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DEVELOPMENT OF A LEARNING MANAGEMENT SYSTEM FOR KNOWLEDGE TRANSFER IN ENGINEERING

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Abstract: *The current amount of information available on different media and the strong interdisciplinarity of many technological processes makes it difficult for the younger generation to learn in depth and to understand the requirements of a specific process. A high level of expertise on every technological process exists at the level of senior experts (engineers aged over 50 and up to 75) which are willing to share this in a proper framework. The paper presents a learning management system (LMS) developed and customized as an interactive on-line platform that can bridge the gap between generations transferring the knowledge from senior experts to developing companies. This comprehensive platform provides experts the tools and resources to communicate and the companies the means to obtain relevant and personalized information achieving both a comprehensive industrial development and support and purpose for the senior experts.*
Keywords: *Learning management system, software architecture, online collaboration, knowledge transfer*

1. INTRODUCTION

Our society is subjected to a number of challenges which impose swift reactions at the level of all the stakeholders to provide comprehensive answers that would support the continuous progress of humankind towards an ultimate generic but powerful goal: the increase of the quality of life of people.

The ageing of the population. In a report published by the World Health Organization (WHO) humankind experiences a continuous growth of the population lifespan. In Europe alone, the EUROSTAT projections estimate that the population over 65 will reach 30% of the total population until 2060 (with 12.1% being over 80) [1-3].

The rate of change in technology. A report of the Organization for Economic Co-operation and Development (OECD) has shown that in 2012 humankind experienced a doubling of new knowledge every 5 (five) years while in 2020 this happened every 73 days [4].

The evolution towards a digital industry. The fourth Industrial Revolution, which started 10 (ten) years ago, has introduced the concept of "decentralized" smart manufacturing merging production with internet connectivity in the so-called "*Internet of Things*" (IoT) [4].

Fast reconfiguration of the skills desired by employers. A report from World Economic Forum [5] shows that Complex problem solving, Critical thinking and Creativity have become the most targeted skills by employers in 2020.

The COVID-19 pandemic. The pandemic situation [6] accelerates the development and implementation of Industry 4.0 and the birth of the fifth revolution which arrives with mew defined interdependences between man and the machines joining the cohabitation between artificial and the native intelligence.

Considering all the current challenges, a new paradigm is defined with regards to education, as described by Schleicher in his book [7] where the education system switches from an independent entity to a component of an eco-system where all the stakeholders contribute to the decision-making and take responsibility over the competences gained by students. This new paradigm, defined by OECD is the Learning Compass 2030 which expects that the educational system will assist the student to

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achieve a set of skills which, as a compass, will guide them in a faster evolving society.

Fig. 1. OECD learning compass 2030 [4]

Considering these aspects, the society must create a comprehensive environment where the younger generation is provided with the necessary competences to evolve in a fast-changing world. While there is a general concern regarding the sustainability of the ageing population in term of the financial burden which is continuously growing [8], the society can focus on changing their role from a passive to an active one where they can still contribute to the development of society becoming a supporter/contributor to the worldwide progress. The paper focuses on the analysis of a learning management system (LMS) developed as an interactive on-line platform (multi modal personalized tool), which can bridge the gap between generations transferring the knowledge from senior experts to developing companies. Section 2 presents a study regarding the interaction of elderly people with on-line content. Section 3 focuses on the state of the art in on-line platforms for education/training in engineering, emphasizing their limitations. Section 4 defines the needs of the stakeholders (senior experts and companies) to support knowledge transfer and Section 5 presents the architecture and main components of the platform that ensures the satisfaction of its users. Finally, conclusions are drawn in Section 6.

2. ELDERLY PEOPLE INTERACTION WITH ON-LINE PLATFORMS

Many social, demographic and psychological studies revealed that elderly people are facing two great challenges when approaching /reaching the retirement age.

The **first challenge** refers to a sudden change in their paradigm of life when, after several decades of daily professional activities they face the moment when there are no more added-values activities to be done. Even though they enjoy the free time where they can focus more on family and hobbies, most retirees would still like to engage in some activities related to their background and experience.

The **second challenge** refers to the characteristics of on-line instruments (social platforms, media, apps) which are designed to suit the needs of the younger users making them difficult to use, unpleasant and restrictive for the elderly people. Some example are the aggressive advertising, the SPAM, misguiding and hidden information, complex error messages and difficult to use online applications.

According to [9] the digitization of the elderly population through their integration into a social and professional environment reliant on ICT can have a positive influence on their cognitive based issues (preventing cognitive decline) and autonomy (by improving it), and on everyday functioning. Several aspects must be adopted in the platform development strategy, to ensure an efficient interaction with the mentoring portal.

Firstly, what is most important is the **first impression** that the user gets when accessing the application. Many user interfaces tend to be cluttered with different functions and options or rather empty (with multiple embedded options in drop-down menus). All of these methods of approaching the user interface (UI), have been developed in mind with the largest customer group (the youth or people born from the 80s onwards), disregarding the inconveniences that such design might pose for an elderly person wishing to use platforms of such type.

Secondly, another major aspect that is directly related to the life quality and meaning of life improvement [10,11] of the elderly has to do with the platform's **capacity to satisfy their driving motives**. This is also emphasized in [12] which focuses on identifying the needs and motivation.

Based on the analysis of the topics and areas covered by most existing mobile platforms, they focus on the development of e-skills (the use of

internet, mobile communication, e-commerce platforms) and the management of different diseases specific to this age segment. However, their success is limited as it was demonstrated that an elderly person needs to find added value in the time invested in these platforms which most of the time is missing.

In order to understand the specific needs of the elderly people in terms of information exchange and interaction with online tools, a usability study on a control group of 123 seniors spanning over 18 years was conducted [13]. The research entailed the use of a multitude of websites and apps from a wide range of genres, in order to study the ease of use with which the elderly were faced on these platforms. The selection of the most significant one forms the following list:

- **Ecommerce** (Amazon, Target, Whole Foods, Home Depot, Instacart, Maytag);
- **Health** (WebMD, Mayo Clinic, Center for Disease Control, rxlist.com);
- **Banking** (Chase, Charles Schwab);
- **Government** (National Institute of Health, Medicare.gov, Government of Canada);
- **Tourism and travel** (National Parks Service, Airbnb, United Airlines);
- **Media and entertainment** (Spotify, Apple Podcasts);
- **News** (NPR, Washington Post, Globe and Mail, Canadian Broadcasting Company);
- **Social media** (Facebook, Twitter).

According to the authors, following a series of previous studies, it was determined that between the ages of 25 and 60 a person's ability to interact with platforms such as websites declines at a rate of 0.8% per year, under the influence of physiological and psychological factors. As such it would be safe to argue that the development of technologies for users based on their age and cognitive capacities becomes a necessity in order to ensure an active and meaningful lifestyle for all the population segments.

Since the studies have first started in 2001 the characteristics of the seniors and the technologies available to them have evolved and despite prejudice that might suggest seniors adapt slowly, according to [13] there have been substantial changes as to that regard. As an example, while senior citizens in 2001 presented shyness in their behaviour online, the elderly in more recent times are more confident and willing to adapt to the on-line medium. Many have begun learning how to install ad blockers (to remove annoyances), modifying search parameters (to avoid sponsored results), deleting accounts (remove personal data), etc. [13].

Due to the inevitable passage of time, as people are ageing, hearing, vision and manual dexterity decline, and many digital interfaces do not take this into account, and features such as small text, poor colour contrast and small targets hinder users of all ages not just the elderly, the difference being that whatever features irritate younger users, usually tend to become a serious barrier for the elderly. As a result of these studies, a series of challenges that senior citizens are faced with in the on-line medium, have been identified. These could be used as indicators as to what an e-platform should be capable of, when developed specifically for the elderly.

The same study reflected an interesting behaviour from the elderly (which is not found in the younger generations) as they took specific actions towards the efficiency improvement of their online activities:

- **Usage of ad blockers** - to filter unwanted content;
- **Usage of advanced search strategy –** to eliminate sponsored results;
- **Eliminating time/resource consuming apps -** to improve efficiency;
- **Account removal -** to prevent data collection and unwanted advertisement.

This data supports even more the statement that seniors can adapt, to learn and to use new technologies if there is added value for them.

The same report pointed out that most on-line platforms still discriminate elderly people, through multiple elements that make them hard to use for this population segment. The most critical aspects underlined in the study are illustrated next:

- Small Font Sizes and Small Targets;
- Unforgiving and inflexible Interfaces;
- Exclusion from Online Content.

3. ON-LINE PLATFORMS FOR EDUCATION AND TRAINING IN ENGINEERING

Based on the reports of the European Union, 99% of the companies in Europe are small and medium enterprises (SME) but over 92% of them fail in the first years of existence due to some poor decisions in terms of product development and commercialization. Consistent with the EU commitment to create an industrial climate where more products are developed in-house, the new businesses require guidance when implementing/developing new technologies.

Some of the most known, current e-learning platforms - **udemy.com**, **linkedin.com**, **coursera.org** - offer a self-learning standard content. The content is generally of a high quality, but it is not specific and customized, the instructor interaction is low, resulting in lack of motivation of the student. This leads to a considerably high abandon rate.

The fees for training are relatively low and the service model is based on a high volume of sales for the same content. To be able to offer the same content to many users, the content ends up being at a basic level. This represents a limitation for the users that would like to become experts in certain areas. In this way, the typical outcome for the end user is a certificate and not real knowledge or expert advice.

On the other end of the spectrum, many companies provide, through local distributors specific trainings and specializations with deep focus on their products, where the trainings are very expensive while the content is focused more on the efficient use of a specific product rather than the technology behind.

The e-learning platforms realized so far have mostly addressed children, young and active people. There are no commercial digital platforms whose main objective is the social involvement of elderly people as mentors in technological fields aiming to achieve the transfer of knowledge between generations.

A lot of efforts have been done to create to create an on-line medium for elderly mentors in two platforms that have been developed and tested (but unfortunately not commercialised) which are presented next as reference.

ProMe is an on-line platform developed with the purpose of providing work opportunities in the lives of the elderly post-retirement [14]. The **ProMe** platform places great emphasis on user preferences and matchmaking between users (Eg. Between Mentor, the one who shares the knowledge, and Mentee, the one who absorbs the knowledge). The reputation and trust that a user is "assigned" on the platform comes under the form of user ratings. As for the specific functionalities that the platform provides the user the following have been showcased by the software's creation: a Search portal, Content posting, Account creation engine, Calendar of events, Alerts, Video Conference. As mentioned previously the main feature of the ProMe platform that aims to distinguish it from other similar technologies is the implementation of a machine learning algorithm for user matchmaking that aims to create the most efficient mentor/mentee pair or pairs.

T-echo is an on-line platform being developed by the University of Tokyo [15]. The system itself aims to reintegrate the seniors within modern society by providing them means of interacting on a social and even professional lever with youth, through the use of modern communication technologies. The **T-echo** platform is mostly focused on the concept of "growing gamification" and "calendar-based interface" as the authors put it. An important aspect that this platform used in its development is the implementation of technologies or concepts that the elderly population segment is familiar with, hence one of the motivations between introducing a calendar-based interface, as it provides a familiar element to the older generations.

However, **both projects failed** due to a set of specific reasons:

- failure to meet the expectations of their clients (poor interface design and general rather than specific content);
- insufficient support for interaction;
- lack of matchmaking strategy.

4. STAKEHOLDERS NEEDS AND REQUIREMENTS

Looking at the concept of Industry 4.0 which promotes a paradigm change from mass production, the new learning concept defined as the OECD learning compass and the high failure rate of new companies it can be seen that education and training are still trailing behind

the industry not being able to provide **on time and on-site** support and knowledge transfer for engineering processes.

The authors propose the development of a unique concept in terms of knowledge transfer bridging senior experts with companies in need of specific/targeted support in a form of an on-line platform developed as a multi-modal Learning Management System that provides one-on-one support based on an intelligent matchmaking tool.

Rather than targeting independently the worldwide challenge caused by the ageing of the population, or the one of the extreme failure rate of emerging companies, WisdomOfAge provides a blended solution that addresses both challenges as one. The generic concept of the new platform, created in the framework of the AAL programe [16], is presented in figure 2, aiming to dissolve the existing barriers by integrating the industrial actors with senior experts.

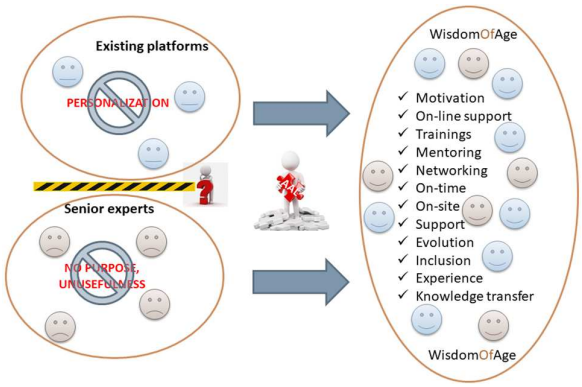

Fig. 2. The generic concept of WisdomOfAge

4.1. Example scenario

Peter Watson is an engineer specialized in robotics with over 30 years of experience in this field. He reached retirement age and on the one hand he enjoys the idea of spending more time with his family, planning to travel around and spend time in the nature. On the other hand, as he doesn't feel old, **the idea of not having a professional activity starts to affect his mood** making him feel insecure, upset and without a purpose. He does not need the money but he would like to engage in some professional activities. One night, after getting annoyed by the amount of unwanted information and advertise on classical on-line platforms, **he discovers WisdomOfAge**. While not confident, he decides to give it a try. Entering the platform, he finds easy to register, create a profile and add his personal skills and experience in robotics. The platform stores his data in a secured database and based on the needs of companies registered it generates a profile where Peter fills easily some more specific data. A few days later **he is invited to participate in a match-up meeting** with a company who needs his help. The simple communication platform enables him to discuss with the company and **a mentoring plan is established** as the company intends to implement a new robotic line but fails to find the proper solution. With Peter's help **the company gets the job done and Peter also receives a payment for his effort**. Feeling much better he studies more facilities of the platform, discusses with other mentors and in a few weeks a team is assembled to create a set of training materials on robotics. Soon the training materials bring him and his new colleagues' invitations to conduct some customer-oriented knowledge-based transfers. **He can schedule everything** to enjoy both his retirement, family, excursions and the new professional activity. **He is happy to see that** as companies are involved, the portal supports itself financially, **he can do everything free and receives proper payment for his work**. Now the question is: where will he take his family in the next dream excursion?

4.2. Proper identification of stakeholders

A preliminary analysis of the WisdomOfAge concept defines two main stakeholders [17]: the senior experts which act as mentors and industrial companies which act as mentees (end-users) or service beneficiaries. However they represent only the first layer of actors involved in this task which alone, cannot accomplish anything.

Referring again to the concept of the **OECD learning compass,** to achieve a solution that can merge together the needs and demands of the mentors and mentees more stakeholders must join this endeavor.

Academia.

One of the major components of the platform is the Learning Management System, where the academia plays a crucial role in defining the knowledge transfer methods to reach maximum output results, while blending the needs of the senior experts in terms of content creation and information dissemination in an on-line environment with the needs of the companies which require personalized on-site, on-time, on-demand data.

Private industrial sector.

The main role of the platform is to provide added value to the companies in need of knowledge transfer, and to have market success this aspect must always be kept in front.

Senior Organizations.

As the service providers are the senior experts they must be reached through multiple channels where senior organizations play a crucial role to identify a critical mass of specialists that provide the required support for companies. The joint effort and contribution of all the actors involved is illustrated in the triangle of knowledge describing the WisdomOfAge concept.

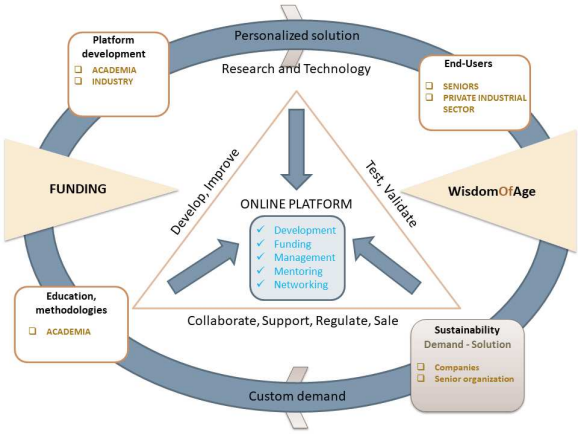

Fig. 3. WisdomOfAge triangle of knowledge

5. ARCHITECTURE AND MAIN COMPONENTS OF WISDOMOFAGE

The platform is developed in a seven (7) steps iteration where the external stakeholders play an active role as the final beneficiaries of the solution. The development steps are illustrated in figure 4. The WisdomOfAge platform is conceived on three layers [18], which integrate the main actors (senior experts and industrial companies), the specific databases of users and the created content along with specific modules that ensure efficient knowledge transfer based on the demand-supply principle. These layers are illustrated in figure 5.

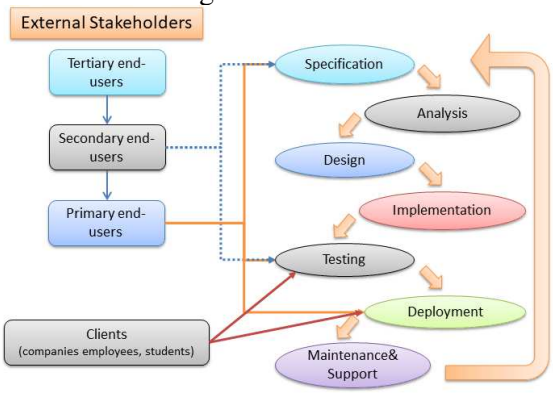

Fig. 4. WisdomOfAge development steps

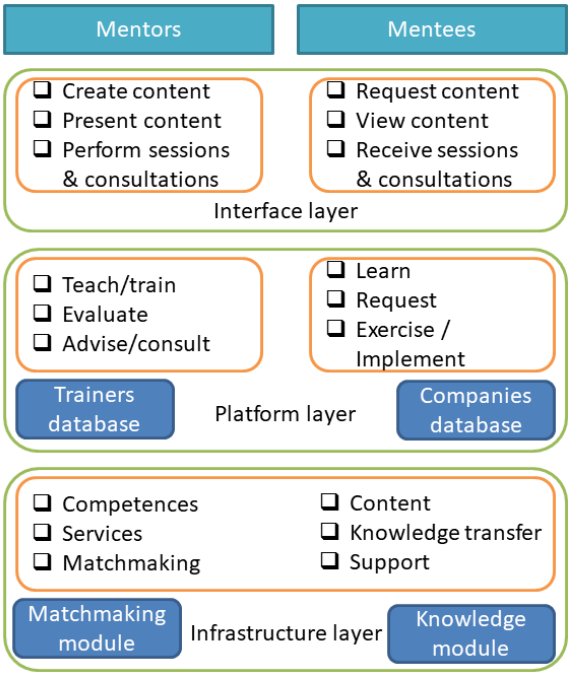

Fig. 5. WisdomOfAge layered architecture

An important aspect regarding the actors involved is their specific interaction with the platform, which must provide custom tools for each category.

Interface layer. Cleary specific for each type of actor, the interface represents the level where content is added and used on the platform. On one hand, the senior experts must have the tools to add information in different forms: learning materials, presentations, tests, demonstrations, use-case scenarios. On the other hand, the companies must be able to view specific content, complete tests and add specific requests. An

interactive interface must be added for one-on-one sessions.

Platform layer. Its main role is to gather information in two separate databases, for experts and companies in need of support. The databases must be flexible to store both common information but also specific characteristics that can be browsed by the interested parties.

Infrastructure layer. It contains, two main elements, the matchmaking and the knowledge modules. The matchmaking module is the backbone (unique selling point) and probably the most important feature of the platform as is merges demand with supply and creates added value and satisfaction. For the matchmaking module AI agents are implemented, which based on the existing information, prior experience and availability will provide the best possible pairing between mentors and mentees. As the user database will expand the matchmaking module will be developed consequently. In case of very specific requests these will be filtered with respect to the known competences of the mentors and then presented (displayed) to the identified ones. The Knowledge module integrates the tools needed to create, edit and present content useful for the mentors to disseminate their knowledge and companies to better present their requests.

6. CONCLUSIONS

While the industry has reached maturity in its fourth revolution, the educational system is trailing behind.

Embedding the latest concepts of the OECD based on the concept of the 2030 learning compass, the authors propose the development of a new learning system capable to exploit one of the most important assets of the society, the senior experts, while providing an answer to a societal challenge where the growing number of elderly people becomes a greater burden for the governments each day.

Thus, WidsomOfAge takes an important step towards unlocking this potential and putting it into a very good use by closing the gap between generations and bridging together both the primary end-users (senior experts), secondary end-users (organizations that support healthy and active ageing) along with industrial companies. Thus, the senior experts can transfer their knowledge and experience towards companies in mentoring, coaching and advisory sessions.

To develop a functional platform the specific needs of elderly have been assessed with respect to their capabilities and willingness to use on-line tools in an efficient way. The concept, development strategy and architecture of WisdomOfAge was presented along with all the actors involved in the process.

As future work, several workshops are thought to identify and quantify the requirements of senior experts that would enable them to develop relevant content based on the needs of industrial companies.

7. Acknowledgement

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Dezvoltarea unui sistem de management educațional pentru transferul de cunoștințe în inginerie

Rezumat: Volumul actual de informație disponibilă în toate mediile și gradul ridicat de interdisciplinaritate al multor procese tehnologice fac imposibil pentru noua generație să învețe și să înțeleagă în profunzime cerințele unui proces specific. Aceste procese tehnologice sunt cunoscute în detaliu de experții în vârstă (ingineri cu vârste cuprinse între 50 și 70 de ani) care sunt dispuși să transfere aceste cunoștințe într-un cadru eficient. Lucrarea prezintă un sistem de management educațional dezvoltat sub forma unei platforme on-line care creează o punte de legătură între generații transferând cunoștințele de la experții în vârstă spre companii în creștere. Această platformă structurată oferă experților instrumentele și resursele pentru diseminare iar companiilor soluții pentru a obține date relevante, personalizate conducând spre dezvoltare industrială și susținerea și motivarea experților în vârstă.

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