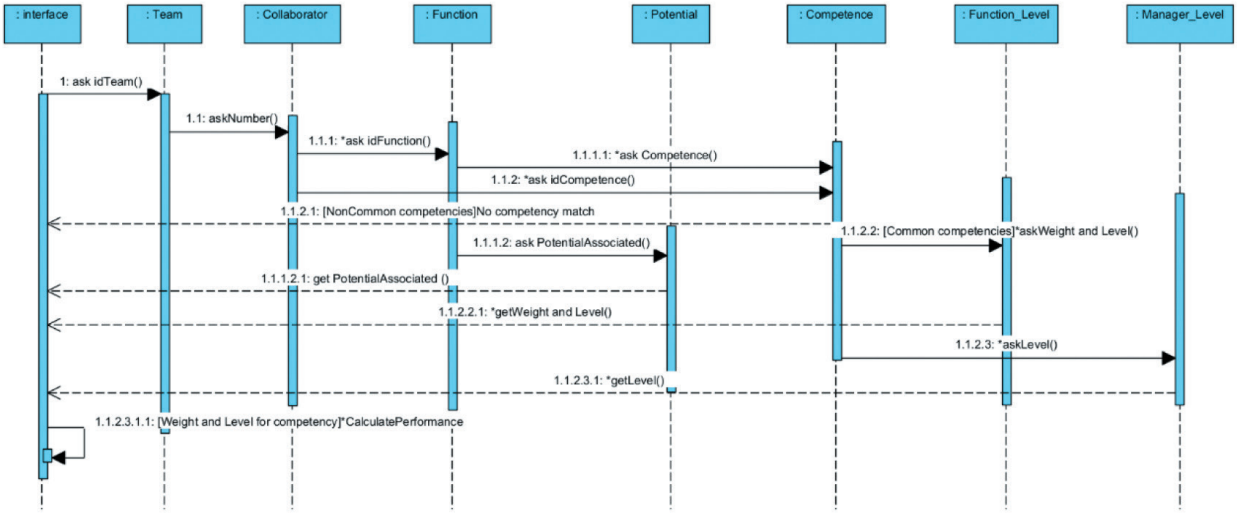

Figure 8. Sequence Diagram to the interface designed to allow the supervisor to see the talent review

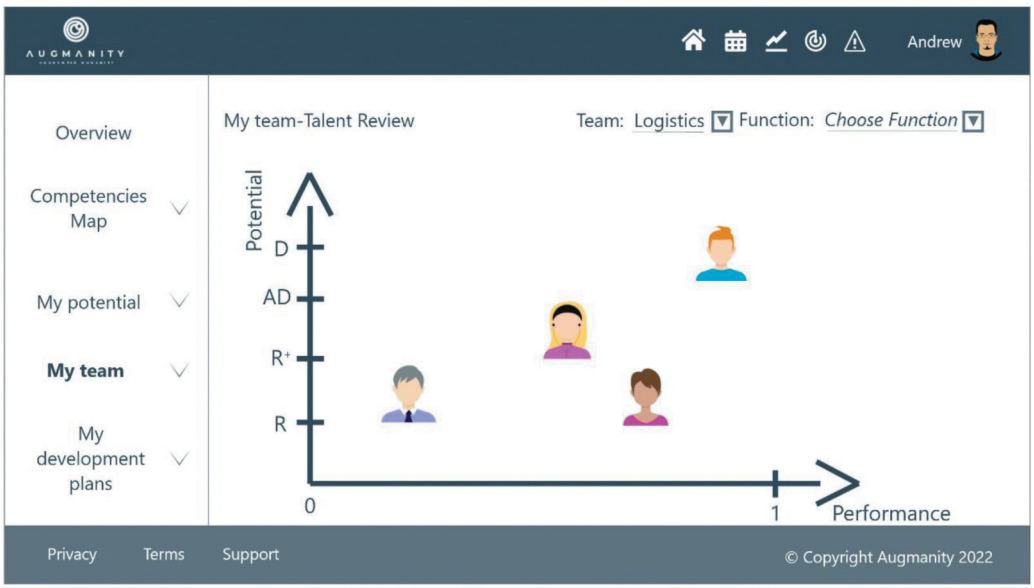

Figure 9. Interface designed to allow the supervisor to see the talent review

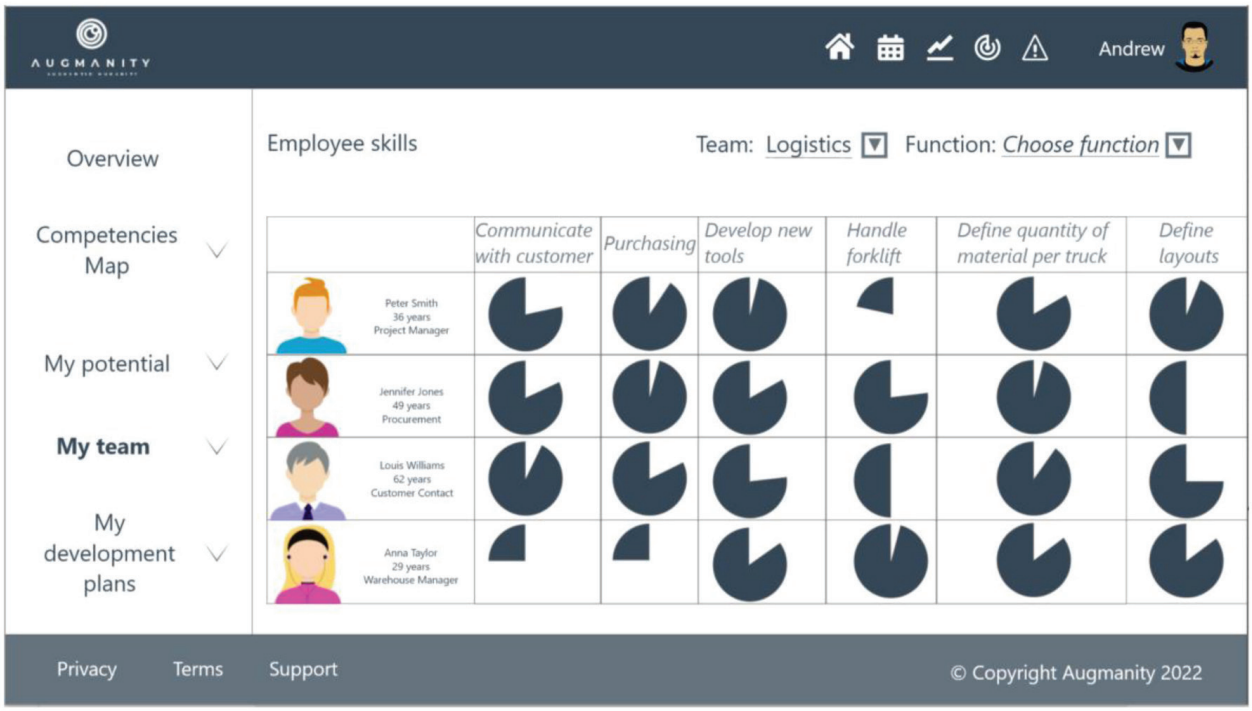

Figure 10. Interface designed to allow the supervisor to see the skills matrix

Table 2. Summary of comparation between the requirements reached and applied in the tool proposed and some existing apps

Requirements \ Apps	Leapsome®	BizMerlinHR®	AG5®	Spidergap®	bizneoHR®	CompetencyCore®
1- View skills in progress bars (with a structure of 3 levels)	✓	✓	✓b		✓	✓
2- Enter the preference of skills that want to develop						
3- Enter the preference by using a particular skill						
4-Visualize the gap between his/her skills, and the skills needed to perform a certain function (radar chart)	✓a		✓c		✓	✓c
5- Observe the potential that the company associates to him/her	✓				✓	
6- Enter your self-assessment regarding your job skills	✓		✓	✓	✓	✓
7- Visualize the most suitable employees to perform each function (skills matrix)	✓	✓	✓		✓	✓
8- View the talent review	✓				✓	

a- It uses the radar chart, to compare competencies among employees, teams, managers, and/or the entire company, not with desired profiles.
b- Identical logic of levels, but with 4 instead of 3
c- Allows to perceive gaps, but does not use the radar graph

ible in applications for these purposes. At the level of preferences, applications such as BizMerlinHR® have the possibility of customizing the training. The approach of communicating preferences by the employee remains unidentified, because in the personalized choice of training there is no guarantee that the individual interests of the employee are being addressed. The radar chart have been used not only by Leapsome® [43] to compare teams, but also by SpiderGap® [44] to compare the current state of employees with the desired profile for their future. In the case of bizneo®, this platform uses radar charts

to realize "gaps" of competencies in employees [45], a similar approach to an approach similar to that used in the tool proposed in this article. Applications such as Leapsome®, SpiderGap®, AG5® and BizneoHR® not only include competency assessment by partners, but also give the employee the possibility of self-assessment. BizMerlinHR®, as well as the above-mentioned apps, makes it possible to communicate which employees are best suited for which functions [46]. Finally, Leapsome® and BizneoHR® also offer the possibility of analyzing which employees have the best performance and potential (named talent review in the previous table) [43], [45].

4. Discussion and final remarks

Systems complexity has increased because of technological advancements, requiring changes in employees' skill profiles and shifts in the labor market and human resource management [4]. It should be noted that companies will continue to have people, and therefore must adapt and deal with the complexity and volatility required by the new work contexts. To improve the effectiveness of the systems, teams must be trained to match employee profiles with standard profiles for the task [27].

In addition to the demand for skills required in the new paradigm, the turnover associated with the human resource is getting bigger [7]. Thus, it is necessary that companies are more capable of providing a more agile allocation of people to tasks, as well as the retention of employees, to preserve the organizational knowledge. Engagement is then the key factor of this achievement [9] and the promotion of training across all layers of employees is one of the pillars capable of enhancing it [6]. Organizations and leaders that support learning led to a decrease in the desire to seek new employment. Some works shows the positive impact that technological tools have in the promotion of this concept. The employee must, therefore, be able to manage his individual professional development, providing an adequate management of his skills. Recruiting, training, and development are just a handful of the HR functions that will undergo significant transformations [19]. The skillsets required by organizations at various phases of industry 4.0 deployment must inevitably promote different outcomes. Surprisingly, it appears that soft skills are becoming increasingly important as industry 4.0 matures. The fact that it is easier to educate managers and employees hard skills (they can attain a reasonable level of these capacities relatively fast) but teaching the necessary soft skills is a far more difficult and time-consuming process might explain the above-mentioned trend [22].

The concept of the tool presented in this study, aims to assist the human capital in the transition to the digital paradigm, thus the prototype serves as a good starting point for the construction of this artifact in technological terms. It is possible to see interfaces that can serve as a reference for user-friendly tools, as they allow employees to intuitively visualize their current competencies states and at the same time enter their preferences. If on the one hand the interface must be soft to facilitate the use by employees, its relationship with the back end (database structure) is not so simple as illustrated in the sequence diagrams, sometimes requiring many class instructions to be called to trace the desired output.

This is a tool capable of providing the employee with an adequate management of his/her competencies and visualizing possible future development lines (through comparison with competencies of other functions), which focuses on the component of fostering engagement. As far as the supervisor is concerned, he/she will be able to perform a more agile allocation of tasks to human resources, as well as perceive which members are more valuable and have greater potential for progress, thus supporting the maximum need for agility resulting from the high turnover rate in the digital paradigm.

This tool presents itself as innovative, because although it includes artifacts used by others, such as the radar graph, the approach is different, including the comparison of three lines, allowing the employee to compare the ideal profile to perform the function with his profile in his vision and in the vision of his superior. But the big difference and what gives this tool a disruptive character is the presence of requirements that foster "voice behavior", possibilities to introduce preferences about what competencies you want to develop and what competencies you want to use.

In a climate that threatens organizational stability so much, a technology of this kind, with these functionalities, gives some decision-making power to the employee. They can more easily see a future for themselves within the organization in a more transparent way and, at the same time, express preferences in terms of their performance. In addition to this, the supervisor is more easily alerted to the wishes of his team, while collaborating more quickly in assigning the most appropriate tasks to each one. In such a volatile climate it is essential to count on the workers' voice behavior, contributing to an organization that, being made up of people, pays more attention to them.

5. Implications and Contributions

The practical implications of this study are the presentation of a concept of a tool that intends to facilitate the transition of human capital in the fourth industrial revolution, through the management of competencies, their positioning in relation to those required for other functions and also the attribution of performance preferences. All the functionalities presented here contribute to the repositioning of the human factor in the digital paradigm, fostering workforce engagement.

As theoretical contributions, this article highlights the role that human resource management plays in developing and preparing employees to face the challenges of the new digital paradigm. Technology can be applied for inclusion of voice behavior, visible in the possibility of communicating preferences, which, not being an explored path in existing applications, may prove useful in human resource management. All these factors foster a more engaged organization, where workforce retention will become more possible, preserving the organizational knowledge, a potentiator of competitive advantage.

6. Study limitations and future work

Despite having a strong literary base, the research presents the realization of a focus group with only a few companies, which can be considered a flaw in this work. Thus, it is considered preponderant to add more insights from other entities, so that the features identified here are corroborated. Besides this, the future work that is currently being developed includes the addition of elements that help in the design of appropriate training to suit the demands and preferences of workers in terms of development plans, as well as the realization of usability studies in real-world scenarios to evaluate the effectiveness of the prototypes.

Funding

The present study was developed in the scope of the Project Augmented Humanity [POCI-01-0247-FEDER-046103 e LISBOA-01-0247-FEDER-046103], financed by Portugal 2020, under the Competitiveness and Internationalization Operational Program, the Lisbon Regional Operational Program, and by the European Regional Development Fund.

References

[1] S. Vaidya, P. Ambad, and S. Bhosle, "Industry 4.0–a glimpse," Procedia Manuf., vol. 20, pp. 233–238, 2018, doi: 10.1016/j.promfg.2018.02.034.

[2] K. Ejsmont, "The impact of industry 4.0 on employees—insights from Australia," Sustain., vol. 13, no. 6, p. 3095, 2021, doi: 10.3390/su13063095.

[3] L. Gualtieri, E. Rauch, and R. Vidoni, "Emerging research fields in safety and ergonomics in industrial collaborative robotics: A systematic literature review," Robot. Comput. Integr. Manuf., vol. 67, p. 101998, 2021, doi: 10.1016/j.rcim.2020.101998.

[4] A. Reiman, J. Kaivo-oja, E. Parviainen, E. P. Takala, and T. Lauraeus, "Human factors and ergonomics in manufacturing in the industry 4.0 context – A scoping review," Technol. Soc., vol. 65, p. 101572, 2021, doi: 10.1016/j.techsoc.2021.101572.

[5] H. Onn Malaysia, N. Ahmad, A. Shamsuddin, and N. Aslinda Abu Seman, "Industry 4.0 Implications on Human Capital: A Review," J. Stud. Manag. Plan., vol. 4, no. 13, pp. 221–235, 2018, [Online]. Available: https://pen2print.org/index.php/jsmap/issue/view/252.

[6] E. Kaasinen et al., "Empowering and engaging industrial workers with Operator 4.0 solutions," Comput. Ind. Eng., vol. 139, p. 105678, 2020, doi: 10.1016/j.cie.2019.01.052.

[7] J. Salvadorinho and L. Teixeira, "Organizational knowledge in the I4.0 using BPMN: A case study," Procedia Comput. Sci., vol. 181, pp. 981–988, 2021, doi: 10.1016/j.procs.2021.01.266.

[8] M. Ciccarelli, A. Papetti, M. Germani, A. Leone, and G. Rescio, "Human work sustainability tool," J. Manuf. Syst., vol. 62, pp. 76–86, 2022, doi: 10.1016/j.jmsy.2021.11.011.

[9] B. Schneider, A. B. Yost, A. Kropp, C. Kind, and H. Lam, "Workforce engagement: What it is, what drives it, and why it matters for organizational performance," J. Organ. Behav., vol. 39, no. 4, pp. 462–480, 2018, doi: 10.1002/job.2244.

[10] M. Molino, C. G. Cortese, and C. Ghislieri, "The promotion of technology acceptance and work engagement in industry 4.0: From personal resources to information and training," Int. J. Environ. Res. Public Health, vol. 17, no. 7, p. 2438, 2020, doi: 10.3390/ijerph17072438.

[11] L. Bonekamp and M. Sure, "Consequences of Industry 4.0 on Human Labour and Work Organisation," J. Bus. Media Psychol., vol. 6, no. 1, pp. 33–40, 2015, [Online]. Available: www.journal-bmp.de.

[12] H. Stern and T. Becker, "Concept and evaluation of a method for the integration of human factors into human-oriented work design in cyber-physical production systems," Sustain., vol. 11, no. 16, p. 4508, 2019, doi: 10.3390/su11164508.

[13] T. Sarı, H. K. Güleş, and B. Yiğitol, "Awareness and readiness of Industry 4.0: The case of Turkish manufacturing industry," Adv. Prod. Eng. Manag., vol. 15, no. 1, pp. 57–68, 2020, doi: 10.14743/APEM2020.1.349.

[14] M. Sony, "Industry 4.0 and lean management: a proposed integration model and research propositions," Prod. Manuf. Res., vol. 6, no. 1, pp. 416–432, 2018, doi: 10.1080/21693277.2018.1540949.

[15] M. Jones, L. Zarzycki, and G. Murray, "Does industry 4.0 pose a challenge for the sme machine builder? A case study and reflection of readiness for a uk sme," in IFIP Advances in Information and Communication Technology, 2019, vol. 530, pp. 183–197, doi: 10.1007/978-3-030-05931-6_17.

[16] C. Zhang, Y. Chen, H. Chen, and D. Chong, "Industry 4.0 and its Implementation: a Review," Inf. Syst. Front., 2021, doi: 10.1007/s10796-021-10153-5.

[17] G. Rana and R. Sharma, "Emerging human resource management practices in Industry 4.0," Strateg. HR Rev., vol. 18, no. 4, pp. 176–181, 2019, doi: 10.1108/shr-01-2019-0003.

[18] K. Piwowar-SULE, "Human resource management in the context of Industry 4.0," Organ. Manag. Sci. Quartely, vol. 2020, no. 49, 2020, doi: 10.29119/1899-6116.2020.49.7.

[19] A. Verma and M. Venkatesan, "HR factors for the successful implementation of Industry 4.0: A systematic literature review," J. Gen. Manag., vol. 47, no. 2, pp. 73–85, 2022, doi: 10.1177/03063070211019141.

[20] B. A. Kadir and O. Broberg, "Human-centered design of work systems in the transition to industry 4.0," Appl. Ergon., vol. 92, p. 103334, 2021, doi: 10.1016/j.apergo.2020.103334.

[21] F. Hecklau, M. Galeitzke, S. Flachs, and H. Kohl, "Holistic approach for human resource management in Industry 4.0," Procedia Cirp, vol. 54, pp. 1–6, 2016, doi: 10.1016/j.procir.2016.05.102.

[22] B. Plawgo and A. Ertman, "Competency Needs of Industry 4.0 Companies," Cent. Eur. Manag. J., vol. 29, no. 4, pp. 172–195, 2021, doi: 10.7206/cemj.2658-0845.64.

[23] G. Urrutia Pereira, W. de Lara Machado, and M. Ziebell de Oliveira, "Organizational learning culture in industry 4.0: relationships with work engagement and turnover intention," Hum. Resour. Dev. Int., pp. 1–21, 2021, doi: 10.1080/13678868.2021.1976020.

[24] S. Rothmann, "Job satisfaction, occupational stress, burnout and work engagement as components of work-related wellbeing," SA J. Ind. Psychol., vol. 34, no. 3, pp. 11–16, 2008, doi: 10.4102/sajip.v34i3.424.

[25] S. Aromaa et al., "User Evaluation of Industry 4.0 Concepts for Worker Engagement," in Advances in Intelligent Systems and Computing, 2019, vol. 876, pp. 34–40, doi: 10.1007/978-3-030-02053-8_6.

[26] E. Lithoxoidou et al., "A novel social gamified collaboration platform enriched with shop-floor data and feedback for the improvement of the productivity, safety and engagement in factories," Comput. Ind. Eng., vol. 139, p. 105691, 2020, doi: 10.1016/j.cie.2019.02.005.

[27] D. Romero, J. Stahre, and M. Taisch, "The Operator 4.0: Towards socially sustainable factories of the future," Computers and Industrial Engineering, vol. 139. Elsevier, p. 106128, 2020, doi: 10.1016/j.cie.2019.106128.

[28] E. Diedericks and S. Rothmann, "Flourishing of information technology professionals: The role of work engagement and job satisfaction," J. Psychol. Africa, vol. 23, no. 2, pp. 225–233, 2013, doi: 10.1080/14330237.2013.10820618.

[29] SoftwareAdvice, "Sobre o Leapsome," 2022. https://www.softwareadvice.pt/software/87623/leapsome (accessed Sep. 08, 2022).

[30] Leapsome, "Why leapsome." https://www.leapsome.com/why-leapsome (accessed Sep. 08, 2022).

[31] Capterra, "BizMerlinHR." https://www.capterra.pt/software/153907/bizmerlin (accessed Sep. 08, 2022).

[32] GetApp, "AG5 Skills Management Software." https://www.getapp.pt/software/2035147/ag5 (accessed Sep. 08, 2022).

[33] G2, "Spidergap Reviews & Product Details." https://www.g2.com/products/spidergap/reviews (accessed Sep. 08, 2022).

[34] Capterra, "Bizneo HR." https://www.capterra.pt/software/184073/bizneo (accessed Sep. 06, 2022).

[35] SoftwareAdvice, "CompetencyCore Software." https://www.softwareadvice.com/hr/competencycore-profile/ (accessed Sep. 07, 2022).

[36] K. Siau and L. Lee, "Are use case and class diagrams complementary in requirements analysis? An experimental study on use case and class diagrams in UML," Requir. Eng., vol. 9, no. 4, pp. 229–237, 2004.

[37] G. Booch, J. Rumbaugh, and I. Jacobson, The Unified Modelling Language User Guide, 2nd Editio. Reading (MA): Addison-Wesley, 2005.

[38] Leapsome, "Development framework & skill matrix." https://www.leapsome.com/product/development-framework (accessed Sep. 02, 2022).

[39] HRSG, "Job Description + Competency Management Software," 2022. https://www.hrsg.ca/hr-management-software (accessed Sep. 03, 2022).

[40] BizMerlinHR, "BizMerlinHR-Skill Matrix." https://www.bizmerlin.com/skill-management/skill-matrix/ (accessed Sep. 08, 2022).

[41] Bizneo, "bizneo-Performance Appraisal Software." https://www.bizneo.com/en/performance-management/ (accessed Sep. 08, 2022).

[42] AG5, "How it works." https://www.ag5.com/how-it-works/ (accessed Sep. 02, 2022).

[43] Philine, "Review analytics," 2022. https://leapsome.zendesk.com/hc/en-us/articles/360007230718-Review-analytics (accessed Sep. 05, 2022).

[44] SpiderGap, "How it works - 5 simple steps to run your first 360° feedback assessment." https://www.spidergap.com/how-it-works (accessed Sep. 01, 2022).

[45] Bizneo, "Avaliação de desempenho por competências." https://www.bizneo.com/pt/avaliacao-desempenho/ (accessed Sep. 02, 2022).

[46] BizMerlin, "Skill Management-What you focus on will grow." https://www.bizmerlin.com/skill-management/ (accessed Sep. 02, 2022).

[47] W. Liu, R. Zhu, and Y. Yang, "I warn you because I like you: Voice behavior, employee identifications, and transformational leadership," Leadersh. Q., vol. 21, no. 1, pp. 189–202, 2010, doi: 10.1016/j.leaqua.2009.10.014.