JARTE
Journal of Applied Research in Technology & Engineering

6(1): 24-33, 2025
https://doi.org/10.4995/jarte.2025.21755

Received: May 17, 2024; Accepted: October 23, 2024;
Available on line: January 17, 2025; Published: January 31, 2025

EZATECH: DESIGN AND DEVELOPMENT OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES FOR KNOWLEDGE MANAGEMENT THROUGHOUT THE LIFE CYCLE OF WORKERS IN ORGANIZATIONS

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Abstract:

This research presents the results of a project called “EZATECH: Design and development of Artificial Intelligence technologies for knowledge management through the life cycle of workers in organizations”, funded by the Basque Government (BG) (Economic Development, Sustainability and Environment Department). The project started in April 2021 and was completed in December 2023. The aim of the study was to develop an architecture to organize and structure knowledge from educational and industrial companies based on the professional profiles that composed the company and the key competencies necessary for the achievement of their organizational objectives. This objective responds to the challenges derived from the existence of a multitude of approaches that have “significantly hindered” the practical development of Knowledge Management in the business environment: The majority of practical application cases published to date refer to large companies or service companies. Machine Learning, Learning Analytics and People Analytics are the techniques used for the development of the EZATECH architecture, which is a software system to unable Knowledge Management in Educational and Industrial sectors.

Keywords: knowledge management; education; industry; artificial intelligence.

Cite as: Ruiz, M., Igartua, J.I., Retegi, J., Uriondo, A., Sudupe, J.A., Heriz, I., Garate, E. (2025). EZATECH: Design and development of Artificial Intelligence technologies for knowledge management throughout the life cycle of workers in organizations. *J Appl Res Eng Technol & Engineering, 6*(1), 21755. https://doi.org/10.4995/jarte.2025.21755

1. Introduction

The EZATECH project, funded by the Basque Government, focused on the design and development of Artificial Intelligence (AI) technologies for knowledge management throughout the life cycle of workers in organizations. Initiated in April 2021 and completed in December 2023, the primary objective of the project was to develop an architecture that organizes and structures knowledge from educational and industrial companies based on professional profiles and key competencies necessary for achieving organizational objectives.

We can all understand knowledge as awareness or familiarity gained by experience of a fact or situation (Nonaka & Takeuchi, 1995). In the context of organisations, knowledge is understood as the information, skills, experience and expertise or know-how that individuals possess as well as the information and knowledge that is embedded in processes, products or systems which can be used to achieve the organisations goals (Chaithanapat et al., 2022a; Kianto et al., 2019a).

Knowledge management (Davenport & Prusak, 1998)) on the other hand is the process of identifying, capturing, storing, sharing and using knowledge effectively within an organisation to improve performance, foster innovation and gain a competitive advantage. It involves creating a supportive culture, processes and technologies, and behaviours for individuals to continuously develop and share their learning and to make decisions informed by others’ knowledge (Gold et al., 2001; Mäki et al., 2001).

When managed effectively, knowledge can be a source of competitive advantage for organizations – it can improve decision-making, stimulate learning and innovation, help organizations adapt more quickly to changing environments (Chaithanapat et al., 2022b; Ibrahim & Reid, 2009; Kianto et al., 2019b). This makes

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knowledge management relevant because organizations that manage their knowledge assets effectively are likely to increase their efficiency and effectiveness, become more innovative and achieve a sustainable competitive advantage.

For organizations to develop effective knowledge management, they must create an environment that promotes the exchange of knowledge, and also create the systems and processes that enable them to manage that knowledge effectively (Beesley & Cooper, 2008; Dei & van der Walt, 2020; Kazemi & Zafar Allahyari, 2010; Mäki et al., 2001; Raudeliūnienė et al., 2018).

The fundamental premise of knowledge management is that knowledge is not just a static resource that needs to be stored and retrieved, but – in an era of rapid change – a dynamic and evolving asset that can be created, shared, applied, and updated in new ways. Knowledge is also seen as residing not only in individuals, but also in the collective knowledge of project teams, organizations, and communities (Gold et al., 2001; Ibrahim & Reid, 2009).

As a result of organisational dynamics, talent shortages and generational shift, knowledge management in business faces some limitations and difficulties, and this evolution is taking place right at the time that the technologies associated with artificial intelligence are emerging. So, on the one hand, we really should make knowledge management conform to the employee cycle life (Cattermole, 2019; Gladka et al., 2022); and, on the other, we should conform it to the potential offered by information technologies and artificial intelligence.

Knowledge management has to consider how the employee changes his relation with the organisation from the point of entry, which is the attraction and recruitment stage, to the exit point, which is the off-boarding and happy exit stage (Supriya P Inamdar, 2020). These are attraction, recruitment, onboarding, retention, development, offboarding and happy exits. The ELC model (Gladka et al., 2022) helps the organisations to map the micro stages of an employee within the employee life-cycle, and enhance the employee experience to perfect the organisation's employee lifecycle management as well as its knowledge management and human resource development strategies (Gloet & Berrell, 2003).

Related to this, in a systematic review of knowledge management literature, Ferreira & Nobre (2022) identified every dimension of human resource developments (individual, professional, technological, organisational, social, economic, environmental) that were impacted by knowledge management. The authors suggested that knowledge management mostly contributed to individual and professional human resource developments. Furthermore, they determined that creation and sharing of knowledge were the most relevant knowledge management processes. The authors indicated that human resource development of technological, organisational and social dimensions could be improved by managers by paying more attention to knowledge management.

Other studies have examined particular aspects of KM and ELC: how to design and implement knowledge management-infused onboarding processes to enhance the onboarding and learning of employees, for example, (eg, Bauer et al., 2007; Kammeyer-Mueller et al., 2005); how to create a culture of knowledge sharing that facilitates employee collaboration and innovation (eg, Cabrera & Cabrera, 2005; Lin, 2007); how to use knowledge management tools and techniques for employee development and career planning (eg, Slotte et al., 2004); and how to manage departing employees' knowledge and transfer their valuable knowledge to others that remain with the organisation (eg, DeLong, 2007; 2009; Massingham, 2018).

On the one hand, from the perspective of what affordances information technologies and AI in particular hold for knowledge management, two clear-cut humanistic literatures point to a divergence: one focused on how AI can serve as a facilitator or amplifier of the practice and outcomes of knowledge management; and another that focuses on how knowledge management can, in its turn, function as an enabler or facilitator of the development and implementation of AI (Jarrahi et al., 2023).

The first strand examines how AI techniques and tools, such as machine learning, natural language processing, expert systems and neural networks, can help organizations identify, capture, share and apply knowledge more effectively and efficiently (Jarrahi et al., 2023; Sundaresan & Zhang, 2022; Taherdoost & Madanchian, 2023). For example, AI can help automate the extraction of knowledge from various sources, such as documents, databases or social networks; improve knowledge representation and storage, such as the use of ontologies, semantic networks or knowledge graphs; enable knowledge retrieval and recommendation, such as the use of search engines, chat-bots or recommender systems; and support knowledge creation and innovation, such as the use of data mining, text mining or generative models (Aljapurkar et al., 2022; Ashwini & Patil, 2018; Jarrahi et al., 2023; Taherdoost & Madanchian, 2023).

However, despite the potentialities for organizations of a knowledge management based on these two perspectives (ELC) and (AI), there are few practical case studies of application, and the contrast of the interest of this approach for organizations. This article seeks to address these approaches and provide more information and best practices for managers and practitioners who want to leverage the synergies between knowledge management and AI through the employee lifecycle (ELC).

EZATECH project is presented by a consortium composed of the following entities:

- AXULAR LIZEOA S.COOP., as project leader, a school specialized in the development of innovative pedagogical projects with a high technological component.
- JMA ALEJANDRO ALTUNA S.L.U., a people-focused company, leading the global locksmith industry.
- Their commitment lies in providing expertise, technology, and innovation to create profitable opportunities in the market of opening solutions.

- ELKARMEDIA S.L., theya re focused on customizable software development and technological and digital needs of companies from different sectors.
- MONDRAGON GOI ESKOLA POLITEKNIKOA J.M.A. S.COOP., the engineering faculty of Mondragon Unibertsitatea, a practical university immersed in entrepreneurial reality. A university that offers a training and learning experience that combines the educational and research needs of companies, organisations, and society.
- ISEA S.COOP., as a private R&D centre and member of the Basque Science and Technology Networks, specialised in launching new business initiatives related Management.

2. Objectives

The primary objective of the EZATECH project was to develop an architecture that organizes and structures knowledge based on professional profiles and key competencies necessary for the achievement of organizational objectives. This objective addresses the challenges posed by the multitude of approaches that have hindered the practical development of Knowledge Management in the business environment, particularly for small and medium-sized enterprises.

EZATECH aims to leverage AI technologies to enhance knowledge management throughout the ELC. AI techniques such as machine learning, natural language processing, and expert systems are used to identify, capture, share, and apply knowledge more effectively and efficiently.

The EZATECH project also aimed to explore the development of a support system for organizing and structuring both explicit and tacit knowledge (Nonaka & Takeuchi, 1995). within educational and industrial companies. Explicit knowledge refers to information that can be easily articulated, codified, and stored, such as documents, databases, and manuals. In contrast, tacit knowledge is personal, context-specific, and more challenging to formalize, encompassing skills, experiences, and insights owned by individuals.

3. Methods

The main objective of EZATECH was to develop and design an innovative system based on Artificial Intelligence technologies for Knowledge Management associated with the life cycle of people in industrial companies (covering recruitment, training and generational change).

For the development of this project there were three separate phases: i) technological research and design of the global solution, ii) application of research to the development of global solution tools, and iii) integration and validation.

During the first phase, the methodological and technological foundations of the project were laid by developing exhaustive research on the set of technologies involved in the development of the EZATECH tool.

3.1. PHASE I

Likewise, all aspects related to the execution of the project were designed. This phase was intended to ensure that the objectives set out at the beginning were covered, designing an execution plan that would guarantee the overall success of the project.

Finally, during this phase the specifications of the global solution as well as of each of the tools to be developed were defined. In addition, a first architecture proposal for the solution was generated.

3.2. PHASE II

During this phase, the knowledge acquired in the research phase was applied and the technological modules that were to make up the EZATECH solution were developed and implemented.

3.3. PHASE III

In this last phase, the tools developed during the previous phase were integrated, resulting in a fully functional prototype. This prototype was validated in the scenarios described during Phase I, in order to measure its effectiveness and correct its possible deficiencies. At the same time, it will be disseminated and prepared for exploitation.

The work packages (WP) associated with each of these development phases were seven.

Table 1: Work Package 1.

WP1. ANALYSIS AND SPECIFICATIONS
Analysis of Technologies, related to the Project. • Analysis and identification of Best Practices and experiences of international success. • Share and homogenize the consortium's Knowledge taking as reference the scientific-technological bases of departure for the development of the project. • Technology validation.
Analysis of needs in the educational and industrial field of knowledge management needs throughout the Employee Lifecycle Management (ELM). • State of the art in relation to key Knowledge Management activities throughout the ELM. • Analysis and identification of Best Practices and experiences of international success. • Share and homogenize Knowledge on key Knowledge Management activities throughout the ELM among project partners. • Validation of activities and processes related to Knowledge Management throughout the ELM, in relation to the needs of users.

Firstly, an analysis of the existing technologies related to the project was made. In this way, the identification of best practices and experiences of international success was arranged. Moreover, the sharing and homogenisation of common knowledge in the Consortium was necessary to define the scientific-technological bases for beginning to develop the project.

Table 2: Work Package 2.

WP2. DEVELOPMENT OF THE SYSTEM COMPONENTS
T2.1. Smart Repository • Review and Adoption of existing technology regarding the development of learning object repositories. • Generation of the functional specifications of the Repository. • Design and Development of a repository of Contents and Learning Objects • Integration of components, development of interoperability gateways with LMS systems.
T2.2. Interaction Interfaces Based on the specifications defined for users, the interfaces for accessing the learning content, and the visualization and interaction with them, will be developed.
T2.3. Middleware system and connector to LMS Throughout this task, low-level protocols will be designed that make data transmission possible between user interactions and the corresponding LMS (Learning Management System).
T2.4. Control panel Development of a Dashboard, in which it is easy to visualize the impact indicators to be measured in the end, etc.

The objective of this work package was to build the modules that will support the operation of the Comprehensive Learning System.

At the system support level, the following specific components have been identified:

1. Smart Repository
2. Interaction Interfaces
3. Middleware system and Connector to the Learning Management System (LMS).

Table 3: Work Package 3.

WP3. COMPONENT DEVELOPMENT INTEGRATION IN THE WORKPLACE
T3.1. Design of the management system for the selection process and the information of each candidate and its corresponding database.
T3.2 Development of the Candidate Filtering Tool (establishment of parameters, keywords, etc.)
T3.3 Development of algorithms for automatic analysis of candidate data.
T3.4 Development of Machine Learning Algorithms for the identification of connections and correlation of candidate data.
T3.5 Development of the Hand Panel for managing the selection process.
T3.6 Compilation and integration of 360º content, recordings of the children's real learning environments (classrooms), for integration into immersive learning environments.
T3.7 Generation of immersive environments in the workplace. In the case of ALEJANDRO ALTUNA, the immersion will focus on knowledge of the job.

The objective of this work package was the design and development of specific technological tools and solutions for the first component of "integration in the workplace". The development of learning itineraries, data storage and integration of content into the platform.

Table 4: Work Package 4.

WP4. DEVELOPMENT OF "TRAINING OF PROFESSIONALS WITHIN THE ORGANIZATION" MODULE
T4.1 Definition of target behavior of the Intelligent Tutor The Intelligent Tutor will act as a mentor of the personal organization assigned to each professional, so that, based on the needs that are automatically detected by the professional and based on the knowledge of the system itself, he adapts or creates new ones. training itineraries and adapted talent management.
T4.2 Tutor Module Development: This Tutor Module will define and apply a development strategy for each of the professionals. It will be the module that, based on the processing of different sources of information, adapts or creates new training itineraries tailored to each of the profiles. Basically it will work based on the following information: a) Talent development protocols, which will be stored in a database. b) Training itinerary planner. c) Professional Profile Analyzer for itinerary recommendation. It will integrate knowledge about the development method, teaching techniques and the professional's level of knowledge.
T4.3 Development of Training Monitoring Module: This module will aim to diagnose the professional and model it for adequate feedback of the system.

The objective of this work package is the design and development of specific technological tools and solutions associated with the management component of the training of professionals within the organization.

Table 5: Work Package 5.

WP5. DEVELOPMENT OF "KNOWLEDGE RETENTION AFTER THE GENERATIONAL RELEASE" MODULE
T5.1 Information Search and Classification Tool: At this stage it is important to identify, systematize and standardize the treatment that must be given to business information.
T5.2: Business Intelligence. It is a strategic factor for an organization, generating a competitive advantage, since it provides privileged information to respond to the organization's problems.
T5.3 Tool for transforming information into knowledge: Automatically provide information to the employee based on their user profile, the user does not have to worry about personally searching for said information and can focus on other tasks.
T5.4 Corporate Knowledge Portal: Entry point to a set of company services and information, which are accessed in a simple, unified and secure way.
T5.5 Knowledge map

The objective of this work package was the design and development of specific technological tools and solutions for the management and retention of knowledge in the organization.

Table 6: Work Package 6.

WP6. INTEGRATION OF SOLUTIONS AND SERVICES
T6.1 Integration of the Component “Integration in the workplace”
• Web module for defining candidate skills
• Control panel module
• Candidate search module
• Database Module
• AR and VR for integration into the workplace
T6.2 Integration of the Component “Training of professionals within the organization”
• General Information Module
• New personnel incorporation module
• Work environment measurement module
• Module of skills developed by profile
• Organization strategy definition module
T6.3 Integration of the Component “Knowledge retention after generational change”
• Needs detection module
• Competency Profile Module
• Evaluation module

Each of the tools developed in the Base Platform will be integrated into a single system.

The result of this integration will be the specific products of each of the components, capable of being marketed independently.

Table 7: Work Package 7.

WP7. VALIDATION AND EVALUATION
T7.1. Determination of the validation and evaluation method
• Determination of the validation method of the developments and the validation areas (usability, etc.)
• Specification of the way to perform the test, the criteria of the elements to be validated
• Determination of the method of evaluating the effectiveness of the systems
T7.2. Pilot development plan
• Determination of the pilot development plan
• Monitoring and coordination of pilots
T7.3. Development of the Pilots of the developed Modules
Generation of knowledge domains and content associated with each system and pilot tests with end users of each of the developed modules.
T7.4. Development of EZATECH System Integrity Pilots
• Pilot test of System integrity
• Evaluation of system interoperability and distributed architecture
• Validation of Results
• Final prototype where the results obtained in the pilot test will be incorporated
T7.5. Validation of the Effectiveness and Usability of the System
• Specification of the way to perform the test, the criteria of the elements to be validated
• Evaluation of the results of the pilot tests and comparison with a parallel test with traditional supports.
T7.6. Development and validation of the Platform with services
• Specification of the way to perform the test, the criteria of the elements to be validated
• Evaluation of the Platform services
• Validation of the effectiveness of the Platform.

The objective of this final work package was to evaluate the correct functioning of the tools, modules and systems developed throughout the EZATECH project. The pilot was arranged in both AXULAR LIZEOA educational centre and JMA ALEJANDRO ALTUNA. They bring to the research the real perspective of the users. They took part in three different rounds. In the first one they identified improvements related to the contents to be included in the software. In the second, they were focused on facts related to the framework, and lastly, workers from different positions used the tool for evaluation.

Given the nature of the project, it was especially important that small groups of users participate in the evaluations and report feedback about the usability of the system to ensure effectiveness.

4. Results

EZATECH technological solution for Knowledge Management is composed by 5 main modules: i) company, ii) departments, iii) workplaces, iv) workers, and v) competences.

4.1. Company

The main module of the tool presents the general view when users could operate with two principal tasks : i) “departments” where the general “knowledge tree” is accessible, and ii) “meetings” where the general action planning of each “Knowledge Manager” could be shown.

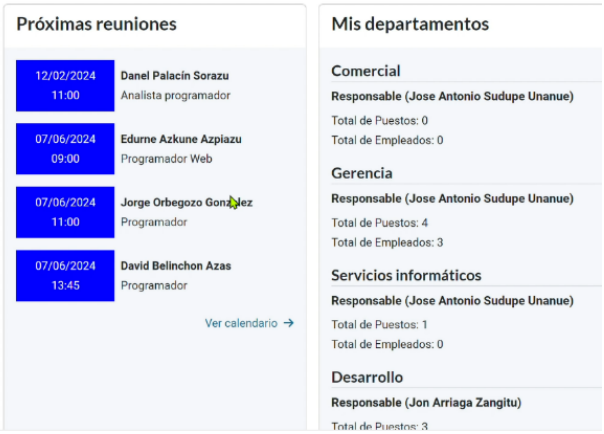

Figure 1: General view of EZATECH tool.

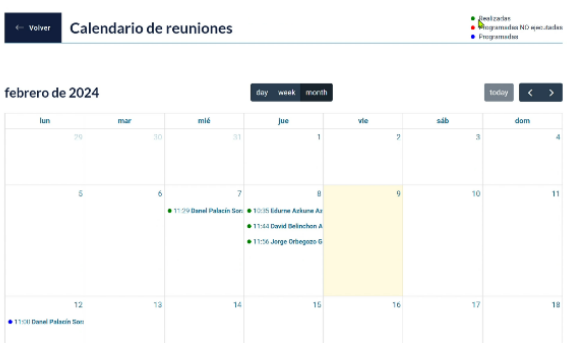

Figure 2: General calendar of the action planning of “Knowledge Managers” in the company.

Figure 3: Different modules of EZATECH tool.

4.2. Departments

Departments is the second level in EZATECH tool. In this module we can identify the different departments of the company included in the "Knowledge Management" process and their connection to Job Position.

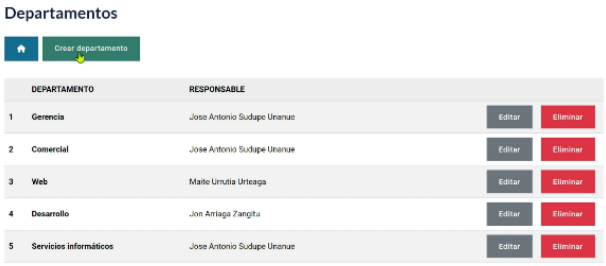

Figure 4: Departments and responsible person of each department.

Figure 5: Example of the General View Knowledge Manager could have of their work places.

4.3. Work Places

Work Places are the third level in EZATECH tool.

Each work place must be connected to a department, and at the same time it is defined by some competences, and the evaluation of the level of knowledge of each competence.

Wok places are described by the role each person with that specific job position has, and details related to those job functions, i.e. academic qualifications.

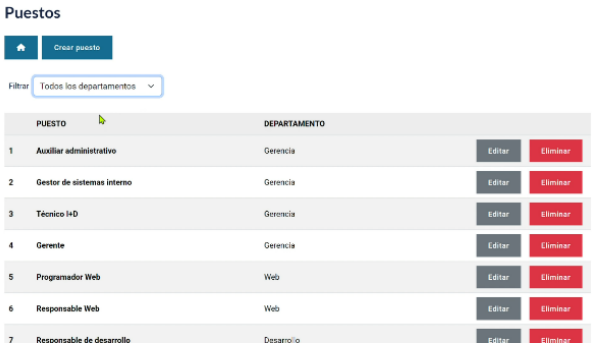

Figure 6. Description of *work places.*

Figure 7: Evaluation of the competences related to work places (definition, indicator, level of achievement).

4.4. Workers

In this level, profiles of the workers involved in the process of "Knowledge Management" of the company are included.

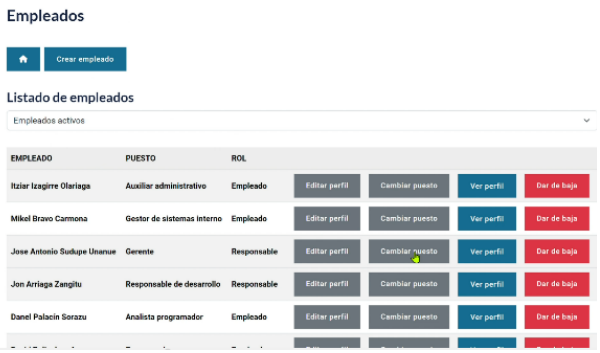

Figure 8: Person, workplace, role, and data related to specific profile of the worker.

4.5. Competences

This is the most specific level of the analysis, each competence is evaluated by the manager. For an efficient evaluation, job functions are described by the label, the competences linked to that lable, the indicator with the grade of evolution in the learning of the specific competence, and the state described by the colour.

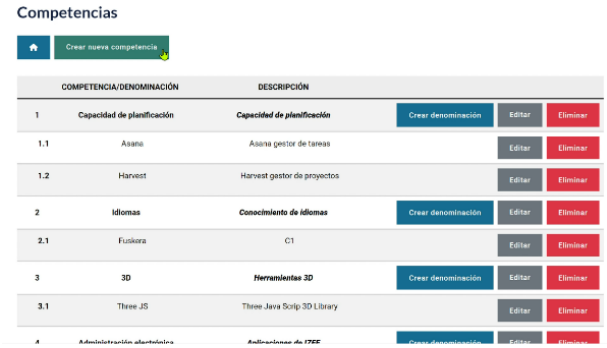

Figure 9: Example of the list of competences to be evaluated by *Knolwedge Managers.*

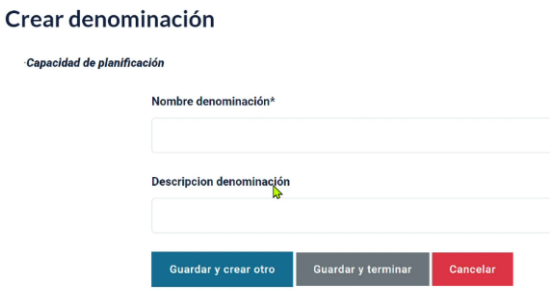

Figure 10: Procedure to creare a new competence.

Figure 11: Worker and her profile description linked to the competences to be evaluated.

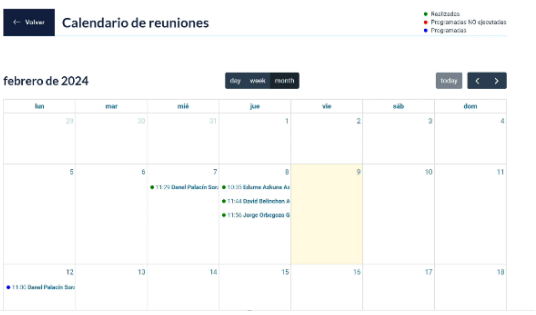

Figure 12: Worker and her profile description linked to the competences to be evaluated.

Figure 13: Comments inside the workers to be evaluated about his learning advances.

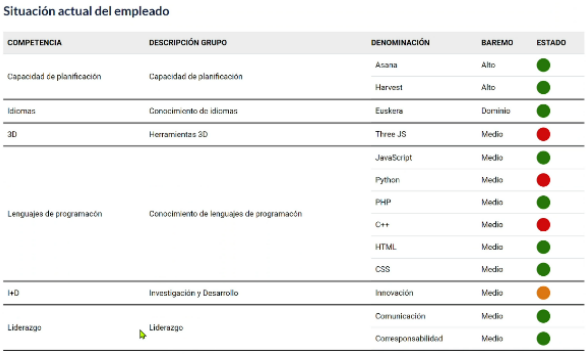

Figure 14: General view of the evaluation (competence, description, indicator, grade of achievement and colour alert).

Figure 15: General view connected to the a specific job function.

Figure 16: Action planning connected to a Knowledge Manager and the workers he needs to evaluate.

5. Discussion

The EZATECH project, funded by the Basque Government, aimed to design and develop AI technologies for knowledge management throughout the life cycle of workers in organizations.

This architecture is based on an Intelligent Tutor for the acquisition of needed competences by the professionals from the company that took part in the pilot. These competences are managed, controlled, and measured through personalized learning itineraries. Around the Tutor are the four different modules that compose our technological solution: i) general information, ii) onboarding for new workers, iii) module for the measurement of work environment, and iv) module for developed abilities for each profile.

The architecture developed in this project is designed to enhance knowledge management by leveraging AI technologies. It consists of several key components that work together to identify, capture, and utilize explicit and tacit knowledge within the organization. These components include a smart repository, interaction interfaces, a middleware system, a control panel, a candidate filtering tool, an intelligent tutor module, training monitoring modules, and knowledge retention tools. The final result is an architecture that enables the automatization of knowledge management inside the company based on departments, job position description, level of achievement, and following steps.

The smart repository is responsible for storing and managing learning objects and content, integrating with Learning Management Systems (LMS) to ensure seamless access and interoperability. Interaction interfaces allow users to access and interact with the learning content, enhancing usability and engagement. The middleware system facilitates data transmission between user interactions and the LMS, ensuring smooth communication and data flow. The control panel visualizes impact indicators and provides an overview of the system's performance. The candidate filtering tool uses algorithms to analyze candidate data and identify connections and correlations, aiding in the recruitment process. The intelligent tutor module acts as a mentor for professionals, adapting or creating new training itineraries based on detected needs and system knowledge. The training monitoring module diagnoses and models professionals for adequate feedback and continuous improvement. Finally, the knowledge retention tools include tools for information search and classification, business intelligence, and transforming information into knowledge.

The integration of AI technologies into the system brings several advantages. AI techniques such as machine learning and natural language processing help automate the extraction of knowledge from various sources, making it easier to identify valuable insights. The smart repository and interaction interfaces ensure that knowledge is captured and stored efficiently, reducing the risk of knowledge loss. The control panel and intelligent tutor module enable organizations to utilize knowledge for training and development, leading to better decision-making and innovation. AI-powered tools can provide personalized learning paths and development plans based on individual needs and competencies, enhancing employee growth and performance. Additionally, AI technologies allow the system to scale and adapt to changing organizational needs and environments, ensuring its long-term relevance and effectiveness.

Despite the potential benefits, implementing such an architecture can be complex and may require significant resources and expertise. The system needs to be adaptable to changes in the environment and user demands. Ensuring data privacy and security is crucial, especially when dealing with sensitive information. Future research could focus on developing evaluation patterns originating from different professional evaluation profiles within the organization, integrating ChatBots fed from the documentary architecture to ensure knowledge management in terms of the response process, and enhancing automation through advanced machine learning networks.

In conclusion, the EZATECH project has successfully developed an architecture that leverages AI technologies to enhance knowledge management throughout the employee lifecycle. The system's key components work together to identify, capture, and utilize knowledge effectively, providing several advantages such as improved decision-making, innovation, and personalized learning paths. However, the implementation of such a system presents challenges that need to be addressed, including complexity, adaptability, and data privacy. Future research directions include further development of evaluation patterns, integration of ChatBots, and enhancement of automation through machine learning networks.

6. Acknowledgements

We would like to thank the Basque Government for their support in the development of this project. Special thanks to the Economic Development, Sustainability and Environment Department.

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