

EDUCATIONAL AND DIDACTIC TOOLS DEVELOPMENT – MODERN CONSTRUCTION MANAGEMENT PROJECTS

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Purpose: This paper aims to explore the dynamic evolution of the European construction industry in recent years, focusing on diverse domains such as environmental protection, occupational safety and health (OSH), data protection, HR, career development, waste management, urban mining, infrastructure maintenance, and modern information technologies. It emphasizes the evolving role of the project manager in construction, who now integrates knowledge with IT and management skills, and the necessity for contemporary managerial education to prepare construction staff comprehensively in these areas.

Design/Methodology/Approach: The research employs a multi-faceted approach, analyzing the latest educational materials developed under the Erasmus+ CLOEMC VI, 3Msite and the ID4Ex projects. It examines educational strategies, including the creation and implementation of new teaching methods, and evaluates the qualifications and educational pathways of construction managers in 14 countries. The study also considers the impact of language skills and worker mobility across the EU.

Findings: The study reveals the critical need for multidisciplinary collaboration in the construction industry, especially in the renovation of historic buildings. It underscores the importance of involving diverse professionals such as archaeologists, surveyors, engineers, and architects. The research identifies the increasing relevance of ecological, sociological, technological, and health considerations in managing modern, multi-ethnic, and multi-cultural construction sites.

Research Limitations/Implications: Future research should expand on the interdisciplinary collaboration models and explore the long-term impacts of these educational approaches on construction project success. The study's scope is limited to Europe and might not fully represent global construction industry trends.

Practical Implications: The findings suggest modifications in construction management practices, emphasizing the need for updated educational programs and methodologies. These changes are expected to enhance project efficiency, safety, and sustainability.

Social Implications: The research highlights the significant social impact of incorporating comprehensive training in the construction industry, which can lead to improved public safety, better quality of life, and enhanced environmental stewardship.

Originality/Value: This paper offers a novel insight into the intersection of construction management, education, and technology in the European context. It provides valuable guidelines for educators, policymakers, and construction industry professionals, addressing the urgent need for a holistic approach in construction management education.

Keywords: project and construction management, modern education of managers, pedagogical and didactic tools, fuzzy logic, EU projects.

Category of the paper: viewpoint, research paper.

1. Introduction

The European construction industry has been developing exceptionally intensively in recent years. These changes are observed in various areas, such as: environmental protection, raising employee awareness of safety and health issues on construction sites (OSH), data protection, human resources management and the career path of particularly talented personnel, waste management, mining urban, infrastructure maintenance management and the use of modern information technologies. In order to properly prepare construction staff in these fields, an appropriate approach to education and teaching methods should be implemented. The authors decided to present to interested parties Erasmus+ projects related to education of construction managers development:

- a set of seven latest manuals that will be prepared during the implementation of the sixth stage of the Erasmus+ CLOEMC project (VI),
- assumptions of the use of Immersive Design in the education of specialists in the renovation of historic buildings (ID4EX),
- the most important aspects relating to the management of modern, multi-ethnic, and multi-cultural construction with aspects of ecology, sociology, technology, and health on the construction site, as part of the Erasmus+ 3Msite project methodology.

2. Erasmus+ CLOEMC VI Project

2.1. Project's objectives

The project discussed in this article is based on the results of Erasmus+ CLOEMC VI, titled: "COMMON LEARNING OUTCOMES FOR EUROPEAN MANAGERS IN CONSTRUCTION, PART VI" - number 2022-1-PL01-KA220-HED-000087357, is implemented from December 1, 2022, up to May 31, 2025. The project's logo and QR code are shown in Fig. 1. The Phase V CLOEMC project (realized in years 2019-2022) closely

related to the issue of continuous improvement and unification of the system of education, certification, assessment, and comparison of managerial qualifications of employees related to the construction industry in the European Community countries, in accordance with the assumptions of the EU Directive 89/48/EEC on regulated professions. It also contributed to increasing mobility on the European labor market and effective exchange of knowledge and experience between experts from different countries. Thanks to the CLOEMC V project, the collection of the Construction Manager's Library was expanded by seven textbooks namely: M26: Mentoring and coaching in construction, M27: Archaeological and heritage protection aspects in construction, M28: Breakthrough innovations in construction management, M29: Modern circular economy in construction, M30: Affordable housing, M31: Social sustainability in construction, M32: Crisis management of the COVID-19 epidemic in the construction industry.



Figure 1. Logo and QR of the CLOEMC VI project.

Source: Own source.

The CLOEMC VI project - in response to the needs of the modern world - will support the development of high-quality vocational education and training with an emphasis on work-based learning, providing the best approach to education and learning, combined with the needs of people working in the European labor market in the construction sector. It will also contribute to increasing the innovative managerial competences of engineers, construction managers and government officials, enabling multicultural exchange of knowledge and best practices between EU countries. Moreover, it will ensure the implementation of modern and unified mechanisms for the recognition, assessment, certification, and compensation of qualifications of all employees employed in the construction industry. The project will also enable the improvement of language skills, as the planned textbooks will be prepared in Polish, English, Turkish, Italian and German versions (with an extended summary in Icelandic). However, the international Partnership will not only strengthen cooperation between the industry and the educational sector but will also consolidate the mobility of construction staff in the global and multicultural environment of construction companies throughout the EU.

2.2. Project questionnaire and beneficiaries' opinions

Project team decided to check how the suggested conspectuses of the manuals fulfill the needs of the managers from construction industry. Conspectuses could be found here: <https://www.cloemcvi.il.pw.edu.pl/wp-content/uploads/2023/08/WP3-conspectuses-final-draft-29082023.pdf>.

Conspectuses were tested in the series of multiplier events and during other dissemination actions. Questionnaire 1 is available at:

https://www.cloemcvi.il.pw.edu.pl/?page_id=1018&lang=en;

and was distributed in paper version as well. Please feel free to answer the questions. Testing of target groups in country of venue for better engagement of stakeholders and target groups and share know how in the subjects foreseen for the manuals. Results of the survey were the base for establishing detailed content related contents of 7 manuals. Results (average scores) from nearly 200 responses from Poland, Italy, Turkey, Ireland, and Germany are presented in table 1.

Table 1.

Assessment of manuals according to the questionnaire no 1 (grades from 1 to 5)

Manual title	Final grade (avg. score)
M33: DESIGN AND EXECUTION OF FACADES FOR CONSTRUCTION MANAGERS	4,39
M34: DIGITAL TWIN IN CONSTRUCTION	4,49
M35: URBAN MINING IN CONSTRUCTION	4,32
M36: ENVIRONMENTAL IMPACTS OF EARTHQUAKES AND MINING FOR CONSTRUCTIONS MANAGERS	4,40
M37: LOGISTICS IN CONSTRUCTION	4,61
M38: GREEN TECHNOLOGY FOR CONSTRUCTION MANAGERS	4,47
M39: TALENT MANAGEMENT AND FUTURE COMPETENCES OF CONSTRUCTION MANAGERS	4,29
Is the presented scope of knowledge important for Building Managers for qualifications recognition?	4,40
Are the manuals properly responding to the industry needs in respect of the managerial knowledge?	4,37
Will you participate (or delegate the personnel) in the Postgraduate Studies based on the created manuals?	4,28

Source: CLOEMC VI project working materials, 2023.

2.3. Project results

As part of the CLOEMC VI project, seven more manuals (M) for the Construction Manager's Library (CML) will be created, namely:

- M33: Design and construction of facades in construction - this manual focuses on issues related to the design, implementation of innovative solutions and coordination of efficient and safe (Fig. 2) execution of sustainable and environmentally responsive building facades on the EU market, in particular in urban space. The Manual will also enable interested parties to understand and recognize the most important legal regulations related to the construction of facades in the European Community countries.

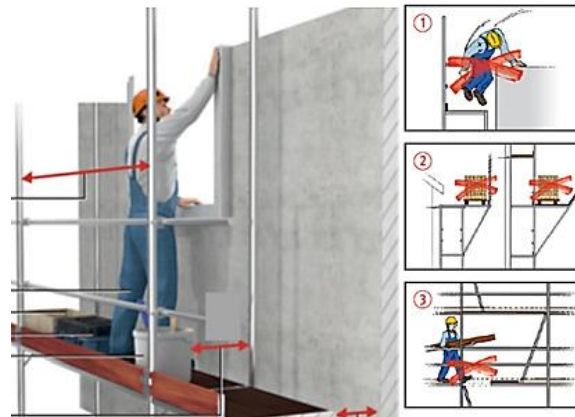


Figure 2. Efficient and safe construction of building facades on the EU construction market.

Source: BG BAU.

- M34: Digital twins in construction - the textbook covers the aspect of optimizing and modernizing the everyday work of construction managers by using available modern and innovative digital tools, including: such as: scanning, use of drones, GIS, BIM, IoT, Augmented and Mix Reality (augmented and mixed reality - Fig. 3).

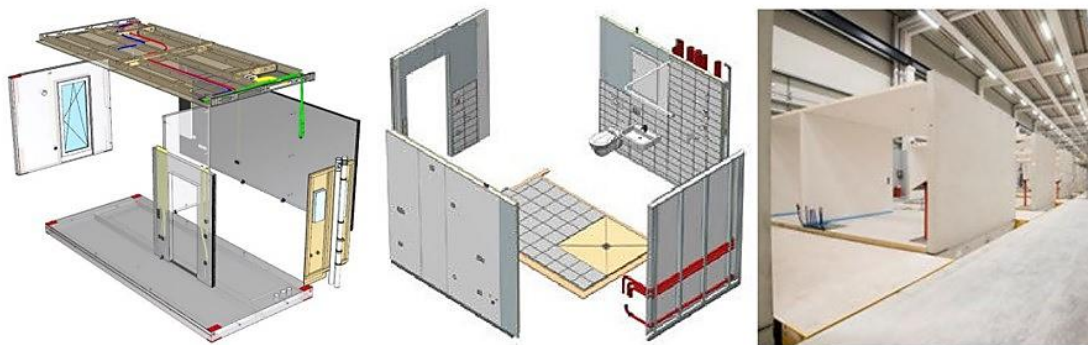


Figure 3. Individual modules of the facility in a digital version.

Source: BG BAU.

- M35: Urban mining in construction - the manual presents in detail modern methods of recycling and management of construction and demolition waste in construction (Fig. 4).



Figure 4. Recycling in construction.

Source: Own source.

- M36: Environmental effects of earthquakes in construction - the textbook presents contemporary methods of everyday use of the latest, innovative tools that enable minimizing the impact of earthquakes on the construction investment process, starting from the design of the facility in specific areas prone to earthquakes (Fig. 5), including those related to mining, to safe operation and maintenance.



Figure 5. Soil, foundations and safety of facilities in construction.

Source: Own source.

- M37: Logistics in construction - is a modern textbook combining the issues of optimized and safe implementation of construction processes, combined with efficient logistics of deliveries to the construction site, which is currently one of the important success factors in the implementation of investment projects. In addition, it also contains the most important guidelines and recommendations relating to sustainable investment financing, green construction, supply chains, proper flow of information between all participants of the construction process, starting from the planning phase (Fig. 6) and modeling of construction processes, through the stage of facility implementation, until the operation of the building.



Figure 6. Safely designed construction site and logistics in construction.

Source: Own source.

- M38: Green technology in construction - is an innovative textbook reflecting the latest global trends relating to ecological construction, in accordance with the assumptions of the European Green Deal policy, in the area of ecological and environmentally sustainable construction (Fig. 7) and green industry.



Figure 7. Environmentally sustainable and state-of-the-art ecological construction.

Source: Own source.

- M39: Talent management and future competences of construction managers. Obtaining and maintaining a competitive advantage currently requires companies to be highly flexible in their operations, react quickly and adapt to changes. However, if employees have outdated knowledge and do not have access to important information, it often turns out that it is simply impossible for the company to compete on the market. Therefore, constant updating of knowledge, further training of staff, and development of employee competences are necessary for the proper functioning of a given organization on the construction market. It is also necessary to develop solutions and take actions that will enable companies to attract and retain the best, most talented and most valuable employees (Fig. 8). The manual will present new trends and needs regarding human resources management and continuous personal and professional development of staff in the construction industry due to, among others, factors such as: the new reality on the labor market, the variability of the construction sector conditions and employment uncertainty resulting from the post-COVID-19 pandemic situation and the war in Ukraine, as well as the complexity and ambiguity of the needs of the entire European community. Especially in modern organizations in the construction industry, which also employ refugees and immigrants, the ability to properly direct the career path of talented and gifted employees is particularly important.



Figure 8. Aspects of human resources management in construction.

Source: Own source.

The new CML manuals will also contain the best practical case studies in the area of construction design and implementation, covering important aspects of a manager's daily work and the effective exchange of knowledge and experience between experts from different European countries (Fig. 9). Additionally, the project will largely contribute to eliminating certain restrictions resulting from, among others: from the mismatch of cultural differences and deficiencies in specific skills of personnel employed in economic sectors related to construction.



Figure 9. The latest textbooks of the Construction Managers Library (in red).

Source: Own work.

All textbooks from the Construction Managers' Library are the basis for the recognition of managerial qualifications in construction on a European scale, as well as used to verify the acquired theoretical knowledge by candidates for obtaining the EURBE (European Building Expert) card, issued by AEEBC (www.aeebc.org). The scope of knowledge presented in the textbooks is essential in the activities of managers - construction engineers managing projects in the conditions of a modern market economy. They are addressed to engineers and construction managers, architects and other employees related to the construction industry, as well as students completing construction studies. CML textbooks are also the basic source of substantive information for postgraduate studies in Construction Management organized by the Department of Production Engineering and Management in Construction at the Faculty of Civil Engineering of the Warsaw University of Technology. (since 2017, the studies have been accredited by an international organization - Royal Institution of Chartered Surveyors (RICS) www.rics.org (as the only postgraduate studies for construction specialists in Poland). For detailed information about the project, please visit www.cloemcVI.il.pw.edu.pl.

3. Erasmus+ ID4Ex Project

3.1. Project background

The imperative of preserving and rehabilitating built heritage underscores the need for innovative methodologies that not only honor historical authenticity but also address contemporary challenges. Built heritage, with its architectural and cultural significance, serves as a tangible chronicle of human progress. However, the intricate nature of heritage preservation requires a nuanced approach that seamlessly integrates traditional methods with modern

technologies (Balzani et al., 2020; Raco, 2023; Rosłon et al., 2022). In this context, the ID4Ex project (Immersive Design for Heritage Rehabilitation) takes center stage (figure 10).

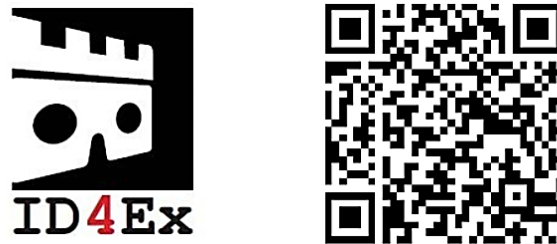


Figure 10. ID4Ex project logo and QR code for project the website.

Source: Nowak et al., 2023.

The venture's initiation stems from a dual recognition: the critical importance of digitizing and modernizing the construction sector, and the unique challenges posed by built heritage rehabilitation. Recognizing the limitations of conventional approaches, ID4Ex places a strategic emphasis on immersive design technologies, notably extended reality (XR) tools like Virtual Reality (VR) and Augmented Reality (AR) (Kaczorek et al., 2022). (figure 11). These technologies serve as catalysts for a transformative shift in the rehabilitation paradigm, not only by offering advanced restoration tools but also by enabling multi-disciplinary teams to co-operate through virtual experiences (Camiz, 2021; Sezer, 2019) (figure 12).

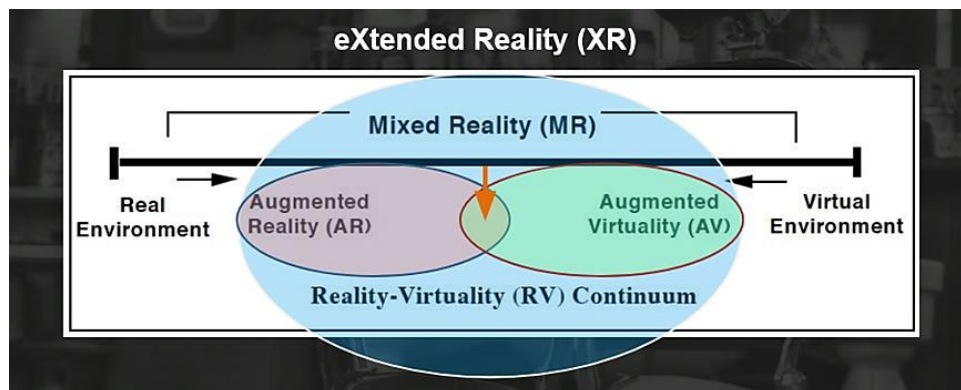


Figure 11. Extended reality definition.

Source: ID4Ex learning materials, based on Milgram et al., 1995.

Project management within ID4Ex is a crucial issue. The project recognizes the necessity for improving communication frameworks between specialists from of different backgrounds and means of remote collaboration (Bekar et al., 2018; Nicał et al., 2018). Built heritage is a complex ecosystem, demanding expertise from various fields. Architects, civil engineers, conservators, historians, digital artists, and technology specialists converge in a multidisciplinary team, each contributing unique insights to ensure that immersive technologies align with preservation principles. The emphasis on teamwork, coordination, and comprehensive training programs speaks to the project's commitment to cultivating a collaborative environment.

3.2. Project objectives and goals

The ID4Ex project (Immersive Design for Heritage Rehabilitation) is underpinned by a set of robust objectives and goals, collectively designed to usher in a new era in the preservation and rehabilitation of built heritage. Each facet of the project is meticulously crafted to address the evolving needs of the heritage rehabilitation sector and to harness the transformative potential of immersive design technologies.

1. Upgrading Training Programs

The primary goal is to elevate and innovate existing training programs in the heritage rehabilitation sector. This involves integrating the latest immersive design methods and tools into training modules, ensuring that professionals are equipped with the skills needed to navigate both virtual and dimensional environments. To provide a comprehensive educational framework that goes beyond static structures, incorporating time-based narratives and story spaces. This ensures that heritage professionals are not only proficient in the technical aspects of immersive design but also understand the dynamic, living tapestry of stories embedded in heritage sites.

2. Improving Teaching and Learning Effectiveness

ID4Ex project embraces an inclusive, immersive design approach to significantly enhance the effectiveness of teaching and learning in the heritage sector. To cultivate an educational landscape that fosters critical thinking and problem-solving, producing professionals who are not only adept in the application of immersive design but also possess a deep understanding of the cultural and historical contexts that underpin heritage rehabilitation.

3. Promoting Synergistic Use of Technologies

Another goal is to advocate for an integrated approach to technology by maximizing the synergetic use of up-to-date technologies. To seamlessly combine Virtual Reality (VR), Immersive Interactive Experience (IIE), advanced 3D modeling, and other cutting-edge tools. This integrated approach ensures a holistic understanding of built heritage, promoting a teamwork approach and emphasizing personal development among professionals (figure 12).

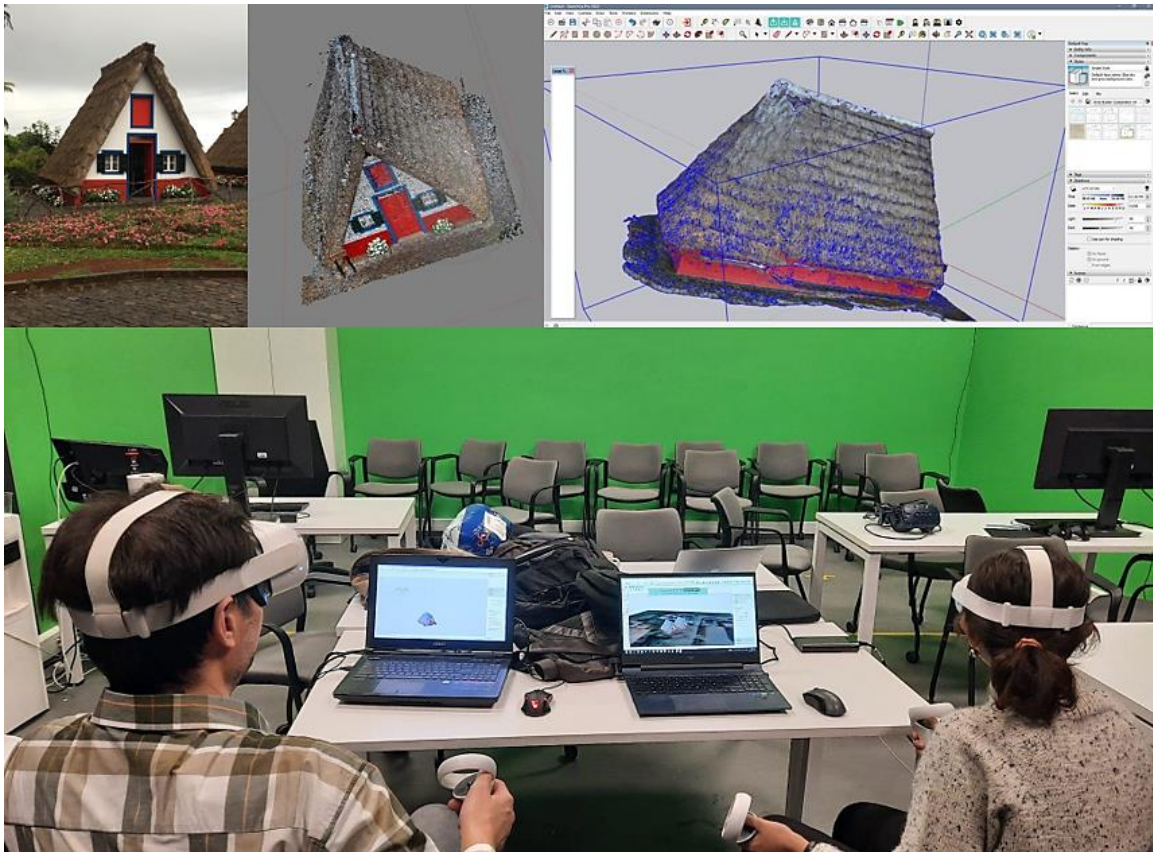


Figure 12. Collaborative work in a virtual environment – Santana house case study.

Source: ID4Ex learning materials.

4. Increasing Cooperation Among Educational Institutions and Enterprises

The project also helps to recognize the interdependence of academia and industry in successful heritage rehabilitation. It fosters collaboration among educational institutions and enterprises in the European Union, creating a dynamic ecosystem that not only enhances employability in the heritage sector but also bridges the gap between theoretical knowledge and practical industry demands.

5. Advancing Cross-Disciplinary Collaboration

The developed modules on managerial and soft skills are fostering multidisciplinary collaboration among project managers, architects, civil engineers, conservators, historians, digital artists, and technology specialists. By providing technological solutions and encouraging virtual collaboration, the project creates a blueprint for successful cross-disciplinary teamwork. This collaborative ethos ensures that heritage rehabilitation projects benefit from a rich tapestry of expertise, enriching the final outcomes.

The overarching aim of the ID4Ex project is to orchestrate a harmonious convergence of heritage preservation and digital innovation. By achieving these objectives and goals, the project endeavors to empower professionals, advance the sector's competencies, and ensure the sustainable future of our architectural and cultural treasures through the transformative lens of immersive design.

3.3. Project results

ID4Ex project developed a series of transformative results that underline the project's ambitious objectives. These outcomes not only propel the heritage rehabilitation sector into the digital age but also lay the groundwork for innovative, multidisciplinary collaborations and the widespread adoption of immersive design technologies.

1. Comparative Research on VR Technologies

A comprehensive exploration of Extended Reality (XR) technologies and their applications in the rehabilitation of built heritage. This research delves into best practices, emerging trends, and opportunities, providing a nuanced understanding of how immersive technologies can be optimally utilized in heritage preservation.

2. Training Modules for Immersive Design Experts

The development of detailed training modules that cover key aspects of immersive design in heritage contexts. These modules span from foundational immersive technologies and digital surveying to soft skills essential for successfully renovating heritage buildings with digital tools:

- Module 1 - Immersive technologies and tools.
- Module 2 - Digital survey and scan to BIM protocols.
- Module 3 - Immersive Technologies for Design in Heritage contexts.
- Module 4 - Immersive Technologies for Construction, Operation and Maintenance in Heritage contexts.
- Module 5 - Soft Skills for Successfully Renovating Heritage Buildings with Digital Tools.
- Module 6 - Green and sustainability skills.
- Module 7 - Managerial and financial skills for digital heritage protection.

3. Digital Training Toolkit for Immersive Design Experts

The creation of a digital training toolkit that houses a wealth of resources, including guides, software solutions, videos, e-learning platforms, 3D models, and presentations. The toolkit serves as a dynamic repository, providing experts with a diverse array of resources to enhance their immersive design capabilities. This digital infrastructure facilitates continuous learning and supports professionals in navigating the intricacies of heritage rehabilitation with immersive technologies.

4. Report on Pilot Actions for Immersive Design Experts

A detailed report showcasing the successes and lessons learned from practical applications of immersive design in built heritage rehabilitation. The report acts as a living document, helping trainers, tutors, and organizations to draw insights from the experiences documented, gleaming practical knowledge for their own immersive design endeavors.

By achieving these milestones, the project not only elevates the competencies of heritage professionals but also contributes to the broader conversation on the intersection of technology, culture, and historical preservation. The immersive design outcomes promise a sustainable and digitally enriched future for the built heritage.

3.4. Case Study - Digitally Preserving Santana Houses in Madeira with ID4Ex

The successful digital preservation of the Santana houses in Madeira (Portugal) stands as a tangible demonstration of the impactful contributions of the ID4Ex project. This case study delves into the collaborative efforts of a multinational, multidisciplinary team, influenced by the immersive design methodologies promoted by ID4Ex, to digitally safeguard these culturally significant structures (figure 12). The case study serves as one of the workshops in the developed training materials.

Employing photogrammetry techniques, the team meticulously captured high-resolution images from multiple perspectives to ensure an accurate representation. The integration of Extended Reality (XR) and advanced 3D modeling, in line with ID4Ex methodologies, added depth and interactive elements to the digital replicas of the Santana houses (figure 13).

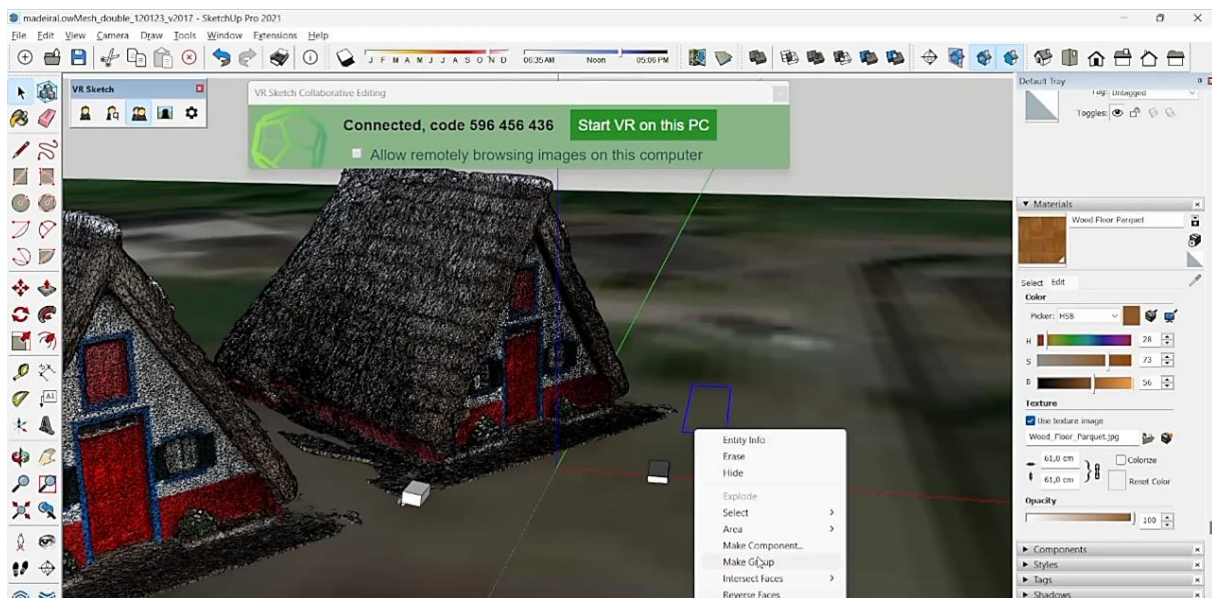


Figure 13. Santana house 3D model - case study.

Source: ID4Ex learning materials.

Beyond the specific achievements of this sub-project, the digital preservation of the Santana houses carries broader implications. The 3D models and VR experiences contribute significantly to educational initiatives, enabling virtual exploration for students and enthusiasts. Additionally, the digitally preserved Santana houses enhance tourism experiences, offering immersive attractions to a global audience. The case study is used in the ID4Ex materials in two workshops, on team collaboration in 3D environment, and on AR applications in heritage contexts.

In essence, the Santana houses case study serves as a practical testament to the applicability of ID4Ex's immersive design methodologies in safeguarding cultural heritage. More than a technological endeavor, it exemplifies ID4Ex's commitment to fostering collaborative, multidisciplinary approaches, ensuring a sustainable and digitally enriched future for cultural treasures worldwide.

4. Erasmus+ 3Msite Project

4.1. Project background

The Erasmus+ 3Msite project, i.e., "MANAGEMENT OF MODERN, MULTIETHNIC AND MULTICULTURAL CONSTRUCTION SITE WITH ASPECTS OF ECOLOGY, SOCIOLOGY, TECHNOLOGY AND HEALTH" - number 2022-1-PL01-KA220-HED-000087368, is implemented from December 1, 2022 - January 31, 2025. The project's logo and QR code are shown in Fig. 14.

The project concerns the issue of modern management of a multi-ethnic and multi-cultural construction site, taking into account aspects of environmental protection and ecology, sociology, health protection and occupational safety, as well as technical and technological issues of construction site development.



Figure 14. Logo and QR of the 3Msite project.

Source: Own work.

The global political and economic situation and the labor shortage in many European Union countries resulted in the implementation of new programs or amendments to the Act on Labor Promotion. According to Eurostat research, migrants play an important role in the labor markets of the European Union countries where they settle, and their participation is becoming more important in individual Member States, like Poland. However, cultural, and ethnic differences

are often a key aspect of the lack of social integration of such migrants. It should be emphasized that a significant number of foreigners are employed on construction sites due to the key role of construction in the EU national economy. With such major staffing problems, companies are recruiting employees from increasingly distant parts of the world: from Ukraine, Belarus Azerbaijan, Georgia, Tajikistan, Uzbekistan, Kazakhstan, Pakistan, Syria, and even from Nepal or Mongolia. This makes it necessary to take a different approach than usual when it comes to managing a multi-ethnic, multi-cultural construction site. Appropriate preparation, instruction and even education of employees in the field of cultural and technical differences, occupational health and safety at construction sites, environmental protection and ecology are also important.

4.2. Project objectives and goals

The main goals of the 3Msite project are: to facilitate migrants' integration in the new environment; improving the integration and diversity of the EU construction market; helping local management and employees understand migrants and employees with a different culture, religion, or ethnicity; teaching how to deal with such subordinates and co-workers while working on a construction site.

Additional, beneficial goals of the project are: improving knowledge in the field of construction site development and competences in the field of occupational health and safety and environmental protection; building an effective, loyal and motivated team of construction workers; educating EU citizens in a modern way; promotion of green deal policy and pro-ecological habits; improving effective communication on the construction site; increasing knowledge about conflict resolution; promoting appropriate behaviors and actions among subordinates; learning how to deal with difficult situations and with employees.

4.3. Project didactic results

The expected results of the project are:

- the 3Msite teaching methodology and
- four textbooks covering the following issues: formal, legal, technical and technological aspects of construction site development and management; sociological aspects of managing a multi-ethnic and multi-cultural construction site, occupational health and safety at the construction site; environmental protection on the construction site.

All textbooks will be based on experiences from European countries, written in three languages (English, Polish and Turkish) and developed by a multicultural team.

The results of the 3Msite project focus on the construction industry, but a large part of the project addresses general issues that are key to the existence of integrated and shared EU values. The project promotes and strengthens European ideas of social inclusion and increasing access to training and qualifications for all, especially the need to educate migrants on environmental issues, as EU ecological standards (e.g. sustainable development guidelines and the Green Deal)

are often not taught and understood outside Europe. The project is particularly important nowadays in the context of the ongoing war in Ukraine, a new wave of migrants and the need to function in a multicultural environment.

The 3Msite project raises a very important issue: the integration of refugees and migrants into the construction labor market. Currently, there are no training courses and manuals available on the issue of multiculturalism and how to deal with it on European construction sites. Therefore, the concept of combining economic, technological, environmental, sociological, and psychological issues proposed as part of the 3Msite methodology is unique and innovative. The recipients of the project are: both local construction workers and migrants, construction students, interns and construction engineers, construction management staff, stakeholders and associations operating in the construction sector, all enterprises related to the construction industry, universities and organizations dealing with the improvement of education professional. For detailed information about the project, please visit www.3Msite.il.pw.edu.pl.

4.4. Project's scientific proposal

Based on the 3Msite Project, we can consider the phenomenon of multiculturalism on the construction site. We can also characterize the so-called intercultural management in construction (construction site) in terms of universal problems - similar to those occurring in human resources management. At the same time, specific problems related to internationality should be taken into account. The results of the 3Msite project contribute to the development of multicultural team management in the construction industry (construction companies). During construction projects, major organizational unit are teams entrusted with certain tasks. The term "team" is understood as employees who interact cooperatively. The main features of the group are the mutual desire of cooperation, and perception of each other (team) as a unity. Within the team accepted and acceptable forms of action are in use. In case of multi-cultural teams, you can encounter problems in the functioning of these organizational structures, especially in terms of both the identification of the group and communication between its members. Ability to work effectively in a culturally diverse environment, tact, and tolerance in building interpersonal relationships, become today a respected asset of managers and construction workers.

Multicultural construction is considered to be the construction of a building with the participation of at least two groups of workers with different cultures, or a team of workers with internal cultural diversity (Pheng et al., 2000). The source of cultural diversity can be ethnicity, nationality (for the most part), religion, etc. It is obvious that IHRM (International Human Resource Management) will be more difficult, with increasing numbers of cultural diversity and their distance. As an intercultural management on construction site, is understood realization of fundamental function of management, taking into account cultural diversity as a factor affecting to staff cooperation, and subsequent operation of construction. Cultural diversity can be result of international recruitment to main contractor team (model b); it is also

possible cooperation of numerous diversity monoculture team (model a); as well as – both situation at the same time (model c), fig. 15. There are also other configuration possible, these three were considered as most typical.

The human resource management can be divided into the following approaches:

Ethnocentric with motto:

'this work in my country therefore, it must work in other countries also'.

Polycentric with motto:

'Local People know what is best for them. Let's give them some money and leave them alone as long as they make us a profit' (each country is different).

Geocentric with motto:

'Right Person for the Right Job' (global integration connect the good elements from each country to find one best way).

Cultural diversity could be the source of risk. There are many exterior and interior sources of risk occurring on multicultural construction site; among all, group of socio-cultural risk can be found, related with language, religion, and culture. Considering the insufficiently language skills, as well as differences in notional, cooperation could lead to misunderstanding and contention. Racism, ethnocentrism and stereotyping also perform as a challenge for intercultural management.

However, many companies derive profit from diversity, and use it as a competitive advantage. Multicultural workgroup often overtake these monocultures; especially at realization task, which demand creativity and multi-skill.

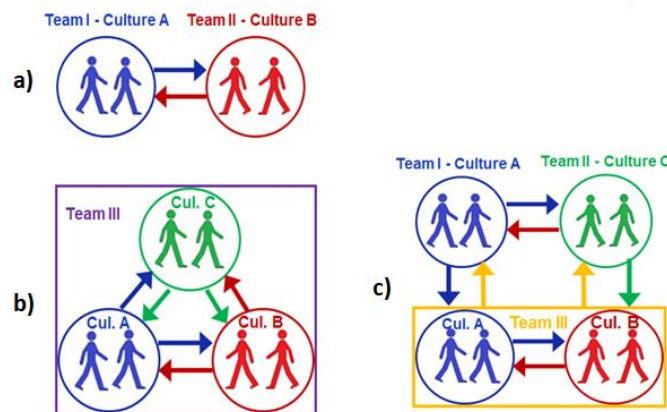


Figure 15. The structure of the working groups – team models.

Source: Own source.

From observations and analysis of literature (Kozłmiński, 2004), several management principles in multicultural organizations can be deduced:

- reflexivity - the ability to identify the forms, manifestations and sources of multiculturalism,
- empathy - understand perceptions, feelings, motives and emotions of various groups,
- acceptance of diversity (differences),

- community - taking into account common interests, motivations and values of different groups and ethical orientation,
- compromise - the ability to make concessions with respect to different groups,
- continuous adaptation - sensitivity to cultural changes and new challenges,
- speed of action - the ability to predict cultural changes in conjunction with a preparing new patterns of action and standards before changes occur.

These guidelines are universal, introducing them to the construction site through managers, thereby providing strategy of behavioral shaping, organizing teams, and the last - their cooperation.

Authors suggest application of fuzzy decision support methods for the selection of a manager managing a multi-ethnic and multi-cultural construction site (figures 16-19) and formulas 1-3.

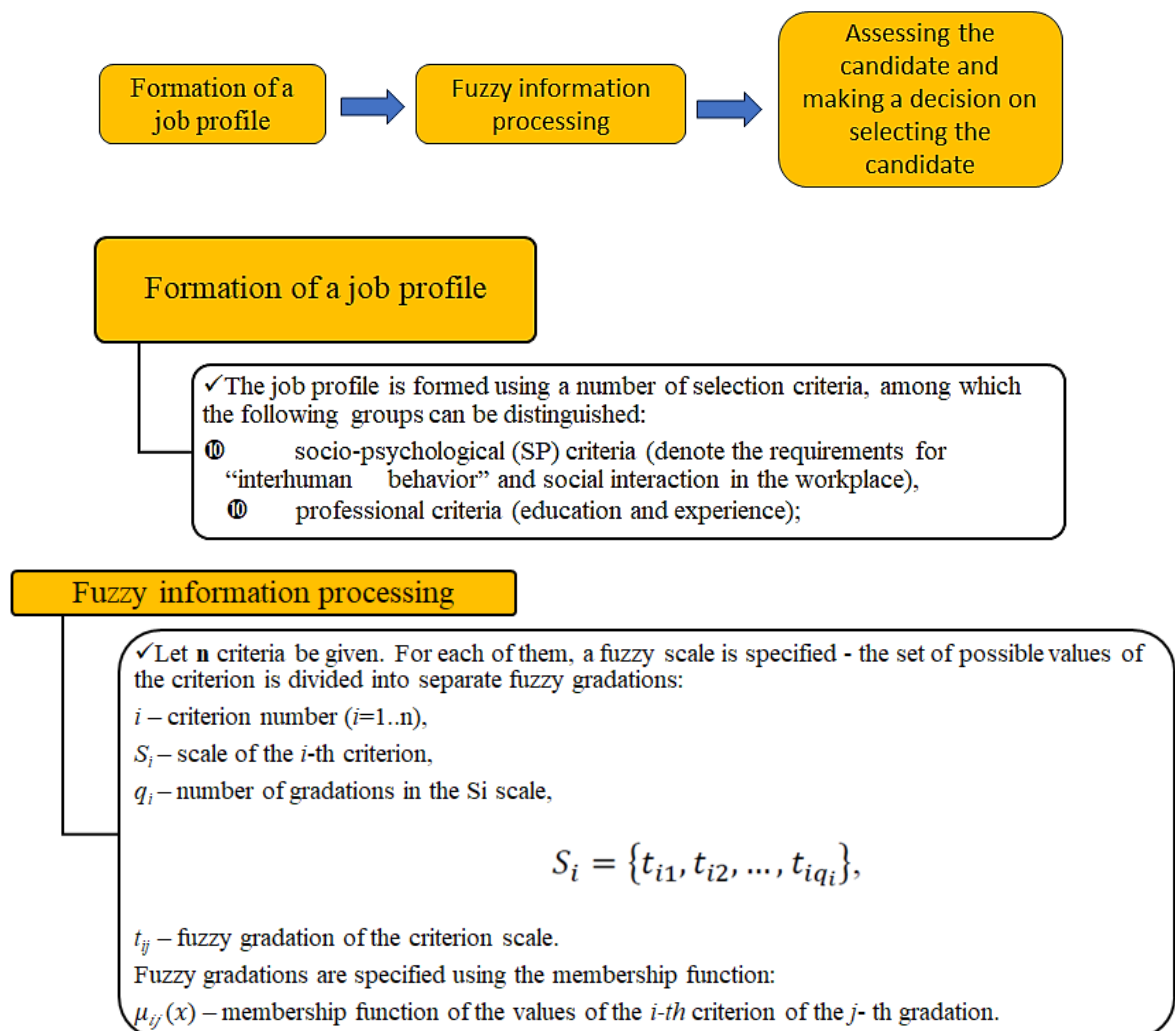


Figure 16. Stages of personnel selection using Fuzzy Logic.

Source: Ibadov et al., 2015.

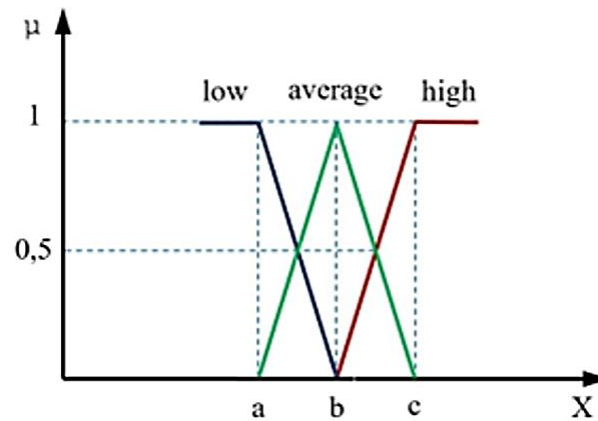


Figure 17. General idea of Fuzzy Logic – degree of membership.

Source: Ibadov, 2017.

The analytical form of membership function presented in figure 17 can be calculated as follows (Ibadov et al., 2015; Ibadov et al., 2019):

$$Low = (x; a, b) = \begin{cases} 1 & \text{for } x \leq a \\ \frac{b-x}{b-a} & \text{for } a \leq x \leq b \\ 0 & \text{for } x \geq b \end{cases} \quad (1)$$

$$Average = (x; a, b, c) = \begin{cases} 0 & \text{for } x \leq a \\ \frac{x-a}{b-a} & \text{for } a \leq x \leq b \\ \frac{c-x}{c-b} & \text{for } b \leq x \leq c \\ 0 & \text{for } x \geq c \end{cases} \quad (2)$$

$$High = (x; a, b) = \begin{cases} 0 & \text{for } x \leq b \\ \frac{x-b}{c-b} & \text{for } b \leq x \leq c \\ 1 & \text{for } x \geq c \end{cases} \quad (3)$$

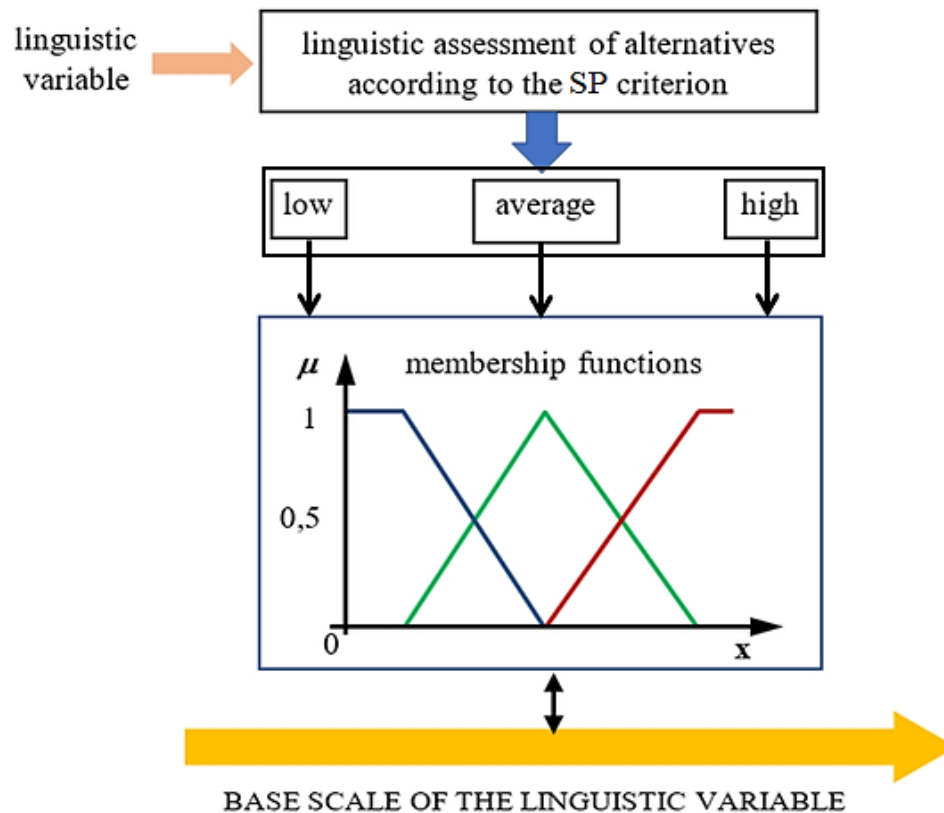


Figure 18. Conceptual model of fuzzy linguistic evaluation of alternative manager according to the degree of SP (Socio-Psychological criteria).

Source: Own source.

In figure 18 the μ is the degree of membership in the fuzzy set, x is the numerical value from the base scale according to the considered criterion. The assessment of candidates for managers and final decision-making process is subject to the following scheme (Ibadov et al., 2015; Ibadov et al., 2019) (figure 19).

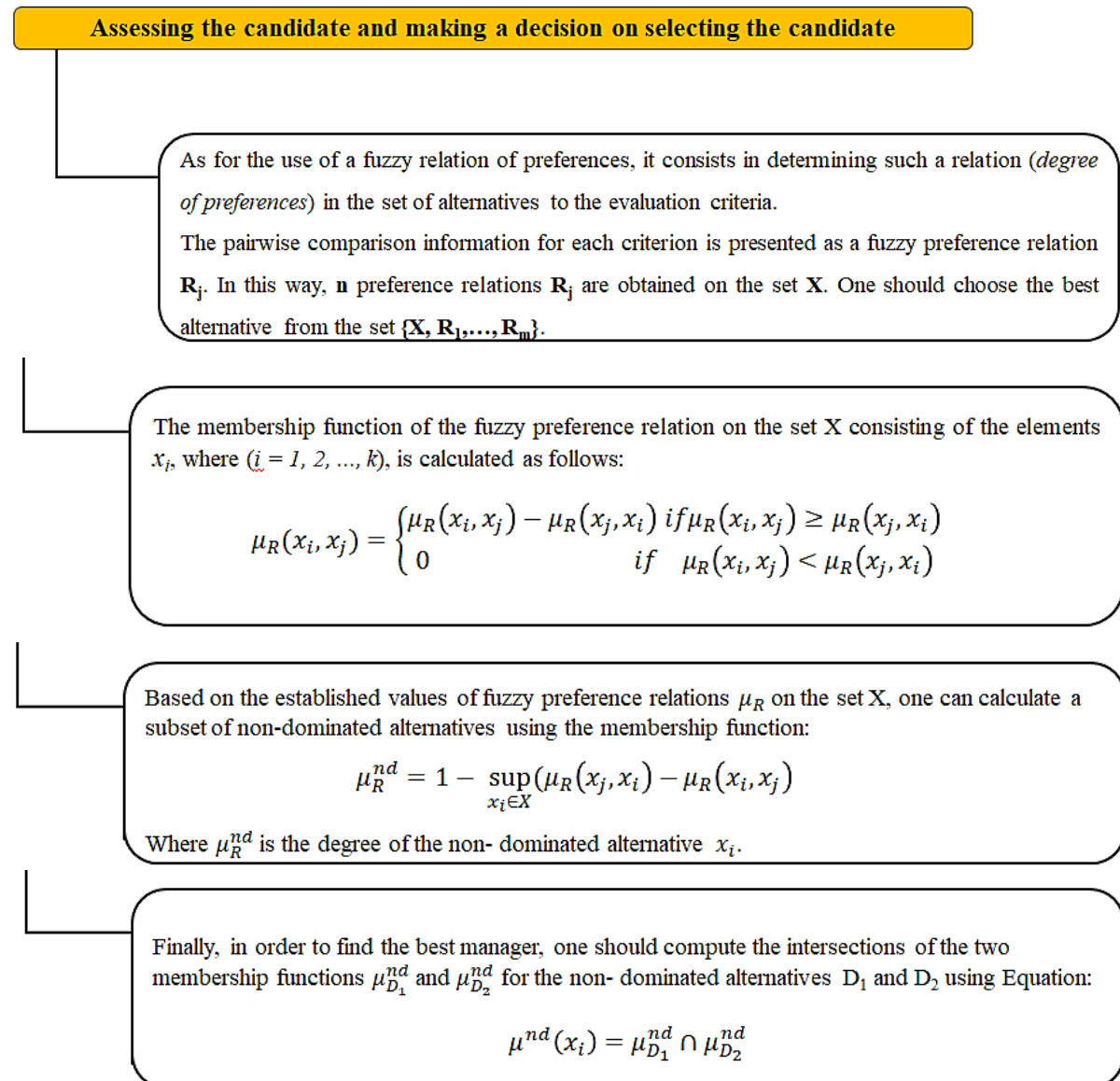


Figure 19. Assessing the candidate and decision making.

Source: Own source.

The higher the degree of non-dominance, the more preferable the alternative. In this way, it can be said that the thematic scope and results of the 3Msite project provide many opportunities for use in both teaching and scientific research.

5. Summary

The main result of the projects presented in this article is improvement of construction personnel education at all levels - from direct labor, through students and new graduates, to highly qualified managers. The above-mentioned projects also allow for the identification of needs in terms of qualifications of construction personnel, recognition of applied education systems, personnel certification and accreditation of studies (such as postgraduate studies titled "Construction Management" at WIL PW accredited by **IPMA** (International Project Management Association), **PSMB** (Polskie Stowarzyszenie Menedżerów Budownictwa – Polish Association of Building Managers) and **RICS** (Royal Institution of Chartered Surveyors) and studies titled "Psychology of Project Management in Construction (prepared in cooperation with lecturers of the Faculty of Psychology of the University of Warsaw - www.il.pw.edu.pl/studia-podyplomowe). They also facilitate programs and courses of technical schools and VET organizations in the EU. These projects use an innovative approach to education - immersive design, distance, and blended learning. Erasmus+ teaching projects are also extremely useful for strengthening cooperation between various entities in the European economic market: higher education institutions, professional bodies, companies, secondary schools, and enterprises. Projects create positive synergies for economic and educational systems. Detailed information for all interested persons can be found at: <https://erasmusplus.il.pw.edu.pl/>.

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