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Fostering Workforce Engagement in Industry 4.0 Through Development Plans: Concept, Model and Prototype of a Digital Tool

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Abstract

All organizations need results to survive and, technology, because of its possible benefits, becomes something attractive to try to achieve "such" results. However, technology without qualified personnel to use it, does not bring the intended advantage. There is therefore a clear need to develop employees with the aim of being able to fulfill the requirements of the "new" roles. In addition to competence, employee involvement also has positive impacts on organizational results. Career plans, are good engagement promoters and can also promote a more capable workforce. Thus, the main objective of this paper is to propose the concept of a tool that can facilitate the management of the individual development plans. This study was conducted with the following methodology: a literature review, in the first phase, and 9 semi-structured interviews in the second phase. Therefore, a concept of a tool emerged that not only helps people to develop individually, but also the collective. Inherent to this artifact are different concepts such as: data visualization with Lean tools, to help in the decisions and in the visualizations of the goals' status and coaching tools to help the person's positioning and facilitate the detailing of the next steps at the career level. In this way, it is believed that this tool can impact very positively on the workforces of the future, making them more ready for the challenges that the industrial context poses.

Keywords
Digitalization; Data visualization; Smart HR 4.0; Human Factor; Prototype

1. Introduction
The industry 4.0 represents a significant opportunity to improved performance and strategic value creation. These changes present enormous opportunities for innovative businesses, but they may also pose a serious threat to businesses that do not respond quickly and effectively to current changes (Stachová et al. 2019). This growing

technological wave must change the labor market paradigm, employees need to adapt, less skilled professions tend to disappear (Mahlmann et al. 2021). This problem will lead to dismissals or the opportunity to requalify employees. Ligarski et al. (Ligarski et al. 2021) states that surrounding 28% of the employees be afraid that their jobs can be replaced by automated technologies.

This process of converting analog into digital will only be possible if the workforce is prepared to use the technologies. Aromaa et al. (Aromaa et al. 2019) states that to achieve the paradigm shift in operator 4.0, it will not be enough just to introduce technologies. In this paradigm, it is crucial for both organizations and individual workers to train operators. Organizations should invest in training and development programs for their human resources to achieve their objectives (Ninan et al. 2019). This will bring huge challenges to human resource management (HRM), which can be interpreted as the strategic management of the people to achieve organization's goals (Rana & Sharma 2019). Besides the low performance by lack of knowledge, the engagement of people affects the organizational results (Stirpe et al. 2022). The career planning is also important as promoter of engagement (Lartey 2021), so it is important emphasize individual growth.

Another driver of organizational engagement is the visualization of information (Aromaa et al. 2019), in this sense data visualization may make it easier to understand certain issues, facilitating decision making. Dashboards are widely used in data visualization because they include summaries and important indicators.

In this context, the major purpose of this paper is to present a concept of a tool that assists employees' training and allows them to monitor their goals in an agile way. This will allow not only individual management but also team objectives. Thus, the basic premise of this tool is the visualization of information regarding the status of the "curricular plan" of the employees. The tool includes concepts from various areas such as Lean, coaching, business management or neurolinguistic programming. Besides the concept, it also presents the conceptual model using use-cases and class diagrams in UML, as well as some interfaces sketched on the Adobe XD tool. This concept was formulated based on literature review and interviews conducted with employees from two organizations.

The paper is structured as follows, first it starts with a theoretical contextualization, followed by an explanation of the methodology used to reach the objective, showing some quotes from the interviewees. In this same chapter the concept of the tool and the prototype are presented. In the fourth chapter the concept is discussed based on the theoretical introduction and the interviews. In the last chapter the limitations are presented.

2. Theoretical background

2.1 Digitalization, data visualization and KPI's

Industry 4.0 (I4.0) relates to the actual tendency in manufacturing automation technologies, and it primarily refers to technological solutions such as cyber-physical systems (CPS), the Internet of Things (IoT), and cloud computing (Xu et al. 2018). Its goal is to create open and intelligent manufacturing platforms for the application of data in industrial networks, resulting in new business models. Because of this, the new digital paradigm is one of the most significant jumps in global industry and economics (Sima et al. 2020). Some consequences of this paradigm are the raising of the operations' speed or the boosting the efficiency of production systems, that will result in cost savings (Sima et al. 2020). Digitization can make organizations more responsive to customer needs (Dutta et al. 2021). The digitalization process is "converting analog information (such as artefacts, printed texts, drawings and photo images and sounds) into a digital format that computers can understand" (Rodríguez et al. 2020). In this process some challenges can be possible identified such: the lack of digital skills or the difficulty in integrate the organizational structure. Concerning to barriers associated to this transition one can point out some, such as lack tech skills, lack of strategy or security concerns. As a result, investing in technology will not help a firm flourish or progress in its digital transformation, (Machado et al. 2019).

The presenting of data in a graphical style is known as data visualization. The data must be expressed in a systematic and methodical style. Data visualization is important for grouping many data points, understanding data relationships, discussing issues, and deciding where to focus research more quickly. Data visualization may be used to identify areas that require attention or development (Al-Sulaiti et al. 2021; Chawla et al. 2018).

The integration of Internet of Things and Cyber-Physical Systems into industry processes provide a huge amount of information (of data) which will need visualization tools to facilitate the analysis (Mohammad-Amini et al. 2021). The lack of perception of potentially relevant information is one of the reasons for the creation of dashboards. A dashboard is defined as a very modest collection of interrelated important performance measures and underlying performance factors (Pauwels et al. 2009).

An indicator is any statistical result that offers some kind of indication. Depending on its purpose, an indicator might have a broad range of uses, but it should give information that aids the user's analysis and decision-making (Andersson & Thollander 2019). The indicator could also help in identification of wastes and facilitate the improvement of systems (Lindberg et al. 2015).

2.2 Smart HRM 4.0 - The new role of the human factor in the digital world

Even though human resources are critical to a company's success, most Human Resource (HR) departments across sectors today appear to be constrained to operational duties due to inefficient procedures that rely on outdated or obsolete technology. HR procedures like as personnel onboarding, development, and offboarding might be altered by Smart Human Resource 4.0, which is powered by developing technology and new generation workers (Rana & Sharma 2019).

Over the time, the concept of Operator had change. Briefly, Operator 1.0 is referred as humans that perform physical labor. The Operator 2.0 era is a human entity whose employment is aided by certain tools. In the third generation, also known as human-robot cooperation, the humans are involved in cooperative work with robots (Ruppert et al. 2018). The Operator 4.0 is the worker in an I4.0 assembly line, furthermore, that concept comprises the responsibility for cooperating, administering, and monitoring these sophisticated technologies arising from I4.0, while these technologies also assist worker operations. The resulting socio-technical interaction ensures continuous and efficient manufacturing (Margherita & Bua 2021).

Factory work in the 4.0 age will be more qualitatively enhanced and flexible, and new certifications will be required to understand the digital technology that is sweeping workplaces. The introduction of new technology on the shop floor will not be enough to bring the Operator 4.0 paradigm change to fruition. In order to promote continual skill development, work processes must be redesigned, and new methods to training are required (Aromaa et al. 2019).

The decrease of standardized work imposed by the technological context will lead to a reduction in tasks with lower skill levels. Conversely, those requiring higher levels of qualifications will boost (Ahmad et al. 2018; Kucharčíková et al. 2021). A skilled labor force is a facilitating factor for technological innovation (Vereycken et al. 2021). To address the human capital issue, all relevant participants must contribute in employee retraining and upskilling in order to improve their readiness to confront rising unemployment and talent shortages (Ahmad et al. 2018). HRM is also in charge of transforming the culture and establishing favorable conditions for I4.0 implementation (Margherita & Bua 2021). HR practices are regarded as one of the most important ways for businesses to mold their workers' skills, competencies, behaviors, and attitudes in order to accomplish organizational goals (Shamim et al. 2016). Organizations will need to connect their human resource management strategies and practices with Industry 4.0, covering subjects like workforce employment and skill development. In this regard, some digital talents, such as problem-solving, non-routine jobs, and the development of digital outputs, may be required in this Industry 4.0 future (Liboni et al. 2019).

Lartey (Lartey 2021) discusses the importance of career planning, highlighted that this affects positively the engagement. Career planning is defined as the process through which a person recognizes his or her talents, goals and plans the processes and activities necessary to acquire those positions. Employees should take career planning into account while creating goals. Employees anticipate that meeting their objectives year after year will propel them to the next stage of their careers.

3. Goals and Methods

The main goal of this work is to conceptualize a tool that will help the individual development of employees. For that, a literature review was conducted, in a first phase, and in second one, semi-structured interviews were performed with the aim of understanding the importance of this tool in industrial vision and perceived some requirements that can be

added in the solution. After showing the perspective of the interviews, the requirements pool will be shown, as well as the conceptual model and the prototype designed in Adobe XD.

3.1 Interviews perspective

As cited above, the drive of the interviews is understanding the importance of this tool in industrial vision and perceived some requirements that can be added in this solution. In this way, two major objectives were defined: **understand whether employees consider it an added value to have access to a platform, where they can monitor their individual development plans (i)** and **understand the importance of viewing a progress bar, with inputs from supervisors, for the status of the objectives (ii).** The sample of this study was composed by nine collaborators from two companies, belonging to metal-mechanic sector (company A) and chemical sector (company B). The Table 1 details the sample.

Table 1. Details about sample used in the interviews

Interviewee's code	Age	Function	Company
I1	20-30	Project engineer in the commercial department	B
I2	30-40	Engineering department with functions in product development (molds) and safety issues.	B
I3	40-50	Product Architect, manages platform and system issues of device concepts as well as design innovation	A
I4	30-40	Industrial planning department, receives orders that come from the commercial part and plans them in time according to the resources	B
I5	40-50	Quality manager of the plant and responsible for the residential water area. Degree in industrial engineering and management.	A
I6	40-50	Manufacturing Process and Digitalization responsible	A
I7	40-50	Business owner for a product segment	A
I8	50-60	Responsible for the area of industry digitalization and this role for the entire TT division	A
I9	30-40	Purchasing Project Engineer, responsible for bringing the know-how of our suppliers to our development teams	A

After conducting the interviews there are four conclusions that should be highlighted. The first one attaches with the purpose of the tool. As shown by the citations below, the interviewees note that, effectively, can be benefic to the workforce by facilitating the management of goals and progress. Moreover, it is also a promoter of engagement. It is also important to add that the progress bar can make the tool more appealing visible in the declaration.

> (…) it increases people's commitment, by the fact of seeing the little bar growing. (I1)

> (…) I think this would be important, to help with engagement, commitment, and self-motivation. (I2)

> (…) I think it's very interesting and I think it's important. (…) It also helps that the objectives are executed. I think this helps performance, and at the engagement level it can also serve as a guide for the leader and thus help. (I3)

The second conclusion that can be highlighted in these interviews is the importance of the jour fixed for its use in organizations to define objectives (short term and long term) as proved by the sentences below. The jour fixed allows the communication of successes and failures and can promote a better communication to shy people.

> (...) we already have the jour fixed and the feedback to give is fantastic, I'm really enjoying it, we talk about our successes, our failures and from there we can take actions to combat that. Then we have the opportunities (...) Imagine I'm super shy and I'm afraid to speak in public, in this tool we work out actions to get around that and overcome my fear (...) (I4)

> (...) I make jour fixed with each employee that reports directly and indirectly to me. In this jour fixed we have a template where we put the improvement area and what actions we are going to take. (...) (I5)

> (...)There are functional jour fixed and then there are development jour fixed. Functional jour fixed are sometimes for group or individual problem solving. (...) (I6)

The third conclusion are related to the importance of coaching in the organizations to catapult employees to other levels, helping them in their future goals. And the last one, evident in the last declaration presented, note the value of have indicators to measure the progress.

> (…) I had a coaching session with the employees and those sessions are recorded (which area do we want to improve; we define actions and then see the progress). We had several coaching trainings in the company in my leadership. (I7)

> (...) We have a monthly meeting (coaching or status). (...) It can be pure coaching (what I want to improve and how I am going to do that). I did a coaching training in 2014, 2 weeks including weekends. (...) (I8)

> (...) What we perceive is whether there is periodic feedback or not. I don't really like to translate personal development into numbers. (...) Again generalized to the function, I agree with the indicators, individually it has to be more qualitative. (...) (I9)

3.2 Conceptual model

In Table 2 is visible all the requirements achieved. At the level of use cases, the employee has the possibility to enter his successes, the factors that contributed and failures, its frequency at the joint meeting (manager and employee) called jour fixed. In this tool Jour Fixed follow the GROW model from coaching. Briefly, GROW means Goal, Reality, Options and Will. Goal is what do attendees want to accomplish by the end of the meeting. Reality is what is going on right now, and what resources are required, and those people possesses. Options is what can individuals commit to, who will accomplish it, and when will it be completed. Will is what suggestions individuals provide to reach the aim (Wilson, 2020). The requirement mentioned and next ones have the main purpose to follow the GROW model structure in the context of the individual and team objectives.

Table 2. List of the requirements of the system

Entity	Requirements
Collaborator	- Record successes and failures - Insert success factors - Insert frequency of challenges and difficulties - Insert what was done to suppress difficulties - Define performance objectives and metrics to evaluate them - Visualize the current state of the objectives - Define development objectives - Update the objective state - Make SWOT Analysis - Fill Action-Consequence Consideration Matrix - Define micro-objectives - Insert final feedback of jour fixed
Supervisor	- Give collaborators' objective feedback - Accept collaborators' objectives - Visualizes authentizotic climate indicators - Define team objectives - Record team successes and failures - Update team objectives - Visualize the current state of the team objectives - Insert final feedback of team's jour fixed

The possibility of defining performance objectives, more specific goals with a shorter period for achievement. After this collaborator's communication, the system will send a notification to the supervisor with the purpose of the latter being able to accept the goal proposed. In addition to the goals already mentioned, the collaborator can also define another type of objectives, the development ones (more targeted to his/her career development). Within this

functionality the employee must do SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis, fill out the Action-Consequence Consideration Matrix (ACCM) and define the micro-objectives. So, to assist the design of the development objectives, making it easier to analyze them, two matrices - the SWOT and the ACCM - were proposed. SWOT matrix is a business strategy technique used to evaluate how a company compares to its competitors. Internally, "strengths" and "weaknesses" are linked. In terms of the external environment, "opportunity" are facts that may be used to benefit the entity. "Threats," on the other hand, are realities in the larger environment that may cause issues for the business (Teoli et al. 2019). The goal of the ACCM is to assist in decision making by facilitating the perception of what is gained and what is lost in the two possible situations for an action, to do or not to do, thus there are four slots to fill that can facilitate the decision (ChangingMinds n.d.). At the end there will still be the possibility for the contributor to make a short comment about the overall jour fixed.

Also, as far as the employee is concerned, he or she has the possibility to see how the progress is evolving in terms of goals. This requirement will be achievable with the same logic as the PDCA (Plan, Do, Check, Act) cycle, widely used to enhance processes. The first phase is planning, which entails establishing quality goals and keeping track of the process. In the second stage, data is gathered, and issues are identified. The difficulties are investigated and assessed in the third stage. Finally, efforts are taken to eradicate issues and achieve quality goals (Kholif et al. 2018). In this tool, circle logic with one iteration will be used, so the four phases will be, Planned, In Progress, For Feedback, and Completed. In the first, the goals described in the above requirement then with validation from the supervisor are added. In the second, those that are in development are visible, here the collaborator has a progress bar that will drag as the activity is being developed. When this activity is completed, so the percentage of conclusion is 100%, it moves to the third slot, awaiting validation from a superior to move on to the completed phase.

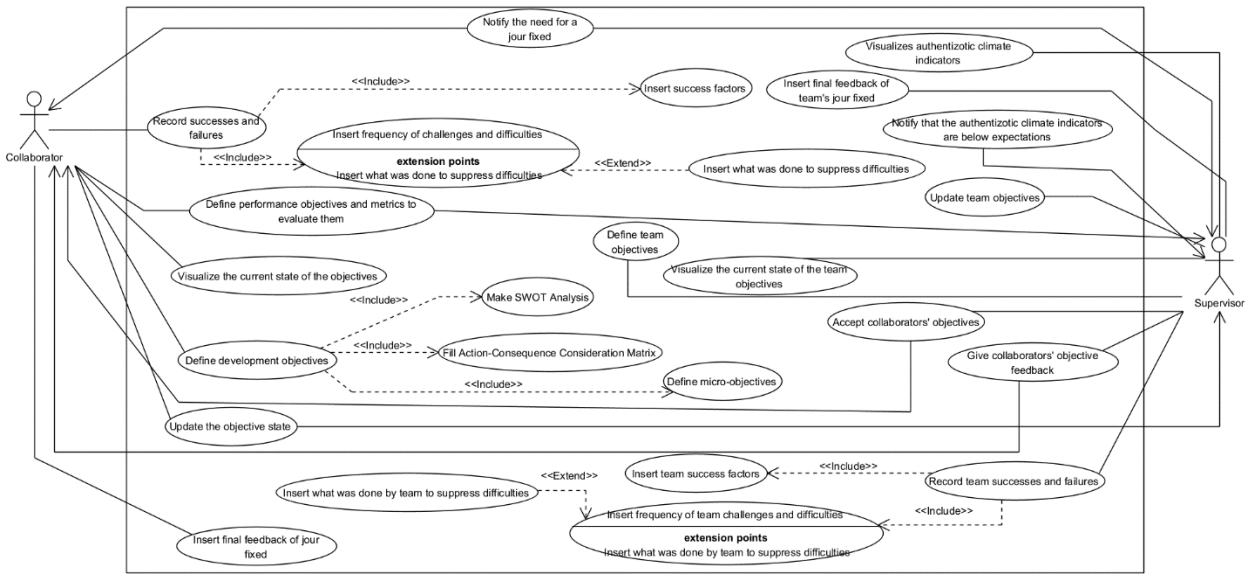


Figure 1. Use-case diagram modeled in UML

As already mentioned, two use cases of the supervisor are about giving feedback on the employees' progress, validating this increase in the percentage realized and consequent validation of the goal completion, and the second one is about accepting the goals proposed by the employees. Regarding indicators, the supervisor actor has the possibility to see indicators concerning the team's authentizotic climate (Rego & Cunha 2005) (which is a specific validated scale of organizational climate and whose answers will be obtained, through pulse surveys in this technological tool, but belonging to another module). At the team level there will also be meetings to see current states and set goals. As far as team goals are concerned, the supervisor can set goals, view progress, and even update the team's progress. Finally, the supervisor will introduce feedback about the team's jour fixed.In addition, the system will notify supervisors and employees about the need for Jour Fixed (a meeting between supervisor and employee to set

goals) and notify the supervisor when the authentizotic climate indicators fall below the expected levels. The Figure 1 shows the use-case diagram.
To store all information a structure of database was created. At the collaborator level and the team level, there are Jour Fixed (*Jour_Fixed*), and it is important to save the date they occur. Other important part is to consider the current situation, so it is essential to save the successes (*Success*) and factors (*Success_Factor*) that contribute to them. In the *Success* class is crucial to record description, already in the *Success_Factor* class, it is important save the name of the factor, when it happens, the frequency and a short comment. In addition to successes, it is important to record challenges (*Challenge*). For frequent challenges it is important to record what has been done to reverse this trend (*Overcoming_challenge*). The attribute of challenge frequency aims not to be specific for each challenge, but rather something more generic looking at all the challenges listed, for this reason this information will be recorded in the *Jour_Fixed* class. In addition to the current paradigm, the goals (*Objective*) are recorded, which may be performance (*Performance_Objective*) or development (*Development_Objective*).

Within a performance goal, it is important to record the goal (a little description), the progress, the completion date, the status (if it is accepted by management or if it is still an unapproved proposal) and the percentage realized. As for development goals, they have a description and have performance objectives, to allow the definition of micro-objectives to achieve the general. Besides the micro-objectives, they also have a SWOT matrix and an ACCM. The first is composed of four classes, strengths (S*trength*), weaknesses (*Weakness*), opportunities (*Opportunity*), and threats (*Threat*). In the case of ACCM this has, in addition to the overall balance attribute, four classes that represent the different constituents of the matrix. The class that represents what will happen if I do? (*happen/do*); the other that represents will happen if I don't? (*happen/dont*) and the last two that denotes what won't happen if I do? (*Not_happen/do*) and what won't happen if I don't? (*Not_happen/dont*). The last component of Jour Fixed is feedback (*Feedback*), to allow you to insert a short comment.
With the major goal of making the database structure clearer, it was modeled in UML and the final model is represented below in Figure 2. It should be noted that the database structure referring to the authentizotic climate indicators is allocated to another module of the technological application and, as such, is not shown here.

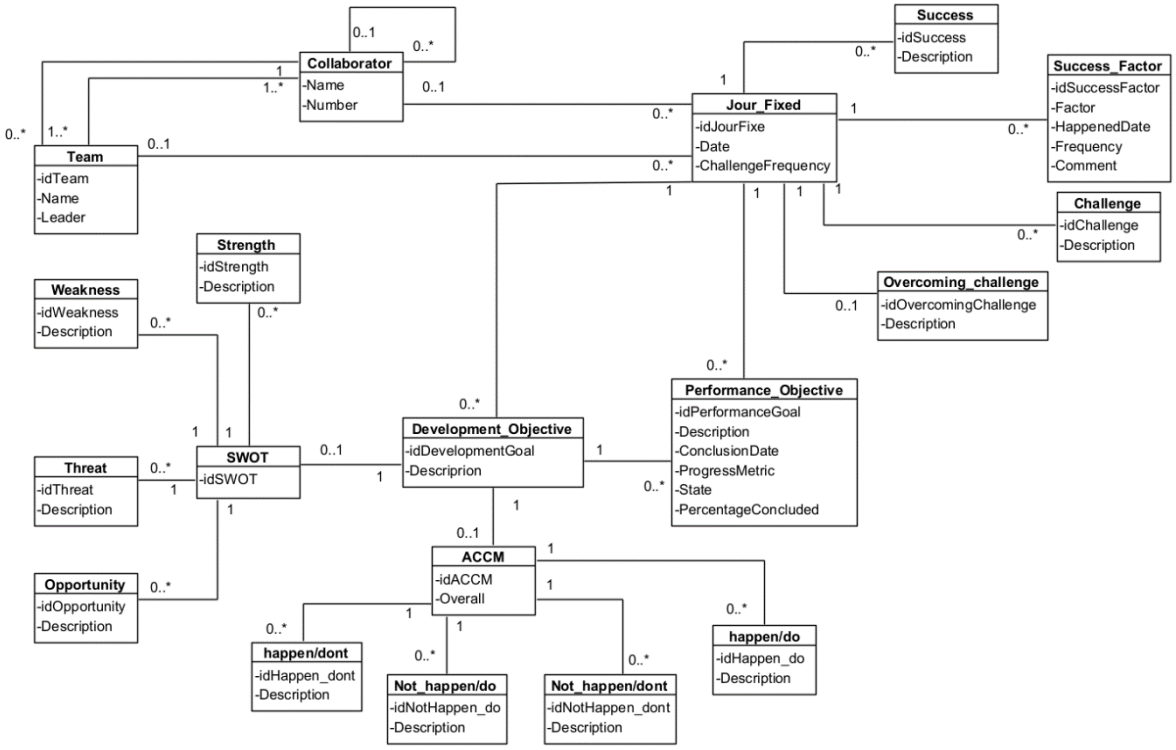


Figure 2.Class diagram modelled in UML

3.3 Prototype

The biggest aim of this section is to represent some interfaces of the prototype and explain some functionalities. The first interface represented (Figure 3) shows an overview of collaborator status in terms of individual development plans. This interface couldn't be compressed in a unique frame because it is possible to scroll in two directions, horizontal and vertical, for this reason four frames were represented showing the four possible combinations to be made with these two axes.

In the left side, a progress bar represents the status of the objectives, in terms of percentage accomplished, the average

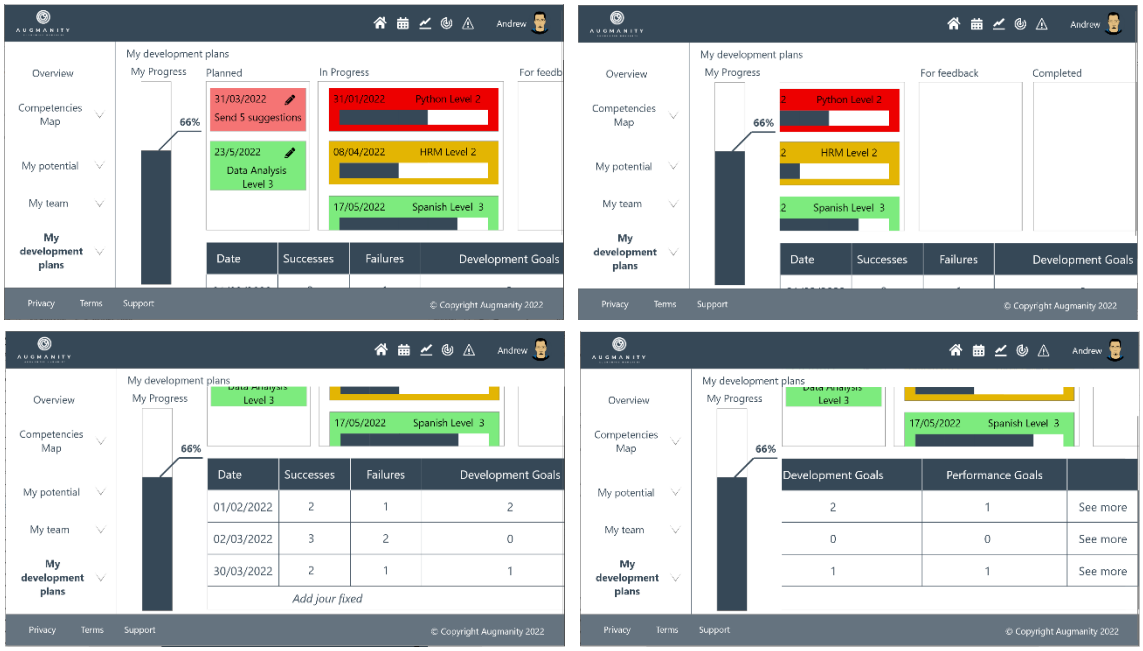


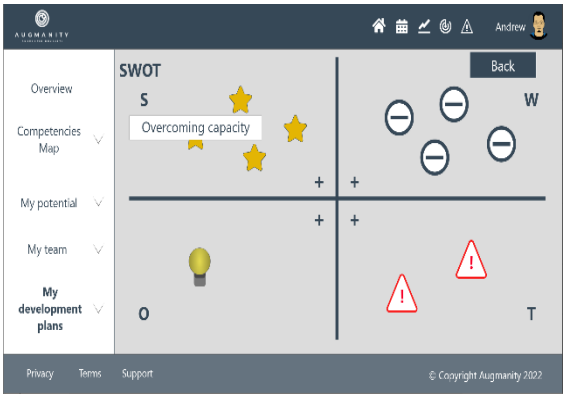
Figure 3. Interface for the overview of development plans

percentage of work done on an objective. Then we have a rolling bar composed of the four phases of the adapted PDCA cycle, as explained in the use cases chapter. Within the first squares, planned and in progress, the various objectives are colored according to the risk of not being achievable in in proposed date. Green means expected to be achieved, yellow means that objective has some risk of not being achievable, light red with high risk of not being achievable, and darker red for failed objectives. At the bottom, another scroll group is visible. This one with data regarding past Jour Fixed, showing the number of successes, the number of failures (challenges and difficulties), number of development goals, number of performance goals, and a button "See more" to find the details of the Jour Fixed. Additionally, there is a button to make new Jour Fixed.

In Figure 4 (a) is visible the interface for the SWOT matrix analysis. This is composed by a group of four slots. Inside individually slot, each symbol indicates an element of that group, with the strengths represented by stars, the weaknesses by prohibition signs, the opportunities by lamps, and finally the threats by danger signs. In addition, in each section there is a more sign to allow the addition of other elements. When the user hovers the mouse on the symbol, the description of that element becomes visible.

Alongside the SWOT interface, it also has four groups for inputting information to answer the four of the ACCM questions talked about above. After doing the individual analysis of the questions, it has a sequence of emojis that represent various emotions about the overall balance of the answers previously given. The interface that represents the description is visible in Figure 4 (b), here like the Figure 3, it is impossible to see all components in one frame, so two frames are shown (one shows the top and one the bottom).

a



b

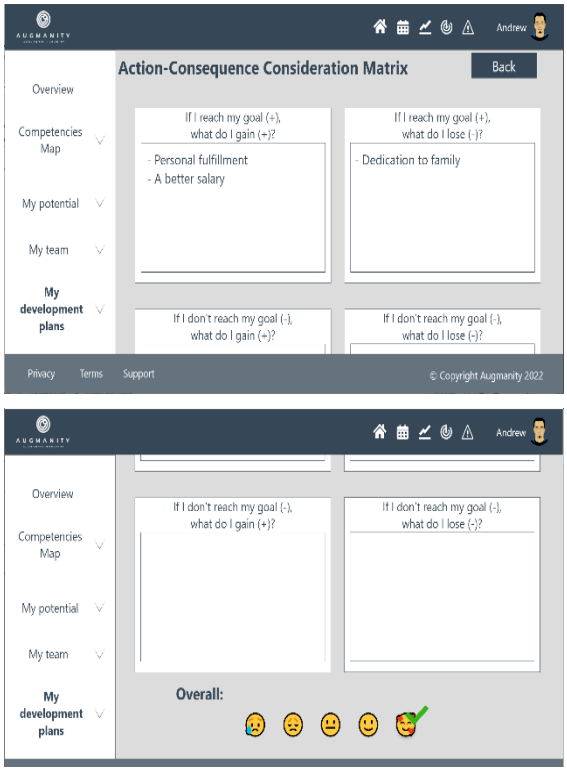


Figure 4. (a) SWOT Matrix interface (b) ACCM interface

In the last interface shown, Figure 5, the various dimensions of the authentizotic climate questionnaires at the top and at the bottom the adapted PDCA cycle (explained above) allocated to the team's objectives are observed. Regarding the four proposed slots, there is a difference in the version of the teams, which present only three. The field "For feedback" in one of the four slots shown in the individual dashboard (Figure) appears to accommodate goals that are completed from the employee's perspective and await validation by the manager. In the case of the team only the bosses change the status of the objectives and for this reason the need for validation disappears, leaving only 3 slots (Planned, In progress and Concluded).

Figure 5. Team development plans interface

5. Conclusions

As far as the theoretical contribution of this work is concerned, it is assumed that this is an area under development and to which more attention needs to be paid. The human being needs to be considered the center of technological integration for it to occur effectively. Thus, through the literature review and the empirical study presented, it is possible to highlight the need to retain talent in the organization by investing in their development (using development plans for this purpose). This second aspect is closely related to the practical contribution of this paper, since a prototype of a tool aligned with the promotion of work engagement is presented. This factor is essential in the digital context, since it ensures the preservation of organizational knowledge and determines the retention of talent, listed in the theoretical contribution.

Within the interviews the Jour Fixed technique was identified and integrated in the technological tool as being advantageous in organizations given its importance in both goal setting and disinhibiting shy employees. Since the Coaching method shows more and more applications in organizations, the GROW model was added to the Jour Fixed to define objectives more clearly (following the SMART steps -specific, measurable, achievable, realistic and timely) (Ogbeiwi, 2017). Allied to this model and to try to facilitate individual analysis, two matrices were considered: SWOT and ACCM. The first matrix analyzes the strengths and weaknesses of the employee together with their external context and the second matrix allows an ecological analysis of the impact of the objectives to be achieved in the short- and long-term life of the employee. It should be noted that this last matrix comes from neurolinguistic programming, widely associated with coaching tools, showing once again the role of coaching in defining and supporting the achievement of objectives.

The concept of data visualization proves to be preponderant in the presented tool, being very much applied in the scope of Industry 4.0. This term is associated with the simplification of the amount of information collected by the gadgets of this paradigm. In what refers to this research, data visualization focuses on facilitating the perception of information (of the status of development goals). In this way, and here associated, is the concept of dashboards, which is also visible in this work. These dashboards were applied both individually and collectively. To facilitate this visualization of information, it was used a Lean tool (philosophy that emphasizes visual management), the PDCA cycle to group the various states of the objectives. In addition, still within the dashboards, we have indicators. The importance of indicators is highlighted both in the literature and in the interview work, showing their relevance, hence their inclusion in this concept. This concept is visible in the individual dashboard but is more visible in the team dashboard with authentizotic climate data.

This study contained essentially two sources of information for the elaboration of the concept, the literature review, and interviews with people from the industrial environment. A limitation of this study is that the interviews were carried out only in two organizations, which can make the interpretations of the interviews biased. Future work will be based on programming the platform and testing it in a real environment, with people from different hierarchical levels, to understand if it meets the purpose, if the formulated requirements are sufficient and the interactivity/usefulness of the interface.

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